A Joint Report by the Nuclear Energy Agency
and the International Atomic Energy Agency

Uranium 2026
Resources, Production and Demand

International Atomic Energy Agency

NUCLEAR ENERGY AGENCY

A Joint Report by the Nuclear Energy Agency
and the International Atomic Energy Agency

Uranium 2026:

Resources, Production and Demand

© OECD 2026
NEA No. 7770

NUCLEAR ENERGY AGENCY
ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

The OECD is a unique forum where the governments of 38 democracies work together to address the economic, social and environmental challenges of globalisation. The OECD is also at the forefront of efforts to understand and to help governments respond to new developments and concerns, such as corporate governance, the information economy and the challenges of an ageing population. The Organisation provides a setting where governments can compare policy experiences, seek answers to common problems, identify good practice and work to co-ordinate domestic and international policies.

The OECD member countries are: Australia, Austria, Belgium, Canada, Chile, Colombia, Costa Rica, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Latvia, Lithuania, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, the Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Türkiye, the United Kingdom and the United States. The European Commission takes part in the work of the OECD.

OECD Publishing disseminates widely the results of the Organisation's statistics gathering and research on economic, social and environmental issues, as well as the conventions, guidelines and standards agreed by its members.

This work is published under the responsibility of the Secretary-General of the OECD and the Director General of the IAEA and does not necessarily reflect the official views of Member countries of the OECD or its Nuclear Energy Agency or the Members States of the IAEA.

NUCLEAR ENERGY AGENCY

The OECD Nuclear Energy Agency (NEA) was established on 1 February 1958. Current NEA membership consists of 34 countries: Argentina, Australia, Austria, Belgium, Bulgaria, Canada, Czechia, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, the Netherlands, Norway, Poland, Portugal, Romania, Russia (suspended), the Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Türkiye, the United Kingdom and the United States. The European Commission and the International Atomic Energy Agency also take part in the work of the Agency.

The mission of the NEA is:

- to assist its member countries in maintaining and further developing, through international co-operation, the scientific, technological and legal bases required for the safe, environmentally sound and economical use of nuclear energy for peaceful purposes.
- to provide authoritative assessments and to forge common understandings on key issues as input to government decisions on nuclear energy policy and to broader OECD analyses in areas such as energy and the sustainable development of low-carbon economies.

Specific areas of NEA competence include the safety and regulation of nuclear activities, radioactive waste management, radiological protection, nuclear science, economic and technical analyses of the nuclear fuel cycle, nuclear law and liability, and public information. The NEA Data Bank provides nuclear data and computer program services for participating countries.

Please cite this publication as:

NEA (2026), *Uranium 2026: Resources, Production and Demand,* OECD Publishing, Paris, https://doi.org/10.82155/p81b-p514.

The names and representation of countries and territories used in this joint publication follow the practice of the OECD. This document, as well as any data and map included herein are without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area. The designations employed and presentation of material do not imply the expression of any opinion whatsoever on the part of the IAEA concerning the legal status of any country or territory or its authorities or the delimitation of its boundaries.

Corrigenda to OECD publications may be found online at: *www.oecd.org/about/publishing/corrigenda.htm*.

© OECD 2026

Attribution 4.0 International (CC BY 4.0).

This work is made available under the Creative Commons Attribution 4.0 International licence. By using this work, you accept to be bound by the terms of this licence (https://creativecommons.org/licenses/by/4.0).

Attribution – you must cite the work.

Translations – you must cite the original work, identify changes to the original and add the following text: *In the event of any discrepancy between the original work and the translation, only the text of original work should be considered valid.*

Adaptations – you must cite the original work and add the following text: *This is an adaptation of an original work by the OECD. The opinions expressed and arguments employed in this adaptation should not be reported as representing the official views of the OECD or of its Member countries.*

Third-party material – the licence does not apply to third-party material in the work. If using such material, you are responsible for obtaining permission from the third party and for any claims of infringement.

You must not use the OECD logo, visual identity or cover image without express permission or suggest the OECD endorses your use of the work.

Any dispute arising under this licence shall be settled by arbitration in accordance with the Permanent Court of Arbitration (PCA) Arbitration Rules 2012. The seat of arbitration shall be Paris (France). The number of arbitrators shall be one.

Cover photos: The Ranger uranium mine, Kakadu National Park, Australia (CC BY-NC-ND 2.0); LHM haul trucks (Paladin Energy); LHM blast prepping (Paladin Energy).

Acknowledgements

This joint report was prepared by the NEA and IAEA Secretariats. The contributions from across the two agencies were led by Kateryna Poliakovska, Jamie Fairchild and Franco Michel-Sendis at the NEA, and Adrienne Hanly and Katrin Kärner at the IAEA. The NEA and the IAEA gratefully acknowledge the attentive support provided by members of the Joint NEA/IAEA Group on Uranium, as well as the co-operation of those organisations and individuals listed in Appendix 1 that replied to the Red Book 2025 questionnaire. In compiling and preparing Chapters 1 and 3, the IAEA Secretariat highlights the collective efforts of Jean René Blaise (Consultant, France), Alexander Boytsov (TENEX, Russian Federation), Luis López (National Atomic Energy Commission, Argentina), James Marlatt (GeoTotal Group Ltd., Canada), Jiří Mužák (DIAMO State Enterprise, Czechia) and Dave Neuburger (Consultant, Canada). The input and participation of all was essential for the successful completion of this report.

Table of contents

List of appendices

List of boxes

List of figures

List of tables

Executive summary

Uranium 2026: Resources, Production and Demand provides a cohesive summary of world uranium market fundamentals and offers a statistical profile of the uranium industry. It contains 46 country reports covering uranium exploration, resources, production and reactor-related requirements, 39 of which were prepared from officially reported government data and narratives, and seven of which were prepared by the secretariats of the Nuclear Energy Agency (NEA) and the International Atomic Energy Agency (IAEA). The report includes projections for nuclear generating capacity and reactor-related uranium requirements through 2050, as well as a discussion of long-term uranium supply and demand dynamics.

The data reporting period for *Uranium 2026: Resources, Production and Demand* (also known as the "Red Book") covers 1 January 2023 to 1 January 2025 (calendar years 2023 and 2024), although some relevant information for 2025 and 2026 is also included in the discussions.

Resources

Global uranium resources (as of 1 January 2025) marginally increased compared to the previous edition of the Red Book (2024), with total identified recoverable resources at <USD 260/kg of just over 8.1 million tU (+2.1%), comprised of 61% reasonably assured resources (1% increase from previous edition) and 39% inferred resources. At <USD 130/kgU, total identified recoverable resources of 5.9 million remained largely unchanged compared to 1 January 2023, with slight increases at <USD 80kg/U (+3.5%) and <USD 40/kgU (+2.1%), respectively. Increases in the <USD 80kg/U cost category are largely attributed to Canada reporting a 70% increase of identified recoverable resources in this category. The increase in the lowest cost category is solely due to exploration success at several deposits in Kazakhstan.

The trend of re-assignment of resources to higher cost categories, as observed in the previous edition, continued. As of 1 January 2025, only four countries reported resources in the <USD 40/kgU cost category, with an unchanged 75% of the global total attributed to Kazakhstan.

Globally, Australia continues to dominate the world's uranium resources, accounting for 29% of identified recoverable resources at costs <USD 130/kgU and 24% at costs <USD 260/kgU. Notably, approximately 69% of Australia's uranium endowment, which is equivalent to about 17% of global identified recoverable resources, is contained in the Olympic Dam deposit in South Australia, where uranium is produced as a co-product of copper mining.

Australia is followed by Kazakhstan, which holds approximately 14% of the world's identified recoverable resources at <USD 130/kgU and 11% at <USD 260/kgU. Canada ranks third, with 9% of identified recoverable resources at <USD 130/kgU and 10% at <USD 260/kgU.

While global identified recoverable uranium resources changed only marginally, several notable developments occurred at the country level. China reported increases of approximately 20% in the <USD 130/kgU category and 19% in the <USD 260/kgU category, primarily as a result of domestic exploration success.

The United States recorded a significant increase in identified recoverable resources in the <USD 260/kgU category, due in part to an approximate 8% increase in reasonably assured resources but driven largely by the Secretariat's inclusion of inferred resource estimates based on publicly available data.

Re-estimates of mineral resources in Botswana and Namibia resulted in significant and moderate reductions, respectively, in the higher cost categories. Following a comprehensive reassessment of its resource base, Ukraine reported substantial increases of 51% and 45% in the higher cost categories of <USD 130/kgU and <USD 260kg/U, respectively.

Canada was the only country reporting significant changes at <USD 80/kgU, attributable to the reclassification of resources into this lower cost category. In the <USD 40/kgU cost category, Kazakhstan was the only country reporting significant resource figures, recording a minor increase of approximately 3%, compared with 2023.

It is noted that resources allocated to the lowest cost category, i.e. <USD 40/kgU have been gradually declining in importance over time, reflecting rising mining and extraction costs, the higher development costs associated with newly discovered deposits and the progressive depletion of existing low-cost resources.

Although resources in this publication are primarily reported as recoverable resources, representing the amount of uranium available after accounting for mining and processing losses, reporting in situ resource estimates also provides valuable insight into the total uranium endowment in the ground. By quantifying average recovery factors and the corresponding non-recovered portion, in situ estimates help illustrate how uranium availability may vary with changes in mining and processing technologies.

Total identified in situ uranium resources increased gradually over the past decade, rising from 10.2 million tU in 2016 to 10.9 million tU at <USD 260/kgU in 2025, representing an increase of approximately 7% (and a 2% increase from the previous edition). Based on the 2025 estimates, the average recovery factor from in situ to recoverable resources is 74%, implying 26% losses during mining and processing. This ratio has remained relatively stable over time; in 2016, the corresponding average recovery factor was 75%, with 25% losses.

Potential future additions to the resource base are estimated at 7.5 million tU and are derived from undiscovered resources, including prognosticated and speculative categories. This represents a decrease of approximately 5% compared to the previous edition, largely attributable to Mongolia's revision of its undiscovered speculative resources, which were reduced by nearly 300 000 tU. Smaller downward revisions were also reported by Argentina, Kazakhstan and Russia.

It should be noted, however, that confidence in estimates of undiscovered resources remains low. At present, there is no uniform, systematic assessment methodology applied consistently across reporting countries. Furthermore, it is expected that currently identified undiscovered resources would require higher uranium prices to incentivise active exploration, as these resources are likely to occur at greater depths and/or in remote, less accessible locations. Consequently, these undiscovered resources are unlikely to contribute to supply in the short to medium term.

Unconventional resources represent another potentially important source of future uranium supply and an increasingly examined component of the global uranium endowment. Despite this growing interest, only a limited number of countries currently report estimates of unconventional resources and/or are actively exploring such resources or advancing related projects towards development. During the 2023-2024 reporting period, Saudi Arabia was the only country to make a significant advancement in delineating its unconventional uranium resource base. In addition, Finland commenced by-product uranium recovery at the Talvivaara black schist-hosted polymetallic deposit.

The uranium resource figures presented in this edition are a snapshot of the situation as of 1 January 2025, as reported mainly from official government sources. Readers should keep in mind that resource figures are dynamic and related to commodity prices.

Exploration and mining development

The upward trend in domestic uranium exploration expenditures observed since 2021 continued, supported by the recovery in uranium prices and renewed interest in nuclear energy. These factors have revived and, in some cases, accelerated exploration activities. Domestic exploration expenditures nearly doubled from USD 490 million in 2021 to approximately USD 970 million in 2024. Total spending for 2025 is anticipated to reach USD 1 billion, based on preliminary data of around USD 930 million, as several countries, including the United States and Kazakhstan, did not provide estimates.

Non-domestic expenditures, which represent a subset of global exploration and development spending, declined from USD 70 million in 2022 to USD 50 million in 2023 and underwent a further decline to USD 40 million in 2024. This decrease is largely attributable to reduced non-domestic investment by China. Nevertheless, preliminary data indicate that non-domestic expenditures are likely to increase significantly in 2025, reflecting renewed interest in overseas activities by China and Russia, as well as continued foreign investment by France.

Total exploration and development expenditures for the 2023-2024 period amounted to approximately USD 1.8 billion, representing a substantial increase of 46% compared with the 2021-2022 period and continuing the upward trend observed since 2021. Canada and China have led global expenditures over the past decade, a pattern that remained unchanged in 2023-2024. Canada accounted for 39% of total expenditures, followed by China at 26%, the United States at 7% and India at 6%. Australia and Uzbekistan each represented a further 5% of total spending.

The total volume of exploration and development drilling reported for 2023 and 2024 amounted to approximately 8 500 km, representing a 27% increase compared with the previous edition, and underscoring the strengthened exploration and investment appetite. Nearly one-fifth of all drillholes were undertaken for development purposes. During the 2023-2024 period, Uzbekistan, China, Kazakhstan and the United States accounted for 31%, 28%, 12% and 11% of total drilling, respectively, while Namibia, Canada and India collectively contributed a further 16%.

Production

Global uranium mine production increased by approximately 20% between the 2021-2022 and 2023-2024 reporting periods. Total production amounted to 96 851 tU for the two years 2021-2022 and rose to 116 487 tU for 2023-2024. This increase marks a clear reversal of the previous downward trend observed from 2017, which bottomed out in 2021, and is expected to continue in the near and medium term due to favourable market conditions, the restart of previously idled mines and the development of new production capacity.

As of 1 January 2025 (with some updates through December 2025), idled uranium mines represented a combined annual production capacity of just over 21 100 tU. Of this total, mines accounting for approximately 9 400 tU of annual capacity have either recently restarted production or have firm commitments with restart activities underway. The remaining 11 750 tU of idled capacity represents additional potential supply, although with notable uncertainties. Many of these operations have been idled for close to a decade, and prolonged shutdown periods can complicate and increase the cost of restarting production. It is therefore reasonable to assume that only part of this remaining idled capacity will ultimately return to production, and likely at levels below the nominal listed capacity.

During the 2023-2024 period, Kazakhstan remained the world's leading producer, accounting for 38% of total production, followed by Canada (22%), Namibia (12%), and Australia and Uzbekistan, each contributing 8%. Collectively, these five countries accounted for nearly 90% of global uranium production. Additional contributions were made by Russia (5%) and China (3%), with several other countries producing smaller amounts.

In 2024 alone, uranium production reached 61 924 tU, approaching levels last observed in 2016. Production has been increasing since 2022, following a five-year period of declining output, with production reaching a low of 47 371 tU in 2021, primarily due to mine shutdowns and production reductions, in response to depressed uranium market conditions. The 20% increase in output since 2022 is largely attributable to the return of Canadian mines to full production, the restoration of production driven by more favourable market conditions, the ramp-up of new mining capacity in Kazakhstan, and increased output in Uzbekistan following a presidential decree to double uranium production from 3 500 tU to 7 000 tU by 2030. These gains were partially offset by production disruptions following the July 2023 coup d'état in Niger.

In situ leaching (ISL) remained the dominant uranium production technology throughout the reporting period, continuing a trend that has persisted for 16 consecutive years, since 2009. ISL accounted for approximately 55% of global uranium production in 2023 and 2024. Underground mining represented the second most significant production method, with a share of 26%, reflecting the return of Canadian underground mines to full production. This marks a substantial recovery from 2021, when the underground mining share had declined to approximately 15%.

Environmental and social aspects of uranium exploration and production

With uranium production projected to expand over the medium term in response to growing global demand, policymakers and industry stakeholders continue to strengthen the development and implementation of best practices for safe uranium exploration and mining. These efforts are aimed at minimising the environmental footprint of exploration and mining activities. Key measures include strict compliance with applicable laws and regulations, the conducting of robust and credible environmental and social impact assessments, and the strict implementation of environmental management plans to mitigate potential environmental and social risks. Over time, these practices have become standard across the global uranium sector and are widely recognised as essential to maintaining a social licence to operate.

Although the focus of this publication remains uranium resources, production and demand, the environmental and social aspects of the uranium production cycle are of great importance and, as in the last few editions, updates on activities in this area have been included in the country reports. With a need for increased uranium production to meet demand, the continued development of transparent, safe and well-regulated operations that minimise environmental impacts is crucial, particularly for those countries hosting uranium production for the first time.

For this edition, 28 out of 46 countries (61%) provided information on activities related to the environmental and social aspects of the uranium production cycle.

A dominant theme across all regions is the remediation of legacy uranium mining and milling sites, developed prior to modern environmental standards. Remediation activities include decommissioning of underground and open-pit mines, stabilisation and capping of tailings and waste rock facilities, water treatment, site re-vegetation and long-term monitoring. In several countries, remediation is expected to extend over multiple decades, with significant public expenditure required for long-term environmental protection and stewardship.

Water protection and treatment are a central component of remediation programmes. Mine water treatment plants operate at several former uranium districts to control radionuclide and heavy-metal releases, with ongoing monitoring of surface water and groundwater. Environmental monitoring programmes commonly include measurements of gamma radiation, and radon in air and water, among others. In many cases, monitoring indicates improved conditions over time and compliance with national standards.

Socio-cultural aspects are most prominently addressed in jurisdictions with Indigenous or locally affected communities. Measures include consultation during environmental assessments, social support mechanisms for former workers and community redevelopment initiatives following mine closure. Selected sites have been repurposed for educational, recreational or tourism uses following remediation. In certain regions, remediation programmes explicitly prioritise the reduction of health risks to affected populations.

Uranium mining and milling are generally subject to comprehensive environmental and social impact assessment processes. These assessments typically address radiological and non-radiological impacts, waste management, water protection, land disturbance and post-closure obligations. Public participation has become a standard component of approval processes in most countries, and several jurisdictions explicitly consider Indigenous rights, land access and cultural heritage (e.g. Australia, Canada).

Regulatory oversight for radiation protection is commonly based on national frameworks aligned with international recommendations. Responsibilities are often shared between central authorities (e.g. radiation protection agencies or nuclear safety regulators) and regional governments.

For additional information on the environmental and social aspects of uranium production the reader is referred to *Best Practice in Environmental Management of Uranium Mining* (IAEA, 2010) and *Managing Environmental and Health Impacts of Uranium Mining* (NEA, 2014), both of which outline the significant improvements made in these areas since the early strategic period of uranium mining. The IAEA Bulletin, *Uranium: From Exploration to Remediation* (IAEA, 2018), and the IAEA Nuclear Energy Series, *Milestones in the Development of National Infrastructure for the Uranium Production Cycle* (IAEA, 2023), include information on this topic. More recently, the NEA published a comprehensive overview of experiences in the uranium mining industry of working with Indigenous people and local communities to maximise overall benefits for all stakeholders in *Maximising Uranium Mining's Social and Economic Benefits: A Guide for Stakeholders* (NEA, 2023).

Uranium demand

Global nuclear capacity is expected to increase in the coming years as energy demand grows. Reactor-related uranium needs vary significantly by region, largely reflecting projected nuclear capacity growth, with East Asia anticipated to have the highest annual uranium demand by 2050. Security of supply will be essential for further nuclear capacity expansion and will, in turn, result in greater uranium demand.

As of 1 January 2025, a total of 441 commercial nuclear reactors were operational globally, with a net generating capacity of 398 GWe requiring about 64 500 tU annually. Taking into account changes in policies announced in several countries and nuclear programmes as of 1 January 2025, world nuclear capacity by 2050 is projected to increase to 565 GWe in the low demand case, and to 916 GWe in the high demand case, an increase compared to 2024 capacity of around 42% and 130% respectively. Accordingly, world annual reactor-related uranium requirements are projected to rise to between around 84 800 tU/yr and 143 900 tU/yr by 2050.

Nuclear capacity projections vary considerably from region to region. East Asia is projected to experience the largest increase, which, by the year 2050, could result in total capacity of between 226 GWe and 335 GWe in the low and high cases, respectively, representing an additional capacity of between 96% and 190% of the 115 GWe capacity existing at the end of 2024. While representing a significant regional capacity increase, countries of this region (e.g. China) have consistently demonstrated the ability to build multiple reactors within the set budgets and schedules.

Other regions projected to experience significant nuclear capacity growth by 2050 include the Middle East, Central and South Asia, for which the low and high cases project capacity of 46 GWe and 73 GWe, up from 17 GWe at the end of 2024. In Europe, nuclear capacity in non-EU member countries is projected to increase in the high-case scenario to 106 GWe by 2050, more than doubling 2024 capacity. Even in the low-case scenario, nuclear capacity of non-EU member countries in Europe is projected to reach around 90 GWe by 2050, nearly doubling 2024 capacity.

For the European Union, however, nuclear capacity in 2050 is projected to decrease by around 25% in the low case and increase by around 62% in the high case with respect to 2024 capacity. Modest growth in capacity is projected in Africa (between 7 and 13 GWe in 2050, for the low and high cases respectively), Central and South America (between 6.5 and 18 GWe in 2050) and Southeastern Asia (between 1 and 6.5 GWe in 2050).

For North America, the projections anticipate nuclear generating capacity in 2050 increasing by 4% in the low case and by 84% in the high case, over the 2024 capacity of 111 GWe. The ultimate values will be derivative of future electricity demand, the successful execution of new builds, lifetime extensions of existing reactors and government policies.

As in the case of nuclear capacity, and directly related to it, uranium requirements vary considerably from region to region, reflecting projected capacity increases and possible inventory building. By 2050, annual uranium requirements are projected to be the largest in the East Asia region, driven by an increase in installed nuclear generating capacity, particularly in China.

The key factors shaping the future of nuclear energy capacity include growing electricity demand, the economic competitiveness of nuclear power plants, innovative financing solutions for these capital-intensive projects, resilient supply chains (including fuel), robust waste management strategies, public acceptance and alignment with national energy security objectives.

In response to the growing demand for reliable energy amid rising geopolitical uncertainties and the pressing need for cleaner sources of electricity, many countries have recently shifted their policies to favour nuclear energy. Notable examples include the reversal of planned phase-outs in Belgium, France and Korea; incentives in the United States to support the continued operation of existing plants and the construction of new conventional, advanced and small modular reactors; the establishment of regional alliances such as the European Nuclear Alliance; and plans or considerations by several countries, including Ghana, Kazakhstan, Kenya, Poland, Saudi Arabia, Uganda and Uzbekistan, to develop their first nuclear reactors.

Supply and demand adequacy

The current uranium resource base is sufficient to meet even high-demand projections through 2050, but achieving this will require timely investments to convert resources into active production. Meeting high-demand needs through 2050 alone would consume approximately 33% of the currently identified recoverable resource base at a cost of under USD 260/kgU (USD 100/lb U_3O_8). Beyond 2050, a timeframe aligned with the operational lifespan of new reactors, sustaining both high-growth and even low-growth demand scenarios will make investment in uranium exploration and new production centres essential to replenish depleted reserves.

In 2024, global uranium production met approximately 96% of world reactor requirements, an increase from around 85% in 2022. The remaining demand was met through secondary sources, including excess government and commercial inventories, spent fuel reprocessing, underfeeding at enrichment plants, re-enrichment of depleted uranium tails, and uranium inventory derived from blending down highly enriched uranium

Declining uranium market prices from 2011 to 2021, coupled with uncertainty around nuclear power development in some countries, led to reduced uranium demand, depressed prices, and a slowdown in mine production and development. 2021 marked the beginning of a long-awaited recovery. After reaching USD 25/lb U_3O_8 in 2020, uranium spot prices rose to USD 30/lb U_3O_8 (USD 80/kg U) at the start of 2021, climbing further to USD 50/lb U_3O_8 (USD 130/kg U) by early 2023 and reached a high of USD 106/lb U_3O_8 (USD 275/kg U) in January 2024. Prices then fell to about USD 64/lb U_3O_8 (USD 167/kg U) by March 2025 but rose again to about USD 94/lb U_3O_8 (USD 245/kg U) in January 2026. The rise in uranium prices over the past few years can be attributed to two key factors: the growing global interest in nuclear energy, which has increased expectations for higher uranium demand, and heightened geopolitical risks, primarily arising from the war in Ukraine. Both of these factors have exacerbated concerns over the security of fuel supply and caused significant shifts in uranium market dynamics.

Improved market conditions have already spurred a supply-side response, with several idled mines reactivated and delayed projects advancing towards final investment decisions to support a growing global nuclear fleet. While the global uranium mining network remains sparse, posing potential supply risks, utilities have maintained and built substantial inventories in recent years, providing a buffer against short-term disruptions.

Meeting high-demand growth requirements by 2050 would use approximately 46% of the currently identified recoverable resource base at costs below USD 130/kgU and about 33% at costs below USD 260/kgU. Beyond 2050, however, even if nuclear capacity remains at 2050 levels, cumulative uranium requirements would surpass 100% of the current total identified resource base in the highest cost category by the 2080s under high demand, or by the 2120s under low demand (Figure ES.1).

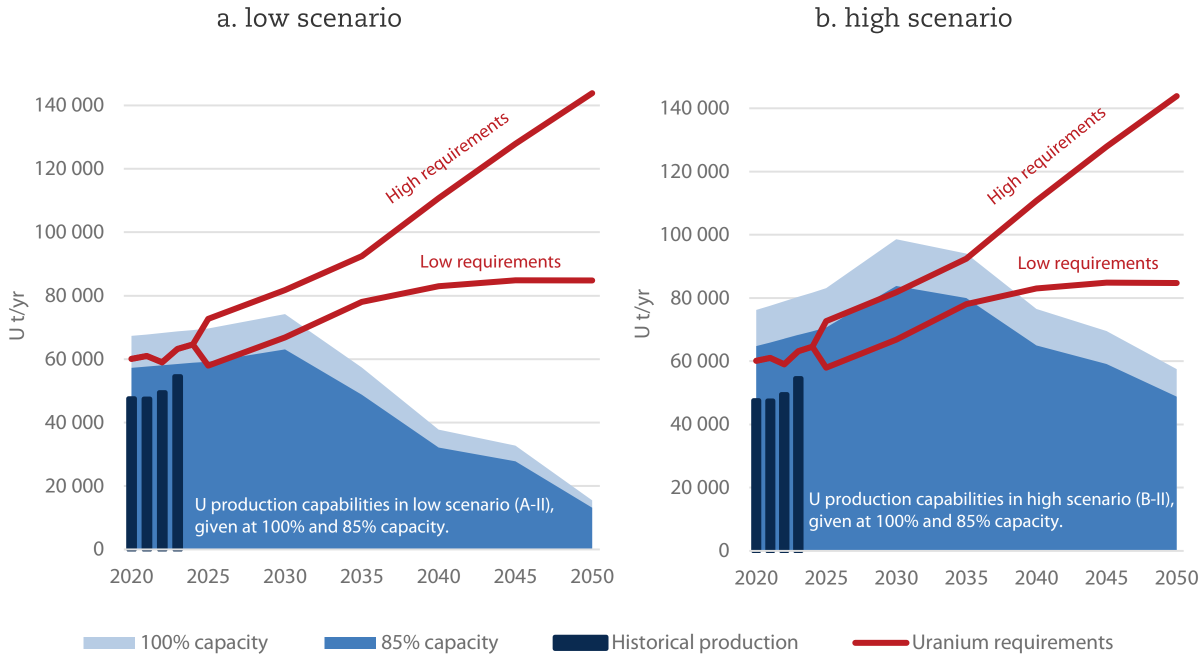
Figure ES.1. **Projected resource utilisation under low and high demand scenarios, assuming capacity is maintained from 2050 to 2100, shown as a consumed percentage of total identified resources at costs below USD 130/kg U (left) and USD 260/kgU (right)**

In the near term, if existing and committed mines operate near their stated production capacity, primary production is expected to meet low-demand scenarios through 2032. However, under high-demand scenarios, a production shortfall is anticipated as early as 2025 (Figure ES.2). While secondary sources will continue to supply a portion of uranium demand, it is crucial to bring new facilities online from planned and prospective production centres and to sustain exploration efforts to identify additional resources.

Bringing these resources to market will require substantial investment and technical expertise. Producers must navigate significant, often unpredictable challenges in launching new production facilities, including geopolitical and local factors, technical hurdles and complex legal and regulatory frameworks. Sustained strong market conditions will be essential to drive the necessary industrial investment.

In the longer term, developing and implementing alternative fuel cycles that move away from the default once-through approach used by most countries – especially by closing the fuel cycle – could have a substantial impact on the uranium market.

Figure ES.2. **Projected world uranium production capability to 2050 (supported by identified resources at a cost of <USD 130/kgU) compared with reactor requirements**



Source: Tables 1.23 and 2.5 (NEA, 2023 and NEA, 2018c).

Figure ES.2.a illustrates the A-II case (production capability of existing, idled and committed centres supported by RAR and inferred resources recoverable at <USD 130/kgU). Figure ES.2.b illustrates the B-II case (production capability of existing, idled, committed, planned and prospective centres supported by RAR and inferred resources recoverable at <USD 130/kgU). Both figures illustrate two production capacities per case: the light shaded area represents 100% of production capacity, the darker shade represents 85% of the production capacity. Dark blue bars show the actual production values for 2020-2024.

Note that figures do not include the secondary supply forecast, which has in the past filled the gap between primary production and demand.

Conclusions

As of 1 January 2025, the global uranium sector is characterised by a broadly stable but gradually evolving resource base, coupled with a clear resurgence in exploration, production and demand.

The currently identified uranium resources are sufficient to meet both low- and high-growth nuclear capacity needs through 2050 and beyond. However, these resources will require further development to come into production and supply the future needs of the industry. In both scenarios, even if nuclear capacity remains stable at 2050 levels through the end of the century, cumulative demand could exceed the current identified uranium resource base of about 8.1 million tonnes by the 2080s under the high-growth demand scenario, and by the 2120s under the low-growth demand scenario outlined in this edition.

Historically, strong market signals have driven significant investment in uranium exploration, leading to the discovery and production of economically viable resources. However, various factors affect the timing and feasibility of resource recovery, including political stability, jurisdictional mining policies and local experience with uranium mining.

To bring in-ground resources into production, market conditions must offer confidence in project returns. Poor or uncertain market conditions delay not only new supply but also exploration investments, which impacts long-term resource development. For sustained uranium supply, both consumers and producers must ensure a stable framework for uranium exploration, mining and transportation, supported by pricing mechanisms that encourage long-term investments. Sustained, adequate uranium prices are essential to support both new projects and ongoing exploration, as global uranium demand could more than double by 2050 in a high-demand scenario and increase by 42% in a low-demand case.

Following a decade-long downturn, the uranium market began to recover in 2021, with spot prices rising from USD 30/lb U_3O_8 at the start of 2021 to a high of USD 106/lb U_3O_8 in January 2024. While prices experienced periods of volatility thereafter, they have remained structurally higher than those prevailing during the pre-2021 downturn. In response, exploration and mine development activities have increased, with some previously stalled projects nearing final investment decisions. A significant share of previously idled production capacity has returned to operation, although the remaining capacity may require higher prices to resume production.

Ongoing geopolitical tensions are reshaping the uranium market, prompting some nuclear-generating countries to build up domestic supplies or prioritise imports from trusted or neutral countries. Increasing global momentum for nuclear energy, driven by priorities on energy security and clean energy goals, including growing demand for carbon-free electricity, suggests a positive outlook for uranium demand.

In the longer term, advanced reactor designs and closed fuel cycles with recycling capabilities, if successfully developed, may have the potential to utilise existing uranium resources for at least several centuries, ensuring the long-term sustainability of nuclear energy. Additionally, unconventional uranium sources, such as phosphate deposits and black shales, could further extend uranium availability, particularly with the emergence of new technologies.

While sufficient uranium resources exist to meet demand for nuclear power generation in both low- and high-growth scenarios through 2050 and beyond, substantial investment will be essential to bring all of these identified resources into production. Given the long lead times for project development, identifying and advancing new projects in the near to medium term is crucial to avoid potential supply disruptions. Uranium price adequacy is essential to support ongoing exploration, to justify final investment decisions for new mines to replace depleting resources, and to spur investment in innovative extraction techniques for both conventional and unconventional uranium sources.

References

IAEA (2023), *Milestones in the Development of National Infrastructure for the Uranium Production Cycle*, IAEA Nuclear Energy Series No. NF-G-1.1, International Atomic Energy Agency, Vienna, www.iaea.org/publications/15010.

IAEA (2018), *Uranium: From Exploration to Remediation*, IAEA Bulletin, Volume 59-2, June 2018, International Atomic Energy Agency, Vienna, www.iaea.org/bulletin/59-2.

IAEA (2010), *Best Practice in Environmental Management of Uranium Mining,* IAEA Nuclear Energy Series No. NF-T-1.2, International Atomic Energy Agency, Vienna, www.iaea.org/publications/8122.

NEA (2023), *Maximising Uranium Mining's Social and Economic Benefits: A Guide for Stakeholders*, OECD Publishing, Paris, www.oecd-nea.org/7547.

NEA (2014), *Managing Environmental and Health Impacts of Uranium Mining*, OECD Publishing, Paris, www.oecd-nea.org/7062.

Chapter 1. **Uranium supply**

This chapter summarises the status of worldwide uranium resources, exploration and production. The data reporting period for this edition of the Red Book covers 1 January 2023 to 1 January 2025 (i.e. the calendar years 2023 and 2024). However, some important information for 2025 has also been included when needed to provide timely context.

Uranium resources

Uranium resources are classified by a scheme (based on geological certainty and costs of production) developed to combine resource estimates from a number of different countries into harmonised global figures. ***Identified resources*** (which include ***reasonably assured resources****,* or *RAR,* and ***inferred resources***, or *IR*) refer to uranium deposits delineated by sufficient direct measurement to conduct pre-feasibility and, occasionally, feasibility studies. For ***reasonably assured resources***, high confidence in estimates of grade and tonnage are generally compatible with mining decision making standards. ***Inferred resources*** are not defined with such a high degree of confidence and generally require further direct measurement prior to making a decision to mine. Unless otherwise noted, both ***reasonably assured resources*** and ***inferred resources*** are expressed in terms of quantities of uranium ***recoverable*** from mineable ore, as opposed to quantities contained in mineable ore, i.e. quantities in situ. ***Undiscovered resources*** (which include ***prognosticated resources****,* or *PR*, and ***speculative resources***, or *SR*) refer to resources that are expected to exist based on geological knowledge of previously discovered deposits and regional geological mapping. ***Prognosticated resources*** refer to those expected to exist in known uranium provinces, generally supported by some direct evidence. ***Speculative resources*** refer to those expected to exist in geological provinces that may host uranium deposits. Both ***prognosticated*** and ***speculative resources*** require significant amounts of exploration before their existence can be confirmed, and grades and tonnages can be defined. ***Undiscovered resources*** are normally expressed in terms of uranium contained in mineable ore, i.e. ***in situ*** quantities. ***Unconventional resources*** are defined as very low-grade resources or those from which uranium is only recoverable as a minor by-product or co-product. For more detailed descriptions, see Appendix 3.

Identified conventional resources

The global distribution of recoverable identified conventional resources at a cost of less than USD 260/kgU is shown in Figure 1.1. Total identified resources consist of *reasonably assured resources* (RAR) plus *inferred resources* (IR) at costs of less than USD 260/kgU (USD 100/lb U_3O_8; see Appendix 3). Unless otherwise noted, resource figures in this report refer exclusively to recoverable resources; that is, the potential amount of uranium recovered after losses from mining and processing are deducted. In situ resources are also presented at times in this report, commonly in the exploration section, referring to the estimated amount of uranium in the ground, and are clearly indicated as such.

Relative changes in different resource and cost categories of global identified recoverable resources between this edition and the 2024 edition of the Red Book are summarised in Table 1.1 (note that resources of a given cost category also include resources from lower cost categories – in other words, the resource amounts are cumulative from lowest to highest cost category; see Appendix 3 about reading and interpreting cost category resource figures).

Figure 1.1. **Global distribution of identified recoverable conventional uranium resources**

(<USD 260/kgU as of 1 January 2025)

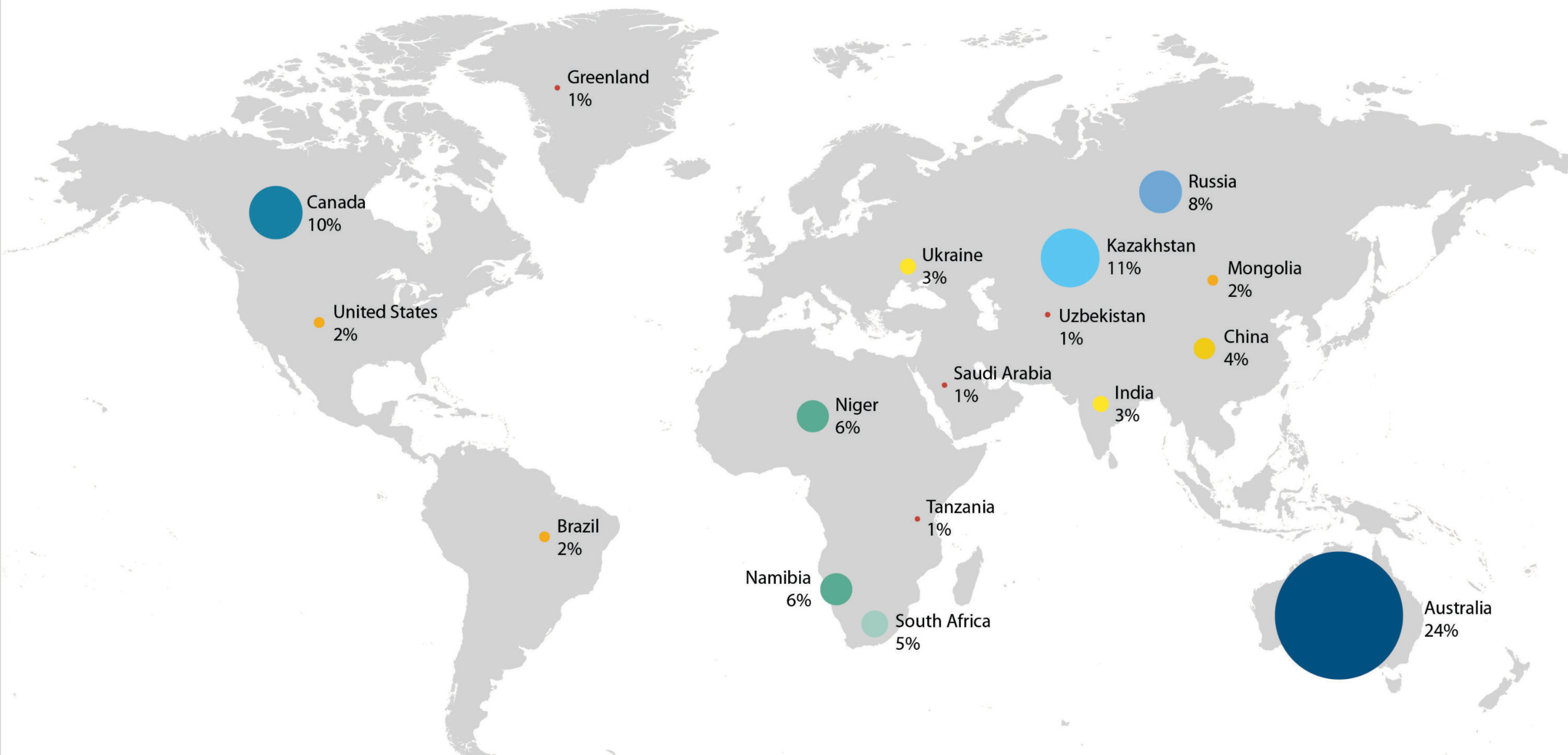


Table 1.1. **Changes in identified recoverable uranium resources 2023-2025**

(as of 1 January 2025, tonnes U, rounded to nearest 100 tonnes†)

Resource category	2023	2025	Change[(a)]	% change
Total identified resources				
<USD 260/kgU	7 934 500	8 104 500	170 000	2.1
<USD 130/kgU	5 925 700	5 864 500	-61 200	-1.0
<USD 80/kgU[(b)]	1 881 100	1 946 400	65 300	3.5
<USD 40/kgU[(b)]	666 900	680 600	13 700	2.1
Reasonably assured resources				
<USD 260/kgU	4 778 700	4 970 800	192 100	4.0
<USD 130/kgU	3 868 800	3 904 400	35 600	0.9
<USD 80/kgU[(b)]	1 180 700	1 251 100	70 400	6.0
<USD 40/kgU[(b)]	364 700	367 400	2 700	0.7
Inferred resources				
<USD 260/kgU	3 155 700	3 133 700	-22 000	-0.7
<USD 130/kgU	2 056 900	1 960 100	-96 800	-4.7
<USD 80/kgU[(b)]	700 400	695 400	-5 000	-0.7
<USD 40/kgU[(b)]	302 200	313 200	11 000	3.6

† Totals may not sum exactly, or exactly match totals reported in other tables of this report, due to rounding.

(a) Changes might not equal differences between 2023 and 2025 because of independent rounding.

(b) Totals for <USD 40/kgU and <USD 80/kgU cost ranges should be regarded with some caution as certain countries do not report low-cost resource estimates, whereas other (non-producing) countries may underestimate mining costs.

From 1 January 2023 to 1 January 2025 there was a modest increase in global identified recoverable conventional uranium resources at the <USD 260/kgU cost category to a total of 8.1 million tU, an increase of 2.1% (170 000 tU) from 2023. At the other cost categories, the overall picture is mixed, with a -1.0% (61 000 tU) decrease in identified recoverable conventional uranium resources at the <USD 130/kgU cost category, and increases of 3.5% (65 000 tU) and 2.1% (14 000 tU) at the <USD 80/kgU and <USD 40/kgU cost categories, respectively. At the <USD 260/kgU cost category, RAR increased by 4%, compared with a 2.1% increase in total identified resources, indicating a marginal improvement in the overall confidence level of identified resources. At the lowest cost category (<USD 40/kgU), the increase in total identified resources was primarily the result of a 3.6% increase in IR, with minimal contribution from a 0.7% increase in RAR.

The increase in the lowest cost category (<USD 40/kgU) of identified conventional resources is the result of an additional 13 700 tU reported in this cost category by Kazakhstan. Notably, as of 1 January 2025, only Brazil (86 800 tU), China (73 200 tU), Kazakhstan (512 500 tU) and Spain (8 100 tU) reported uranium resources in the lowest cost category (<USD 40/kgU). At the highest cost category (<USD 260/kgU), the increase in total identified resources is the net result of numerous changes. Some of the more significant changes include a substantial increase arising from a comprehensive review of Ukraine resources, inclusion of Secretariat estimates (compiled from publicly available company disclosures) of United States inferred resources, notable exploration success in northern China and various exploration additions or other resource upgrades leading to increases for Australia, India, Uzbekistan, Saudi Arabia and Kazakhstan. These additions were partially offset by resource depletion from mining (116 500 tU over the two years), and reductions from Botswana due to an updated resource estimate, revised resource estimates for three deposits in Namibia and removal of a deposit inferred resource estimate for Canada.

Current estimates of recoverable and in situ identified resources, RAR and IR, on a country-by-country basis, are presented in Tables 1.2, 1.3 and 1.4, and graphically summarised in Figures 1.2 and 1.3. Table 1.5 summarises major changes in recoverable resources between 2023 and 2025 in selected countries.

Table 1.2a. **Identified recoverable uranium resources**

(as of 1 January 2025, tonnes U, rounded to nearest 100 tonnes†)

Country	Cost ranges			
	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Algeria[a,b]	0	0	0	19 500
Argentina	0	9 600	33 700	34 700
Australia	0	0	1 701 600	1 959 200
Bolivia[a,b,c]	0	0	0	1 300
Botswana*	0	0	27 100	27 100
Brazil [a]	86 800	86 800	167 800	177 800
Bulgaria[a,b,d]	0	0	0	5 100
Cameroon[a,b,c]	0	0	0	21 000
Canada	0	411 900	551 700	805 800
Central African Republic*[a,c]	0	0	0	29 200
Chad*[a,b,c]	0	0	0	2 400
Chile*[b]	0	0	0	1 400
China[a]	73 200	175 800	325 400	347 200
Congo, Dem. Rep.*[a,b,c]	0	0	0	2 700
Czechia	0	0	700	119 000
Denmark/Greenland[a,b]	0	0	0	114 000
Egypt[a,c]	0	0	400	12 100
Finland[a,b,f]	0	0	1 200	1 200
Gabon[b,c]	0	0	4 800	5 800
Germany [b]	0	0	0	7 000
Greece[b,c]	0	0	0	7 000
Guyana[a,b]	0	0	0	4 600
Hungary[a]	0	0	0	16 700
India[a,d]	0	0	0	273 700
Indonesia[a]	0	1 500	8 600	8 600
Iran, Islamic Republic of*[a,b,c]	0	0	7 400	7 400
Italy[b,c]	0	6 100	6 100	6 100
Japan[b]	0	0	6 600	6 600
Jordan[a]	0	0	0	49 000
Kazakhstan[a]	512 500	744 300	827 500	886 900
Malawi[g]	0	0	6 500	18 600
Mali*[a,b,c]	0	0	8 900	8 900

Table 1.2a. **Identified recoverable uranium resources (cont'd)**

(as of 1 January 2025, tonnes U, rounded to nearest 100 tonnes†)

Country	Cost ranges			
	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Mauritania*	0	0	28 100	35 400
Mexico(a,c)	0	500	4 500	5 100
Mongolia	0	16 900	144 600	144 600
Namibia*	0	39 500	392 800	494 500
Niger*	0	34 600	351 100	462 800
Pakistan*(a,c)	0	0	0	22 500
Paraguay*(a,e)	0	0	4 300	4 300
Peru*(a,b)	0	33 400	33 400	33 400
Portugal(a,b)	0	3 400	5 300	5 300
Romania(b,c)	0	0	8 000	8 000
Russian Federation	0	29 900	471 700	650 400
Saudi Arabia(a,h)	0	0	0	64 100
Senegal(a)	0	0	0	5 100
Slovak Republic(a,b)	0	12 700	15 500	15 500
Slovenia(a,b)	0	5 400	9 200	9 200
Somalia*(a,b,c)	0	0	0	7 600
South Africa*	0	228 000	320 900	436 000
Spain(a)	8 100	28 500	28 500	28 500
Sweden*(a,b,c)	0	0	9 600	9 600
Tanzania*	0	46 800	57 700	57 700
Türkiye(a)	0	0	27 100	36 000
Ukraine(a)	0	4 200	161 300	269 000
United States*(a,i)	0	0	16 700	200 600
Uzbekistan(a)	0	26 700	64 100	81 800
Viet Nam(a,b)	0	0	0	3 800
Zambia*	0	0	24 300	24 300
Zimbabwe(a,b)	0	0	0	2 000
Total(k)	**680 600**	**1 946 400**	**5 864 500**	**8 104 500**

† Totals may not sum exactly, or exactly match totals reported in other tables of this report, due to rounding. * Secretariat estimate.

(a) In situ resources were adjusted by the Secretariat to estimate recoverable resources using recovery factors provided by countries or estimated by the Secretariat, according to the expected production method (See Appendix 3 for recovery factors). (b) Assessment not made within the last five years. (c) Not reported in 2025 responses; data is from Red Book 2024. (d) Cost data not provided; therefore, resources are reported in the <USD 260/kgU category. (e) Recovery factors partially adjusted by the Secretariat. (f) Finland also reports ~12 100 tU unconventional identified recoverable resources (8 700 tU RAR + 3 400 tU inferred) for Talvivaara black schist-hosted deposit. (g) Secretariat estimate of <USD 130/kgU category, based on Kayelekera restart study information. (h) Unconventional resources for the Ghurayyah polymetallic (Th-U-Nb-Ta and REE-bearing minerals) deposit and Jabal Sayid U-Th prospect. (i) Other than the RAR <USD 260/kgU category total per the United States country report, Secretariat estimates are based on publicly disclosed information, as the US withholds details due to stated concerns over confidentiality of company data, and does not report inferred resources in country reports. (k) Totals for <USD 40/kgU and <USD 80/kgU cost ranges should be regarded with some caution as certain countries do not report low-cost resource estimates, whereas other (non-producing) countries may underestimate mining costs.

Table 1.2b. **Identified in situ uranium resources**

(as of 1 January 2025, tonnes U, rounded to nearest 100 tonnes†)

Country	Cost ranges			
	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Algeria(b)	0	0	0	26 000
Argentina(a)	0	11 900	45 300	46 800
Australia(a)	0	0	2 687 600	3 066 700
Bolivia(b,c)	0	0	0	1 700
Botswana*(a)	0	0	43 700	43 700
Brazil	133 600	133 600	236 300	250 500
Bulgaria(b,d)	0	0	0	7 900
Cameroon(b,c)	0	0	0	28 000
Canada(a)	0	473 500	634 100	926 200
Central African Republic*(c)	0	0	0	36 500
Chad*(b,c)	0	0	0	3 200
Chile*(a,b)	0	0	0	1 900
China	104 600	249 900	456 500	485 500
Congo, Dem. Rep.*(b,c)	0	0	0	3 600
Czechia(a)	0	0	1 200	197 200
Denmark/Greenland(b)	0	0	0	228 000
Egypt(c)	0	0	500	16 100
Finland(b,f)	0	0	1 500	1 500
Gabon(a,b,c)	0	0	6 400	7 700
Germany(a,b)	0	0	0	9 300
Greece(a,b,c)	0	0	0	9 300
Guyana(b)	0	0	0	6 200
Hungary	0	0	0	22 200
India(d)	0	0	0	363 200
Indonesia	0	2 000	11 500	11 500
Iran, Islamic Republic of*(b,c)	0	0	9 900	9 900
Italy(a,b,c)	0	8 100	8 100	8 100
Japan(a,b)	0	0	7 800	7 800
Jordan	0	0	0	63 000
Kazakhstan	575 800	836 900	933 100	1 004 700
Malawi(a,g)	0	0	8 000	24 200
Mali*(b,c)	0	0	11 800	11 800
Mauritania*(a)	0	0	35 100	44 800
Mexico(c)	0	700	6 000	6 800
Mongolia(a)	0	22 500	192 200	192 200
Namibia*(a)	0	49 400	481 500	606 600
Niger*(a)	0	41 700	418 800	560 900
Pakistan*(c)	0	0	0	30 000
Paraguay*(e)	0	0	5 100	5 100
Peru*(b)	0	47 700	47 700	47 700

Table 1.2b. **Identified in situ uranium resources (cont'd)**

(as of 1 January 2025, tonnes U, rounded to nearest 100 tonnes†)

Country	Cost ranges			
	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Portugal(b)	0	4 500	7 000	7 000
Romania(a,b,c)	0	0	10 600	10 600
Russia(a)	0	39 800	578 200	832 500
Saudi Arabia(h)	0	0	0	85 400
Senegal	0	0	0	6 800
Slovak Republic(b)	0	15 800	19 300	19 300
Slovenia(b)	0	7 200	12 200	12 200
Somalia*(b,c)	0	0	0	10 100
South Africa* (a)	0	307 400	430 500	589 100
Spain	9 800	34 400	34 400	34 400
Sweden*(b,c)	0	0	12 800	12 800
Tanzania*(a)	0	58 500	72 200	72 200
Türkiye	0	0	33 500	45 400
Ukraine	0	5 600	184 500	306 800
United States*(i)	0	0	23 900	272 300
Uzbekistan	0	38 100	91 500	116 900
Viet Nam(b)	0	0	0	5 200
Zambia*(a)	0	0	26 700	26 700
Zimbabwe(b)	0	0	0	2 700
Total(k)	**823 800**	**2 389 200**	**7 826 900**	**10 892 400**

† Totals may not sum exactly, or exactly match totals reported in other tables of this report, due to rounding. * Secretariat estimate.

(a) Recoverable resources were adjusted by the Secretariat to estimate in situ resources using recovery factors provided by countries or estimated by the Secretariat according to the expected production method (See Appendix 3 for recovery factors). (b) Assessment not made within the last five years. (c) Not reported in 2025 responses; data is from Red Book 2024. (d) Cost data not provided; therefore, resources are reported in the <USD 260/kgU category. (e) Recovery factors partially adjusted by the Secretariat. (f) Finland also reports ~27 000 tU unconventional identified in situ resources (19 400 tU RAR + 7 600 tU inferred) for the Talvivaara black schist-hosted deposit. (g) Secretariat estimate of <USD 130/kgU category, based on Kayelekera restart study information. (h) Unconventional resources for the Ghurayyah polymetallic (Th-U-Nb-Ta and REE-bearing minerals) deposit and Jabal Sayid U-Th prospect. (i) Other than the RAR <USD 260/kgU category total per the US country report, Secretariat estimates are based on publicly disclosed information, as the United States withholds details due to stated concerns over confidentiality of company data, and does not report inferred resources in country reports. (k) Totals for <USD 40/kgU and <USD 80/kgU cost ranges should be regarded with some caution as certain countries do not report low-cost resource estimates, whereas other (non-producing) countries may underestimate mining costs.

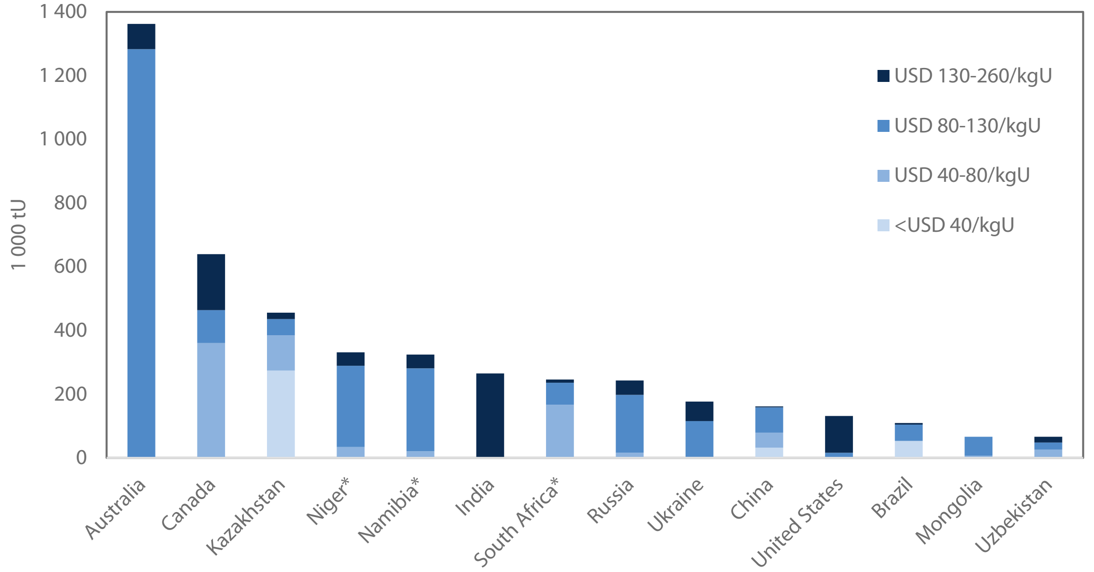
Table 1.2c. **Comparison of identified uranium resources reported as in situ vs. recoverable**

(as of 1 January 2025, tonnes U, rounded to nearest 100 tonnes†)

Identified resources	Cost ranges			
	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Total in situ	823 800	2 389 200	7 826 900	10 892 400
Total recoverable	680 600	1 946 400	5 864 500	8 104 500
Difference	143 200	442 800	1 962 400	2 787 900
Difference %	17.4	18.5	25.1	25.6
Recovery %	82.6	81.5	74.9	74.4

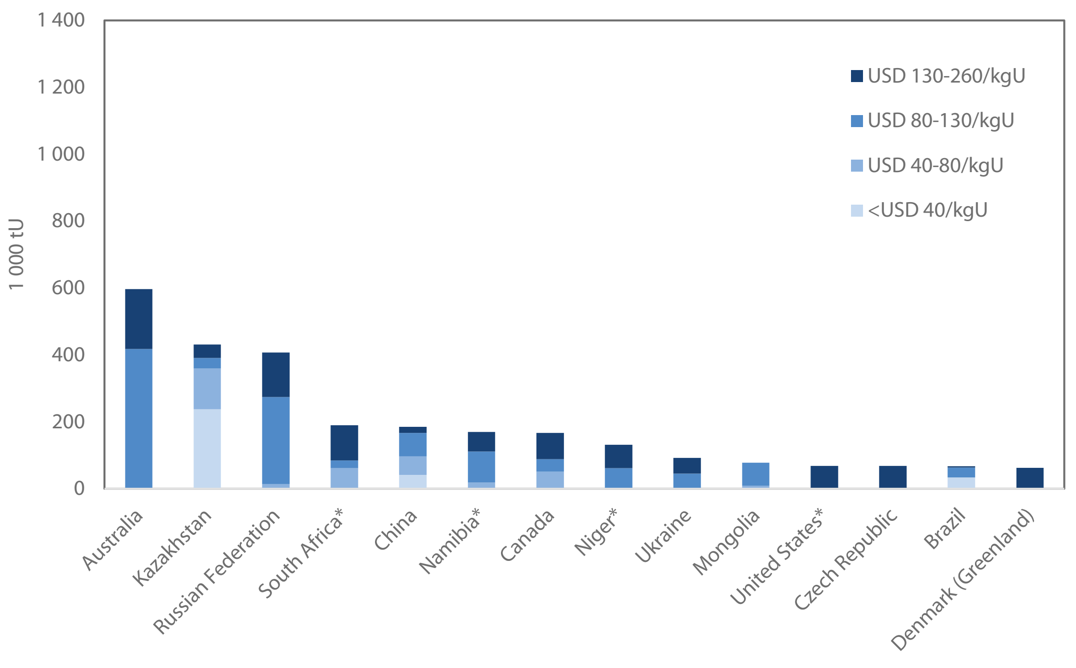
† Totals may not sum exactly, or exactly match totals reported in other tables of this report, due to rounding.

Figure 1.2. **Distribution of reasonably assured recoverable conventional uranium resources among selected countries with a significant share of resources (1 000 tU)**



* Secretariat estimate or partial estimate.

Figure 1.3. **Distribution of inferred recoverable conventional uranium resources among selected countries with a significant share of resources (1 000 tU)**



* Secretariat estimate or partial estimate.

Table 1.3a. **Reasonably assured recoverable uranium resources**

(as of 1 January 2025, tonnes U, rounded to nearest 100 tonnes†)

Country	Cost ranges			
	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Algeria(a,b)	0	0	0	19 500
Argentina	0	7 300	15 900	15 900
Australia	0	0	1 283 400	1 362 400
Botswana*	0	0	13 600	13 600
Brazil (a)	53 000	53 000	104 600	110 000
Canada	0	360 600	463 700	639 200
Chile*(b)	0	0	0	600
China(a)	31 800	79 200	158 700	162 200
Congo, Dem. Rep.*(a,b,c)	0	0	0	1 400
Czechia	0	0	700	50 800
Denmark/Greenland(a,b)	0	0	0	51 400
Finland(a,b,f)	0	0	1 200	1 200
Gabon(b,c)	0	0	4 800	4 800
Germany (b)	0	0	0	3 000
Greece(b,c)	0	0	0	1 000
Guyana(a,b)	0	0	0	2 400
India(a,d)	0	0	0	264 900
Indonesia(a)	0	1 500	5 500	5 500
Iran, Islamic Republic of*(a,b,c)	0	0	3 200	3 200
Italy(b,c)	0	4 800	4 800	4 800
Japan(b)	0	0	6 600	6 600
Jordan(a)	0	0	0	5 400
Kazakhstan(a)	274 500	384 500	435 900	455 600
Malawi(g)	0	0	6 500	13 800
Mali*(a,b,c)	0	0	5 000	5 000
Mauritania*	0	0	12 300	12 600
Mexico(a,c)	0	0	2 500	2 500
Mongolia	0	7 600	66 200	66 200
Namibia*	0	21 100	281 100	324 600
Niger*	0	34 600	289 600	331 600
Paraguay*(a,e)	0	0	2 900	2 900
Peru*(a,b)	0	14 000	14 000	14 000
Portugal(a,b)	0	3 400	4 500	4 500
Romania(b,c)	0	0	3 300	3 300
Russian Federation	0	16 000	197 800	243 200
Saudi Arabia(a,h)	0	0	0	31 700
Senegal(a)	0	0	0	1 900
Slovak Republic(a,b)	0	8 800	8 800	8 800
Slovenia(a,b)	0	1 700	1 700	1 700
Somalia*(a,b,c)	0	0	0	5 000
South Africa*	0	166 300	236 000	246 100
Spain(a)	8 100	19 100	19 100	19 100

Table 1.3a. **Reasonably assured recoverable uranium resources (cont'd)**

(as of 1 January 2025, tonnes U, rounded to nearest 100 tonnes†)

Country	Cost ranges			
	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Sweden*[a,b,c]	0	0	4 900	4 900
Tanzania*	0	38 300	40 400	40 400
Türkiye[a]	0	0	3 700	3 700
Ukraine[a]	0	2 700	115 800	176 600
United States[a,i]	0	0	16 700	131 700
Uzbekistan[a]	0	26 700	48 300	66 100
Viet Nam[a,b]	0	0	0	800
Zambia*	0	0	20 800	20 800
Zimbabwe[a,b]	0	0	0	2 000
Total[k]	**367 400**	**1 251 100**	**3 904 400**	**4 970 800**

† Totals may not sum exactly, or exactly match totals reported in other tables of this report, due to rounding. * Secretariat estimate.

(a) In situ resources were adjusted by the Secretariat to estimate recoverable resources using recovery factors provided by countries or estimated by the Secretariat according to the expected production method (See Appendix 3 for recovery factors). (b) Assessment not made within the last five years. (c) Not reported in 2025 responses; data is from Red Book 2024. (d) Cost data not provided; therefore, resources are reported in the <USD 260/kgU category. (e) Recovery factors partially adjusted by Secretariat. (f) Finland also reports unconventional reasonably assured recoverable resources of ~ 8 700 tU for the Talvivaara black schist-hosted Ni-Zn-Cu-Co deposit. (g) Secretariat estimate of <USD 130/kgU category, based on Kayelekera restart study information. (h) Unconventional resources for the Ghurayyah polymetallic (Th-U-Nb-Ta and REE-bearing minerals) deposit and Jabal Sayid U-Th prospect. (i) Secretariat estimate for other than the <USD 260/kgU category total, since other cost category data withheld, for concerns over confidentiality of company data. (k) Totals for <USD 40/kgU and <USD 80/kgU cost ranges should be regarded with some caution as certain countries do not report low-cost resource estimates, whereas other (non-producing) countries may underestimate mining costs.

Table 1.3b. **Reasonably assured in situ uranium resources**

(as of 1 January 2025, tonnes U, rounded to nearest 100 tonnes†)

Country	Cost ranges			
	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Algeria[b]	0	0	0	26 000
Argentina[a]	0	9 000	20 900	20 900
Australia[a]	0	0	2 031 700	2 154 800
Botswana*[a]	0	0	21 900	21 900
Brazil	81 600	81 600	146 800	154 500
Canada[a]	0	414 500	533 000	734 700
Chile*[a,b]	0	0	0	700
China	45 400	112 700	222 600	227 300
Congo, Dem. Rep.*[b,c]	0	0	0	1 900
Czechia[a]	0	0	1 200	83 700
Denmark/Greenland[b]	0	0	0	102 800
Finland[b,f]	0	0	1 500	1 500
Gabon[a,b,c]	0	0	6 400	6 400
Germany[a,b]	0	0	0	4 000
Greece[a,b,c]	0	0	0	1 300
Guyana[b]	0	0	0	3 200
India[d]	0	0	0	351 700
Indonesia	0	2 000	7 400	7 400

Table 1.3b. **Reasonably assured in situ uranium resources (cont'd)**

(as of 1 January 2025, tonnes U, rounded to nearest 100 tonnes†)

Country	Cost ranges			
	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Iran, Islamic Republic of*(b,c)	0	0	4 300	4 300
Italy(a,b,c)	0	6 400	6 400	6 400
Japan(a,b)	0	0	7 800	7 800
Jordan	0	0	0	6 800
Kazakhstan	308 400	432 300	491 300	514 900
Malawi(a,g)	0	0	8 000	18 000
Mali*(b,c)	0	0	6 700	6 700
Mauritania*(a)	0	0	15 300	15 700
Mexico(c)	0	0	3 300	3 300
Mongolia(a)	0	10 100	88 200	88 200
Namibia*(a)	0	26 400	343 400	396 800
Niger*(a)	0	41 700	342 600	391 900
Paraguay*(e)	0	0	3 400	3 400
Peru*(b)	0	20 000	20 000	20 000
Portugal(b)	0	4 500	6 000	6 000
Romania(a,b,c)	0	0	4 400	4 400
Russia(a)	0	21 300	245 900	315 800
Saudi Arabia(h)	0	0	0	42 200
Senegal	0	0	0	2 600
Slovak Republic(b)	0	11 000	11 000	11 000
Slovenia(b)	0	2 200	2 200	2 200
Somalia*(b,c)	0	0	0	6 700
South Africa* (a)	0	221 800	314 100	327 300
Spain	9 800	23 000	23 000	23 000
Sweden*(b,c)	0	0	6 500	6 500
Tanzania*(a)	0	47 900	50 500	50 500
Türkiye	0	0	4 300	4 300
Ukraine	0	3 600	132 500	201 500
United States(i)	0	0	23 900	180 100
Uzbekistan	0	38 100	69 000	94 400
Viet Nam(b)	0	0	0	1 200
Zambia*(a)	0	0	22 900	22 900
Zimbabwe(b)	0	0	0	2 700
Total(k)	**445 200**	**1 530 000**	**5 250 100**	**6 694 100**

† Totals may not sum exactly, or exactly match totals reported in other tables of this report, due to rounding. * Secretariat estimate.

(a) Recoverable resources were adjusted by the Secretariat to estimate in situ resources using recovery factors provided by countries or estimated by the Secretariat according to the expected production method (See Appendix 3 for recovery factors). (b) Assessment not made within the last five years. (c) Not reported in 2025 responses; data is from Red Book 2024. (d) Cost data not provided; therefore, resources are reported in the <USD 260/kgU category. (e) Recovery factors partially adjusted by Secretariat. (f) Finland also reports unconventional reasonably assured in situ resources of ~19 400 tU for the Talvivaara black schist-hosted Ni-Zn-Cu-Co deposit. (g) Secretariat estimate of <USD 130/kgU category, based on Kayelekera restart study information. (h) Unconventional resources for the Ghurayyah polymetallic (Th-U-Nb-Ta and REE-bearing minerals) deposit and Jabal Sayid U-Th prospect. (i) Secretariat estimate for other than the <USD 260/kgU category total, since other cost category data withheld, for concerns over confidentiality of company data. (k) Totals for <USD 40/kgU and <USD 80/kgU cost ranges should be regarded with some caution as certain countries do not report low-cost resource estimates, whereas other (non-producing) countries may underestimate mining costs.

Table 1.4a. **Inferred recoverable uranium resources**

(as of 1 January 2025, tonnes U, rounded to nearest 100 tonnes†)

Country	Cost ranges			
	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Argentina	0	2 300	17 800	18 900
Australia	0	0	418 200	596 700
Bolivia(a,b,c)	0	0	0	1 300
Botswana*	0	0	13 600	13 600
Brazil (a)	33 800	33 800	63 200	67 800
Bulgaria(a,b,d)	0	0	0	5 100
Cameroon(a,b,c)	0	0	0	21 000
Canada	0	51 300	88 000	166 600
Central African Republic*(a,c)	0	0	0	29 200
Chad*(a,b,c)	0	0	0	2 400
Chile*(b)	0	0	0	900
China(a)	41 400	96 600	166 800	185 000
Congo, Dem. Rep.*(a,b,c)	0	0	0	1 300
Czechia	0	0	0	68 300
Denmark/Greenland(a,b)	0	0	0	62 600
Egypt(a,c)	0	0	400	12 100
Gabon(b,c)	0	0	0	1 000
Germany (b)	0	0	0	4 000
Greece(b,c)	0	0	0	6 000
Guyana(a,b)	0	0	0	2 200
Hungary(a)	0	0	0	16 700
India(a,d)	0	0	0	8 700
Indonesia(a)	0	0	3 000	3 000
Iran, Islamic Republic of*(a,b,c)	0	0	4 200	4 200
Italy(b,c)	0	1 300	1 300	1 300
Jordan(a)	0	0	0	43 600
Kazakhstan(a)	238 000	359 800	391 500	431 400
Malawi(f)	0	0	0	4 900
Mali*(a,b,c)	0	0	3 900	3 900
Mauritania*	0	0	15 800	22 800
Mexico(a,c)	0	500	2 000	2 600
Mongolia	0	9 300	78 400	78 400
Namibia*	0	18 400	111 700	169 900
Niger*	0	0	61 500	131 200
Pakistan*(a,c)	0	0	0	22 500
Paraguay*(a,e)	0	0	1 400	1 400

Table 1.4a. **Inferred recoverable uranium resources (cont'd)**

(as of 1 January 2025, tonnes U, rounded to nearest 100 tonnes†)

Country	Cost ranges			
	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Peru*[a,b]	0	19 400	19 400	19 400
Portugal[a,b]	0	0	800	800
Romania[b,c]	0	0	4 700	4 700
Russian Federation	0	13 900	273 900	407 200
Saudi Arabia[a,g]	0	0	0	32 400
Senegal[a]	0	0	0	3 100
Slovak Republic[a,b]	0	3 900	6 700	6 700
Slovenia[a,b]	0	3 800	7 500	7 500
Somalia*[a,b,c]	0	0	0	2 600
South Africa*	0	61 700	84 800	189 900
Spain[a]	0	9 400	9 400	9 400
Sweden*[a,b,c]	0	0	4 700	4 700
Tanzania*	0	8 500	17 300	17 300
Türkiye[a]	0	0	23 400	32 300
Ukraine[a]	0	1 500	45 500	92 400
United States*[a,h]	0	0	0	68 800
Uzbekistan[a]	0	0	15 700	15 700
Viet Nam[a,b]	0	0	0	3 000
Zambia*	0	0	3 500	3 500
Total[i]	**313 200**	**695 400**	**1 960 100**	**3 133 700**

† Totals may not sum exactly, or exactly match totals reported in other tables of this report, due to rounding. * Secretariat estimate.

(a) In situ resources were adjusted by the Secretariat to estimate recoverable resources using recovery factors provided by countries or estimated by the Secretariat according to the expected production method (See Appendix 3 for recovery factors). (b) Assessment not made within the last five years. (c) Not reported in 2025 responses; data is from Red Book 2024. (d) Cost data not provided; therefore, resources are reported in the <USD 260/kgU category. (e) Recovery factors partially adjusted by Secretariat. (f) Secretariat estimate of <USD 130/kgU category, based on Kayelekera restart study information. (g) Unconventional resources for the Ghurayyah polymetallic (Th-U-Nb-Ta and REE-bearing minerals) deposit and Jabal Sayid U-Th prospect. (h) Secretariat estimate, based on compilation of company disclosures, as the United States does not include inferred resources in country reports. (i) Totals for <USD 40/kgU and <USD 80/kgU cost ranges should be regarded with some caution as certain countries do not report low-cost resource estimates, whereas other (non-producing) countries may underestimate mining costs.

Table 1.4b. **Inferred in situ uranium resources**

(as of 1 January 2025, tonnes U, rounded to nearest 100 tonnes†)

Country	Cost ranges			
	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Argentina(a)	0	2 900	24 400	25 900
Australia(a)	0	0	655 900	911 900
Bolivia(b,c)	0	0	0	1 700
Botswana*(a)	0	0	21 900	21 900
Brazil	52 000	52 000	89 500	96 000
Bulgaria(b,d)	0	0	0	7 900
Cameroon(b,c)	0	0	0	28 000
Canada(a)	0	59 000	101 200	191 500
Central African Republic*(c)	0	0	0	36 500
Chad*(b,c)	0	0	0	3 200
Chile*(a,b)	0	0	0	1 200
China	59 200	137 300	233 900	258 200
Congo, Dem. Rep.*(b,c)	0	0	0	1 700
Czechia(a)	0	0	0	113 500
Denmark/Greenland/(b)	0	0	0	125 100
Egypt(c)	0	0	500	16 100
Gabon(a,b,c)	0	0	0	1 300
Germany(a,b)	0	0	0	5 300
Greece(a,b,c)	0	0	0	8 000
Guyana(b)	0	0	0	2 900
Hungary	0	0	0	22 200
India(d)	0	0	0	11 500
Indonesia	0	0	4 100	4 100
Iran, Islamic Republic of*(b,c)	0	0	5 500	5 500
Italy(a,b,c)	0	1 700	1 700	1 700
Jordan	0	0	0	56 200
Kazakhstan	267 400	404 500	441 800	489 800
Malawi(a,f)	0	0	0	6 200
Mali*(b,c)	0	0	5 200	5 200
Mauritania*(a)	0	0	19 700	29 100
Mexico(c)	0	700	2 700	3 400
Mongolia(a)	0	12 400	104 100	104 100
Namibia*(a)	0	23 000	138 100	209 800
Niger*(a)	0	0	76 200	168 900
Pakistan*(c)	0	0	0	30 000
Paraguay*(e)	0	0	1 600	1 600

Table 1.4b. **Inferred in situ uranium resources (cont'd)**

(as of 1 January 2025, tonnes U, rounded to nearest 100 tonnes†)

Country	Cost ranges			
	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Peru*(b)	0	27 700	27 700	27 700
Portugal(b)	0	0	1 000	1 000
Romania(a,b,c)	0	0	6 200	6 200
Russia(a)	0	18 500	332 200	516 700
Saudi Arabia(g)	0	0	0	43 200
Senegal	0	0	0	4 200
Slovak Republic(b)	0	4 900	8 400	8 400
Slovenia(b)	0	5 000	10 000	10 000
Somalia*(b,c)	0	0	0	3 500
South Africa* (a)	0	85 600	116 400	261 800
Spain	0	11 400	11 400	11 400
Sweden*(b,c)	0	0	6 300	6 300
Tanzania*(a)	0	10 600	21 700	21 700
Türkiye	0	0	29 200	41 100
Ukraine	0	2 000	52 000	105 200
United States*(h)	0	0	0	92 300
Uzbekistan	0	0	22 500	22 500
Viet Nam(b)	0	0	0	4 000
Zambia*(a)	0	0	3 900	3 900
Total(i)	**378 600**	**859 200**	**2 576 800**	**4 198 300**

† Totals may not sum exactly, or exactly match totals reported in other tables of this report, due to rounding. * Secretariat estimate.

(a) Recoverable resources were adjusted by the Secretariat to estimate in situ resources using recovery factors provided by countries or estimated by the Secretariat according to the expected production method (See Appendix 3 for recovery factors). (b) Assessment not made within the last five years. (c) Not reported in 2025 responses; data is from Red Book 2024. (d) Cost data not provided; therefore, resources are reported in the <USD 260/kgU category. (e) Recovery factors partially adjusted by Secretariat. (f) Secretariat estimate of <USD 130/kgU category, based on Kayelekera restart study information. (g) Unconventional resources for the Ghurayyah polymetallic (Th-U-Nb-Ta and REE-bearing minerals) deposit and Jabal Sayid U-Th prospect. (h) Secretariat estimate, based on compilation of company disclosures, as the United States does not include inferred resources in country reports. (i) Totals for <USD 40/kgU and <USD 80/kgU cost ranges should be regarded with some caution as certain countries do not report low-cost resource estimates, whereas other (non-producing) countries may underestimate mining costs.

Table 1.5. **Major identified recoverable uranium resources, changes by country**

(as of 1 January 2025, tonnes U, rounded to nearest 100 tonnes)

Country	Resource category	2023	2025	Changes	Reasons
Australia	**RAR**				RAR increase (+3.8% at <USD 130/kgU) is a result of resource increases at Olympic Dam and Mulga Rock, partially offset by resources depletion from mining (> 9 000 tU for 2023-2024). Decrease in inferred resources (-3.9% at <USD 130/kgU) directly attributable to decrease of inferred resources at Olympic Dam.
	<USD 130/kgU	1 236 200	1 283 400	47 200	
	<USD 260/kgU	1 317 000	1 362 400	45 400	
	Inferred				
	<USD 130/kgU	435 000	418 200	-16 800	
	<USD 260/kgU	618 300	596 700	-21 600	
Botswana	**RAR**				Decrease both in RAR and inferred resources as a result of new drilling information, application of higher cut-off grade and new resource estimate constrained by an optimal pit shell at Letlhakane.
	<USD 130/kgU	20 400	13 600	-6 800	
	<USD 260/kgU	20 400	13 600	-6 800	
	Inferred				
	<USD 130/kgU	66 800	13 600	-53 200	
	<USD 260/kgU	66 800	13 600	-53 200	
Canada	**RAR**				Decrease in RAR at <USD 130/kgU (and <USD 260/kgU) is primarily a result of mining depletion (> 25 000 tU for 2023-2024). Decrease in inferred resources at <USD 260/kgU is attributable to the removal of a resource estimate. Resource increases at <USD 80/kgU are due to reclassification consistent with published cost estimates of technical studies.
	<USD 80/kgU	278 200	360 600	82 400	
	<USD 130/kgU	492 700	463 700	-29 000	
	<USD 260/kgU	667 400	639 200	-28 200	
	Inferred				
	<USD 80/kgU	9 700	51 300	41 600	
	<USD 130/kgU	89 300	88 000	-1 300	
	<USD 260/kgU	184 800	166 600	-18 200	
China	**RAR**				Significant increase in both RAR and inferred resources as a result of successful exploration, particularly in expanding resources of sandstone-type deposits for ISL mining in northern China.
	<USD 40/kgU	31 800	31 800	0	
	<USD 80/kgU	79 200	79 200	0	
	<USD 130/kgU	132 800	158 700	25 900	
	<USD 260/kgU	136 300	162 200	25 900	
	Inferred				
	<USD 40/kgU	41 400	41 400	0	
	<USD 80/kgU	96 600	96 600	0	
	<USD 130/kgU	137 700	166 800	29 100	
	<USD 260/kgU	155 000	185 000	30 000	
India[a]	**RAR**				Increase (~8.3%) in both RAR and inferred resources due to appreciable additions contiguous to the stratabound carbonate deposit in the Cuddapah Basin, extension of known metamorphite deposits in the Singhbhum Shear Zone and metasomatite deposits in the North Delhi Fold Belt.
	<USD 260/kgU	244 600	264 900	20 300	
	Inferred				
	<USD 260/kgU	8 000	8 700	700	
Kazakhstan	**RAR**				Minor increase (~1.6%) in total identified resources due to additional resources from exploration at Budenovskoye, Western Mynkuduk, Moinkum and Kharasan deposits, partially offset by resource depletion from mining (> 44 000 tU for 2023-2024).
	<USD 40/kgU	271 800	274 500	2 700	
	<USD 80/kgU	363 400	384 500	21 100	
	<USD 130/kgU	414 800	435 900	21 100	
	<USD 260/kgU	434 500	455 600	21 100	
	Inferred				
	<USD 40/kgU	227 000	238 000	11 000	
	<USD 80/kgU	367 300	359 800	-7 500	
	<USD 130/kgU	399 100	391 500	-7 600	
	<USD 260/kgU	438 900	431 400	-7 500	

Table 1.5. **Major identified recoverable uranium resources, changes by country (cont'd)**

(as of 1 January 2025, tonnes U, rounded to nearest 100 tonnes)

Country	Resource category	2023	2025	Changes	Reasons
Namibia*	**RAR**				Significant decrease (~10.8%) in total identified resources as a result of resource re-estimation of three different deposits – Husab, Etango, Norasa – and mining depletion at Husab and Rössing (> 14 000 tU for 2023-2024), offset slightly by additional resources estimated at Koppies deposit.
	<USD 80/kgU	14 800	21 100	6 300	
	<USD 130/kgU	322 000	281 100	-40 900	
	<USD 260/kgU	337 600	324 600	-13 000	
	Inferred				
	<USD 80/kgU	18 400	18 400	0	
	<USD 130/kgU	175 900	111 700	-64 200	
	<USD 260/kgU	213 100	169 900	-43 200	
Saudi Arabia	**RAR**				Substantial increase (~39%) in total identified resources and upgrading of inferred to RAR, due to additional resources from continued exploration success at the polymetallic Th-U-Nb-Ta and REE-bearing Ghurayyah deposit and the Jabal Sayid U-Th prospect.
	<USD 260/kgU	6 000	31 700	25 700	
	Inferred				
	<USD 260/kgU	40 000	32 400	-7 600	
Ukraine	**RAR**				Substantial increase (~46%) in total identified resources at <USD 260/kgU resulting from a comprehensive reassessment of Ukrainian identified uranium resources. Ukraine also assessed resources at <USD 390/kgU, representing a further ~40 000 tU recoverable identified resources.
	<USD 80/kgU	44 800	2 700	-42 100	
	<USD 130/kgU	72 900	115 800	42 900	
	<USD 260/kgU	120 000	176 600	56 600	
	Inferred				
	<USD 80/kgU	26 700	1 500	-25 200	
	<USD 130/kgU	33 800	45 500	11 700	
	<USD 260/kgU	64 800	92 400	27 600	
United States(b)	**RAR**				~8.5% increase in reported recoverable identified resources. Additionally, Secretariat estimate of inferred resources is included this edition, based on publicly available company disclosures (United States country report does not report inferred resources).
	<USD 80/kgU	0	0	0	
	<USD 130/kgU	67 800	16 700	-51 100	
	<USD 260/kgU	121 400	131 700	10 300	
	Inferred				
	<USD 260/kgU	0	68 800	68 800	
Uzbekistan	**RAR**				Substantial increase (~28.6%) in total identified resources as a result of successful exploration and reassessment of some deposits, partially offset by resource depletion from mining (> 9 000 tU for 2023-2024).
	<USD 80/kgU	24 900	26 700	1 800	
	<USD 130/kgU	40 200	48 300	8 100	
	<USD 260/kgU	54 200	66 100	11 900	
	Inferred				
	<USD 80/kgU	3 600	0	-3 600	
	<USD 130/kgU	4 800	15 700	10 900	
	<USD 260/kgU	9 400	15 700	6 300	

* Secretariat estimate.

(a) Cost data not provided; therefore, resources are reported in the <USD 260/kgU category. (b) Secretariat estimate for other than the RAR <USD 260/kgU category total, since other cost data withheld, over concerns for confidentiality of company data. In this edition, a Secretariat estimate is also included of total recoverable inferred resources, based on a compilation of company disclosures, as the United States does not include inferred resources in country reports.

Reasonably assured resources amount to 61% of the identified resource total, a 1% increase compared to the previous report. As of 1 January 2025, low-cost RAR and IR comprised 7.4% and 10.0%, respectively, of total RAR and IR, declining by 0.2% and increasing by 0.4%, respectively, from 2023.

Australia reported increased RAR and decreased IR due to delineation of new resources at Olympic Dam (resulting in shift from IR to RAR), and an increased resource estimate for Mulga Rock, partially offset by depletion from mining. Botswana reported decreased RAR and decreased IR resulting from a new resource estimate for the Letlhakane deposit, applying a higher cut-off grade and constrained by an optimal pit shell. Canada reported a decrease in higher-cost RAR (<USD 130/kgU, <USD 260/kgU) owing mainly to mining depletion, a decrease in IR at <USD 260/kgU attributable to removal of a deposit resource estimate, and increases to lower-cost (<USD 80/kgU) RAR and IR due to reclassification consistent with published technical study cost estimates. China reported significantly increased RAR and IR due to exploration success translating to resource expansion, primarily at the ISL amenable sandstone deposits in northern China. In India, ongoing exploration efforts led to an 8% increase in high-cost (<USD 260/kgU) RAR and IR, compared to 2023. Kazakhstan reported increased RAR in all cost categories, partially offset by decreased IR in all but the lowest-cost (<USD 40/kgU) category, due to exploration success at Budenovskoye, Western Mynkuduk, Moinkum and Kharasan deposits, partially offset by resource depletion from mining. Namibia recorded a significant decrease in RAR and IR due to resource re-estimations for the Husab, Etango and Norasa deposits, and mining depletion, offset slightly by additional resources estimated at the Koppies deposit. Saudi Arabia saw an increase in identified resources and upgrading of IR to RAR, due to continued exploration success at the Ghurayyah deposit and the Jabal Sayid prospect. Ukraine reported a substantial increase in RAR and IR at the higher cost categories (<USD 130/kgU, <USD 260/kgU) and a substantial decrease at the lower-cost category (<USD 80/kgU), arising from a comprehensive reassessment of their identified uranium resources. The United States reported an 8% increase in RAR at <USD 260/kgU, and a Secretariat estimate of IR based on publicly available company disclosures is included for the first time in this edition (as the United States does not report IR). Uzbekistan saw an increase in both RAR and IR at higher cost categories (<USD 130/kgU, <USD 260/kgU) from successful exploration results and reassessment of some deposits, partially offset by resource depletion from mining.

Three countries, Australia, Kazakhstan and Canada, collectively host approximately half of global identified conventional uranium resources (53% at USD 130/kgU, 45% at <USD 260/kgU). Australia dominates the world's uranium resources with 29% of the total identified recoverable resources at <USD 130/kgU and 24% of identified resources at <USD 260/kgU. Fully 69% of Australia's uranium resources (and nearly 17% of global identified resources) are attributed to the world-class polymetallic Olympic Dam deposit, where uranium is mined as a co-product of copper. Kazakhstan remains second, hosting approximately 14% of worldwide identified resources at <USD 130/kgU and 11% at <USD 260/kgU. Canada's share reduced slightly from that reported in the 2024 edition to about 9% in the <USD 130/kgU category and 10% in the <USD 260/kgU category. Fifteen countries represent approximately 95% of the total identified resources in the <USD 130/kgU cost category (see Figure 1.1) and almost 90% at <USD 260/kgU.

With respect to the lower cost categories, four countries reported recoverable uranium resources in the lowest cost category (<USD 40/kgU), and of these Kazakhstan has by far the largest share (75%), followed by Brazil (13%), China (11%) and Spain (1%). In the <USD 80/kgU cost category, Kazakhstan holds a 38% share, followed by Canada (21%), South Africa (12%), China (9%) and Brazil (4%), with nine other countries each holding shares of 1% to 2% in this cost category. Readers are cautioned concerning resource estimates for both of these lower cost categories. Costs of <USD 40/kgU (<USD 15/lb U_3O_8) are extremely low and, in the case of undeveloped resources, unlikely, other than for very few unique situations. Recognising this, many countries no longer report in the <USD 40/kgU category. Costs of <USD 80/kgU (<USD 30/lb U_3O_8) should be viewed as low cost for undeveloped resources. Size of the resource, quality (i.e. grade, amenability of uranium to recovery, accessibility), expected mining and processing method, and infrastructure are all factors that have significant impact on costs. In many cases the resources have been assigned to the cost categories based on the results of technical evaluation studies that range broadly in accuracy and precision from Preliminary Economic Assessments (PEA) to Preliminary Feasibility Studies (PFS), to Feasibility Studies or Definitive Feasibility Studies (FS, DFS), and generally, studies have proven to underestimate actual costs. A total of 21 countries reported recoverable uranium resources in the <USD 80/kgU category. Ten of these countries, accounting for approximately 5% of the <USD 80/kgU resources, warrant thorough review for the next Red Book edition cycle.

Starting with the 2016 edition, a summary of worldwide in situ identified conventional resources (see Tables 1.2b, 1.3b and 1.4b) has been prepared. Table 1.2c is a summary comparison of in situ identified resources and recoverable identified resources by cost category. Overall, there is a 17% to 26% increase in the resource figures when they are reported as in situ. This corresponds to average recoveries ranging from approximately 74% to 83%. Total identified in situ resources increased 1.7% from 10 714 400 tU reported in the last edition to 10 892 400 tU for this edition.

Reporting in situ resources provides a view of the full available resource base in the ground, allows clear comparison of average recoveries, and by quantifying the non-recovered portion, gives an indication of how the resources could be increased with improvements in mining and processing methods. Nonetheless, recoverable resources provide the more realistic estimate for forecasting future uranium supply.

Distribution of resources by production method

For this edition of the Red Book, countries continued to report identified resources by cost categories and by the expected production method: open-pit mining, underground mining, acid or alkaline in situ leaching (ISL, also referred to as in situ recovery, or ISR), co-product/by-product or unspecified.

In the cost category <USD 40/kgU, with only four countries reporting resources in this lowest cost category, there is a limited subset of production methods represented, as is evident in Table 1.6 (RAR): mainly ISL acid, ISL alkaline and co-product/by-product production methods. Low-cost resources amenable to production by ISL, mainly in Kazakhstan and to a lesser extent in China, dominate this lowest cost category, representing 83% of total RAR resources. Resources suited for co-product/by-product from phosphates in Brazil make up most of the remainder. The <USD 40/kgU category should be interpreted with caution due to limited reporting and potential underestimation of mining costs in countries without recent uranium mining activity.

Table 1.6. **Reasonably assured recoverable uranium resources by production method**

(as of 1 January 2025, tonnes U, rounded to nearest 100 tonnes†)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Open-pit mining	8 100	123 200	876 800	1 064 600
Underground mining	0	348 500	955 500	1 510 400
In situ leaching acid	282 900	500 300	612 300	679 900
In situ leaching alkaline	23 300	54 900	101 100	141 600
Co-product/by-product	53 000	219 400	1 316 000	1 462 800
Unspecified	0	4 800	42 700	111 500
Total	**367 400**	**1 251 100**	**3 904 400**	**4 970 800**

† Totals may not sum exactly, or exactly match totals reported in other tables of this report, due to rounding.

In the <USD 80/kgU category, resources amenable to production by ISL (Kazakhstan, China, Uzbekistan, Russia, Mongolia, Canada, Namibia and Ukraine) make the most significant contribution (44% total ISL) with resources identified for underground mining (mainly from Canada, with minor amounts from four other countries) being the second most represented at 28% of total resources. The by-product/co-product category (Brazil and South Africa) makes up 18%, with open-pit mining (Argentina, Namibia, Niger and others) at 10%.

In the <USD 130/kgU category, resources in the by-product/co-product category make up 34% of the total, predominately as a result of the Olympic Dam deposit in Australia, adding to the resources in Brazil and South Africa. At this cost category, underground (mainly from Australia, Canada, China, Niger, Russia and Ukraine) and open-pit mining (mainly in Australia, Brazil, Namibia, Niger and Tanzania) resources contribute 24% and 22% respectively, followed by ISL acid at 16%.

In the <USD 260/kgU category, the underground (predominantly Australia, Canada, India, Russia and Ukraine) and co-product/by-product (from Australia, Brazil, Greenland and South Africa) production methods contribute about 30% each, followed by open-pit mining (mainly in Australia, Namibia and Niger) at 21% and ISL acid at 14%. Australia holds the largest resource for co-product/by-product, by far, while Canada holds the largest underground mining resource and Namibia makes the largest contributions in the open-pit production category. Kazakhstan holds the most resources for ISL acid, while the United States holds the most resources for ISL alkaline.

The pattern of resource distribution by production method for IR (Table 1.7) is similar to that for RAR. In the lowest cost categories (<USD 40/kgU and <USD 80/kgU), resources amenable to ISL production dominate, principally in Kazakhstan. In the <USD 130/kgU category, ISL amenable resources (dominated by Kazakhstan, China and Mongolia), contribute the most resources, followed closely by underground mining (mainly Australia, Canada, China, Russia and Ukraine), co-product/by-product (from Australia, Brazil and South Africa), and open-pit mining (mainly Australia, Namibia and Niger). In the highest cost category (<USD 260/kgU), underground mining (mainly Russia and Canada) is the leading contributor, with ISL (mainly Kazakhstan, followed by Australia, China, Czechia, Mongolia and the United States), co-product/by-product (mainly Australia, Brazil, Greenland and South Africa), and open-pit mining (mainly Australia, Namibia and Niger) all making significant contributions.

Table 1.7. **Inferred recoverable resources by production method**

(as of 1 January 2025, tonnes U, rounded to nearest 100 tonnes†)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Open-pit mining	0	39 600	327 600	571 800
Underground mining	0	71 500	543 700	911 000
In situ leaching acid	249 000	420 500	521 900	641 900
In situ leaching alkaline	30 400	64 700	89 000	123 100
Co-product/by-product	33 800	97 100	443 800	636 500
Unspecified	0	1 800	34 100	249 500
Total	**313 200**	**695 400**	**1 960 100**	**3 133 700**

† Totals may not sum exactly, or exactly match totals reported in other tables of this report, due to rounding.

Distribution of resources by processing method

Countries also continued to report identified conventional resources by cost categories and by the expected processing method: conventional from open-pit or conventional from underground mining, ISL, in-place leaching, heap leaching from open-pit or heap leaching from underground, or unspecified. The overall distribution for both RAR and IR at all cost categories is very similar to the last reporting period.

With only four countries reporting resources at the lowest cost category (<USD 40/kgU), Kazakhstan ISL acid amenable RAR dominate (See Table 1.8). At <USD 80/kgU, conventional processing from underground mining becomes an equal contributor to ISL acid, largely driven by RAR from Canada and South Africa. At the higher cost categories (<USD 130/kgU and <USD 260/kgU), a majority of RAR is classified as conventional processing from underground, owing principally to

Australia's Olympic Dam deposit, followed by conventional processing from open-pit and ISL. Heap leaching, primarily from open-pit mining, becomes increasingly prevalent at the higher cost categories (<USD 130/kgU and <USD 260/kgU), particularly for Namibia and Niger.

Table 1.8. **Reasonably assured recoverable uranium resources by processing method**

(as of 1 January 2025, tonnes U, rounded to nearest 100 tonnes†)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Conventional from OP	58 400	159 500	693 900	895 600
Conventional from UG	2 800	515 900	2 195 400	2 770 900
In situ leaching acid	282 900	500 300	612 300	679 900
In situ leaching alkaline	23 300	54 900	101 100	141 600
In-place leaching*	0	0	500	500
Heap leaching** from OP	0	14 000	240 200	285 900
Heap leaching** from UG	0	0	16 800	23 900
Unspecified	0	6 500	44 300	172 500
Total	**367 400**	**1 251 100**	**3 904 400**	**4 970 800**

† Totals may not sum exactly, or exactly match totals reported in other tables of this report, due to rounding.

* Also known as stope leaching or block leaching.

** A subset of open-pit and underground mining, since it is used in conjunction with them.

With respect to IR (Table 1.9), ISL dominates in the two lowest cost categories, and in the two higher cost categories is surpassed by conventional from underground, largely due to resources from Australia, Russia, Canada and South Africa, followed by conventional from open-pit mining. Heap leaching from open-pit becomes increasingly prevalent in the higher cost categories (<USD 130/kgU and <USD 260/kgU), particularly from Namibia and Jordan. At the highest cost category more than 10% of IR is reported as unspecified processing method, as the exploration of many deposits is insufficiently advanced for planning to define likely methods.

Table 1.9. **Inferred recoverable uranium resources by processing method**

(as of 1 January 2025, tonnes U, rounded to nearest 100 tonnes†)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Conventional from OP	28 300	50 200	292 300	536 400
Conventional from UG	5 500	134 900	940 300	1 386 500
In situ leaching acid	249 000	420 500	521 900	641 900
In situ leaching alkaline	30 400	64 700	89 000	123 100
In-place leaching*	0	0	2 100	4 600
Heap leaching** from OP	0	19 400	65 800	106 300
Heap leaching** from UG	0	0	6 700	8 000
Unspecified	0	5 600	42 000	327 100
Total	**313 200**	**695 400**	**1 960 100**	**3 133 700**

† Totals may not sum exactly, or exactly match totals reported in other tables of this report, due to rounding.

* Also known as stope leaching or block leaching.

** A subset of open-pit and underground mining, since it is used in conjunction with them.

The predominance of ISL amenable resources at lower cost categories is evident from these tables. Considering only ISL acid, this processing method makes up 14% of total RAR and 20% of total IR at <USD 260/kgU, whereas at <USD 40/kgU it accounts for 77% and 80% respectively, and 40% of RAR and 60% of IR at <USD 80/kgU.

Distribution of resources by deposit type

In 2025, countries also continued to report identified resources by cost categories and by geological types of deposits using the deposit classification scheme introduced in the 2014 edition (See Appendix 3). The overall distribution at all cost categories is similar to the last reporting period.

Sandstone-type RAR, mainly in Australia, China, Kazakhstan, Niger and the United States, tops all cost categories (Table 1.10). In the higher cost categories (<USD 130/kgU and <USD 260/kgU), polymetallic iron-oxide breccia complex deposits, namely at Olympic Dam in Australia, become increasingly prevalent, along with Proterozoic unconformity-related resources (mainly in Canada), followed by metasomatite (mainly in Brazil, Russia and Ukraine), intrusive (mainly Greenland, Namibia and Russia) and paleo-quartz-pebble conglomerate resources (South Africa).

Table 1.10. **Reasonably assured recoverable resources by deposit type**

(as of 1 January 2025, tonnes U, rounded to nearest 100 tonnes†)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Proterozoic unconformity	0	360 600	542 200	705 900
Sandstone	306 200	603 600	1 127 700	1 336 100
Polymetallic Fe-oxide breccia complex	0	0	1 027 200	1 067 700
Paleo-quartz-pebble conglomerate[(a)]	2 800	169 100	231 500	239 200
Granite-related	8 100	26 800	60 900	87 100
Metamorphite	50 300	51 800	59 900	129 300
Intrusive	0	0	206 600	373 000
Volcanic-related	0	27 500	136 700	142 700
Metasomatite	0	3 500	300 100	456 800
Surficial deposits	0	8 200	159 900	192 400
Carbonate	0	0	0	159 800
Collapse breccia	0	0	600	1 400
Phosphate	0	0	34 600	42 300
Lignite – coal	0	0	16 400	16 400
Black shale	0	0	0	11 700
Unspecified	0	0	0	9 000
Total	**367 400**	**1 251 100**	**3 904 400**	**4 970 800**

† Totals may not sum exactly, or exactly match totals reported in other tables of this report, due to rounding.

(a) In South Africa, Paleo-quartz-pebble conglomerate resources include tailings resources.

Similar patterns are apparent for IR (Table 1.11). Sandstone-hosted resources dominate all cost categories and, at the lowest cost category (<USD 40/kgU), account for almost 90% of IR. In the higher cost categories (<USD 130/kgU and <USD 260/kgU), polymetallic iron-oxide breccia complex type deposits (from Australia), metasomatite (mainly Kazakhstan, Russia and Ukraine), intrusive (mainly Greenland, Namibia, Russia and Saudi Arabia) and Proterozoic unconformity-type deposits (from Canada) rise in prevalence, but do not rival sandstone-based resources in abundance.

Table 1.11. **Inferred recoverable resources by deposit type**

(as of 1 January 2025, tonnes U, rounded to nearest 100 tonnes†)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Proterozoic unconformity	0	51 300	126 300	197 900
Sandstone	279 500	500 900	765 600	1 089 000
Polymetallic Fe-oxide breccia complex	0	0	333 000	396 700
Paleo-quartz-pebble conglomerate[(a)]	5 500	67 200	79 900	110 800
Granite-related	0	17 900	42 200	59 100
Metamorphite	28 300	28 300	35 500	42 200
Intrusive	0	0	61 600	256 600
Volcanic-related	0	24 600	100 800	118 400
Metasomatite	0	4 100	325 800	498 900
Surficial deposits	0	1 100	65 700	177 800
Carbonate	0	0	19 800	19 800
Collapse breccia	0	0	0	0
Phosphate	0	0	7 100	45 900
Lignite – coal	0	0	1 900	72 700
Black shale	0	0	0	11 700
Unspecified	0	0	0	36 200
Total	**313 200**	**695 400**	**1 965 200**	**3 133 700**

† Totals may not sum exactly, or exactly match totals reported in other tables of this report, due to rounding.

(a) In South Africa, Paleo-quartz-pebble conglomerate resources include tailings resources.

Proximity of resources to production centres

Estimates on the availability of resources for near-term production in eight countries are provided by reporting the percentage of identified resources (RAR and IR) recoverable at costs of <USD 80/kgU and <USD 130/kgU that are proximal to existing and committed production centres (Table 1.12). Resources proximal to existing and committed production centres in seven of the countries listed a total of 1 379 400 tU at <USD 80/kgU (about 88% of the total resources reported in this cost category). This is a 9.5% increase over the 2023 value of 1 259 600 tU. This change over the two-year reporting period is attributed to increased proximal resources in this cost category for Canada and Kazakhstan. Resources proximal to existing and committed production centres in the eight countries listed total 3 359 300 tU at <USD 130/kgU (about 70% of the total resources reported in this cost category). This is 5.5% greater than the 3 185 800 tU reported for 2023 and is the result of increases of proximal resources in this cost category for Canada, Kazakhstan, Niger and Australia, slightly offset by a decrease for Namibia.

Table 1.12. **Identified recoverable resources proximate to existing or committed production centres***

(as of 1 January 2025, tonnes U, rounded to nearest 100 tonnes)

Country	Identified recoverable resources					
	at <USD 80/kgU			at <USD 130/kgU		
	Total	Proximate	% Proximate	Total (tU)	Proximate	% Proximate
Australia	NA			1 701 600	1 411 500	83%
Brazil[(a)]	86 800	0	0%	167 800	47 400	28%
Canada	411 900	388 900	94%	551 700	513 600	93%
Kazakhstan	744 300	698 000	94%	827 500	698 000	84%
Namibia**	39 500	0	0%	392 800	206 500	53%
Niger**[(b)]	34 600	34 600	100%	351 100	77 900	22%
Russia	29 900	29 900	100%	471 700	101 300	21%
South Africa**	228 000	228 000	100%	320 900	303 100	94%
Total	**1 575 000**	**1 379 400**	**88%**	**4 785 100**	**3 359 300**	**70%**

* Identified resources only in countries that reported proximity to production centres; not world total.

** Secretariat estimate.

(a) Resources from existing production centre Caetité – Lagoa Real – Engenho (9 927 tU) not included as these are >USD 130/kgU.

(b) Assumes the Dasa project is committed.

Undiscovered resources

Undiscovered resources (prognosticated and speculative; see Appendix 3) refer to resources that are expected to occur based on geological knowledge of previously discovered deposits and regional geological mapping. *Prognosticated resources* (PR) refer to those expected to occur in known uranium provinces, generally supported by some direct evidence. *Speculative resources* (SR) refer to those expected to occur in geological provinces that may host uranium deposits. Both PR and SR require significant amounts of exploration before their existence can be confirmed, and grades and tonnages can be more accurately determined. All PR and SR are reported as in situ resources (see Table 1.13).

Worldwide, reporting of PR and SR is incomplete; undiscovered resources for a total of 38 countries are reported this edition, compared to the 59 countries with identified resources. In most cases these estimates of undiscovered resources have not been updated for several years. Eighteen countries report both PR and SR. Nine countries (Bulgaria, Egypt, Greece, Hungary, Indonesia, Paraguay, Portugal, the Slovak Republic and Slovenia) report only PR, whereas 12 countries (Brazil, China, Germany, Italy, Jordan, Madagascar, Mauritania, Nepal, Poland, Uzbekistan, Venezuela and Zimbabwe) report only SR. These inconsistencies are likely due to a lack of standardised assessment, and evaluation approaches and methodologies, as well as the absence of a unified reporting standard.

In addition to a few recently updated assessments, some countries with significant resource potential, such as Australia, do not report undiscovered resources. A number of different quantitative mineral resource assessment approaches, and integrated quantitative and mineral prospectivity mapping methods have been investigated and applied at local, regional and national scales, including in Australia (for surficial-type uranium deposits, using a variety of integrated methodologies) and the United States (for sandstone-hosted and surficial-type uranium deposits, using integrated mineral prospectivity mapping and 3-Part quantitative methods). For additional details on such methods and applications, see IAEA (2018a). As of 2025, about 10% of the undiscovered uranium resources in the United States have been reassessed with modern methods (see Chapter 3).

Table 1.13. **Undiscovered (prognosticated and speculative) in situ resources**

(as of 1 January 2025, tonnes U, rounded to nearest 100 tonnes)

Country	Prognosticated resources			Speculative resources			
	Cost ranges			Cost ranges			Total SR
	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	<USD 130/kgU	<USD 260/kgU	Unassigned	
Argentina	0	20 100	21 300	0	56 100	0	56 100
Brazil	0	0	0	0	0	254 400	254 400
Bulgaria(a)	0	0	25 000	0	0	0	0
Canada(a)	50 000	150 000	150 000	700 000	700 000	0	700 000
Chile(a)	0	0	2 300	0	0	2 400	2 400
China(c)	NA	NA	NA	NA	NA	1 000 000	1 000 000
Colombia(b)	0	11 000	11 000	217 000	217 000	0	217 000
Czechia(a)	0	0	222 900	0	0	17 000	17 000
Egypt(b)	0	10 200	10 200	NA	NA	NA	NA
Germany(a)	0	0	0	0	0	74 000	74 000
Greece(b)	6 000	6 000	6 000	NA	NA	NA	NA
Hungary	0	0	14 800	0	0	0	0
India(d)	NA	NA	148 400	NA	NA	59 400	59 400
Indonesia	0	0	37 300	0	0	0	0
Iran, Islamic Republic of(b)	0	9 800	9 800	0	0	48 100	48 100
Italy(b)	0	0	0	10 000	10 000	0	10 000
Jordan(e)	0	0	0	0	70 000	NA	70 000
Kazakhstan	85 800	113 700	113 700	186 300	186 300	NA	186 300
Madagascar*	0	0	0	0	0	10 000	10 000
Mauritania*	0	0	0	NA	NA	19 000	19 000
Mexico(b)	NA	NA	NA	NA	NA	NA	NA
Mongolia	13 300	13 300	13 300	1 030 000	1 030 000	NA	1 030 000
Namibia	0	0	57 000	0	0	150 700	150 700
Nepal(b)	0	0	0	0	0	12 300	12 300
Niger(a)	0	13 600	13 600	0	51 300	0	51 300
Paraguay	0	8 900	21 500	NA	NA	NA	0
Peru	6 600	19 800	19 800	45 400	45 400	0	45 400
Poland(a)	0	0	0	0	0	20 000	20 000
Portugal(a)	1 000	1 500	1 500	NA	NA	NA	NA
Romania(b)	0	3 300	3 300	3 000	3 000	NA	3 000
Russia	0	115 300	164 000	157 100	528 700	0	528 700
Slovak Republic(a)	0	3 700	10 900	0	0	0	0
Slovenia(a)	0	1 100	1 100	0	0	0	0
South Africa(a)	0	74 000	159 000	243 000	411 000	280 000	691 000
Ukraine(a)	0	8 400	22 500	0	120 000	255 000	375 000
United States(f)	NA	NA	NA	NA	NA	NA	NA
Uzbekistan	NA	NA	NA	NA	NA	44 600	44 600
Venezuela(b)	NA	NA	NA	0	0	163 000	163 000
Viet Nam(a)	NA	NA	81 200	NA	NA	321 600	321 600
Zimbabwe(b)	0	0	0	0	25 000	0	25 000
Total	**162 700**	**583 700**	**1 341 400**	**2 591 800**	**3 453 800**	**2 731 500**	**6 185 300**
Total prognosticated and speculative resources							**7 526 700**

NA = Data not available. * Secretariat estimate; no change since last edition. (a) Reported in 2025 response, but values have not been updated within the last 5 years. (b) Not reported in 2025; data is from Red Book 2024. (c) China has conducted systematic domestic uranium resource prediction and evaluation between 2008-2013 and 2020-2022, with results noted in their country report. As a result, total speculative resources estimated by the Secretariat are more than 1 million tU at an unassigned cost range. (d) Cost data not provided; therefore, resources are reported in the <USD 260/kgU category. (e) Jordan also reports speculative unconventional resources of 98 000 tU at <USD 130/kgU category, associated with two phosphorite deposits. (f) US estimates of undiscovered resources were carried forward without alteration from RB1994 to RB2009. Since RB2011 entries in these categories were discontinued until updated undiscovered resource estimates can be completed. To date, no updated undiscovered resource estimates have been completed; however, in 2021-2024 progress was made towards completing some of the elements required.

China reports significant resource potential, that until last edition, was not included in Table 1.13. China's country report previously included a comment that systematic nationwide uranium resource prediction and evaluation estimated that PR amounted to 2 million tU, with no cost range assigned. For the last edition, understanding that the statement was based on evaluation of a systematic and nationwide resource prediction, the Secretariat determined it forms the basis for speculative resources, that were then included in Table 1.13, estimated by the Secretariat to be more than 1 million tU at an unassigned cost range. China's country report for this edition includes a comment that "China has conducted domestic uranium resource prediction and evaluation between 2008-2013 and 2020-2022 with undiscovered resources estimation at approximately 2.88 million tU." This represents a very significant increase from last edition. No adjustment to Table 1.13 has yet been incorporated.

Total prognosticated resources in the highest cost category (<USD 260/kgU) amounted to 1 341 000 tU, a minimal 1.2% decrease compared to 2023, primarily due to a 20 000 tU reduction from Uzbekistan, with minor changes for India and Kazakhstan, and insignificant adjustments for Argentina and Romania. In the lower cost categories (i.e. <USD 80/kgU and <USD 130/kgU), the PR totals decreased by 12% and 3% respectively, as the Uzbekistan change impacted all cost categories. There were no changes to the PR for the remaining countries.

Speculative resources in the <USD 130/kgU and <USD 260/kgU cost categories decreased by 11% since 2023. Mongolia conducted new estimations based on earlier and recent geological mapping and reconnaissance, resulting in an updated SR estimate of 1 030 000 tU, about 290 000 tU less than the previous estimate. Three other countries (Kazakhstan, Argentina and Russia) each saw SR reductions of between 33 000 tU and 23 000 tU, resulting from reviews and re-evaluations of previous resource assessments. No other countries reported changes in speculative resources.

High-cost (<USD 260/kgU) PR and total SR amount to a combined total of 7 527 000 tU, a decrease of 5% from the 7 912 000 tU reported as of 1 January 2023.

Unconventional resources

Conventional resources are defined as resources from which uranium is recoverable as a primary product, a co-product or an important by-product, while unconventional resources are resources from which uranium is only recoverable as a minor by-product, such as uranium associated with phosphate rocks, non-ferrous ores, carbonatite, black shale and lignite (see Appendix 3 for definitions).

In essence, conventional resources are the types of resources that have historically been mined, whereas unconventional resources have been mined only occasionally, although there are exceptions. Moreover, the distinction between conventional and unconventional resources is not consistently defined: some countries consider unconventional resources to be a part of their conventional resource endowment: 1) if uranium grades are relatively high; 2) if uranium was the principal exploration target; or 3) if conventional resources are not available in the quantities needed to meet domestic requirements.

Unconventional resources are not usually classified to the same degree of certainty as conventional resources (i.e. they are commonly not reported as identified resources), although there are notable exceptions (see below). The majority are undeveloped, but a minority has been mined in the past. With the increased uranium price (i.e. spot, forward and long-term pricing typically on average USD 210/kgU [USD 82/lb U_3O_8] throughout 2025), some unconventional resources may become economically feasible to exploit.

Most of the unconventional uranium resources reported to date are associated with uranium in black shales and phosphate rocks (see Box 1.1. on uranium from phosphates), but other potential sources exist (e.g. seawater, discussed below).

Box 1.1. **Uranium from phosphates as a future resource**

Phosphate rock is among the five most mined materials on earth. The ore is largely used for mineral fertiliser production, and is mined globally with the largest mining and processing centres found in China, Morocco and the United States.

Uranium is found naturally in trace concentrations in phosphate rocks, particularly those of sedimentary origin, in which concentrations can reach levels above 100 ppm U. Compared to other unconventional uranium sources, such as seawater (containing 3 ppb or 0.003 ppm U), the uranium concentrations in sedimentary phosphate rocks are relevant.

Historically, several countries, including Belgium and the United States, extracted uranium from phosphate rock; however, this practice was discontinued more than two decades ago due to unfavourable market conditions.

Nevertheless, the large quantities of phosphate rock mined annually (i.e. approximately 250 million tonnes in 2025), together with the motivation to remove uranium from phosphates to produce fertilisers, highlights the significance of this resource. In addition, the industrial maturity of uranium recovery from phosphates and its seamless integration into existing phosphate fertiliser production plants, make it one of the most promising unconventional uranium resources, with the potential to become economically viable again and be increasingly reconsidered for extraction as uranium prices and demand rise in the long-term. Morocco's state-owned URANEXT announced in 2025 that it is investing approximately USD 100 million to extract uranium from phosphate deposits near Jorf Lasfar.

Historically, phosphate deposits (Barthel, 2005) are the only unconventional resources from which a significant amount of uranium has been produced. Processing of Moroccan phosphate rock in Belgium produced 690 tU between 1975 and 1999, and about 17 150 tU were recovered in the United States from Florida phosphate rocks between 1954 and 1962. As much as 40 000 tU were also recovered from processing marine organic deposits (essentially concentrations of ancient fish bones) in Kazakhstan. In the former German Democratic Republic, low grade (<0.006% U) Silurian black shales in the Ronneburg ore field were a source of significant quantities of uranium (nearly 100 000 tU) between 1950 and 1990 (IAEA, 2020). However, except for Belgian production from phosphates, production from such unconventional resources was undertaken principally to meet strategic demand when uranium prices were high and, in some cases, production costs were not considered important.

At present, unconventional uranium resources form an important and increasingly examined component of the global uranium endowment, with several countries already producing uranium as a by-product of other commodities, while others are preparing for mining and many more are undertaking exploration to define the potential of deposits not traditionally considered part of the conventional uranium sector. A number of countries treat certain unconventional deposits as conventional within their national reporting frameworks, either because uranium extraction is integrated into established mining operations or because uranium constitutes a significant co-product relative to other commodities extracted.

In Australia, the Olympic Dam deposit stands as the pre-eminent example of uranium recovered as a routine by-product of a large multi-metal mining operation. Uranium has long been produced alongside copper and gold, and is therefore viewed domestically as part of the conventional uranium sector despite the ore body's polymetallic nature. India, likewise, counts uranium hosted in carbonate deposits as part of its conventional resource base, as these deposits account for the majority of its recoverable uranium resources and have supplied feed to the Tummalapalle mill since 2017, although limited public disclosure prevents detailed assessment of grades and production levels. Kazakhstan contains uranium in phosphates and lignite coal, but these materials represent only a minor share of the country's total recoverable resources; small quantities of uranium have been recovered during vanadium mining activities. In Russia, uranium contained in phosphate deposits is considered conventional because uranium remains the principal commodity of interest, even though these deposits constitute only a small proportion of the country's total resource base. South Africa provides a complex example, with uranium occurring in paleo-quartz-pebble conglomerates, coal deposits and historic tailings. Several of these materials now fall within the country's conventional reporting framework after reclassification, although this remains subjective and reflects evolving interpretations of resource definitions. Offshore phosphate nodules containing low uranium grades have also been identified, though they are currently uneconomic. Uzbekistan hosts black shale uranium deposits that were extensively explored in the 1960s; although technically well defined, these low-grade resources remain high-cost, and have seen development repeatedly postponed due to processing challenges and economic constraints.

Some countries with unconventional uranium deposits have advanced to well-defined project development and have firm plans for mining. Brazil's Santa Quitéria project, involving phosphate deposits, is progressing through licensing procedures with uranium considered a meaningful co-product. Denmark's (Greenland's) Kvanefjeld deposit represents one of the world's most significant rare earth element resources with associated uranium, but its development has been hampered by political changes, regulatory complexities and a national prohibition on uranium mining. Finland's Talvivaara polymetallic deposit, hosted by black schists, contains low-grade uranium, recoverable as a by-product. After years of delays, the uranium recovery plant has recently begun producing concentrates and is expected to reach full capacity in the near future.

Additional countries with nuclear power aspirations that have not yet defined sufficient conventional uranium resources, view unconventional uranium resources as potential contributors to future supply. In Jordan, large phosphorite deposits with uranium potential have undergone successive feasibility assessments, though economic extraction has been hindered by fluctuating uranium prices. Malawi's Kanyika deposit, primarily a niobium-tantalum project, contains uranium that could potentially be recovered as a by-product. Saudi Arabia has undertaken extensive exploration since 2017, identifying several intrusive and sedimentary deposits containing significant uranium and thorium resources, some of which meet modern reporting standards and are now reported as in situ unconventional resources.

In other jurisdictions, unconventional uranium occurrences are recognised but remain at an early stage of study and are not yet considered exploitable. The Central African Republic's Bakouma deposit, hosted in phosphate-rich rocks, was once slated for development but has been suspended due to economic conditions and security concerns. Chile has recognised uranium associated with porphyry copper systems and phosphate. Decades ago, pilot studies demonstrated technical recoverability; however, no commercial extraction has followed. Similar early-stage or largely unevaluated unconventional uranium prospects exist in Ecuador, Egypt, Indonesia, Mexico, Nepal, Peru, Sri Lanka and Viet Nam, where uranium commonly occurs within phosphates, monazite-bearing heavy mineral sands, polymetallic deposits, black shales or bauxite-laterite systems, but further work is required to establish resource confidence, processing viability or economic potential.

Across all these examples, unconventional uranium deposits remain an important but challenging category of resource. Many countries have not undertaken sufficient detailed exploration or feasibility analysis to elevate these deposits to higher confidence resource categories. In jurisdictions without a history of uranium mining, regulatory licensing is a significant constraint, as development requires compliance with both radiological and non-radiological regulations. For deposits in which uranium is a co- or by-product, the feasibility of uranium recovery is dependent not only on uranium prices but also on market conditions for the primary commodity, the operational focus of mining companies and their capacity to integrate uranium into existing process flows. Despite these constraints, rising uranium demand, sustained price strength, and growing interest in critical minerals such as rare earth elements and battery metals, may improve the prospects for unconventional uranium deposits, enabling them to contribute more meaningfully to the global supply in the future as technological, regulatory and market conditions evolve.

For additional reference on unconventional uranium resources, the IAEA's global uranium and thorium deposits and occurrences database (UThDEPO) provides comprehensive geological information on uranium deposits and occurrences worldwide: www.iaea.org/resources/

databases/world-distribution-of-uranium-deposits. UThDEPO is maintained by the IAEA and serves primarily as a geological mineral deposit database, with limited emphasis on the economic characteristics or production viability of the listed occurrences.

In the 2024 edition of the Red Book, nine countries reported unconventional uranium resources. Finland reported the Talvivaara black-schist-hosted nickel-zinc-copper-cobalt deposit, where uranium is present as a minor by-product, amounting to approximately 26 200 tU (identified, in situ). Saudi Arabia documented three unconventional deposits, including the Ghurayyah polymetallic intrusion, with in situ identified resources of 49 000 tU, and the Jabal Sayid uranium-thorium deposit, containing 12 400 tU of in situ identified resources, alongside phosphorite-hosted uranium mineralisation at Thaniyat Turayf with an estimated 14 600 tU of in situ inferred resources. Indonesia outlined resources associated with monazite and tin mining tailings, with 25 200 tU of in situ identified resources, as well as uranium occurring in lateritic and bauxitic environments, totalling less than 2 000 tU. Jordan reported speculative phosphorite-hosted uranium resources estimated at 98 000 tU in situ, while Egypt noted unconventional uranium occurrences in both phosphate deposits and heavy mineral black sands, amounting to approximately 40 000 tU. Additional unconventional potential was acknowledged in Chile, Peru, Ecuador, Nepal and Mexico.

During the 2023-2024 period, Saudi Arabia was the only country to advance its unconventional uranium base. Unconventional identified resources at the Ghurayyah deposit increased by 8 800 tU (18%) to 57 800 tU, while the Jabal Sayid uranium-thorium deposit saw a remarkable increase of 15 200 tU (122%). Both deposits also recorded significant growth in reasonably assured resources, reflecting focussed exploration activities aimed at increasing resource confidence. Minor adjustments (of less than 1 000 tU) were reported for the Talvivaara deposit in Finland.

Seawater

Although being classified as an unconventional resource, uranium in seawater is singled out conceptually, because it differs from other unconventional resources in several fundamental technical, economic and policy-relevant ways. The distinction is less about geology and more about resource ontology, extractability and strategic meaning.

The world's oceans have long been regarded as a possible source of uranium because of the large amount of contained uranium (over 4 billion tU) and its inexhaustible nature. However, because seawater contains such low concentrations of uranium (3-4 parts per billion), developing a cost-effective method of extraction remains a challenge.

Research on uranium recovery from seawater was carried out initially from the 1950s to the 1980s in Germany, Italy, the United Kingdom and the United States. From 1981 to 1988, the Agency for Natural Resources and Energy, the Ministry of International Trade and Industry, and the Metal Mining Agency, all of Japan, jointly operated an experimental marine uranium adsorption plant. In recent years, China, in particular, has become more active in this area of research.

Laboratory studies have focussed on developing porous, high-surface-area materials that can hold specific chemical groups designed to bind uranium. Among these approaches, sorption has been the most widely explored, involving materials functionalised with nitrogen-, oxygen-, sulphur- or phosphorus-containing groups that can form strong chemical interactions with uranium. Amidoxime groups, in particular, have shown strong affinity, enabling materials such as tailored metal-organic frameworks, covalent organic frameworks and hydrogel membranes to capture several milligrams of uranium per gram of material, even at trace seawater concentrations (Sun et al., 2025).

Other approaches rely on light-driven reactions (photocatalysis), where sunlight excites specially designed materials and triggers the conversion of dissolved uranium into solid mineral forms that can be collected continuously. By optimising how these materials absorb light and move electrical charge internally, researchers have achieved progressively higher rates of uranium conversion and selective capture, including systems capable of producing hydrogen peroxide in situ, to transform dissolved uranium into solid studtite [$(UO_2)(O_2)4H_2O$] (Gao et al., 2024, in Sun et al., 2025).

Additional work has focussed on electrocatalytic extraction, where electricity drives uranium capture and conversion at the surface of engineered electrodes (Sun et al., 2025).

Beyond these core methods, researchers have experimented with unconventional approaches such as piezoelectric materials that harness wave motion to generate small electrical fields capable of reducing and capturing uranium, as well as organic frameworks that bind uranium directly to aromatic molecular structures (Sun et al., 2025). These techniques illustrate how diverse the research landscape has become.

Real-ocean testing, however, has consistently shown that natural marine conditions dramatically reduce material performance due to wave action, microbial growth on active surfaces, competition from other metals and difficulties in recovering fragile materials. Historical sea trials in Japan, the United States and China demonstrated this gap clearly, with typical marine extraction values reaching only a few milligrams per gram, even after long deployment times, well below laboratory performance (Sun et al., 2025).

In 2019, China National Nuclear Corporation (CNNC) led the establishment of the Chinese Technology Innovation Alliance of Uranium Extraction From Seawater with 13 universities and research institutes, followed in 2021 by the establishment of the Council of Chinese Technology Innovation Alliance of Uranium Extraction From Seawater. CNNC's seawater uranium extraction sea test platform was completed in June 2023 and put into use in the South China Sea, off Hainan Province. In February 2026, the Symposium on Seawater Uranium Extraction and the Council Meeting of the Seawater Uranium Extraction Technology Innovation Alliance were held in Shanghai, China. At the symposium, it was announced that China had successfully achieved its goal of extracting kilogram-scale uranium from seawater under real marine environmental conditions (China Nuclear Energy Association, 2026).

Several essential barriers remain before seawater uranium extraction can become a practical industrial process. These include designing materials that remain stable and active under strong ocean forces, ensuring that functional chemical groups do not degrade when applied to fibres or membranes, preventing microbial fouling, achieving high selectivity over competing elements, developing cost-effective, large-scale production routes, and building practical systems for deploying photocatalytic or electrocatalytic devices in open-ocean conditions without losing the captured uranium (Sun et al., 2025). In addition, ecological concerns potentially arising from such a process must be addressed. However, should an economical and sustainable method be developed, it would be the ultimate low-impact method of producing uranium, bolstering the low-carbon standing of nuclear power and dispensing with any concerns of uranium shortages, should nuclear power experience rapid growth.

Uranium exploration

Non-domestic

Only four countries (China, France, Japan and Russia) have reported non-domestic exploration and development expenditures since 2008 (Table 1.14). In the case of China, there is a data gap for 2020, and only partial expenditures are reported for 2023 to 2025 (preliminary). Non-domestic expenditures are a subset of domestic (i.e. within country) expenditures, as the totals reported on a country-by-country basis are a total of expenditures from both domestic and foreign sources within each country. The recent trend in non-domestic exploration and development expenditures is depicted in Figure 1.4. Non-domestic expenditures declined from USD 81 million in 2021 to USD 65 million in 2022, to USD 52 million in 2023 and to USD 42 million in 2024, although this includes only partial expenditures by China for 2023 and 2024. The exploration spending is expected to increase to USD 104 million in 2025 (preliminary data). On an individual country basis, non-domestic exploration and development expenditures reported by France and Japan have each been relatively consistent in recent years; in the case of France at around the USD 25 to 30 million range per year, and for Japan at USD 2 to 3 million per year. China's reported expenditures in recent years were typically in the range of USD 20 to 25 million. However, the partial reporting in this edition may not provide a fully comparable or complete picture.

Expenditures by Russia increased considerably from very low levels in 2018 and 2019 to an average in the range of USD 21 million annually since 2021, as exploration and mine development activities continued in Namibia, Kazakhstan and Tanzania, raising non-domestic expenditures by Russia to levels not seen since 2012.

Several countries do not report non-domestic expenditures or have not reported these expenditures recently, and thus the data are incomplete. Private companies in Canada and Australia are known to make non-domestic investments, and are significant investors in foreign uranium exploration and development activities, but no non-domestic expenditure information has been reported by these governments for the past several years.

Table 1.14. **Non-domestic uranium exploration and development expenditures***

(as of 1 January 2025, USD thousands in year of expenditures, for countries listed)

Country	Pre-2018†	2018	2019	2020	2021	2022	2023	2024	2025 preliminary
Australia(a)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Belgium	4 500	0	0	0	0	0	0	0	0
Canada(b)	355 644	NA	NA	NA	NA	NA	NA	NA	NA
China(c)	3 218 910	41 480	23 580	NA	20 740	20 150	1 100	6 400	30 900
France	1 638 647	30 240	26 400	31 355	32 220	25 290	26 287	26 795	29 274
Germany	403 158	0	0	0	0	0	0	0	0
Japan(d)	460 144	2 239	3 228	3 238	2 962	2 408	2 871	2 561	6 933
Korea(e)	24 039	NA	NA	NA	NA	NA	NA	NA	NA
Russia(f)	280 937	1 700	3 610	11 100	25 300	17 200	21 900	6 200	36 600
Spain	20 400	0	0	0	0	0	0	0	0
Switzerland	29 679	0	0	0	0	0	0	0	0
United Kingdom	61 263	0	0	0	0	0	0	0	0
United States(g)	260 958	NA	NA	NA	NA	NA	NA	NA	NA
Total	**6 758 279**	**75 659**	**56 818**	**45 693**	**81 222**	**65 048**	**52 158**	**41 956**	**103 707**

* Domestic exploration and development expenditures represent the total expenditure from domestic and foreign sources within each country. Non-domestic expenditures are thus a subset of domestic expenditures. They are the expenditures made in other countries by industry (non-government controlled), companies, or by majority government-owned companies.

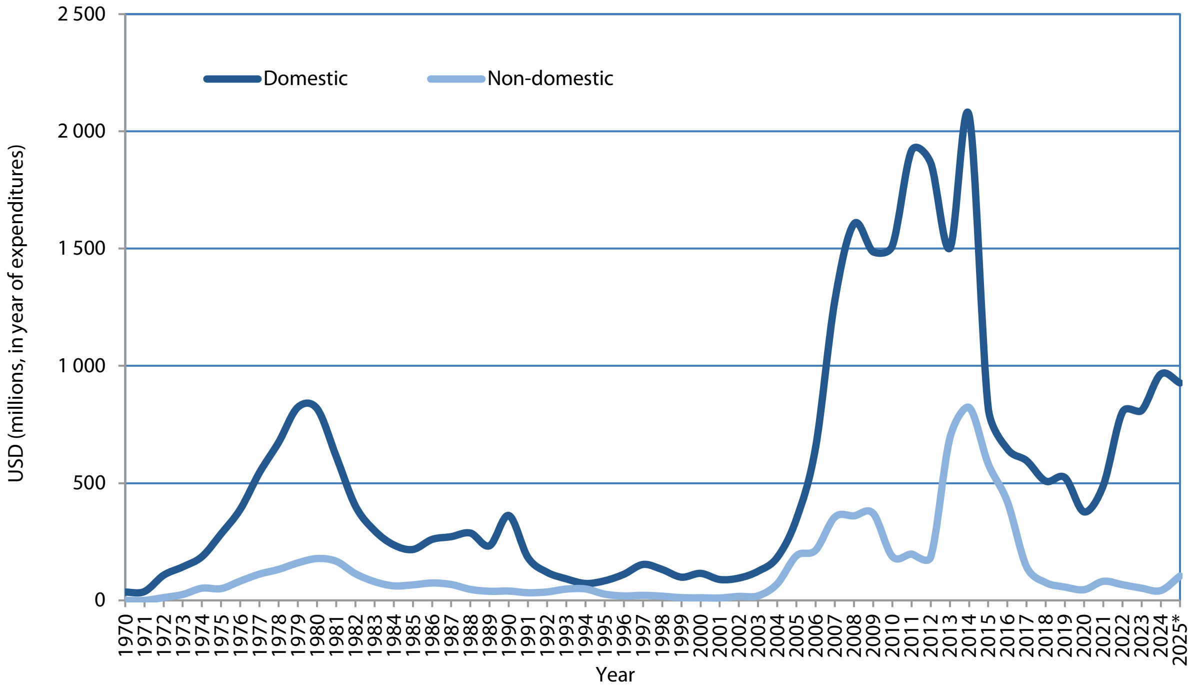
† Non-domestic exploration expenditures were first reported in the 1977 edition of the Red Book. In that first report, annual expenditures were listed beginning with 1972, and pre-1972 expenditures totalling USD 117 million were reported by France, Germany, Japan and the United States.

NA= Data not available.

(a) Australian companies have been active in uranium exploration and development in other countries. However, compiled expenditure data is not readily available and has been reported annually as NA, with the exception of 2004 to 2006 (USD 15 million in Namibia and Malawi) as reported in Red Book 2007. (b) Canada reported industry non-domestic exploration and development expenditures from 1994 until 2007. From 2008 forward, data is not available (NA). (c) China has consistently reported non-domestic exploration and development expenditures since 2007, with the exception of data being unavailable (NA) for 2020. For 2023 to 2025 (preliminary), only partial expenditures are reported – expenditures are for CNNC, whereas CGN data is NA. (d) Japan has consistently reported annual non-domestic expenditures, with the exception of data being unavailable (NA) for the years 2000 to 2006. (e) Korea reported non-domestic expenditures from 1978 to 1998, during which time the Korea Electric Power Corporation (KEPCO) participated in three North American uranium mines. Korea has not reported any annual non-domestic expenditure since 1999, when KEPCO disposed of its share in these operations. (f) Russia first reported annual non-domestic exploration and development expenditures in the 2009 edition of the Red Book, beginning with 2008. (g) The United States reported industry non-domestic expenditures from 1972 until 1998. From 1999 forward, data is not available (NA).

Figure 1.4. **Trends in uranium exploration and development expenditures 1970-2025**

(USD millions in year of expenditures)



Note that expenditures for some significant producing countries were not available at the time of data collection and writing for this edition. Data prior to the early 1970s is incomplete or aggregated across multiple prior years and thus cannot be properly represented in this chart.

* Preliminary data

Domestic

Twenty-four countries reported domestic exploration and mine development expenditures for 2023 or 2024 (Table 1.15). The totals reported are on a country-by-country basis, and represent the total expenditures from both domestic and foreign sources within each country. The recent trend in domestic exploration and development expenditures is depicted in Figure 1.4. The overall picture continues the trend, identified in the last edition, of increasing annual expenditures recovering from the 2020 low of USD 377 million. Total expenditures increased from USD 731 million in 2022, to USD 810 million in 2023, and USD 965 million in 2024. Preliminary estimates of 2025 expenditures total USD 927 million from just ten countries, excluding those that do not report preliminary estimates: notably Kazakhstan, Saudi Arabia and the United States, (where recent activity has been particularly strong). Actual 2025 total exploration and mine development expenditures will likely surpass USD 1 billion, a near tripling since 2020, as the industry continues to respond to sustained uranium price recovery, underpinned by strong worldwide interest in nuclear energy.

Table 1.15. **Domestic (industry and government) uranium exploration and development expenditures***

(as of 1 January 2025, USD thousands in year of expenditures, for countries listed)

Country	Pre-2018	2018	2019	2020	2021	2022	2023	2024	2025 preliminary
Algeria	NA	0	0	0	0	0	0	0	0
Argentina	135 011	2 376	1 496	1 089	4 971	7 815	2 128	1 765	9 678
Australia	1 733 530	9 044	7 138	4 592	9 304	15 059	36 740	47 502	32 744
Bangladesh	453	6	6	7	5	5	7	NA	NA
Belgium	2 487	0	0	0	0	0	0	0	0
Bolivia	9 343	NA	NA	0	0	0	0	NA	NA
Botswana**	12 629	NA	NA	NA	NA	NA	NA	NA	NA
Brazil	191 878	0	0	0	0	0	0	0	0
Cameroon	1 282	NA	NA	NA	NA	NA	NA	NA	NA
Canada	8 261 533	198 496	210 687	112 409	164 639	256 031	312 358	370 614	410 557
Central African Rep.	21 800	NA	NA	0	0	0	0	NA	NA
Chile	9 618	NA	NA	0	0	0	0	0	0
China	1 342 000	120 000	154 000	124 000	124 000	202 000	223 000	232 000	232 000
Colombia	25 946	NA	NA	NA	NA	NA	NA	NA	NA
Costa Rica	364	NA	NA	NA	NA	NA	NA	NA	NA
Cuba	972	NA	NA	NA	NA	NA	NA	NA	NA
Czechia[a]	317 691	9	197	8	56	21	46	0	0
Denmark/Greenland	6 405	NA	NA	NA	NA	NA	NA	NA	NA
Ecuador	1 945	NA	NA	NA	NA	NA	NA	NA	NA
Egypt	117 327	84	90	186	192	160	97	NA	NA
Ethiopia	22	NA	NA	NA	NA	NA	NA	NA	NA
Finland	126 227	0	0	0	0	0	0	0	NA
France	907 240	0	0	0	0	0	0	0	0
Gabon	102 443	NA	NA	NA	NA	NA	NA	NA	NA
Germany[b]	2 002 789	0	0	0	0	0	0	0	0
Ghana	90	NA	NA	0	0	0	0	NA	NA
Greece	17 547	NA	NA	NA	NA	NA	NA	NA	NA
Guatemala	610	NA	NA	NA	NA	NA	NA	NA	NA
Hungary	4 051	NA	NA	NA	NA	NA	NA	0	0
India	857 377	60 852	66 165	47 805	62 205	66 815	60 319	53 163	57 753
Indonesia	18 956	81	246	42	25	169	NA	NA	NA
Iran, Islamic Rep. of	380 676	13 567	8	NA	NA	NA	NA	NA	NA
Ireland	6 200	NA	NA	NA	NA	NA	NA	NA	NA
Italy	75 060	0	0	NA	NA	NA	NA	NA	NA
Jamaica	30	NA	NA	NA	NA	NA	NA	NA	NA
Japan	16 697	0	0	0	0	0	0	0	0
Jordan	48 793	4 831	3 531	2 458	3 602	2 881	3 136	3 531	3 672
Kazakhstan	685 280	37 252	18 779	13 367	9 767	9 489	14 286	18 406	NA
Korea	17 866	NA	NA	NA	NA	NA	NA	NA	NA
Lesotho	21	NA	NA	NA	NA	NA	NA	NA	NA
Madagascar	5 276	NA	23	0	30	32	NA	NA	NA
Malawi	0	NA	NA	NA	NA	NA	NA	NA	NA
Malaysia	10 478	NA	NA	NA	NA	NA	NA	NA	NA
Mali**	59 760	354	298	30	1 157	1 220	NA	NA	NA
Mauritania**	NA	NA	NA	NA	NA	NA	2 027	3 353	NA
Mexico[c]	37 635	1 204	871	660	810	630	1 000	NA	NA
Mongolia	214 561	4 857	158	71	74	4 229	2 681	4 093	NA

Table 1.15. **Domestic (industry and government) uranium exploration and development expenditures* (cont'd)**

(as of 1 January 2025, USD thousands in year of expenditures, for countries listed)

Country	Pre-2018	2018	2019	2020	2021	2022	2023	2024	2025 preliminary
Morocco	2 752	NA	NA	NA	NA	NA	NA	NA	NA
Namibia**	1 407 141	3 718	5 960	11 068	25 329	86 079	16 730	42 950	61 502
Niger**(d)	1 053 753	6 937	2 912	2 527	12 743	3 527	2 143	1 589	NA
Nigeria	6 950	NA	NA	NA	NA	NA	NA	NA	NA
Norway	3 180	0	0	NA	NA	NA	NA	NA	NA
Paraguay	27 050	NA	250	250	250	0	0	0	0
Peru	4 776	NA	NA	NA	NA	NA	NA	NA	NA
Philippines	3 492	NA	NA	NA	NA	NA	NA	NA	NA
Poland	229	NA	NA	0	0	0	0	0	0
Portugal	17 637	NA	NA	0	0	0	0	0	0
Romania	10 060	NA	NA	NA	NA	NA	NA	NA	NA
Russia(e)	1 063 390	8 336	8 782	13 809	25 569	10 956	20 232	34 769	43 199
Rwanda	1 505	NA	NA	NA	NA	NA	NA	NA	NA
Saudi Arabia(f)	9 000	16 000	9 000	3 000	9 889	9 889	15 539	15 539	NA
Senegal	NA	NA	NA	NA	NA	NA	513	781	NA
Slovak Republic	408	0	0	NA	NA	NA	NA	NA	NA
Slovenia(g)	1 581	0	0	0	0	0	0	0	0
Somalia	10 000	NA	NA	NA	NA	NA	NA	NA	NA
South Africa(h)	304 336	NA	NA	NA	NA	NA	NA	NA	NA
Spain	219 636	908	893	284	447	252	355	178	199
Sri Lanka	43	NA	NA	NA	NA	NA	NA	NA	NA
Sudan	200	NA	NA	NA	NA	NA	NA	NA	NA
Sweden	47 900	NA	NA	NA	NA	NA	NA	NA	NA
Switzerland	3 359	0	0	0	NA	NA	NA	NA	NA
Syria	1 151	NA	NA	NA	NA	NA	NA	NA	NA
Tanzania	NA	NA	NA	NA	NA	NA	NA	NA	NA
Thailand	11 299	NA	NA	0	0	0	0	0	0
Türkiye	43 149	2 987	14 245	7 288	4 200	3 315	2 568	2 894	NA
Ukraine	61 129	800	2 235	1 762	3 458	157	78	241	NA
United Kingdom	3 815	0	0	0	NA	NA	NA	NA	NA
United States(i)	3 740 413	15 000	15 000	18 700	15 300	26 200	53 300	69 200	NA
Uruguay	231	NA	NA	NA	NA	NA	NA	NA	NA
USSR	3 692 350	0	0	0	0	0	0	0	0
Uzbekistan(e)	269 715	NA	NA	11 320	11 410	20 370	35 890	56 460	75 490
Viet Nam	23 192	NA	NA	NA	NA	NA	NA	NA	NA
Zambia**(k)	10 442	607	502	536	974	3 751	5 174	5 627	NA
Zimbabwe	6 902	NA	NA	0	0	0	0	NA	NA
Total(i)	**29 850 065**	**508 305**	**523 472**	**377 268**	**490 405**	**731 053**	**810 347**	**964 653**	**926 795**

* Total exploration and development expenditures from both domestic and foreign sources in each country, for the year. ** Secretariat estimate, based primarily on company reports. NA = Data not available.

(a) Includes USD 312 560 expended in Czechoslovakia (pre-1996). (b) Includes USD 1 905 920, spent in German Democratic Republic (GDR) between 1946 and 1990. (c) Government exploration expenditures only. (d) Partial exploration spending. Pan African and Global Atomic exploration spending only in 2018 and 2019, Global Atomic exploration spending only in 2020. Global Atomic and GoviEx exploration spending in 2021, only GoviEx exploration spending in 2022 to 2024. (e) 2022 expenditures reported in the current country report corrected / restated from what was previously reported for Red Book 2024. (f) Secretariat estimate of the annual distribution of multi-year totals reported in Saudi Arabia Country Reports: USD 37 000 000 for 2017-2020, USD 19 778 580 for 2021-2022 and USD 31 078 420 for 2023-2024. (g) Includes expenditures in other parts of the former Yugoslavia. (h) Includes expenditures for both uranium and gold in the Witwatersrand Basin until 2012. (i) Red Book 2024 updated United States and Totals for 2004-2020. Refer to Table 1.15, footnote (h) of Red Book 2024 for details. (k) Non-government industry expenditures between 2011 and 2013, 2017 and 2018.

Amongst the 24 countries with reported exploration and mine development expenditures for 2023, 2024 and 2025 (preliminary estimate), the total expenditures over the three-year period amounts to USD 2.7 billion. Nearly two-thirds of these expenditures were concentrated in just two countries, Canada (USD 1 093 million, or 40.5% of the total) and China (USD 687 million or 25.4% of the total). Expenditures in Canada have consistently been at the top of the list, demonstrating that the Athabasca Basin in Saskatchewan, Canada, remains the prime destination for uranium exploration. The next six countries in order of expenditures, India (USD 171 million, 6.3%), Uzbekistan (USD 168 million, 6.2%), the United States (USD 122 million, 4.5%, excluding 2025), Namibia (USD 121 million, 4.5%), Australia (USD 117 million, 4.3%) and Russia (USD 98 million, 3.6%), together accounted for another 29.5% of the total. As a result, just eight countries accounted for 95% of the total exploration and development expenditures over the three-year period. Another five countries reported expenditures greater than USD 10 million over this period: Kazakhstan (USD 33 million) and Saudi Arabia (USD 31 million), both excluding 2025, Argentina (USD 14 million), Zambia (USD 11 million, excluding 2025) and Jordan (USD 10 million). In total, these 13 countries make up 99% of the three-year reported exploration and development expenditures.

The great majority of countries reported increasing expenditures over the three-year period, and in a few cases, expenditures remained relatively consistent. There are, however, a few notable exceptions. For Niger, annual expenditures averaged close to USD 6 million from 2018 to 2022 but decreased to USD 2.1 million and 1.6 million for 2023 and 2024, respectively, as the country's political change in July 2023 has had a significant impact reducing activity in the uranium industry. In Ukraine, expenditures averaged USD 2 million from 2018 to 2021 but decreased more than ten-fold to an average of less than USD 0.2 million from 2022 to 2024 as the war in Ukraine continued. In the case of Türkiye, as shown in Table 1.15, expenditures appear to have generally decreased since 2019; however, this is due to the extreme devaluation of the Turkish lira (TRY) over this period, and expenditures as reported in Turkish lira have actually generally increased, for example, from TRY 50 million (USD 7.3 million) in 2020 to TRY 95 million (USD 2.9 million) in 2024.

Reported expected global exploration and mine development expenditures for 2025 total USD 927 million, a 4% decrease compared to 2024; however, a modest increase is instead likely since expected 2025 expenditures were not reported for several key countries such as Kazakhstan, Mauritania, Mongolia, Niger, Saudi Arabia, Türkiye, the United States and Zambia. As these eight countries represented 13% (USD 120 million) of total global expenditures for 2024, it is reasonable to instead anticipate 2025 global expenditures between USD 1.0 and 1.1 billion.

For the 2023 to 2025 period, of the countries that separately reported exploration and development expenditures, Canada and China reported greater exploration than mine development expenditures, whereas Kazakhstan, Namibia, Russia and Ukraine reported greater mine development than exploration expenditures (except, in 2023 Kazakhstan and Namibia incurred exploration expenditures greater than development expenditures).

Building on the table first introduced in the 2022 edition of the Red Book, Table 1.16 summarises recent global drilling activities (although neither comprehensive nor complete). In total, 19 countries reported drilling information for this edition, and an additional 3 countries (Egypt, Mexico and Niger) are included in the table with information for 2022 and 2023, from the previous edition of the Red Book. In several cases, countries reported only partially (i.e. some years or entities involved in exploration and/or mine development activities were not reported). In the case of two countries (Uzbekistan and Zambia), 2022 data have been updated/corrected from what was reported in the previous (2024) edition. For the countries reporting data, total drilling increased by 21% from 2022 (3 893 668 m) to 2024 (4 716 179 m). A total of more than 3 436 000 m drilling is expected for 2025 among the limited number of only 11 countries that provided forecast data for 2025. For the countries reporting exploration and development drilling meterage separately, development drilling accounted for 64% of total drilling in 2022, 47% in 2023, and 54% in 2024, although this includes only 12 countries for 2022 and 2023, and 11 countries for 2024. Despite these gaps, it is evident that global drilling effort continued to pick up significantly from 2022 to 2024. The trend continues to be one of increasing drilling, although still down from 2012, when 17 countries drilled 5 368 268 m as reported in the 2016 edition of the Red Book.

Table 1.16. **Exploration and development drilling data for select countries**

(as of 1 January 2025, for 2022-2025, in metres)

Country	2022			2023			2024			2025 (expected)		
	Exploration	Develop.	Total	Exploration	Develop.	Total	Exploration	Develop.	Total	Exploration	Develop.	Total
Argentina	6 880	0	6 880	3 171	0	3 171	4 960	0	4 960	10 895	0	10 895
Brazil	0	0	0	0	0	0	0	0	0	0	0	0
Canada	200 127	64 230	264 357	227 134	34 855	261 989	330 198	18 428	348 626	NA	NA	NA
China***	1 040 000	NA	1 040 000	1 150 000	NA	1 150 000	1 200 000	NA	1 200 000	1 200 000	NA	1 200 000
Egypt***	950	650	1 600	950	650	1 600	NA	NA	NA	NA	NA	NA
India	395 783	NA	395 783	264 767	NA	264 767	157 313	NA	157 313	205 900	NA	205 900
Indonesia	600	0	600	0	0	0	0	0	0	0	0	0
Kazakhstan	188 046	899 497	1 087 543	107 404	347 005	454 409	38 938	501 370	540 308	NA	NA	NA
Mauritania[(a,c)]	5 000	NA	5 000	7 630	NA	7 630	7 633	NA	7 633	NA	NA	NA
Mexico***	0	0	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mongolia	40 662	0	40 662	0	0	0	0	0	0	NA	NA	NA
Namibia***	77 262	19 083	96 345	108 209	9 634	117 843	213 352	27 713	241 065	111 559	23 619	135 178
Niger***[(b)]	6 500	NA	6 500	NA	NA	NA	NA	NA	NA	NA	NA	NA
Paraguay[(c)]	0	0	0	0	0	0	0	0	0	0	0	0
Russia	23 244	NA	23 244	9 657	NA	9 657	13 031	NA	13 031	31 804	NA	31 804
Saudi Arabia[(c)]	38 687	0	38 687	20 242	0	20 242	20 241	0	20 241	NA	NA	NA
Spain	0	0	0	0	0	0	0	0	0	0	0	0
Türkiye***	57 740	0	57 740	41 844	NA	41 844	29 968	NA	29 968	NA	NA	NA
Ukraine	0	2 065	2 065	0	706	706	0	2 203	2 203	NA	NA	NA
United States	46 000	117 000	163 000	156 000	170 000	326 000	187 000	384 000	571 000	NA	NA	NA
Uzbekistan**	643 672	NA	643 672	1 060 468	NA	1 060 468	1 579 831	NA	1 579 831	1 849 050	NA	1 849 050
Zambia**	19 990	0	19 990	15 835	0	15 835	0	0	0	3 500	0	3 500
Totals	**2 791 143**	**1 102 525**	**3 893 668**	**3 173 311**	**562 850**	**3 736 161**	**3 782 465**	**933 714**	**4 716 179**	**3 412 708**	**23 619**	**3 436 327**

* Country added to drilling data table for this Red Book 2026 edition. Data not previously provided.

** 2022 information updated and changed from what was reported in Red Book 2024.

*** 2022, and in some cases 2023 (preliminary), information from Red Book 2024.

(a) Aura Energy's Tiris project drilling only. (b) 2022 drilling data – Global Atomic Corporation's (GAC) Dasa project and ENRG Elements' Takardeit project only. (c) Total drilling reported for multiple year period in country report, divided into equal yearly totals for this table.

In terms of exploration drilling metreage from 2022 to 2025, eight countries reported increasing trends, five countries had no drilling, four countries reported a decreasing trend and three countries had variable year to year metres drilled. Canada, China, Namibia, the United States and Uzbekistan were the major countries among the eight that reported an increasing trend. India, Kazakhstan, Niger and Türkiye reported decreasing drilling distance while Mongolia, Saudi Arabia and Zambia reported variable drilling distance. Excluding 2025 (as numerous countries did not report), the exploration drilling for the combined years of 2022 to 2024 totalled more than 9 746 000 m, and 99% of this was reported from the top ten drilling countries – China (3 390 000 m, 35%), Uzbekistan (3 283 971 m, 34%), India (817 863 m, 8%), Canada (757 459 m, 8%), Namibia (398 823 m, 4%), the United States (389 000 m, 4%), Kazakhstan (334 388 m, 3%), Türkiye (129 552 m, 1%), Saudi Arabia (79 170 m, 1%) and Russia (45 932 m, 0.5%).

Only five countries reported any development drilling and of these only Namibia reported 2025 expected data. Excluding 2025, the development drilling for the combined years of 2022 to 2024 totalled more than 2 599 000 m. More than 99% of this drilling was reported from the top four development drilling countries – Kazakhstan (1 747 872 m, 67%), the United States (671 000 m, 26%), Canada (117 513 m, 5%) and Namibia (56 430 m, 2%). Of these four countries, only the United States reported a clearly increasing trend.

Minimal trenching data was reported for this edition with only Argentina reporting 0 metres trenching for 2022, 288 m (80 trenches) for 2023, 160 m (40 trenches) for 2024 and 925 m (225 trenches) expected for 2025. Additionally, Saudi Arabia reported numbers of trenches (11 for 2021-2022, 7 for 2023-2024) but not metres.

Current activities and recent developments

North America

The North American region continued to dominate reported uranium exploration and mine development activities, accounting for 39% to 46% of total global expenditures in each of the years from 2022 to 2025, reaching levels higher than the region's long-term position accounting for 40% of total pre-2018 global expenditures. This dominance of the region endures as Canada continues to lead the world in uranium exploration and development expenditures.

After almost a decade of depressed uranium prices and declining exploration and development expenditures, as identified in the 2024 edition of the Red Book, 2020 marked the low point and, like the global trend, expenditures reached their decadal low in Canada in 2020, with very strong growth in each subsequent year, continuing through the reporting period of this edition. Total Canadian uranium exploration and development expenditures in 2023 amounted to USD 312 million (39% of global expenditures), a 22% increase from 2022. Similarly, expenditures were USD 371 million in 2024 and USD 411 million (preliminary estimate) for 2025, annual increases of 19% and 11% respectively, representing 38% to 44% of global expenditures.

Canada's high grade uranium deposits associated with the Proterozoic unconformity in the Athabasca Basin of Saskatchewan remain the prime target for uranium exploration, and the location of most uranium exploration projects in the country. In the eastern Athabasca Basin, Denison Mines Corp.'s Wheeler River Project, which includes the Phoenix deposit (26 900 tU recoverable resources), is advancing plans to develop an ISL mining operation, the first proposed use of this method for unconformity-type uranium deposits. The project was in the final stages of regulatory approvals with Canadian Nuclear Safety Commission (CNSC) public hearings in October and December 2025. Also on the Wheeler River property, Denison's Gryphon deposit (24 000 tU in situ resources) has the potential to be mined by conventional underground methods. In the southwestern Athabasca Basin, NextGen Energy Ltd.'s Rook I project was in the final stages of regulatory approvals with CNSC public hearings in November 2025 and February 2026. The project hosts the Arrow deposit, the world's second-largest high-grade uranium deposit (130 000 tU recoverable resources), and includes the development of an underground mine and mill. In the same area, the Patterson Lake South project (Paladin Energy Ltd. acquired Fission Uranium Corp. in December 2024), Triple R deposit (50 000 tU recoverable resources), is progressing through the provincial environmental assessment (EA) process and CNSC regulatory licensing process for the proposed development of an underground mine. Ongoing exploration activity nearby along the Patterson Lake structural corridor, led to NexGen's discovery in 2024, of the Patterson Corridor East deposit. In 2023, outside of Saskatchewan, Paladin consolidated 100% ownership of the Michelin project in Labrador's Central Mineral Belt, and in Nunavut, exploration continued in the Angikuni and Thelon basins.

The United States experienced a dramatic increase in activity over the last few years. Sustained higher uranium prices, significantly increased federal and state government support for nuclear energy, and uranium purchases by the federal government to be held in a national reserve, contributed to industry exploration and development expenditures increasing more than four-fold from USD 15 million in 2021 (last year of the extended downturn), to USD 26 million in

2022, USD 53 million in 2023 and USD 69 million in 2024. Activity focussed heavily on sandstone-hosted deposits in the Powder River Basin, Gas Hills and Shirley Basin in Wyoming; in the South Texas Coastal Plain, including the Goliad and Oakville formations; and in the Colorado Plateau in parts of Utah, Colorado, Arizona and New Mexico. Much of this work was on delineating and expanding known roll-front deposits for ISL projects. Less extensive exploration was carried out for collapsed breccia-type uranium deposits in the northern Arizona Grand Canyon region, where companies conducted resource assessments and permitting activities to restart or expand existing operations. Metasomatite-type deposits were the focus of ongoing permitting efforts in the southeastern United States (Coles Hill, Virginia).

The United States has numerous, generally small, conventional and ISL-amenable mines and deposits with some degree of permitting or development. Most of these were indefinitely paused in the 2010s, awaiting more favourable market conditions. In 2023 and 2024, several ISL and conventional mine production restarts were announced as discussed in the Uranium Production section of this chapter.

Mexico did not submit a country report for this edition of the Red Book. From the information provided for the 2024 edition, it was reported that since 2009, the Mexican Geological Survey (SGM) had been conducting a programme to validate and re-evaluate earlier uranium resource declarations to modern international standards. By 2022, the government had invested more than USD 11 million in this re-evaluation effort and drilled a total of more than 20 000 metres (210 holes), leading to more than 96% of the resources data reported in the Red Book reflecting modern resource estimates from these SGM studies. Less than 4% of the total reported identified resources remain, based on historic estimates. Refer to the 2024 edition of the Red Book for more information.

Central and South America

Uranium exploration and mine development expenditures in the Central and South American region accounted for 0.6% of reported global expenditures from 2022 to 2025, with expenditures, primarily from Argentina, varying from a low of USD 1.8 million in 2024 to a high of USD 7.8 million in 2022, and with USD 9.7 million expected for 2025.

In Argentina, uranium exploration is carried out by the government through the National Atomic Energy Commission (CNEA) and, since the 2000s, by private uranium exploration companies. Reported exploration expenditures by government were USD 0.9 million, USD 0.8 million, and USD 0.4 million for 2022, 2023, and 2024, respectively, with USD 0.3 million expected in 2025. Expenditures by private exploration companies amounted to USD 6.9 million, USD 1.4 million and USD 1.4 million in 2022, 2023 and 2024, respectively, but are expected to increase to USD 9.4 million in 2025. As there is no requirement for private industry to report exploration expenditures to the government, the information about private exploration expenditures may not be complete.

In recent years, government-led exploration has slowed down and drilling has been limited. A six-hole drilling programme of 1 197 m was completed in 2022 in the Neuquén Basin, while in 2023 a single hole of 171 metres was drilled in the same basin. In parallel, 65 exploration trenches with a total of about 228 metres were excavated in the Meseta Sirven area of Santa Cruz, under a co-operation agreement with Fomicruz S.E. The most significant advanced exploration stage uranium deposit managed by the CNEA is Cerro Solo (9 230 tU recoverable resources) in Chubut Province. Work there has included laboratory testing to define hydrometallurgical extraction of uranium and molybdenum minerals, environmental monitoring and baseline surveys, and a natural acidic drainage survey is planned to be carried out in 2025-2026.

Exploration drilling by private companies totalled 5 683 m (387 holes) in 2022, 3 000 m (80 holes) in 2023, 4 960 m (1 246 holes) in 2024, with 10 895 m (451 holes) expected for 2025. From 2022 to 2024, activity on the Amarillo Grande project (Blue Sky Uranium Corp.) included mapping, sampling, radiometric and geophysical surveys to define new targets near the Ivana deposit, followed by 4 194 m of drilling (83 holes) on these targets. The Ivana deposit itself was advanced with 3 346 m of drilling (350 holes) and metallurgical testing. The results of these studies were integrated into an updated NI 43-101 PEA, completed in 2024, including an updated resource estimate (5 390 tU RAR, 1 210 tU IR recoverable resources). In 2025, Blue Sky formed a joint-venture with Abatare Spain, S.L.U., under the new operating company Ivana Minerales S.A., to advance exploration of the Ivana uranium-vanadium deposit. The 2025 plan includes a 5 000 m drilling programme to develop the advanced exploration stage.

The Laguna Salada uranium-vanadium project in Chubut Province has recently had several ownership changes (in 2021 Consolidated Uranium Inc. purchased it from U3O8 Corp., in 2023 IsoEnergy Ltd acquired Consolidated Uranium's Argentine assets and in 2024 Jaguar Uranium Corp. acquired the assets from IsoEnergy). Jaguar Uranium is planning exploration at the La Rosada North area of the Laguna Salada in 2025 and 2026. UrAmerica Ltd's Meseta Central uranium project contains 5 290 tU recoverable inferred resources. UrAmerica's 2025 to 2027 focus is on expanding and upgrading current resources, confirming the suitability of ISL for extraction, and assessing the project's economic viability. In 2023, Sophia Energy S.A. resumed exploration at its Sofía project in the Meseta Sirven region, Santa Cruz Province, and has since identified 12 areas of interest with strong uranium anomalies. Exploration is now focussed on two priority targets, with the objective of defining resources. Since 2022, several companies (Piche Resources Ltd, Lia Energy Corporation, Owl Mines & Oil S.A. and NewEra Metal Resources Ltd) launched early-stage uranium exploration in Argentina.

Brazil reported no exploration or mine development expenditures from 2018 to 2024. For 2026, a 6 000 m drilling programme is scheduled to close the grid and upgrade the resource category of the Lagoa Real (LR) 08 deposit. Planning for future expansion of the Caetité unit production centre includes production of Engenho Mine and other deposits of Lagoa Real Province, by open-pit mining and replacement of the current heap leaching process by conventional milling. The Santa Quitéria project, a partnership between Indústrias Nucleares do Brasil S.A. (INB) and a Brazilian fertiliser producer, is progressing, with operations planned to begin in 2030.

In Chile, no uranium exploration and mine development activities have been carried out in recent years, and no new uranium resources have been identified since the 2011 edition of the Red Book.

In Ecuador, the Geological and Energy Research Institute (IIGE) is conducting the project "Geological Investigation and Availability of Mineral Resource Occurrences in Ecuadorian Territory" and in 2025 to 2026 the project plans to obtain stream-sediment geochemistry results and airborne geophysics data (magnetometry and radiometry), for the Cordillera Real and Sub-Andean Zone that will enable the identification of potential uranium anomalous zones. Other than this background research, there has been no reported private or state uranium exploration in recent years, and no conventional uranium resources have been declared in the country to date.

Guyana did not submit a country report for this edition of the Red Book. From the information provided for the 2024 edition, it was reported that there had been no significant exploration since 2012, but the Guyana Geology and Mines Commission (GGMC) continued to conduct geochemical projects to map the country's mineral potential. Refer to the 2024 edition of the Red Book for more information.

Exploration activities in Paraguay from 2019 to 2021 focussed on the Coronel Oviedo area with several radon emmanometry surveys and approximately 1 000 m of drilling carried out. No exploration activities have been reported in the 2022 to 2025 period.

In Peru, the Macusani district has been the most important uranium district, with uranium mineralisation found in acid volcanic Mio-Pliocene formation in the Department of Puno in southeastern Peru. This district contains American Lithium Corp.'s Macusani project (80 000 tU in situ identified resources). The project includes five near surface deposits hosted in porous volcanic rocks and numerous satellite targets. Technical work at Macusani is advancing, including a new updated Mineral Resource Estimate and Preliminary Economic Assessment. In 2024, Macusani Yellowcake S.A.C., the local subsidiary of American Lithium, announced plans to explore the Isibilla project in Puno. No exploration and development expenditures were reported in this edition as industry is not required to report expenditures to the government.

European Union

Uranium-related exploration and mine development activities in the European Union repeatedly accounted for less than 0.1% of total reported global expenditures from 2022 through 2025, as the main activities continued to be focussed on remediation of closed uranium mines. As previously reported, potential mine project development in Denmark (Greenland) and Spain has been conditioned by the current regulatory framework. As a result, current activity is in arbitration proceedings and legal appeals, not exploration and development. The encouraging news for the uranium industry was from Finland, with commencement of uranium recovery as a by-product at the Talvivarra (nickel-zinc-copper-cobalt) mine and from Sweden, where in November 2025 the Swedish parliament voted to pass legislative changes lifting the country's ban (previously imposed in 2018) on uranium exploration and mining.

Uranium exploration and mine development activities in Bulgaria were terminated in 1990, and no exploration has been conducted in recent years.

In Czechia, recent exploration activities have been focussed on the conservation and processing of previously collected exploration data from Czech uranium deposits. Advanced processing of the exploration data and building of an exploration database continued. In 2023, only geological survey data were processed (geological documentation, final reports and archiving), with expenditures of approximately USD 47 000.

Denmark/Greenland reported no expenditure figures for the 2022 to 2025 period, and no drilling data. Since 2007, Energy Transition Minerals Ltd (ETML), formerly Greenland Minerals Ltd, had conducted exploration activities for REE-uranium-zinc mineralisation in the Kvanefjeld area in southern Greenland. A mining/exploitation licence application was submitted in July 2019, including updated environmental and social impact assessments and a navigational safety investigation study. The project includes recovery of uranium (425 tU/yr) and zinc by-products in addition to the main REE products. However, an April 2021 election in Greenland led to a change in government that passed a new law prohibiting exploration and exploitation of uranium as of December 2021. Passage of this new law led ETML to request arbitration proceedings with the governments of Greenland and Denmark, concerning the impact of new legislation on its exploration licence for the Kvanefjeld project under development. On 20 July 2023, ETML announced it had filed a statement of claim with an arbitral tribunal, on the matter of this dispute (Energy Transition Minerals, 2023). Subsequently, there have been several procedural delays. In November 2025 ETML reported that recent rulings by the Arbitral Tribunal and Copenhagen City Court have clarified next steps and that ETML has requested the High Court of Greenland to remove Denmark as a party to the case, clearing the way for the claim against the Greenlandic Government to proceed on its merits (Energy Transition Minerals, 2025).

Uranium exploration in Finland is currently being undertaken for the first time since 2014. As of May 2025, Normetco A S (acquired by Australian company, Basin Energy Ltd, in 2024) had submitted exploration permit applications for the Palmottu, Temo and Löttö exploration targets, while Swedish Minerals AB, which was subsequently acquired by United Lithium Corp. in January 2026, had pending applications for the Riutta and Asentolamminoja projects. In 2024, Terrafame Oy completed construction and commissioning of the uranium recovery plant, received final regulatory operating approvals and produced the first uranium concentrates from by-product uranium recovery at the Talvivaara mine (8 700 tU recoverable RAR) in Sotkamo (see Box 1.2. on uranium extraction at the Talvivaara deposit).

Box 1.2. **Uranium extraction as a by-product from the polymetallic Talvivaara black schist deposit**

Aside from phosphates (discussed in Box 1.1), polymetallic mineral deposits containing very low grades of uranium that can be extracted as a by-product could add to the future supply of uranium from an unconventional resource. One example is the polymetallic Talvivaara deposit in Finland, where uranium has been recovered as a by-product since 2024.

Talvivaara is a black schist-hosted nickel-zinc-copper-cobalt deposit (i.e. metamorphosed black shale deposit), situated in the Palaeoproterozoic Kainuu Schist Belt of the Fennoscandian Shield in Sotkamo, in central Finland. It is a low-grade, high-tonnage deposit, averaging 0.26% nickel, 0.53% zinc, 0.14% copper, 0.02% cobalt, and 0.0018% uranium.

Mining of the Talvivaara deposit commenced in 2008. The production process includes open-pit mining, crushing, large-scale heap bioleaching and metals recovery. In heap leaching, the leach solution is percolated through the heap until its metal content is sufficient for metals recovery. During metals recovery, copper, zinc, nickel and cobalt are precipitated from the pregnant leach solution and filtered to produce saleable metal products.

In addition to these metals, a large amount of uranium also dissolves during the heap leaching process and reports to the same pregnant leach solution. Prior to the commissioning of the uranium recovery plant, most of the uranium reported to the secondary leaching heaps, which function as the final disposal sites for the leached black schist ore. The remainder partitioned into process waste streams, while a small fraction reported to the nickel-cobalt sulphide concentrate as an impurity.

The recently commissioned uranium recovery circuit facilitates the recovery of uranium from the process solution. After nickel-cobalt precipitation, the pregnant leach solution is routed to the uranium recovery plant for uranium extraction. Uranium is separated from the process solution by solvent extraction, comprising uranium loading on the organic phase, scrubbing of impurities from the loaded organic phase using sulfuric acid, and stripping of uranium from the loaded organic phase using sodium carbonate. Uranium is subsequently precipitated as uranium peroxide using hydrogen peroxide, followed by drying and packaging of the uranium concentrate for shipment.

As the average mining recovery during heap leaching is 50%, and the average process recovery in solvent extraction is 90%, the overall uranium recovery factor is 45%. As Measured and Indicated in situ resources of the Talvivaara deposit are 19 400 tU, recoverable resources are estimated at 8 700 tU. Terrafame's uranium production in 2025 has not been publicly quantified, as operations were still ramping up towards the planned full capacity of about 200 tU per year by 2026. The production capacity corresponds to approximately nine months of consumption at the Olkiluoto3 nuclear power plant in Finland. Terrafame plans to continue uranium production alongside the production of other metals throughout the operating period, which covers at least the next 30 years.

The uranium recovery from the Talvivaara deposit is feasible due to high-volume mining, cost-efficient heap leaching and the presence of uraninite, which dissolves readily. Globally, there are no other commercial operations producing uranium as a by-product from ore of such low grade (18 ppm U). The recovery of uranium provides several operational and metallurgical benefits. It introduces an additional metal product to the production portfolio, thereby enhancing the overall value of the operation. The removal of uranium from the process stream reduces its concentration in the process waste, contributing to more effective waste management. Furthermore, by preventing uranium from reporting to the nickel-cobalt concentrate, it eliminates potential complications in downstream refining processes and improves concentrate quality.

In France, no domestic uranium exploration and mine development activities have been carried out since 1999. During the 2022 to 2025 period, the majority government-owned Orano S.A. and its subsidiaries continued working outside France, focussing on the discovery of exploitable resources in Canada, Gabon, Kazakhstan, Mongolia, Namibia, Niger and Uzbekistan. Total non-domestic exploration expenditures remained steady from 2022 to 2025 (preliminary) at EUR 24 million to EUR 25 million, per year (USD 25 million to USD 29 million, per year). In Canada, Kazakhstan and Niger, Orano is also involved in uranium mining operations. Since the July 2023 coup in Niger, Orano has been subject to increasing State interference in the governance of its Nigerien subsidiaries (Somaïr, Imouraren and Cominak), leading Orano to confirm the loss of operational control over its Nigerien subsidiaries and assets as of December 2024.

There have been no exploration activities in reunified Germany since the end of 1990, and no non-domestic exploration by German mining companies since 1997.

There has been neither uranium exploration nor mine development activity in Hungary during the 2022 to 2025 period, nor for years prior. Currently, the only way to establish a mining property is through public concession tendering, provided the government launches the tendering procedure. A previous (2007 to 2014) project to reopen the previously mined Mecsek deposit and surroundings, faced environmental concerns, local opposition and failed to receive environmental approvals; therefore, the proposed project was largely abandoned by 2014. Refer to previous editions of the Red Book for more information.

There are no uranium deposits documented and no recent uranium exploration in Poland. However, there are some prospective indications of uranium and some small occurrences favourable for uranium deposit discovery that could potentially be economically exploited.

Portugal continues to rule out uranium mining and nuclear power as part of its energy strategy. The country's uranium-related activity is focussed on environmental remediation of legacy uranium mines. Environmental remediation is carried out by state-owned Empresa de Desenvolvimento Mineiro (EDM). The Urgeiriça uranium complex (central Portugal) is a prominent example, with ongoing monitoring of radiological and water-quality impacts.

In the Slovak Republic, there has been no change in policy on domestic uranium mining. Uranium extraction remains politically sensitive and no active uranium mining projects are being pursued. The Slovak Republic continues to rely entirely on imported uranium and fuel services, focussing policy attention on supply diversification rather than domestic production. There are no indications of renewed exploration or mining initiatives.

In Slovenia, expenditures on uranium exploration ended in 1990, and there are no recent or ongoing uranium exploration activities in the country. In 1992, the final closure and subsequent decommissioning of the Žirovski Vrh mine and mill complex began with the production facility being dismantled. All remediation work was finished on the mine waste pile site and, in 2015, long-term environmental surveillance began. The Boršt hydrometallurgical tailings and associated waste rock disposal site have been undergoing environmental remediation, with additional recent work (including in 2019 and 2021) and studies to reduce groundwater level and improve site stability. The safety report for the site was revised in 2024, and is the basic document for the closure of the disposal facility and the transition to long-term surveillance and maintenance.

Spain reported annual exploration and mine development expenditures by industry of between EUR 170 000 and EUR 320 000 (USD 180 000 and USD 350 000) for the 2022 to 2025 period. There was no exploration drilling activity.

On 5 November 2025, the Parliament of Sweden passed legislation to come into effect 1 January 2026, repealing the ban (in effect since 2018) on uranium exploration, mining and extraction, and classifying uranium as a concession mineral, which is a mineral especially useful for society (WNA, 2025e). As a result of this change, exploration activity is anticipated to increase, particularly related to the country's substantial alum (black) shale deposits, where uranium could be recovered as a by-product, along with other co-products such as molybdenum, vanadium, nickel, zinc and petroleum products. The Australian company Aura Energy Ltd, that has been advancing the Häggån vanadium, potash and uranium polymetallic project, intend to now examine options to include uranium extraction as they progress the project from the scoping study stage. The Sweden-focussed Canadian company, District Metals Corp., plans to advance their flagship Viken Property, and continue exploration across their other alum shale and basement rock hosted uranium properties.

Europe (non-EU)

Uranium exploration and mine development expenditures in non-EU countries in Europe accounted for 2% of total reported global expenditures in 2022, 3% in 2023, 4% in 2024, and 5% expected for 2025, heavily dominated by activities in Russia, as expenditures were very low for Ukraine throughout this period and modest for Türkiye.

In Russia, early-stage prospecting exploration aimed at new deposit discovery and preliminary evaluation is financed by the federal budget of Russia through the Federal Agency for Mineral Resources (Rosnedra), whereas exploration and development of identified deposits is carried out by the subsidiary uranium mining enterprises of JSC Rosatom Minerals (former Atomredmetzoloto or ARMZ), which is a part of the Russian State Atomic Energy Corporation (Rosatom).

In 2023 to 2024, early-stage work continued focussing on the identification of large deposits suitable for development by ISL, and conventional mining methods were carried out mainly in the Siberian Federal District (Irkutsk Region) and in the Far Eastern Federal District (Republic of Buryatia and Trans-Baikal Region). In 2023, greenfield exploration was carried out within the Tuyukan area (Irkutsk region) and exploration focussed on sandstone type deposit discovery at the Baitakh area (Republic of Buryatia). In 2024, activities targeted sandstone basal channel deposits for future ISL mining at the Baitakh area, the Dulesma area (Republic of Buryatia) and the Bada area (Trans-Baikal Region). Increased activity is planned for 2025 within the Baitakh and Bada areas and eight new areas.

With respect to advanced stage work, in 2023 and 2024 the Priargunsky production centre continued limited exploration drilling from underground mine workings, focussed on identifying uranium resources on the flanks of the deposits. JSC Dalur continued exploration at the Dobrovolnoye deposit in Kurgan district with completion planned for 2027. In 2024, JSC Khiagda continued exploration of the #X2 ore body (Khiagda deposit). JSC Khiagda plans to get the licence for the Tetrakh deposit (6 429 tU in situ resources) and to start its exploration.

Mine development work at JSC Dalur (Kurgan Region) continued in 2023 and 2024, with preparation for pilot uranium mining at the Dobrovolnoye deposit. Pilot plant facilities construction was completed in 2025, and pilot mining will start in 2025. In 2023 to 2024, JSC Khiagda (Republic of Buryatia) continued development at the Kolichikan, Dybryn and Namaru deposits (19 300 tU total in situ resources). Dybryn is planned for commercial mining in 2025 and Namaru in 2026. Also during this period, the Priargunsky production centre continued construction of the surface complex and infrastructure elements of new mine No. 6 (design capacity of 2 300 tU/yr) that will support the development of the Argunskoye and Zherlovoye deposits (40 900 tU total in situ resources), with mining planned to start in 2029. In 2025, Priargunsky plans to obtain a mining licence for the Shirondukui deposit (8 000 tU in situ resources) and to start its development in 2027.

Total domestic exploration and mine development expenditures increased from about USD 11 million in 2022, to USD 20 million in 2023, to USD 35 million in 2024, with USD 43 million expected for 2025, a four-fold increase over the period. Of these totals, mine development expenditures accounted for 76%, 84%, 80% and 57%, respectively.

Russia, through Uranium One Inc. (owned by Rosatom), also carried out exploration for uranium at joint ventures in Kazakhstan, exploration at the Wings deposit in Namibia and at the Mkuju River deposit in Tanzania. In Kazakhstan, five uranium mines jointly owned by Uranium One are in commercial operation. During 2021 to 2023, exploration programmes were carried out at the Kharasan mine, from which Uranium One sold its 30% stake to China Uranium Development Company Ltd in January 2025. Exploration at the Budenovskoye #6,7 mine aimed at converting resources into more reliable categories. In Tanzania, Uranium One's subsidiary, Mantra Tanzania Ltd, completed a major exploration programme at the Mkuju River deposit (58 489 tU in situ resources) in 2016. In 2020, a decision was made to build a pilot processing plant and to proceed with pilot open-pit mining. In 2024, Mantra issued an updated Feasibility Study (FS) for a mining and processing operation with capacity up to 3 000 tU/yr. In 2025, all required approvals were obtained from Tanzanian regulators and pilot operations were launched in late July 2025. Preparatory works started the same year, with construction planned for 2026. In Namibia, Uranium One's subsidiary, Headspring Investments (Pty) Ltd, completed an extensive drilling exploration programme in 2021, that increased JORC compliant resources of the Wings sandstone-type deposit to 18 536 tU RAR and 22 977 tU of IR, with additional exploration potential estimated to be 30 000 tU. A pre-feasibility study (PFS) completed in 2021 confirmed positive economics for the ISL mining method. The Wings deposit is a first deposit in Namibia which is potentially amenable for development by ISL. A pilot test site, including pilot plant and chemical laboratory, was constructed and prepared for commissioning, with pilot tests to start after regulatory approval is issued. 2025 plans include exploration drilling to convert additional resources from IR to RAR.

In Türkiye, government exploration expenditures were USD 3.3 million in 2022, USD 2.6 million in 2023 and USD 2.9 million for 2024. An estimate for 2025 is not available. Exploration drilling amounted to 57 700 m (140 holes) as previously reported for 2022, 41 800 m (109 holes) in 2023 and 30 000 m (68 holes) in 2024. For 2022 to 2024, granite, acidic igneous and sedimentary rocks within the Nevşehir, Yozgat Afyonkarahisar, Isparta, Manisa, Uşak, Kütahya and Denizli provinces were explored for radioactive raw materials. Drilling was conducted at sites licensed by the General Directorate of Mineral Research and Exploration (MTA) within the Nevşehir, Yozgat, Uşak and Manisa provinces.

In 2019, Westwater Resources Inc. reported that in June 2018 the government of the Republic of Türkiye had cancelled all exploration and operating licences held by Westwater's Turkish subsidiary, Adur Madencilik Ltd Sirketi. Adur and its predecessors had been developing the Temrezli and Şefaatli projects, carrying out drilling, testing and studies. In December 2018, Westwater filed a Request for Arbitration before the International Centre for the Settlement of Investment Disputes. On March 3, 2023, the arbitral tribunal issued its final award in the proceeding and in December 2023, Westwater accepted a payment of USD 3.1 million from the government of Türkiye as complete and full settlement of the matters at issue (Westwater Resources, 2023, 2024).

In Ukraine, exploration and development expenditures totalled USD 160 000 in 2022, USD 80 000 in 2023 and USD 240 000 in 2024, with no estimate for 2025. These numbers represent expenditures a full order of magnitude lower than prior to 2022. Mine development expenditures accounted for 100% for each of these years. A total of 4 970 m of government development drilling (204 holes) was carried out for the 2022 to 2024 period (data not available for 2025). State Enterprise Kirovgeology continued to undertake analytical work on existing geological data to identify areas prospective for uranium exploration within the country.

Africa

Uranium exploration and mine development expenditures in Africa accounted for about 13% of total reported global expenditures in 2022, 3% in 2023 and 6% in 2024, with 7% estimated for 2025, although preliminary expenditure information was not available for some countries. In response to the recovery in uranium price, Africa experienced a dramatic increase in the level of uranium exploration and mine development. Total expenditures increased from an annual average of USD 12 million for the 2018 to 2000 period, to an average of more than USD 55 million per year since, particularly as work accelerated on several projects to bring them to the point of Final Investment Decision (FID). Approximately 87% of the region's reported expenditures over this period are attributed to Namibia. The political events in Niger in 2023, and subsequent impacts on the country's uranium industry, are of concern and have greatly elevated the risk profile of the country's uranium production and potential new projects.

In Algeria, in 2017 and 2018, the Agency of the Geological Service of Algeria, in collaboration with the United States Geological Survey, carried out preliminary prospecting work for undiscovered mineral resources, including uranium, related to granites, calcretes, alkaline rocks and carbonatites in the Eglab Region. No uranium prospecting or mine development work was carried out between 2019 and January 2025.

No exploration or mine development expenditures were reported by Botswana; however, there was substantial activity on the Letlhakane project, as reported in detail herein in the country report prepared by the NEA/IAEA. In 2023, Australian based Lotus Resources Ltd and A-Cap Energy Ltd merged, bringing Letlhakane previously held by A-Cap into Lotus Resources' portfolio. Work carried out on the Letlhakane project in 2024 included pit constrained resource estimates, a 12 100 m (164 holes) drill programme consisting primarily of infill holes to increase resource confidence, metallurgical test work and releasing an updated pit constrained, JORC compliant in situ resource estimate (21 850 tU RAR and 21 880 tU IR). In March 2025, Lotus released results of a scoping study for the Letlhakane project, based on the December 2024 Mineral Resource Estimate, for an open-pit mine and heap leach operation at a production rate of 1 100 tU/yr, over 10 years. The Foley project is located directly to the north of Letlhakane. Eastport Critical Minerals Corp. (previously Penbar Capital Ltd) is exploring Foley for sandstone-hosted uranium mineralisation similar to Letlhakane (Eastport Critical Metals, 2006). Uranium resources are yet to be identified.

No country report was submitted for the Central African Republic. As reported in the previous edition, there has been no exploration and mining development for uranium since the attack at the Bakouma project site in 2012 that led to the suspension of all activities. Refer to the 2024 edition of the Red Book for more information. In 2025, the government of the Central African Republic signed a 25-year strategic mining partnership with CVMR Corporation, a Canadian metal-refining and mining group. Under the agreement CVMR will explore for uranium, among other strategic minerals. Uranium exploration will be specifically carried out by Uranium Power Corporation, a wholly owned US subsidiary of CVMR (CVMR, 2025).

No country report was submitted for Cameroon, however for the first time since 1983, a report was provided for the 2024 edition of the Red Book and, as of January 2023, there were no ongoing uranium exploration activities. Refer to the 2024 edition of the Red Book for more information. In September-October 2024, Australian-listed Peak Minerals Ltd, which was renamed Lion Rock Minerals Ltd in 2025, completed the acquisition of an 80% interest in the Kitongo and Lolo uranium projects. The projects have previously been explored by Mega Uranium Ltd and Nu Energy Corporation. In September 2025, Lion Rock announced that they were unable to verify any historical drill intercepts and as such consider historical drilling results only indicative of uranium mineralisation in the area (Lion Rock Minerals, 2025). The projects remain at early-stage evaluation with no announced drilling campaign yet.

The last time the Democratic Republic of Congo (DRC) reported exploration activities for the Red Book was in 1988 (at that time the DRC was known as Zaire). From 2021 to 2025, the IAEA provided support for the identification and evaluation of uranium and other radioactive resources in the Katanga province in the DRC through the regional Technical Co-operation (TC) programme entitled, "Enhancing Regional Capabilities for Sustainable Uranium Exploration and Mining (AFRA)". As of 2025, the DRC has neither licensed uranium exploration nor mining. The country's only historically significant uranium producer, Shinkolobwe (Haut-Katanga), was officially closed by presidential decree in 2004 and remains closed by law.

No country report was submitted for Egypt; however, reports were provided for the previous three editions (2020, 2022 and 2024) of the Red Book and an active government exploration programme was reported over that time. It was noted in the last report that no exploration of new areas had been carried out since the beginning of 2020, as the decision was made to reduce uranium-related activities and new exploration expenditures. Despite this reduction in exploration activity, Egypt has continued to strengthen its uranium-related technical capabilities through international technical co-operation. Egypt has had ongoing support for over two decades in developing uranium exploration and production capacities through several IAEA TC projects. The most recent includes the regional TC programme entitled, "Enhancing Regional Capabilities for Sustainable Uranium Exploration and Mining (AFRA)" from 2021 to 2025.

No country report was submitted for Ghana; however, for the first time since 1983, a report was provided for the previous edition of the Red Book. It was reported then that an African Regional Cooperative Agreement for (a) Research project commenced in January 2022, with the objective of determining uranium and thorium concentrations in Takoradi Carboniferous black shales. Refer to the 2024 edition of the Red Book for more information.

No country report was submitted for Kenya, whereas for the first time the country provided a report for the previous edition of the Red Book. A government funded country-wide geophysical survey programme in search of uranium deposits was ongoing as of January 2023. Refer to the 2024 edition of the Red Book for more information. In August 2025, the Ministry of Mining published Kenya's first Critical Mineral Catalogue, which formally lists uranium among priority minerals. The catalogue describes surficial and magmatic uranium occurrences as reconnaissance-stage and underexplored (Ministry of Mining, Blue Economy and Maritime Affairs, 2025).

No country report was submitted for Madagascar; however, a report was provided for the previous edition of the Red Book. Refer to the 2024 edition of the Red Book for more information.

For Malawi, no exploration and mine development expenses were reported. Lotus Resources Ltd, through its subsidiary Lotus Africa Ltd (LAL), holds the Kayelekera project and the Livingstonia prospect. Lotus owns 85% of LAL, with the remaining 15% held by the Government of Malawi. Early in 2022 Lotus released an updated Mineral Resource Estimate for Kayelekera (17 810 tU in situ identified resources), followed by a Restart Definitive Feasibility Study (DFS), in August 2022. The company's regional exploration in 2022 defined in situ inferred resources at Livingstonia (1 870 tU). In 2024, the Mines and Minerals Act of 2023 was gazetted, followed by the formal establishment and operationalisation of the Mining and Minerals Regulatory Authority (regulator for all mining activities in Malawi, including uranium mining), in October 2024. In that same year, Lotus signed a mine development agreement with the government of Malawi, secured financing and commenced implementation of an accelerated restart plan to refurbish and restart the operation. Commissioning and first production were achieved in 2025, with ramp up to steady-state production rate (923 tU/yr) planned for 2026.

No country report was submitted for Mali; however, a report was prepared by the NEA/IAEA for the Red Book 2024. At that time, it was reported that Canada's GoviEx Exploration, a subsidiary of GoviEx Uranium Inc., was active in the country in 2021 and 2022 exploring the Falea polymetallic uranium-copper-silver project. In January 2023, GoviEx agreed to sell its Malian subsidiary Delta Exploration Mali SARL (holding the Falea, Bala and Madini licences) to African Energy Metals Inc. (TMX, 2023). However, the transaction failed and, as a result, GoviEx retained ownership (Mining Review Africa, 2023).

For Mauritania, a detailed country report based on company reports and previous editions of the Red Book, was prepared by the NEA/IAEA, including exploration and evaluation expenditures for 2023 to 2024 of USD 2.0 million and USD 3.4 million, respectively, with recent activity by Australia's Aura Energy Ltd at the Tiris (Reguibat) project. The Tiris project is 100% owned by Tiris Resources SARL, which is 85% owned by Aura Energy and 15% owned by the Mauritanian Government's Agence Nationale de Recherches Géologiques et du Patrimoine Minier (ANARPAM). The Tiris project envisages a shallow open-pit mine, a processing plant and supporting infrastructure. Uranium mineralisation lies largely within 3 to 5 m of the surface in a relatively soft, free-digging material containing patchy calcrete. Vanadium by-product could be recovered as vanadium pentoxide (V_2O_5). In 2021-2022, Aura Energy completed an Enhanced DFS of the project with a projected production rate of 770 tU/yr. From October 2023 to April 2024, a 15 260 m (2 996 holes) drill programme was completed testing new targets on the existing tenements. Aura subsequently released a new JORC code compliant resource estimate in June 2024 whereby Tiris' total in situ uranium resources increased by 55%, to 35 100 tU. An estimate of the vanadium resource was also completed (13 430 t V_2O_5). In December 2024, an ore reserve estimate was completed based on pit optimisation and mine schedules, whereby the ore reserves increased by 49% to 62.8 Mt ore at 0.021 %U, containing 12 960 tU.

In Namibia, exploration and development activities between 2022 and 2025 were undertaken both at existing mine sites and at developing properties, with intensive activity through the period.

Majority shareholder China National Uranium Corporation (CNUC) resumed exploration drilling on the Rössing mining licence in 2022, with approximately 12 500 m of diamond drilling. In 2023, 23 holes were drilled in various anomalies and, in 2024, 323 m of reverse circulation drilling and 309 m of diamond drilling was carried out.

At the Husab mine, Swakop Uranium (Pty) Ltd, which is jointly owned by China General Nuclear Power Group (CGN) and China-Africa Development Fund (CADF), focussed on assessing the resource potential of mineralised zones surrounding the Zone 1 and Zone 2 pits currently being mined. At their two adjacent exclusive prospecting licences, exploration focussed on other prospects, in particular drilling at the Ida Central, Holland's Dome and Garnet Valley deposits. Future exploration aims to further delineate the resource boundaries at these deposits and initiate independent resource certification thereof.

In 2022 and 2023, Paladin Energy Ltd carried out restart activities at Langer Heinrich mine, including extensive refurbishment, coupled with process upgrades aimed at improving operational efficiency and reliability of the processing plant. Production restarted in early 2024, with a planned four-year production ramp-up underway, targeting a maximum annual output of 2 300 tU/yr. Mill feed for the initial 18 months was sourced from stockpiled ore, with open-pit mining resuming in April 2025 (Paladin Energy, 2025).

While Trekkopje mine remains under care and maintenance, Orano has conducted research to improve future uranium recovery, and in 2023 conducted a PFS for a potential re-opening of the mine. In 2024 Orano started to study all options for Trekkopje development, to fully understand the project feasibility.

Bannerman Mining Resources (Namibia) (Pty) Ltd, and parent Australian company Bannerman Energy Ltd, continued evaluation and permitting work on its Etango project, where two-thirds of the identified in situ resources (79 800 tU) are located within 200 m of the surface. With environmental approvals in place, following metallurgical test work at its demonstration plant, Bannerman decided on an annual production rate of 1 350 tU/yr for the project. The mining licence was granted in December 2023, and early construction works commenced in 2024. The company is targeting Final Investment Decision (FID) in 2026, and commissioning in 2028. In early 2026, Bannerman executed a binding investment subscription and joint venture documentation with China National Nuclear Corporation Overseas Limited (CNOL) for the funding, development and operation of the Etango project (Bannerman Energy, 2026).

In late 2023, Reptile Mineral Resources and Exploration (Pty) Ltd (RMR), and parent Australian company Deep Yellow Ltd, completed the DFS for the Tumas project for a 1 400 tU/yr operation. An 8 000 m (235 holes) infill drill programme was undertaken at Tumas in 2023, aimed at expanding the resource base. Environmental approvals for the project and a 20-year Mining Licence were granted in September 2023. In September 2024 the Mineral Resource Estimate for the Tumas project was upgraded to a higher confidence level following a nearly 13 000 m (660 holes) resource infill drilling programme. In April 2025 the company deferred FID, whereas engineering and early development works continue. Separately, at the Nova JV, in 2023-2024 RMR conducted a 2 000 m (9 holes) follow-up drilling programme at the Barking Gecko North prospect.

Elevate Uranium Ltd has recently focussed primarily on their Koppies deposits, and in October 2024 announced increased identified in situ resources (25 400 tU) for the Koppies project. During 2024-2025, Elevate Uranium carried out 100 000 m (3 605 holes) of drilling across its Namibian projects, that in addition to Koppies, include Marenica and MA7 uranium deposits. In previous years, Elevate Uranium developed its U-pgrade™ beneficiation process to increase the grade of mined ore from calcrete-type uranium deposits prior to leaching. A demonstration/pilot plant has been commissioned in late 2025 (Elevate Uranium, 2025).

At the Happy Valley project, Zhonghe Resources (majority owned by China National Nuclear Corporation [CNNC]) carried out a series of geological and geophysical surveys in 2021-2022, followed by a diamond drilling programme in 2022. No further work has been reported since.

Forsys Metals Corp. started a programme in 2023 to update and improve on its 2015 DFS for the Norasa project, including a 4 100 m geotechnical drill programme. In 2024 Forsys completed a 7 500 m (85 holes) percussion drill programme resulting in a new combined identified in situ resources estimate of 33 800 tU for the Valencia and Namibplaas deposits that comprise the Norasa project. Also in 2024, metallurgical testing was carried out, showing the project supports the use of heap leaching for uranium recovery.

In southeastern Namibia, Headspring Investments (Pty) Ltd (subsidiary of Russian owned Uranium One) has been exploring for sandstone-hosted uranium mineralisation at its Wings project that is potentially amenable for extraction by ISL, the first potential ISL mine in Namibia. An intensive 2019-2021 drilling programme formed the basis for JORC compliant identified in situ resources of 41 500 tU. A 2021 PFS for the Wings project confirmed positive economics for the ISL mining method and in 2022 a pilot plant and well field were constructed. ISL pilot test commissioning and production will start subject to receiving regulatory approvals. In 2024 Headspring started research studies of radionuclides distribution in ground water horizons adjacent to the deposit, investigations that will continue in 2025 and 2026.

After dropping to only USD 5 million annually from 2016 to 2019, uranium exploration and mine development expenditures in Namibia recovered beginning in 2020, to USD 86 million, USD 17 million, and USD 43 million in 2022, 2023 and 2024, respectively, with USD 61 million expected for 2025. Of these totals, mine development expenditures accounted for 79%, 34%, 56%, and 81%, respectively, for the 2022 to 2025 period. A total of 590 400 m (17 200 holes) were drilled in Namibia from 2022 to 2025, with 86% of the drilling for uranium exploration.

Uranium exploration and development expenditures were not reported for all operations in Niger in this edition. Reported expenditures were available only for GoviEx Uranium Inc., and amounted to USD 3.5 million in 2022, USD 2.1 million in 2023 and USD 1.6 million in 2024. On 26 July 2023, a coup d'état occurred in Niger, the country's democratically elected president was detained, and a military junta established (ACLED, 2023). These political events led to disruptions and considerable uncertainties within Niger's uranium industry.

In December 2020, the government approved the Dasa project mining permit and granted Global Atomic Corporation (GAC) three-year permit extensions for each of its six exploration properties in Niger. A Feasibility Study (FS) focussing solely on Phase 1 (underground mine, 17 460 tU production over 12 years) was completed in November 2021 and formed the basis for GAC's decision to proceed with the Dasa project. A new Mineral Resource Estimate (61 800 tU in situ identified resources), based solely on underground mining for the central part of the deposit, was released in May 2023 and, in February 2024, GAC released an update of the FS based on this new estimate.

In July 2022, GoviEx released the results of a new NI 43-101 compliant, uranium and molybdenum Mineral Resource Estimate (44 800 tU in situ identified resources) for the Madaouela project, comprising primarily five deposits (i.e. Marianne, Marilyn, Miriam, MSNE and Maryvonne). In November 2022, GoviEx released an FS for the Miriam open-pit project, process plant and associated infrastructure, and updated a previous Pre-Feasibility Study (PFS) on the two underground mines (i.e. Marianne-Marilyn and MSNE-Maryvonne). A conventional drill, blast, truck and shovel operation was planned for the Miriam open pit. The Marianne-Marilyn and MSNE-Maryvonne deposits were planned to be mined sequentially, as two independent underground room and pillar operations, following completion of the Miriam open-pit operation. A 20-year project life was forecast, producing an estimated total of 19 100 tU, averaging 950 tU/yr. In July 2024, GoviEx announced that the government had withdrawn its mining rights to the Madaouela project (GoviEx, 2024; WNA, 2024b). As a result, GoviEx initiated arbitration proceedings in January 2025; however, in February 2025, GoviEx and the Republic of Niger, signed a letter of intent agreeing to a structured roadmap that details a mutually acceptable plan for negotiations and agreed to suspend the arbitration proceedings while negotiations are ongoing (WNA, 2025a).

In 2021 to 2022, Orano continued exploration and development activities in the Somaïr mine perimeters and Arlit concession, and increased resources and reserves, such that Somaïr had more than ten years of production viability. In September 2023, Somaïr halted yellowcake production at the Arlit mine and brought forward plant maintenance initially planned for early 2024, while continuing only mining operations, as the coup had resulted in disruption of supplies of reagents. In June 2025, the government of Niger announced the nationalisation of Somaïr.

In 2022, as part of optimisation studies for the Imouraren open-pit mining project, a mineral resource update was carried out with the use of a deterministic ore envelope model that led to a decrease in mineral resources and economic reserves recognised by Orano, accompanied by an increase in the average grade and improvement in classification of the resources. In 2022 and 2023 work was undertaken by Orano to determine the technical and environmental feasibility of mining Imouraren using the ISL method, with the aim to minimise the environmental impact and improve the economics of mining the deposit. In June 2024, Orano announced that Nigerien authorities had withdrawn the operating permit for the Imouraren uranium mine (Orano, 2024; WNA, 2024a).

The Takardeit project, now referred to as Agadez project, which includes the Takardeit deposit, was acquired by ENRG Elements Ltd in 2021. In March 2023, ENRG (recently renamed to Barys Resources Ltd) released the results of a new JORC compliant Mineral Resource Estimate (8 300 tU in situ IR) for the Takardeit deposit. In late 2024, ENERG secured a three-year renewal for its exploration permits comprising the Agadez project (ENERG Elements, 2024). In September 2025 the company announced that it will continue to assess all options available to realise maximum value for its shareholders, which may include continued exploration or a possible divestment via an earn in or corporate transaction (ENERG Elements, 2025).

Senegal had no uranium exploration activity reported from 2016 until 2022. Recent exploration expenditures amounted to USD 0.5 million in 2023 and USD 0.8 million in 2024. No preliminary estimate was provided for 2025. Haranga Resources Ltd (70%) and Mandinga Resources SARL (30%, free carried to PFS) own the Saraya project in southeastern Senegal. In September 2023, Haranga announced a Maiden Resource including 6 200 tU IR (in situ) (Haranga Resources, 2023), which was upgraded in 2024 utilising historical drilling data. The upgraded Mineral Resource Estimate contains 2 600 tU RAR (in situ) and 4 200 tU IR (in situ) (Hangara Resources, 2024). In July 2025, Senegalese authorities renewed the exploration permit for an additional three years, allowing continued exploration activities through 2027 (Hangara Resources, 2025).

For South Africa, no exploration and mine development expenditures were reported in this edition. In 2022, Sibanye-Stillwater initiated a PFS to determine the optimal uranium extraction strategy for Cooke tailings. In August 2023, Sunshine Mineral Reserves (Pty) Ltd released a SAMREC compliant Mineral Resources Estimate of 34 320 tU in situ IR and 2.63 million ounces of gold for Beisa North and South. In August 2024, Neo Uranium Resources Beisa Mine (Pty) Ltd (NURB), a subsidiary of Neo Energy Metals plc, signed a binding agreement with Sunshine to acquire 100% interest in the Beisa North and South projects (Neo Energy Metals, 2024). By that time, the mineral resources for the Beisa projects included 34 320 tU in situ IR and 4.17 million ounces of gold. In October 2024, Neo Energy's subsidiary, Neo Uranium Resources South Africa (Pty) Ltd, acquired 100% interest in the Henkries South project from South African Eagle Uranium SA (Pty) Ltd. The Henkries South project is immediately south and adjoins Neo Uranium's existing Henkries uranium project, located in the administrative district of Namaqualand in the Northern Cape Province. Henkries itself, i.e. Central and North, contains 1 000 tU RAR in situ and close to 1 000 tU IR in situ.

For Tanzania, exploration and development expenditures were not reported for this edition. Mantra Tanzania Ltd (owned by Uranium One Group of Russia) continued work at the Nyota sandstone-type deposit (Mkuju River project) with JORC compliant in situ identified resources of 58 500 tU. After earlier confirming the amenability of the portion of the resources below the water table for extraction by ISL, Mantra decided, in 2020, to proceed with small-scale open-pit mining and pilot plant processing (5 tU/yr). Upon receiving necessary approvals, construction works were completed in 2023, and the pilot processing plant equipment installed. In 2025, Mantra obtained all required regulatory approvals and launched pilot operations in July. In addition, the company plans to resume exploration and conduct hydrological research focussed on ISL extraction of parts of the resources.

In 2021, Australian company Gladiator Resources Ltd, recently renamed to US1 Critical Minerals Ltd, acquired Zeus Resources Ltd and the Tanzanian tenements known as the Likuyu North, Mtonya, Minjingu, Mkuju, Liwale, Foxy and Eland uranium projects. In 2021, Gladiator began exploration at the Minjingu project, and in 2022 issued a JORC compliant Mineral Resource Estimate of the Likuyu North deposit (1 770 tU in situ identified resources). In 2024, Gladiator carried out an airborne radiometric survey at Mkuju, while exploration drilling focussed on the SWC and Mtonya targets and testing down-dip extension of the Likuyu North deposit. The area is a target for future drilling aimed at expanding the deposit, focussing on ISL recovery.

In January 2023, AuKing Mining Ltd. acquired uranium projects in Tanzania (i.e. Mkuju, Manyoni, Itigi and Magaga) and started exploration to verify historical Manyoni project resources. However, the Tanzanian Mining Commission revoked five of the issued Prospecting Licences (PLs) that comprise much of the known resources at the Manyoni project, and the company filed an appeal. In 2024, AuKing reported assay results from a soil sampling and auger drilling programme at the Mkuju project, and commenced an 11 000 m (75 holes) Stage 2 air core/RC drilling programme.

Uganda does not report data to the Red Book but has been supported by IAEA's TC programmes, including the national TC programme "Supporting Uranium Exploration and Evaluation", which started in 2022 and will continue through 2026, and the regional TC programme "Enhancing Regional Capabilities for Sustainable Uranium Exploration and Mining (AFRA)" from 2021 to 2026. An IAEA Integrated Uranium Production Cycle Review Mission was conducted in 2024 and focussed on assessing the country's readiness to support uranium exploration activities. The government continues to evaluate national uranium resources utilising their Geological Survey and Mines Department as part of long-term planning as the country considers adding nuclear energy to its future energy mix.

Zambia exploration expenditures increased from USD 3.7 million in 2022, to USD 5.2 million in 2023 and USD 5.6 million in 2024, with no estimate for 2025. GoviEx Uranium Inc.'s Muntanga project consists of five main uranium deposits (i.e. Muntanga, Dibbwi, Dibbwi East, Njame and Gwabi). In 2021 and 2022, GoviEx conducted an extensive 33 600 m (262 holes) infill drilling programme of the Dibbwi East deposit, targeting conversion of inferred resources to the indicated category. Additionally, a bulk ore sample was sent for metallurgical test work. In 2023, a 15 800 m (160 holes) drilling programme was completed on the Muntanga and Dibbwi East deposits to target areas of open mineralisation and potential extensions at the Dibbwi East deposit, in support of a Muntanga project Feasibility Study, and Environmental and Social Impact Assessment. In January 2025, GoviEx released an updated NI 43-101 compliant Mineral Resource Estimate (dated effective January 2024) of 18 200 tU in situ identified resources, which incorporated the results of the 2023 drill programme.

No country report was submitted for Zimbabwe; however, for the first time since 1998, a report was provided for the previous edition of the Red Book and, as of January 2023, there were no ongoing uranium exploration activities. Refer to the 2024 edition of the Red Book for more information.

Middle East, Central and Southern Asia

Uranium exploration and mine development expenditures in the Middle East, Central and Southern Asia region amounted to about 15% of total reported global expenditures for 2022, 16% for 2023, 15% for 2024 and an expected 15% for 2025, levels significantly greater than the region's long-term position accounting for 8% of pre-2018 global expenditures. About 46% of the region's expenditures were in India and 36% in Uzbekistan; however, Kazakhstan and Saudi Arabia also reported significant expenditures, each averaging more than USD 10 million per year.

Bangladesh did not submit a country report, however a report was provided for the previous edition of the Red Book and, as of January 2023, the Bangladesh Atomic Energy Commission, through the Institute of Nuclear Minerals of the Atomic Energy Research Establishment, had been conducting preliminary uranium and thorium exploration. Refer to the 2024 edition of the Red Book for more information.

In India, government exploration expenditures remained relatively consistent from year to year, at USD 67 million in 2022, USD 60 million in 2023, USD 53 million in 2024 and USD 58 million expected for 2025. In 2024, India's expenditures represented about 6% of total global uranium exploration and mine development expenditures. 818 000 m of government exploration drilling was completed in India from 2023 to 2024, with 206 000 m expected for 2025.

Extensive exploration, including ground and heliborne geophysical, ground geological, radiometric, and geochemical surveys and drilling were undertaken in recent years, in geological domains that have the potential to host uranium. These efforts have resulted in an 8% increase in RAR from 2023 to 2025 (building on a 15% increase from 2021 to 2023), due to appreciable resource additions in the southern part of the Cuddapah Basin, the Singhbhum Shear Zone and North Delhi Fold Belt.

No country report was submitted for Iran. However, a Secretariat prepared country report was included in the previous edition of the Red Book. Refer to the 2024 edition of the Red Book for more information.

In Jordan, government uranium exploration and development expenditures continue at similar levels to recent years, ranging between USD 2.9 million and USD 3.5 million for 2022 to 2024, with USD 3.7 million expected for 2025. For this period, 100% of the expenditures were categorised as development expenditures. Having earlier defined JORC compliant, total in situ identified resources of 35 000 tU for the Central Jordan uranium project (CJUP) deposit, the Jordan Uranium Mining Company (JUMCO) has more recently focussed on determining the hydrometallurgical process and establishing a pilot plant. Engineering of the uranium extraction process progressed during the period 2017 to 2022, and a pilot-plant was constructed and commissioned in 2021. As of 1 January 2023, hundreds of tonnes of uranium ore were processed by heap leaching technology to produce several kilograms of uranium concentrate. Supporting this work, a state-of-the-art analytical laboratory was established in 2020 and equipped in co-operation with the IAEA, an added value beyond the project. JUMCO is performing a PFS for CJUP to have better cost estimation that considers different options and scenarios. The PFS will then be the baseline for a future bankable FS.

Uranium production cycle activities in Jordan have been supported by several IAEA TC projects, most recently the "Enhancing the National Capabilities in Exploiting Uranium Ores in a Safe and Environment Friendly Manner" national project, which started in 2022 and continued through 2025, and a new national project "Developing the National Nuclear Energy Programme", which started in 2026 and will last for two years.

In Kazakhstan, exploration and development expenditures increased from a 15-year low of USD 9.5 million in 2022, to USD 14.3 million in 2023 and USD 18.4 million in 2024, with no estimate provided for 2025. During the 2022 to 2024 reporting period, 62% of the total expenditures were devoted to mine development activities, with the remainder devoted to exploration. Drilling over this same period amounted to 2 082 300 m (5 072 holes), with development drilling (1 747 900 m) accounting for 84% of the total metres drilled.

From 2021 to 2024, exploration was undertaken at the Budenovskoye, Inkai, Northern Kharasan and Mynkuduk deposits. JSC NAC Kazatomprom continued exploration work at Inkai site No. 2, and pilot industrial uranium mining was planned to start at Inkai site No. 3 in 2025. In 2023, a re-evaluation of uranium resources at the Western site of the Mynkuduk deposit was completed by APPAK LLC, and JV Turanium LLP completed exploration of the Northern Kharasan deposit. That same year, JV Katco LLC completed an analysis of the depletion of uranium reserves at site No. 1 of the Moinkum deposit, based on which uranium reserves were revaluated. In 2024, uranium exploration licences were issued to Kazatomprom for: the East-Zhalpak site, the Inkai-Mynkuduk site, Budenovskoye North, and Budenovskoye #5-1 and #5-3, all located in the Shu-Sarysu uranium province.

The 2021-2024 exploration resulted in the addition of 77 345 tU total in situ identified resources, among sites No. 6 and No. 7 of the Budenovskoye deposit, the Western site of the Mynkuduk deposit, site No.2 of the Budenovskoye deposit, site No.1 of the Moinkum deposit and site No. 1 of the Northern Kharasan deposit.

Nepal did not submit a country report; however, the country submitted a report for the previous edition of the Red Book – the first time it had done so. Refer to the 2024 edition of the Red Book for more information.

Pakistan did not submit a country report or report exploration and development expenditures. Secretariat reports for previous editions of the Red Book note exploration activities conducted by the Pakistan Atomic Energy Commission (PAEC). Refer to the 2024 edition of the Red Book for more information.

The Kingdom of Saudi Arabia has been actively exploring for uranium and thorium since 2017, and the information submitted for this edition marks the third consecutive Red Book country report they have contributed. For 2023 to 2024, government exploration expenditures totalled USD 31 million, with 40 500 m (196 holes) drilling for this period.

Their initial USD 37 million exploration programme, carried out from 2017 to 2019, evaluated nine designated areas (including 36 subareas) across Saudi Arabia, with seven subareas tested by drilling, leading to detailed exploration and resource estimates for three subareas, namely Ghurayyah, Jabal Sayid and Thaniyat Turayf. From 2021 onwards, exploration programmes have been implemented to follow up on the initial 2017 to 2019 results. The first phase was carried out with modern exploration techniques and brought the database up to modern levels. The second phase continued testing many subareas, both within the Arabian Shield and in the cover rocks (eastern part of the Arabian Shield). Over the four years from 2021 to 2024, USD 51 million was invested in these follow-up exploration programmes, including 117 900 m of drilling (486 holes). The next phase will include the continued exploration of uranium in other prospects and the development of reasonably assured resources at selected deposits.

The uranium resources previously delineated are classified as unconventional resources, including 85 400 tU in situ uranium resources associated with niobium, zirconium, REE, tantalum and thorium, hosted in peralkaline granite and pegmatite (intrusive plutonic deposit type) in the Ghurayyah and Jabal Sayid subareas, and 14 600 tU in situ uranium resources associated with phosphorites at the Thaniyat Turayf prospect. The unconventional total in situ uranium resources for the Ghurayyah deposit (57 800 tU in situ) and Jabal Sayid prospect (JORC compliant 27 600 tU in situ) are, however, included in Chapter 1 resources tables, reflecting the extensive exploration programme, industry standard resource estimates and uranium expected to be a co-product.

In Uzbekistan, since January 2022, mining (including exploration and development) and processing of natural uranium and rare earth metals has been organised under Navoiyuran, the sole state uranium mining company in the country. Uranium exploration is the responsibility of the Navoiyuran subsidiary, Scientific and Production Center “Geology of Uranium and Rare Metals”, that has three geological expeditions (Bukantau, Nuratinsk and Zirabulak) and one drilling company, which conducts exploration within the Bukantau, Nuratin, Ziyavutdin-Zirabulak and Syrdaria uranium regions. Exploration is focussed on ISL amenable resources, expansion of known operating deposits and on resources identification at new prospective areas. Additionally, in December 2019, France and Uzbekistan established the uranium joint venture, Nurlikum Mining LLC (ownership 51% Orano and 49% Navoiyuran), which is focussing on exploration of sandstone-type uranium mineralisation in the Djengeldi region of Kyzylkum province.

In 2022, Uzbekistan’s President signed a resolution to double the country’s uranium production from 3 500 tU in 2021 to 7 100 tU in 2030 and increase uranium resources to 100 000 tU by 2030. Uzbekistan’s ability to reach this target will depend on rapid expansion of its resource base, driving significantly increased exploration activity. Navoiyuran reports a very significant increase in recent exploration drilling activities, focussed on execution of the Presidential resolution, increasing from 608 300 m (1 647 holes) in 2022, to 1 047 000 m (2 623 holes) in 2023, 1 566 000 m (3 978 holes) in 2024 and 1 849 000 m (4 622 holes) planned for 2025. This intensive exploration, i.e. tripling drilling in three years, resulted in additional in situ resources of 6 119 tU in 2023 and 10 805 tU in 2024, about 95% in the RAR category.

Since commencing field exploration in 2020, the Nurlikum Mining joint venture had drilled 114 hydrogeological and exploratory holes by 2022, 43 holes in 2023 and 66 holes in 2024. In June 2023, the company commissioned and launched the pilot plant at the Dzhengeldi deposit to confirm the feasibility of ISL mining and, in 2024, Nurlikum Mining approved 6 484 tU of the Dzhengeldi deposit resources in the Uzbekistan State Reserves Committee. In 2025, Nurlikum continues exploration in the northern part of the region, to increase the resource base.

Total exploration expenditures increased year over year, from USD 20 million in 2022, to USD 36 million in 2023, USD 56 million in 2024 and USD 75 million expected for 2025. By 2024, Uzbekistan's expenditures were the fourth highest among all countries, and about 6% of total global uranium exploration and mine development expenditures.

In October 2025, the IAEA held a Technical Meeting in Samarkand on "Advances and Innovations in the Exploration and Mining of Sandstone Uranium Deposits".

Southeastern Asia

Uranium exploration and mine development expenditures of less than USD 170 000 for the Southeastern Asia region amounted to less than 0.1% of total reported global expenditures for the 2022 to 2025 period. Previous very modest uranium exploration expenditures in Indonesia continued in 2022, with no activity since, whereas Viet Nam reported some ongoing work, although associated expenditures have not been reported since 2017.

Indonesia reported exploration expenditures of USD 169 000 in 2022, with no expenditures and no uranium exploration activities for 2023 and 2024. In 2022, uranium exploration activities were conducted in co-operation with the Energy and Mineral Resources Ministry to delineate potential rare earth element mining areas in the Melawi and Mamuju regions. The programmes consisted of sampling of laterite soils, review of uranium metallogeny, laboratory analysis and a 600 m (12 holes) core drilling campaign in the Mamuju region.

Thailand had no uranium exploration activity since 2019. However, from 2017 to 2018, the Royal Thai Department of Mineral Resources (DMR) conducted reconnaissance/regional survey activities for REE deposits in various parts of Thailand that identified uranium and thorium associated with some weathered granitic profiles in the vicinities of Mae Hong Son, Chiang Mai and Tak Provinces.

In Viet Nam, uranium mineralisation is associated with rare earth element deposits (Lao Cai province), phosphate deposits (Cao Bang province), and sandstone and coal deposits (Quang Nam province). Government uranium exploration expenditures were last reported for 2016 and 2017; however, uranium exploration and research work on uranium extraction work from ores, has continued. Between 2018 and 2024, research on the recovery of thorium and uranium from rare earth concentrates has been carried out by the Institute for Technology of Radioactive and Rare Elements. A process for simultaneous recovery of thorium and uranium was developed for testing of the Yen Phu and Dong Pao rare earth concentrates leach solutions. Results show the extraction method is suitable for recovery of thorium and uranium at purities of greater than 99%.

East Asia

Uranium exploration and mine development expenditures in the East Asia region amounted to 28% of total global expenditures in 2022 and 2023, 24% in 2024 and 25% expected for 2025, levels much greater than the region's long-term position accounting for 5% of total pre-2018 global expenditures. Whereas some expenditures are reported for Mongolia, the region's high share of global expenditures is attributable to intensive uranium exploration and mine development efforts by China, since 2007. From 2022 to 2025, China's uranium exploration and development expenditures were second only to Canada.

China reported total domestic exploration and mine development expenditures of USD 202 million for 2022, USD 223 million for 2023, and USD 232 million for 2024, with USD 232 million expected for 2025. Government exploration expenditures comprised 75% to 80% of the total, followed by industry exploration expenditures and industry development expenditures.

Domestic uranium exploration focussed primarily on sandstone-type uranium deposits in northern China, with positive outcomes resulting in resource expansion in the Ordos, Yili, Songliao and Yine basins. New uranium occurrences were discovered in the Songliao, Junggar, Chaidamu and Erenhot basins. In southern China, exploration focussed on the known uranium ore fields, exploring the deeper parts and periphery of volcanic-related and granite-related uranium deposits, including Xiangshan, South Zhuguang, Lujing and Miaoershan.

In total, 2 350 000 m drilling was completed between 2023 and 2024 (1 150 000 m in 2023 and 1 200 000 m in 2024), resulting in a substantial increase of uranium resources in northern China basins, such as the Ordos, Erenhot, Songliao, Yili and Turpan-Hami Basins, and a modest increase of uranium resources in the deeper parts and on the periphery of the Xiangshan, southern Zhuguang, Xiazhuang and Longshoushan uranium ore fields in southern China. Overall, this exploration resulted in a 79 800 tU (37 000 tU RAR, 42 800 tU IR), or a 20% increase to in situ identified uranium resources, compared to the 2024 edition.

Other than a single year (2020) of data being unavailable, China has consistently reported non-domestic exploration and development expenditures, since 2007. However, the 2023 to 2025 preliminary expenditures reported for this edition are only partial expenditures. China National Nuclear Corporation (CNNC) non-domestic exploration and development expenditures are reported at USD 1.1 million in 2023, USD 6.4 million in 2024 and USD 30.9 million expected for 2025, whereas China General Nuclear Power Corporation (CGN) non-domestic expenditure information was not available.

CNNC and CGN are involved in several non-domestic uranium projects in Namibia, Kazakhstan and Niger. CNNC is the largest shareholder in the Rössing uranium mine in Namibia and the Azelik uranium mine in Niger and holds an equity stake in the Langer Heinrich uranium mine in Namibia. Further exploration and development are also underway for CNNC-held projects in Mongolia (Gurvanbulag), Namibia (Happy Valley) and Zimbabwe (Kanyemba). CNNC is also co-operating with Uzbekistan on development of a processing technology for black shale type deposits. CGN is the largest shareholder of Husab uranium mine in Namibia and holds equity stakes in the Semizbay, Irkol, Central Mynkuduk and Zhalpak mines, in Kazakhstan.

Over the past several years, the IAEA has supported China through the TC programme. There are two recent national TC projects, "Developing Enhanced Exploration Techniques for Hard Rock Type Uranium Resources and Promoting Green and Efficient Uranium Recovery Technology by External Field Reinforcement", which started in 2024 and will continue through 2026, and "Enhancing Lower Cost, Efficient Exploration for the Major Known Uranium Types" which began in 2026.

Japan reported annual non-domestic government exploration and development expenditures in the range of USD 2.4 million to USD 2.9 million for 2022 to 2024, with USD 6.9 million expected for 2025. The Japan Organization for Metals and Energy Security (JOGMEC) continued exploration activities in Uzbekistan and Namibia. In addition, Japanese private companies hold shares in companies developing uranium mines and in companies operating mines in Canada and Kazakhstan.

In Mongolia, after minimal activity from 2019 to 2021, 40 700 m of drilling was reported for 2022, but no drilling was carried out in 2023 or 2024. Industry exploration expenditures rebounded from the 2019 to 2021 annual average of USD 100 000, to USD 4.2 million in 2022, USD 2.7 million in 2023 and USD 4.1 million in 2024. Estimates of expenditures or drilling were not available for 2025.

As outlined in the 2024 Red Book edition, four companies are engaged in uranium exploration, mainly working in the south Mongolian sedimentary basins, focussing on sandstone-type uranium mineralisation amenable to ISL mining. Badrakh Energy LLC conducted exploration and development activities during 2019 to 2020 at the Zuuvch Ovoo and Dulaan Uul deposits in southeast Mongolia, resulting in increased in situ identified uranium resources for the Zuuvch Ovoo deposit to 93 300 tU and a technical report submitted to the Mongolian Professional Committee of Resources, in February 2020. After receipt of all required authorisations from government authorities, a pilot ISL test was started in 2021 and operated until December 2022, confirming the economic and environmental feasibility of the project. Various studies were compiled in 2023 and 2024, the FS was finalised and the study was discussed with the Mineral Resources Professional Council of Mongolia. Commercial production is planned to begin in 2030, with a nominal production capacity of 2 500 tU/yr.

Gurvansaikhan LLC, a Mongolian-Czech joint venture, holds licences for the Kharaat, Khairkhan, Ulziit and Gurvansaikhan uranium deposits in south Mongolia. Major exploration activities were conducted during 1998-2012 and in situ identified resources of 23 000 tU was accepted by the Mongolian Professional Committee of Resources. In 2022, the company restarted activities, conducted an additional 40 700 m of exploration drilling and is working on a technical report updating resources to JORC standards.

Pacific

Uranium exploration and mine development expenditures in the Pacific region (i.e. Australia) accounted for about 4% of total global expenditures reported for this edition of the Red Book, from 2022 through 2025.

In Australia, domestic exploration expenditures continued to recover from the 2020 low of USD 4.6 million (the lowest level since 2003), to USD 15.0 million in 2022, USD 36.7 million in 2023 and USD 47.5 million in 2024, a tenfold increase in four years. The preliminary expenditure estimate for 2025 is USD 32.7 million. During this period, uranium exploration was most active around known resources in Western Australia and South Australia.

In Western Australia, in 2017, the State Government announced a ban on future uranium mining leases but noted that it would not prevent development of four projects that had previously received State Ministerial approval. These projects are, however, subject to legally binding State Ministerial approval conditions and were required to have been substantially commenced within five years from the date of the approval. The Mulga Rock project is wholly owned by Deep Yellow Ltd, following a merger with Vimy Resources Ltd (the previous owner) in August 2022. The project involves shallow open-pit mining of four polymetallic deposits, with a production rate of 1 350 tU/yr for 15 years. In September 2021, the mining proposal and associated closure plan was approved by the Western Australian Department of Mines, Industry Regulation and Safety. In 2024, Deep Yellow announced a 26% increase of the uranium resource associated with the two Mulga Rock East deposits and plan to start a revised DFS in 2025.

The Yeelirrie deposit, wholly owned by Cameco Australia Pty Ltd, is one of the world's largest surficial uranium deposits. The Yeelirrie project, proposed for nearly 3 300 tU/yr production over 19 years, utilising open-pit mining and alkaline leach technology, received environmental approval from the Commonwealth Government in April 2019. However, the environmental approval that was granted by the Western Australian Government in January 2017 has since expired. The unconformity-related Kintyre uranium deposit, also wholly owned by Cameco, is well suited for open-pit mining. It is estimated that average production from Kintyre would be around 2 290 tU/yr with an estimated mine life of 15 years. Cameco Australia secured Commonwealth and state environmental approval for the Kintyre project in 2015, which has since expired. Cameco's current focus is on producing from their tier-one uranium assets at a pace aligned with their contract portfolio and market opportunities. Hence, work is planned neither at Yeelirrie nor at Kintyre.

The Wiluna project is a surficial calcrete-hosted regional resource, comprised of four deposits and wholly owned by Toro Energy Ltd. Mining is planned as shallow strip excavation to a maximum depth of 15 m, with estimated average production of around 500 tU/yr and 340 t/yr of vanadium pentoxide (V_2O_5), for an estimated mine life of 16 years. The Wiluna project received Commonwealth and state environmental approval in 2017, with the state environmental approval now expired. In 2023, Toro Energy continued evaluation activities in respect of optimisation of the project, and reported (Toro Energy, 2023) that it intended to apply for an extension to the "substantial commencement" condition. In October 2025, the Canada-based company, IsoEnergy Ltd, announced the acquisition of Toro Energy, with the deal expected to close in the first half of 2026 (WNA, 2025d).

In South Australia, BHP Ltd.'s Olympic Dam mine, a polymetallic iron-oxide breccia complex deposit, is Australia's largest source of uranium production and the world's largest uranium resource. In 2024, it contributed approximately 60% of Australia's uranium production as a by-product to primary copper production. Recently, BHP has been exploring Oak Dam, another polymetallic iron oxide copper-gold deposit, located 65 km from Olympic Dam. As of April 2024, BHP had completed approximately 158 km of exploration drilling of the 800-metre-deep deposit and has applied to licence an underground access project to enable underground exploration drilling to better define the resource. In August 2024, BHP issued a maiden Oak Dam inferred mineral resource for the primary copper-gold resources.

South Australia also hosts sandstone-type ISL amenable deposits. Uranium-bearing resin from the Four Mile ISL mine, operated by Quasar Resources Pty Ltd, is pumped to the Beverley processing plant for elution, precipitation and drying as uranium concentrate. Delineation drilling has been ongoing at the Four Mile North East deposit. The Honeymoon ISL operation, operated by Boss Energy Ltd, and previously in care and maintenance since 2013, resumed production in early 2024. The Honeymoon project has identified resources of 23 300 tU from the Honeymoon, Gould's Dam and Jason's deposits. During 2024, Boss Energy conducted infill drilling at the Gould's Dam and Jason's deposits and exploration drilling at the Cummins Dam prospect. Alligator Energy Ltd is planning to start an ISL field recovery trial in late 2025 at the Blackbush deposit, one of two uranium deposits comprising the Samphire project. Outcomes of the trial and further exploration will determine if an application for mining will be sought by the company.

Through 2023 and 2024, Australian-listed mineral companies were involved in uranium exploration activities in other countries. However, non-domestic expenditures are not reported by Australia.

Uranium production

In 2024, 18 countries produced uranium, with the global total amounting to 61 924 tU. Kazakhstan remained, by far, the world's largest producer at 38% of global production, even as production continued below subsoil use agreements levels. The second and third largest producing countries were Canada and Namibia, respectively, and these top three producers contributed more than 72% of total world production. Just six countries accounted for nearly 93% of the world's uranium production in 2024, with Uzbekistan, Australia and Russia, respectively the fourth, fifth and sixth largest producers of uranium that year. The seventh through twelfth largest producing countries, China, Niger, India, Ukraine, the United States and South Africa, respectively, collectively accounted for 6.8% of 2024 global production. Of the 18 countries that produced uranium in 2024, six had production of less than 100 tU for the year, and three of these – Czechia, Hungary and Romania – only from mine remediation activities.

Table 1.17 summarises major changes in uranium production and Table 1.18 shows production in all producing countries from 2022 to 2025. Figure 1.5 shows 2024 production shares, and Figure 1.6 illustrates the evolution of production shares over the past decade.

Table 1.17. **Uranium production in selected countries and reasons for major changes 2022-2024**

(as of 1 January 2025, tonnes U)

Country	Production		Difference	Reason for changes in production
	2022	2024		
Canada	7 380	14 327	6 947	McArthur River mine & Key Lake mill back at full production (~7 810 tU in 2024). (Shut down in 2018 in response to market conditions and resumed production in Nov 2022.)
China	1 550	1 956	406	Continued focus on development of ISL mining in northern China, with increased capacity at Yining and Tongliao and a new production centre established at Erenhot, in 2022.
Kazakhstan	21 279	23 270	1 991	Restoration of uranium production due to favourable market conditions and ramp up at new Budenovskoye 6,7 mine launched in 2023.
Namibia*	5 612	7 332	1 720	Continued ramp up of Husab production (from 3 357 tU in 2022 to 4 437 tU in 2024) and restart of Langer Heinrich in 2024 (690 tU).
Niger*	2 020	959	-1 061	Production disruption subsequent to July 2023 coup d'Etat. In July 2025 the government announced nationalisation of Orano majority-owned Somaïr (Arlit mine).
Russia	2 508	2 738	230	Increase at Khiagda ISL mine (~180 tU) as commercial mining ramped up at new deposits. Slight increase in Priargunsky underground mining production (~50 tU).
United States	75	260	185	Restart is ongoing of a number of uranium production centres due to improved market conditions and favourable government policy support.
Uzbekistan	3 561	5 200	1 639	Subsequent to 2022 Presidential decree to double production to 7 100 tU by 2030, number of operating ISL deposits increased from 18 in 2022 to 22 in 2024.

* Secretariat estimate.

Table 1.18. **Historical uranium production**

(as of 1 January 2025, tonnes U)

Country	Pre-2022	2022	2023	2024	Total through end of 2024	2025 (expected)
Argentina	2 582	0	0	0	2 582	0
Australia	235 634	4 555	4 686	4 656	249 531	5 395
Belgium	686	0	0	0	686	0
Brazil	4 286	43	91	85	4 505	64
Bulgaria	16 347	0	0	0	16 347	0
Canada	547 494	7 380	10 986	14 327	580 187	14 251
China	51 039	1 550	1 728	1 956	56 273	2 160
Congo, Dem. Rep. of	25 600	0	0	0	25 600	0
Czechia[a,c]	112 263	26	24	17	112 330	16
Finland	30	0	0	0	30	NA
France	80 978	0	0	0	80 978	0
Gabon	25 403	0	0	0	25 403	0
Germany[b]	219 796	0	0	0	219 796	0

Table 1.18. **Historical uranium production (cont'd)**

(as of 1 January 2025, tonnes U)

Country	Pre-2022	2022	2023	2024	Total through end of 2024	2025 (expected)
Hungary[(c)]	21 091	2	3	3	21 099	3
India*[(d)]	14 403	488	485	485*	15 861	485*
Iran, Islamic Rep of*[(e)]	180	21*	21*	21*	243	21*
Japan	84	0	0	0	84	0
Kazakhstan	402 417	21 279	21 112	23 270	468 078	25 789
Madagascar*	785	0	0	0	785	0
Malawi	4 217	0	0	0	4 217	0
Mexico	49	0	0	0	49	0
Mongolia	535	0	0	0	535	0
Namibia*	153 387	5 612	6 986	7 332	173 317	8 720
Niger*	154 360	2 020	1 130	959	158 469	0
Pakistan*	1 731	50*	50*	50*	1 881	50*
Poland	650	0	0	0	650	0
Portugal	3 720	0	0	0	3 720	0
Romania[(c)]	18 974	0	0	0.7	18 975	NA
Russia	179 117	2 508	2 710	2 738	187 073	2 620
Slovak Republic	211	0	0	0	211	0
Slovenia	387	0	0	0	387	0
South Africa*	161 835	200	132	235	162 402	200
Spain[(f)]	5 028	0	0	0	5 028	0
Sweden[(f)]	200	0	0	0	200	0
Ukraine	134 936	120	350	329	135 735	300
United States[(g)]	377 074	75	19	260	377 428	NA
USSR[(h)]	102 886	0	0	0	102 886	0
Uzbekistan	151 004	3 561	4 050	5 200	163 815	6 000
Zambia	86	0	0	0	86	0
Total	**3 211 485**	**49 490**	**54 563**	**61 924**	**3 377 462**	**66 074**
Total OECD-only	**1 605 405**	**12 038**	**15 718**	**19 263**	**1 652 424**	**19 665**

* Secretariat estimate.

(a) Includes 102 241 tU produced in the former Czechoslovakia and CSFR, from 1946 through 1992.

(b) Production includes 213 380 tU produced in the former GDR, from 1946 through 1989.

(c) Current annual production from mine rehabilitation efforts only.

(d) India provided annual production for 2021 to 2023 (preliminary) as part of reporting for the 2024 edition of the Red Book.

(e) The Islamic Republic of Iran last reported for the 2020 edition of the Red Book, including total production through 2015, and annual production for 2015 to 2019 (preliminary). Secretariat estimates have been applied since.

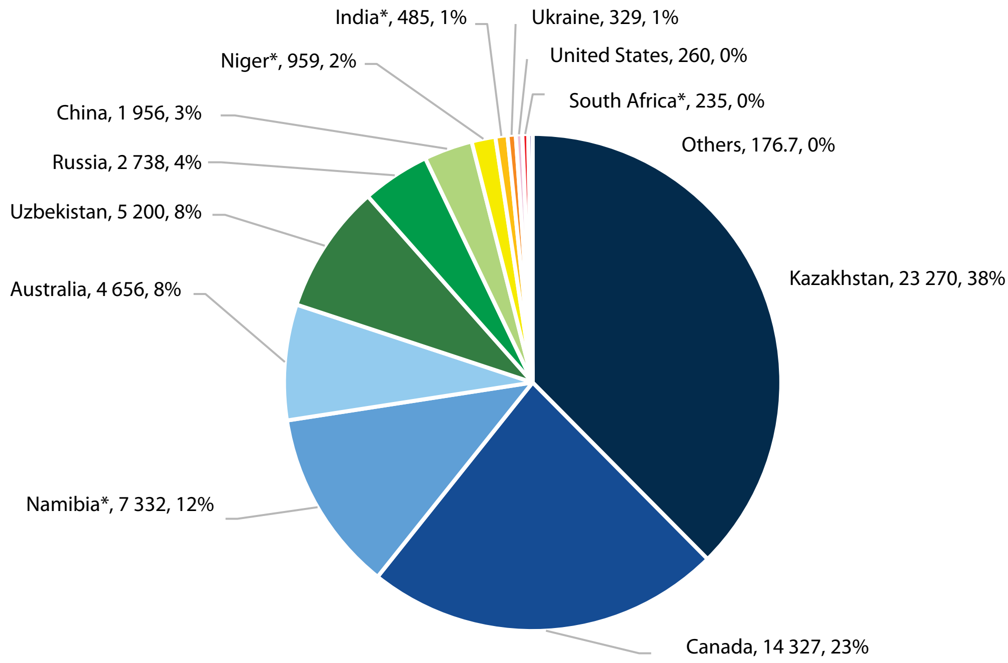
(f) For pre-2010, other sources cite 6 156 tU for Spain, 91 tU for Sweden.

(g) Secretariat estimate of 2020 production based on industry information, as US data withheld to avoid individual company disclosure.

(h) Includes production in former Soviet Socialist Republics of Estonia, Kyrgyzstan, Tajikistan, Uzbekistan.

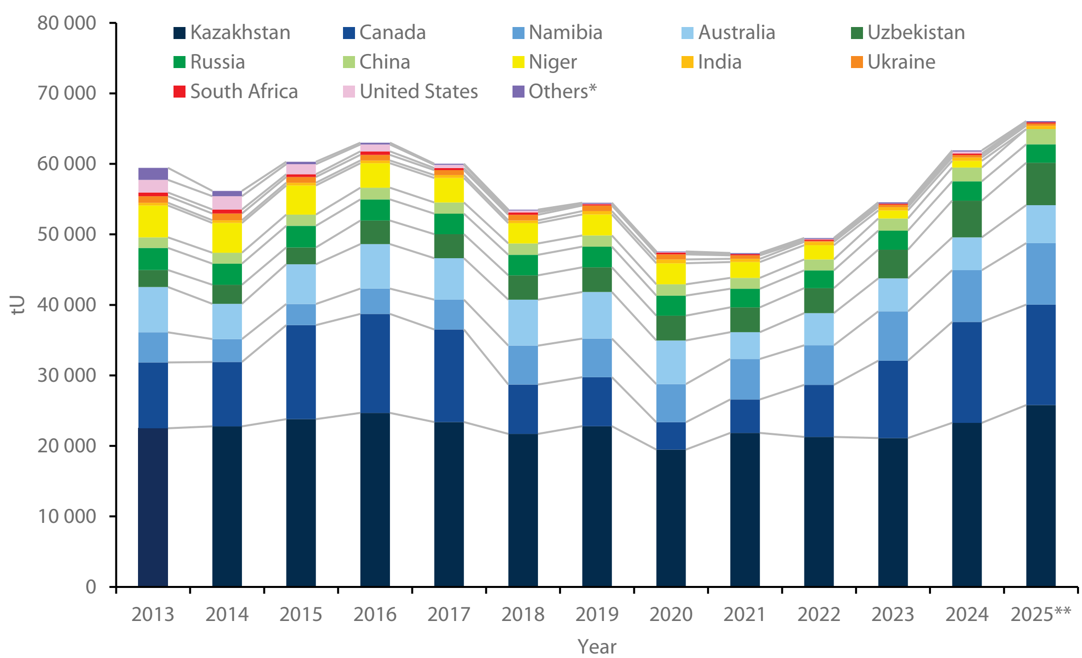
Figure 1.5. **World uranium production 2024: total 61 924 tU**

(as of 1 January 2025; in tU and per cent of total production)



* Secretariat estimate.

Figure 1.6. **World uranium production, 2013-2025**



* "Others" includes the remaining producers (see Table 1.18 and previous Red Book editions).

** NEA/IAEA estimate.

World uranium production reached a low point of 47 361 tU in 2021, before increasing 4.5% to 49 490 tU in 2022 and increasing a further 10.3%, to 54 563 tU for 2023, and increasing another 13.5% to the 61 924 tU produced in 2024. Production for 2024 was still slightly less than the 2016 peak of almost 63 000 tU, reached before the impact of broad-based production cuts that resulted in the 5-year period of declining production from 2016 to 2021. For 2025, expected production of just over 66 000 tU, will surpass the 2016 peak. Among OECD countries, production previously decreased from 21 521 tU in 2016, to a low of 8 477 tU in 2021, a dramatic peak to trough decrease of 60%, due primarily to deliberate production shutdowns in response to low uranium price conditions, with the added impact of the COVID-19 pandemic production suspensions and the end of mine-life closure of the Ranger mine in Australia. With the resumption of production at the previously idled McArthur River mine, OECD production recovered to 12 038 tU and 15 718 tU for 2022 and 2023 respectively, and to 19 263 tU for 2024. For 2025, expected production of 19 660 tU for OECD countries remains approximately 2 000 tU less than the 2016 peak.

With uranium prices having solidly recovered since 2021, as evidenced by year-end spot prices of USD 91.00/lb U_3O_8 (USD 236/kg U) for 2023 and USD 72.63/lb U_3O_8 (USD 189/kg U) for 2024, producers have been unwinding production cuts of the years prior to that and restarting production from previously idled mines. Several previously idled mines resumed production during 2023 and 2024, such as the McArthur River mine and Key Lake mill in Canada (restarted at the end of 2022), the Langer Heinrich mine in Namibia and the Honeymoon ISL mine in Australia. Others, such as the Kayelekera mine in Malawi, initiated restart activities with first yellowcake drummed in 2025. Additionally, various new projects have seen a substantial increase in activity as proponents advance them towards FID in the strong market environment. Regardless of the favourable tailwinds, since 2021 the industry also experienced delays from various causes; for example, shortages of key reagents or materials such as sulphuric acid in Kazakhstan, permitting delays, longer construction periods, slower production ramp-up, etc. These delays serve as a reminder of the numerous risks to increasing, and even maintaining, production rates.

Present status of uranium production

North America

North American production of 14 587 tU amounted to 24% of world production in 2024, an increase of 7 132 tU (96%) compared to 2022. Improving uranium market conditions resulted in restarts of idled operations in the region, particularly the McArthur River mine in Canada.

Canada lost its standing as the world's largest uranium producer in 2009, due to production increases in Kazakhstan; however, it remains the dominant North American producer, and typically the world's second largest producer. In 2024, Canada accounted for 23% of total world production, nearly double that of the next largest producer.

Production in 2024 was 14 327 tU, the highest ever production from Canada, and 30% above 2023 production of 10 986 tU, as operations at the McArthur River mine and Key Lake mill ramped up to full production. McArthur River and Key Lake resumed production in November 2022 after being idled since January 2018.

The McArthur River mine (Cameco Corporation 70%, Orano Canada Ltd 30%), the world's largest high-grade uranium deposit, has identified recoverable resources of 153 000 tU with an average grade of 5.4% U. Processing of ore from McArthur River is carried out at the Key Lake mill (Cameco 83%, Orano 17%). In 2024, the Key Lake mill produced 7 795 tU from McArthur River ore, and 20 tU from low-grade Key Lake stockpiled ore, compared to 2023 production of 5 163 tU from McArthur River ore and 17 tU from Key Lake ore.

The Cigar Lake mine (Cameco 54.547%, Orano 40.453%, Tokyo Electric Power Company 5%), with identified recoverable resources of 82 200 tU at an average grade of 11.5% U, is the world's third-largest high-grade uranium deposit.

The McClean Lake production centre (Orano 77.5%, Denison Mines Corp. 22.5%) processes the ore from Cigar Lake. Production from Cigar Lake ore was 6 512 tU in 2024, a 12% increase from 2023 production of 5 807 tU. The McClean Lake mill will also start processing McClean Lake ore mined, using Surface Access Borehole Resource Extraction (SABRE) technology in 2025 and, as a result, total mill production is expected to increase.

The Rabbit Lake production centre (Cameco 100%) was idled in mid-2016 due to low uranium prices, and the facility placed in care and maintenance. Remaining identified recoverable resources at the facility's Eagle Point mine amount to 27 000 tU at an average grade of 0.63% U.

Uranium production in the United States totalled 260 tU in 2024 from nine facilities: six operating ISL plants in Texas (Alta Mesa and Rosita) and Wyoming (Lost Creek, Ross CPP, Nichols Ranch and Willow Creek), one conventional mill in Utah (White Mesa Mill), and uranium produced from restoration activities at two ISL facilities that remain in standby mode in Nebraska (Crow Butte) and Wyoming (Smith Ranch-Highland). This marks a significant increase compared to recent years; from 2019 to 2023 US production remained less than 100 tU annually and totalled only 245 tU for the full five-year period. In 2024, the United States was the eleventh largest producer, accounting for 0.4% of total world production.

Through the previous uranium market cycle, US production reached a peak of 1 880 tU in 2014, before decreasing sharply from 2015 to 2019, in response to the global oversupply of uranium and resulting low uranium prices after the Fukushima Daiichi Nuclear Power Plant accident. With low levels of domestic production, in 2023 and 2024, the nuclear industry in the United States continued to contract most of its uranium requirements from non-domestic sources. In the last few years, the government has announced plans and implemented legislation to support growth of the nuclear industry, including measures to augment development of domestically enriched uranium. As part of these efforts, the US Department of Energy's (DOE) National Nuclear Security Administration (NNSA) has overseen the direct purchase of an estimated 385 tU of domestically produced uranium oxide (U_3O_8), in up to four separate awards. The first awards were approved in December 2022, and went to Energy Fuels Inc and Peninsula Energy/Strata Energy Inc. (WNN, 2022a). In addition, three more awards were approved shortly afterward to enCore Energy Corp., Uranium Energy Corp. and Ur-Energy Inc. (WNN, 2022b), completing the full NNSA procurement round for the strategic uranium reserve.

Numerous uranium producers and developers in the United States have been accelerating activity in response to sustained higher uranium prices and uranium purchases by the federal government, to be held in a national reserve. The increased uranium prices beginning in the second half of 2021, reaching over USD 208/kgU (USD 80/lb U_3O_8) in 2023 and peaking over USD 260/kgU (USD 100/lb U_3O_8) in early 2024, have generated much activity restarting operations or resuming development of conventional and ISL-amenable projects with some existing degree of permitting or development.

In May 2023 Ur-Energy Inc. restarted production at the Lost Creek ISL project in Wyoming. 2023 production was 76 tU. The target for initial stage production was 230 tU/yr (licensed production capacity is 846 tU/yr). At the end of 2023, Energy Fuels Inc. began mining ore from three conventional underground mines, i.e. Pinyon Plain (formerly Canyon), La Sal and Pandora mines (both in the La Sal complex), with expected combined production of 380 to 540 tU/yr to be trucked to the White Mesa conventional mill in Utah for stockpiling and campaign processing. enCore Energy Corp. restarted the Rosita ISL processing plant in Texas in November 2023, which had its last production in 2008. Target production was 200 tU in 2024 (licensed production capacity is 308 tU/yr). Late in the second quarter 2024, enCore Energy commissioned the Alta Mesa ISL Uranium Central Processing Plant and Wellfield ("Alta Mesa") as its second uranium processing plant, with a licensed production capacity of 577 tU/yr (enCore Energy, 2024a). During the first nine months of 2024, the Company extracted and packaged 100 261 lb U_3O_8 (39 tU) combined between its two operational South Texas Central Processing Plants ("CPP"), the Rosita and Alta Mesa ISL projects (enCore Energy, 2024b).

Also in the second quarter of 2024, Uranium Energy Corp. (UEC) announced plans to restart Christensen Ranch (formerly Willow Creek) ISL production in Wyoming. Production commenced on 6 August 2024 (UEC, 2024). Uranium processing is at UEC's Irigaray ISL Central Processing Plant (licensed capacity is 962 tU/yr). The plant produced its first dried and drummed yellowcake in February 2025. By July 2025, 0.13 million lb U_3O_8 (approximately 50 tU) had been precipitated, dried and drummed, inclusive of material still in solution or awaiting drying (UEC, 2025).

In the third quarter of 2024, Energy Fuels announced the planned restart of production from the Nichols Ranch ISL mine in Wyoming (licensed capacity is 769 tU/yr) as early as mid-2025, contingent on market conditions. The last production was in 2018, and historically drying and processing were carried out at the White Mesa mill. Peninsula Energy Ltd announced production from the Lance ISL project in Wyoming to begin in December 2024, the first low pH ISL (i.e. ISL acid) project in the United States. The initial production target was 423 tU/yr. The first dried yellowcake was produced at the Lance Central Processing Plant (LCCP) in September 2025 (Peninsula Energy, 2025).

South America

South America produced 85 tU in 2024 (93 tU in 2023), all from the Caetité Unit in Brazil. In the region, both Argentina and Brazil look to domestic uranium production to meet domestic demand and are the only countries that have reported historical uranium production.

From 1952 to 1997, Argentina produced 2 582 tU to meet domestic demand. With lower uranium prices, domestic production was no longer competitive and the last facility in operation, the San Rafael Mining-Milling Complex, was placed on standby in 1997. There has been no uranium production since 1997. In November 2025, the IAEA conducted an Integrated Uranium Production Cycle Review Mission to assess the country's readiness to restart uranium mining, focussing on the Chubut region.

At present, both government and industry are carrying out exploration projects with the intention of restarting domestic uranium production towards the goal of self-sufficiency in uranium supply in the future. A large part of the identified uranium resources in Argentina are in the Chubut and Mendoza provinces, where uranium mining and processing is constrained by current legislation. Should legislation be amended in these regions, there is the potential for development, and ultimately mining and processing of uranium deposits.

Argentina has four uranium projects that are considered as prospective production centres. Sierra Pintada and Cerro Solo are both government owned and operated through the National Atomic Energy Commission (CNEA), and are at a PFS level of study. Ivana (Amarillo Grande), operated by Ivana Minerales S.A. (JV between Blue Sky and Corporación América Group) and Jaguar Uranium Corp.'s Laguna Salada, are both at a PEA level.

In Brazil, the Caetité Unit (Lagoa Real uranium province), operated by Indústrias Nucleares do Brasil S.A. (INB), is the only uranium production facility currently in operation. Production, through heap leaching of ore from the Cachoeira open-pit mine started in 1999 and continued until the facility was placed on standby in 2015, as the open-pit portion of the Cachoeira deposit was depleted. The Caetité Unit restarted in 2020 and currently operates with a design capacity of 220 tU/yr, through heap leaching of ore from the Engenho open-pit mine.

The Caetité Unit produced 85 tU in 2024 and 91 tU in 2023, while for 2025, 64 tU production is expected. Production in Brazil is designated for domestic requirements with shortfalls between demand and domestic production met through market purchases. Planned uranium production increases are designed to supply all future reactor requirements.

The expansion of Caetité Unit to 680 tU/yr is progressing, with production expected to start in 2035. Plans include production from Engenho Mine and other deposits of the Lagoa Real Province, all by open-pit mining, and involve replacement of the current heap leaching process to conventional milling.

The Santa Quitéria phosphate/uranium project (1 950 tU/yr design capacity), a partnership between INB and a Brazilian fertiliser producer, is progressing and the operation is planned to begin in 2030. Licensing of this project involves the Brazilian Institute for the Environment and Renewable Natural Resources (IBAMA), and the National Commission of Nuclear Energy (CNEN), with licensing split into a non-nuclear part, involving milling and phosphate production, and a nuclear part, involving uranium concentrate production.

European Union

Uranium production in the European Union (EU) for 2024 amounted to 21 tU, compared to 28 tU reported for 2022. With the end of mining at Rozná in Czechia in 2017 (the last operating mine in the EU), and a new (2021) law in Spain that ends the issuance of new permits for exploitation of radioactive mineral deposits, EU production has continued to decline as uranium recovery from mine remediation declines with progressing remediation. However, the startup of a uranium by-product recovery plant in Finland promises a new long-term source of EU uranium production, expected to trend to 200 tU/yr, beginning in 2026.

Czechia produced 17 tU in 2024, comprised of 12 tU from remediation at the Stráz pod Ralskem former acid ISL production centre (since 1996 production has only been from remediation), and 5 tU from mine water treatment at two other former production facilities. Elsewhere in the EU for 2024, Hungary reported 3 tU and Romania reported 0.7 tU, both also recovered from ongoing mine water treatment in remediation activities. France and Germany had also previously been producing minor amounts as a by-product of mine remediation activities. However, France last reported any such production in 2017 and Germany did so in 2020. In Germany, at the Königstein mine, uranium is no longer separated and recovered, owing to the decreased content of uranium in the flood waters in recent years. In an operational update in December 2024, Wismut GmbH reported continued progress in dismantling former uranium-processing infrastructure at Königstein (Wismut, 2024).

In Finland, Terrafame Ltd started the extraction of uranium as a by-product from the Talvivaara black schist-hosted polymetallic deposit, in 2024. Mining of the deposit commenced in 2008 with recovery of nickel, zinc, copper and cobalt at the mine site in Sotkamo, central Finland. Following years of study leading to a positive FS, in December 2022 Terrafame made the decision to proceed with uranium by-product recovery. Reasonably assured recoverable resources (unconventional) are estimated at 8 700 tU. Final approval for commissioning was received in June 2024, and first uranium concentrates were produced in 2024, although there was no commercial production. The uranium recovery plant is expected to operate at full capacity of 200 tU/yr by 2026.

Europe (non-EU)

Output from non-EU countries in Europe in 2024 amounted to 3 067 tU, a 17% increase from 2022. Production increased in Russia by 230 tU and in Ukraine by 209 tU, over this two-year period. Production by non-EU countries in Europe in 2024 accounted for about 5% of total global production.

In 2024, uranium production in Russia, carried out by three enterprises that are part of the uranium mining company Uranium Holding ARMZ (JSC Atomredmetzoloto), amounted to 2 738 tU, of which 1 047 tU was obtained by traditional underground mining and 1 691 tU by ISL. Since 2022, uranium production in Russia by underground mining has increased by 4.5%, whereas ISL production increased by 12%.

All underground uranium mining was carried out at mine No. 1 and mine No. 8 of the PJSC Priargunsky Industrial Mining and Chemical Union (recoverable resources of 71 800 tU), with mined ore processed either at a hydrometallurgical plant (978 tU) or a heap leaching site (69 tU). During 2023 to 2024, construction of the Mine No. 6 surface complex and infrastructure elements continued at Priargunsky (design capacity of 2 300 tU/yr) for the development of the Argunskoye and Zherlovoye deposits, with the start of mining scheduled for 2029.

JSC Dalur carries out ISL development of the Dalmatovskoye, Khokhlovskoye and Dobrovolnoye deposits (total recoverable resources of 7 900 tU) in the Kurgan Oblast, to maintain 600 tU/yr production capacity, with 588 tU produced in 2024. Pilot plant construction at the Dobrovolnoye deposit was started in 2024 and pilot mining started in 2025. In the Republic of Buryatia, JSC Khiagda carries out ISL mining of the Khiagda ore field (recoverable resources of 21 600 tU), with 1 103 tU produced in 2024. Commercial mining is ongoing at the Khiagda, Vershinnoye, Kolichikan and Istochnoye deposits, with mining to start at the Dybryn deposit in 2025 and at the Namaru deposit in 2026.

In Ukraine, 2024 production amounted to 329 tU by conventional underground mining, a significant improvement from the 120 tU produced in 2022, but still well below 2020 production of 711 tU. The State Enterprise "Eastern Ore Dressing Complex" (VostGOK) operates one hydrometallurgical processing plant in the town of Zhovti Vody, in Dnipropetrovsk Region, that processes ore from three underground uranium mines in the Kirovohrad Region, i.e. Ingulskaya, Smolinskaya and Novokonstantinovskoye. The government approved the decision to shut down mining at the Smolinskaya mine for the period 2023 to 2027, due to mining resource depletion.

The Ukrainian government's uranium policy includes goals to improve the uranium resource base through the exploration of new uranium deposits, increase uranium production by mining existing uranium deposits to meet domestic requirements and create a stock of uranium concentrate (U_3O_8).

Africa

African production totalled 8 526 tU in 2024, a 9% increase from 2022, and accounting for about 14% of global production. 86% of African production came from Namibia, the world's third largest producer in 2024. The country continued to rise as the Husab operation continued to ramp-up to full production capacity and the previously idled Langer Heinrich mine restarted operation. In Niger, production continued to decline; whereas previously the decline was a result of completion and closure of the Akouta mine, for the 2023 and 2024 period, declining production was a direct result of the uranium industry turmoil following from the 2023 coup d'état. With continued improved market conditions uranium production in Africa is expected to increase in the future, as idled mines in Namibia (Langer Heinrich) and Malawi (Kayelekera) reopen and ramp up to full production, and uranium projects in Botswana (Letlhakane), Mali (Falea), Mauritania (Tiris), Namibia (Etango, Tumas, Norasa, Marenica, Trekkopje and Wings), Niger (Dasa, Madaouela and Imouraen), Tanzania (Mkuju River) and Zambia (Mutanga) could be developed. Development of many of these projects had been stalled due to poor market conditions, but in most cases, activity intensified since 2022.

Malawi has had no uranium production since the Kayelekera mine was idled in 2014. Following on a restart DFS issued in 2022, Lotus Resources Ltd released the Front-End Engineering Design (FEED) programme in October 2024, featuring an accelerated Kayelekera restart plan. The first yellowcake was drummed in 2025. Total production of 7 424 tU is expected over the 10-year life of mine, with annual production of 923 tU/yr (2.4 Mlb U_3O_8) over the first seven years.

Uranium production in Namibia totalled 6 986 tU in 2023 (Husab 4 510 tU; Rössing 2 476 tU) and 7 332 tU in 2024 (Husab 4 437 tU; Rössing 2 205 tU; Langer Heinrich 690 tU), a 31% increase from 2022. This record for Namibia is set to grow further, as Husab production is still increasing and Langer Heinrich is ramping up, with future planned and prospective mines in the pipeline. In 2024 Namibia accounted for nearly 12% of total world production, ranking third among uranium producing nations. The forecast production for 2025 is 8 720 tU.

Rössing is one of the largest and longest operating uranium open-pit mines in the world, having commenced production in 1976. Recent mine plans foresaw a cessation of production at the end of 2026; however, a mine life extension FS was completed and approved in 2023, extending the life of mine to 2036. Implementation of the approved extension projects took place in 2023 and 2024, with numerous technologies being tested for production scale implementation.

Husab is the world's largest operating open-pit uranium mine by physical scale, investment size and operational footprint, with a nameplate capacity of 5 700 tU/yr. Mining started in 2014, and the processing operation started towards the end of 2016. Since then, production has steadily increased, reaching approximately 3 400 tU in 2021 and 2022, and 4 500 tU in 2023 and 2024, with plans to continue to ramp up production. In August 2023, Swakop Uranium reported plans to construct a pilot heap leach plant at Husab, to explore the economic feasibility of processing lower-grade uranium ore. Heap leach tests are expected to be concluded by the end of 2025, after which further decision will be made, dependent on the feasibility.

In July 2022, Paladin Energy Ltd announced the FID to restart the Langer Heinrich mine, that had been idled since 2018. The restart plan anticipates a 17-year project operating life, with peak production of up to 2 300 tU/yr for seven years. Several plant upgrades were implemented as part of the restart plan and Langer Heinrich returned to commercial production in March 2024, producing 690 tU for the year. The operation is now focussed on ramping up to name plate production capacity of 2 300 tU/yr.

Trekkopje is planned as an open pit, with heap leach processing at a production level of 2 545 tU/yr. Much of the initial capital development was completed prior to the project having been placed in care and maintenance in mid-2013. Since then, Orano SA has continued metallurgical testing and realised potential for further improvements. In 2024, Orano has started to study all options to potentially resume Trekkopje and bring it into production.

In addition to the existing operating and idled uranium mines, Namibia has numerous projects that can be considered as prospective future production centres. Updates on these projects are included in the earlier section titled *Current activities and recent developments*. Bannerman Energy Ltd commenced early development works at the Etango project (1 350 tU/yr) in 2024, completed a scoping study on an expanded option (Etango XP) to produce 2 770 tU/yr and an option to extend the mine life to 27 years at annual production of 1 350 tU/yr (Etango XT), and anticipate FID during 2026. In April 2025, Deep Yellow Ltd deferred FID for the Tumas project (1 400 tU/yr), whereas engineering and early infrastructure development works continue. Forsys Metals Corp. continues to advance optimisation studies and engineering for its Norasa project. And Headspring Investments (Pty) Ltd anticipates regulatory approvals for start-up of an ISL pilot test for its Wings project.

Production in Niger totalled 1 130 tU in 2023, and 959 tU in 2024, a 53% reduction from 2022. In 2024 Niger accounted for just 1.5% of total world production, ranking eighth among uranium producing nations. All production was from the Arlit open-pit mine operated by Somaïr. The Akouta mine, operated by Cominak, had earlier ceased production in 2021, after more than 40 years of operation. On 26 July 2023, a coup d'état occurred in Niger. In September 2023, Somaïr halted yellowcake production at Arlit mine due to disruption of supplies of chemical products following the coup. On November 12, 2024, Orano suspended expenses related to production activities. In June 2025, the government of Niger announced the nationalisation of Somaïr. Furthermore, Niger had revoked Orano's permit for the Imouraren deposit and removed Orano from operational control of the Cominak site. As a result, Orano retains legal claims through ongoing arbitration but no longer holds operational control over its uranium assets in Niger.

In December 2020, Global Atomic Corporation (GAC) received government approval of its mining permit for the Dasa project and three-year permit extensions for each of its six exploration properties in Niger. Construction of surface infrastructure started in 2022. Underground development of the mine started in November 2022 and in 2024 had reached the ore zone, with development ore being hauled to surface. In the same year, GAC began earthworks to prepare the site for construction of the Dasa processing plant, acid plant and expansion of the camp. Dasa is fully permitted for production, with GAC initially projecting that first uranium delivery to utilities will commence in 2026, but later announcing that actual production timelines are expected to be delayed and will depend on the timing of project financing.

As updated in the earlier section titled *Current activities and recent developments*, in June and July of 2024, the Nigerien authorities withdrew the mining rights for the Imouraren and Madaouela projects from Orano and GoviEx, respectively. Political events since July 2023 have led to significant disruption to uranium production from Niger, with the halting of activities and nationalisation of the single operating mine, and disrupted ownership rights for two of the three development projects of future prospective mines.

Production in South Africa amounted to 132 tU in 2023 and 235 tU in 2024. Most of South Africa's historical production has been as a by-product of gold (from the quartz-pebble conglomerate deposits and associated tailings) or, to a minor extent, copper (from the Palabora copper-bearing carbonatite). Uranium is currently produced from Vaal River operations by processing the reef material from the Moab Khotsong underground gold mine, one of the largest uranium resources in South Africa, with total identified recoverable resources of 11 420 tU.

Most of the uranium projects in South Africa are controlled by gold mining companies. Harmony Gold Mining Company controls the Moab Khotsong mine (the only producing mine), the Mponeng projects, Mine Waste Solutions project, Vaal River and Klerksdorp goldfield surface tailings. In 2022, Sibanye Stillwater Ltd assumed control of the Beatrix (Beisa) underground mine, the Cooke surface operations (tailings), and the Driefontein, Kloof and Randfontein mines. Shiva Uranium (Pty) Ltd controls the Dominium and Rietkuil deposits. In 2024, Neo Uranium Resources Beisa Mine (Pty) Ltd (NURB), a subsidiary of London-listed Neo Energy Metals plc, signed a binding agreement to acquire the Beisa North and Beisa South uranium and gold projects, with total inferred in situ resources of 34 320 tU and 4.17 million ounces gold. Also in 2024, Neo Uranium Resources South Africa (Pty) Ltd (NURSA), also a subsidiary of London-listed Neo Energy Metals plc, entered into an agreement to acquire the early stage Henkries South uranium project, adjacent to Neo's Henkries uranium project with JORC Code compliant resources of 1 810 tU (in situ). Under favourable uranium market conditions, future production centres could include the Beisa (underground mine) and Cooke (tailings) projects.

Middle East, Central and Southern Asia

Production in the Middle East, Central and South Asia region amounted to 29 026 tU in 2024, a 14% increase from 2022, and accounted for about 47% of global production. Production is principally by the world's largest producer, Kazakhstan, which accounted for 37.6% of global production in 2024; however, the region also includes the fourth largest producer, Uzbekistan, and the ninth largest, India, accounting for 8.4% and 0.8%, respectively. Iran (21 tU) and Pakistan (50 tU) each contribute less than 0.1% of global production. India, Iran and Pakistan produce uranium for their own use and in each case, production meets only a part of their domestic requirements.

Uranium production in India was estimated by the NEA/IAEA Secretariat at 485 tU/yr for 2023 and 2024. Note that except for the 2024 Red Book edition, India has not typically reported production in their otherwise comprehensive country reports. The Uranium Corporation of India Ltd (UCIL) operates six underground uranium mines (Jaduguda, Bhatin, Narwapahar, Turamdih, Bagjata and Mohuldih), one open-pit mine (Banduhurang) and two processing plants in the Singhbhum East district of Jharkhand state. In addition, UCIL operates a uranium mine and processing plant (Tummalapalle) in the YSR district (formerly Kadapa) of Andhra Pradesh. Ore produced at the Jaduguda, Bhatin, Narwapahar and Bagjata mines is processed at the Jaduguda mill, commissioned in 1968, that can treat about 2 500 t/day of dry ore. Uranium ore from the Turamdih, Banduhurang and Mohuldih mines is processed at the 3 000 t/day Turamdih mill, commissioned in 2009. The uranium processing plant at Tummalapalle utilises indigenously developed high pressure and temperature alkali leaching technology. The plant was put into operation in 2017 to process 3 000 t/day ore. UCIL also plans to establish a uranium mine and ore processing plant at the Rohil deposit in Sikar district of Rajasthan by 2030, where exploratory underground mining activities have been initiated.

Iran did not provide a report. The NEA/IAEA Secretariat prepared a report for the 2024 Red Book edition, based on earlier reports, trade publications and industry websites (refer to Red Book 2024). According to the Atomic Energy Organization of Iran (AEOI), eight uranium mines were operating in 2023, with some of the open-pit operations using heap leaching. A uranium processing facility, near Ardakan, began operating in 2017 with a nominal production capacity of 50 tU/yr, supplied with ore from the Saghand uranium mine. Annual production is estimated at 21 tU/yr.

Jordan does not have firm plans to produce uranium. The Jordan Uranium Mining Company (JUMCO) has been investigating aspects of uranium production from the Central Jordan uranium project. Building on information generated from previously reported laboratory and small-scale pilot-plant testing, in 2024, JUMCO designed and constructed an extended operation heap leaching demonstration plant, engineered to process approximately 700 cubic metres of agglomerated ore, with an anticipated output of around 75 kgU/yr. The plant commenced operations in April 2025 and will generate technical data needed to prepare a bankable FS.

Uranium production in Kazakhstan, was 21 112 tU in 2023 and 23 270 tU in 2024, an increase of 9% from 2022, and accounting for 37.6% of global production. Uranium was produced at the Kanzhugan, Moinkum, Akdala, Mynkuduk, Inkai, Budenovskoye, North and South Karamurun, Irkol, Zarechnoye, Semizbay and Northern Kharasan deposits. All uranium deposits were mined by ISL using sulphuric acid to produce uranium-bearing solutions. As of 1 January 2025, the aggregated nominal capacity of the 15 uranium production centres in Kazakhstan was 31 200 tU/yr. This marks a 6 000 tU/yr increase in total capacity, associated with Budenovskoye LLP starting commercial production in 2024 at areas 6 and 7 of the Budenovskoye deposit; however, a multiple year ramp-up will be required to reach its 6 000 tU/yr.

With the largest share by far (38%) of the world's lower-cost (<USD 80/kgU) resource base, with 94% of those identified uranium resources associated with existing production centres, and with more than 30 000 tU/yr of existing approved production capacity, Kazakhstan is expected to remain the world's largest producer for the near future. From 2018 to 2024, JSC NAC Kazatomprom flexed down all Kazakhstan production (initially by 20% and later by 10%) below subsoil use agreements, to better match supply and demand in the uranium market. At times tight sulphuric acid supply has impacted whether Kazakhstan production fully meets annual plans, however in years where this has occurred, any shortfall is typically no more than 5% to 10% of aggregated nominal capacity.

Pakistan did not provide a report; however, based on information from trade publications, industry websites and the Pakistan Atomic Energy Commission (PAEC), the IAEA Secretariat estimated annual production at 50 tU/yr. Small-scale uranium mining is understood to be carried out at selected sites, with a major portion of the uranium deposits at various locations in Sulaiman Range, having been mined out. Deposits discovered at Nangar Nai, Bannu Range, have been tested for ISL mining, as they are hosted in poorly consolidated sandstones where conventional mining methods are considered impracticable and hazardous.

Uzbekistan uranium production amounted to 4 050 tU in 2023 and 5 200 tU in 2024, an increase of 46% from 2022, and accounted for 8.4% of global production as the country became the world's fourth largest producer. From 2015 to 2022, Uzbekistan maintained annual production at 3 300 tU to 3 500 tU. Since 1995, Uzbekistan has been producing uranium using only ISL, and has developed and implemented three new technologies of acid ISL for ores with high carbonate content, significantly reducing acid consumption and, in turn, operating costs. In 2024, 22 uranium mines were in operation, and 3 more deposits are planned for development during 2025 to 2026.

In January 2022, the Navoiy Mining and Metallurgy Combinat was split into three independent entities: Navoi Mining and Metallurgical Plant (production of precious metals), Navoiyuran (mining and processing of natural uranium and rare earth metals), and Navoi Mining and Metallurgical Plant Foundation. Navoiyuran produces uranium by ISL at three mining divisions: Uchkuduk Mining Unit operates the Uchkuduk, Kyzylkok and Meilisay deposits; Nurabad Mining Unit operates the Sabyrsai, Ingichki and Agron deposits; and Zafarabad Mining Unit, the largest division of the three, operates 17 deposits. All mining units produce uranium concentrates on-site that are sent by rail to the hydrometallurgical plant, located in Navoi, for further processing and purification.

In July 2022, Uzbekistan's President signed a resolution to increase the country's uranium production from the 2021 output of 3 500 tU to 7 100 tU by 2030. Navoiyuran's ability to reach this target will depend on its ability to rapidly increase its resource base to continue replacing ISL deposits that are being exhausted. From 2025 to 2030, Navoiyuran plans to modernise, re-equip and expand existing uranium production facilities.

East Asia

China, the only producing country in East Asia, reported production of 1 728 tU in 2023 and 1 956 tU in 2024, accounting for over 3% of global production as the world's seventh largest producer. After maintaining annual production between 1 500 tU and 1 650 tU for the decade from 2013 to 2022, production increased by 26% from 2022 to 2024, and China expects to increase production further to 2 160 tU in 2025.

As a response to production cost challenges during the last period of sustained low uranium price, Chinese uranium companies completed a reorganisation and established a production structure that primarily relies on ISL mining in the north, while conventional mining in the south continues to supplement production. Following these changes, China's overall uranium production capacity has increased. The ISL production centres in Yining and Tongliao have increased capacity, and a new production centre was established in Erenhot in 2022. Production from the Ordos ISL operation started in 2025. From 2019 to 2021 underground mining centres in Fuzhou, Chongyi and Qinglong were placed under care and maintenance, and only the Shaoguan underground production centre currently remains in operation.

China is actively planning several other 1 000 tU/yr ISL mines, aiming to achieve continuous development within the next five years. Amid the steady rise in global uranium prices, China's suspended underground uranium mines in the south are now in a position to resume operations. Together with the significant ISL capacity expansion in the northern region, China's domestic uranium production capacity is expected to double in the coming decade.

Pacific

Australia, the only producing country in the Pacific region, reported production of 4 686 tU in 2023 and 4 656 tU in 2024, similar levels to 2022. Australia contributed 7.5% of global production in 2024 and was the world's fifth largest producer. As of 1 January 2025, Australia had three operating uranium mines, Olympic Dam (BHP Ltd), Four Mile (Quasar Resources Pty Ltd) and Honeymoon (Boss Energy Ltd), all in South Australia.

The breccia complex-hosted Olympic Dam is Australia's largest uranium producer. In 2024 it contributed 58% (2 704 tU) of Australia's uranium production, as a by-product to primary copper production. Uranium production is planned to remain stable in the near term. The Four Mile ISL mine, in production since 2014, comprises several significant sandstone uranium deposits, Four Mile East, Four Mile West and Four Mile North, with uranium-bearing resin from a local satellite plant pumped to the Beverley processing plant for elution, precipitation and drying of uranium concentrates. In 2024, Four Mile Mine production amounted to 1 814 tU. Beverley, operated by Heathgate Resources Pty Ltd, and Australia's first ISL mine, started in late 2000. The Beverley and Beverley North mines moved to closure in 2020. Rehabilitation of old production wellfields will continue over the next decade.

Also in South Australia, the Honeymoon uranium ISL mine (owned at the time by Uranium One Inc.), began production in 2011 but was placed on care and maintenance in 2013 due to low uranium prices. Acquired in 2015 by Boss Energy Ltd, Honeymoon recommenced mining in early 2024 and produced 138 tU in the year.

The Western Australia projects may be prospective future production centres. Updates on these projects are included in the earlier section titled *Current activities and recent developments*. However, none of these projects have an imminent FID. Deep Yellow's Mulga Rock project, potentially the furthest advanced, has announced plans to commence a revised DFS in 2025.

Ownership

Table 1.19 shows the ownership of uranium production for all 18 countries that produced uranium in 2024. Total production share owned by the various categories changed modestly since 2022. In 2024, nearly 59% of production was attributed to domestic mining companies, compared to 57% in 2022. Domestic government-owned entities' share decreased from 42% in 2022 to 39% in 2024, and conversely domestic privately-owned companies' share increased from 15% to 20%, primarily because of an increase in production from Canada, as well as an increase from the United States and a decline in production from Niger. Non-domestic mining companies had a 41% share of production in 2024, compared to 43% in 2022. It should be noted that the relative share of government versus private non-domestic mining companies is not reported by Australia and the United States; hence, NEA/IAEA Secretariat estimates of these splits were applied in this edition, based on publicly available information. Overall, 72% of 2024 world production was related to government-owned entities and 28% to private companies.

Table 1.19. **Ownership of uranium production**

(as of 1 January 2025, based on 2024 production output)

Country	Domestic mining companies				Non-domestic mining companies				Total tU
	Government-owned		Privately-owned		Government-owned		Privately-owned		
	tU	%	tU	%	tU	%	tU	%	
Australia[a]	0	0	2 842	61	0	0	1 814	39	4 656
Brazil	85	100	0	0	0	0	0	0	85
Canada	0	0	9 012	63	5 315	37	0	0	14 327
China	1 956	100	0	0	0	0	0	0	1 956
Czechia	17	100	0	0	0	0	0	0	17
Hungary	3	100	0	0	0	0	0	0	3
India*	485	100	0	0	0	0	0	0	485
Iran, Islamic Rep of*	21	100	0	0	0	0	0	0	21
Kazakhstan	12 286	53	0	0	8 371	36	2 613	11	23 270
Namibia*	519	7	0	0	6 240	85	573	8	7 332
Niger*	351	37	0	0	608	63	0	0	959
Pakistan*	50	100	0	0	0	0	0	0	50
Romania	0.7	100	0	0	0	0	0	0	0.7
Russia	2 738	100	0	0	0	0	0	0	2 738
South Africa*	0	0	235	100	0	0	0	0	235
Ukraine	329	100	0	0	0	0	0	0	329
United States[b]	0	0	260	100	0	0	0	0	260
Uzbekistan	5 200	100	0	0	0	0	0	0	5 200
Total	**24 041**	**38.8**	**12 349**	**19.9**	**20 534**	**33.2**	**5 000**	**8.1**	**61 924**
					Total world production				
Total production owned by government-owned companies					44 575	72.0%			61 924
Total production owned by privately-owned entities							17 349	28.0%	

*Secretariat estimate.

(a) Secretariat estimate of non-domestic ownership split. For confidentiality reasons, Australia does not disclose government vs. private ownership.
(b) Secretariat estimate of domestic versus non-domestic ownership split. US withheld data to avoid disclosure of individual company data.

Table 1.19 provides insight to the structure of the uranium industry across different countries. In 11 of the 18 uranium producing countries, production is 100% by domestic, government-owned entities. Most of these eleven countries use their production to meet or offset some of their domestic demand, except for Uzbekistan, where the purpose is to sell uranium into world markets. At the other end of the spectrum, four of the 18 countries have no domestic government ownership of the uranium industry – Australia, Canada, South Africa and the United States. In these countries, uranium operations are generally majority-owned by domestic privately-owned companies, with varying degrees of non-domestic (private or government) ownership. Three of the 18 countries have a mix of domestic government-owned production and non-domestic ownership – Kazakhstan, Namibia and Niger. In the case of Namibia and Niger, the operator and majority-owner of the uranium operations are the non-domestic entities, with minority ownership by domestic government companies. Kazakhstan is unique, as the domestic government-owned company currently owns the majority of the country's total uranium production, is the operator, or holds a significant minority position in each operation and exerts significant control over the country's uranium industry.

Employment

Although the data is incomplete, Table 1.20 shows that employment levels at existing uranium production centres increased 10% from 2022 to 2024, owing to increased employment in many countries. Notably, the United States experienced a 450% increase as many companies resumed activity, Canada saw a 40% increase as the McArthur River mine and Key Lake mill resumed production, and Russia, Australia, Uzbekistan, Namibia, Ukraine and Kazakhstan reported increases ranging between 17% to 7%, respectively. No official employment figures were reported for Niger and South Africa.

Table 1.20. **Employment in existing uranium production centres (2018-2025)**

(as of 1 January 2025, for listed countries, person-years)

Country	2018	2019	2020	2021	2022	2023	2024	2025 preliminary
Argentina[(a)]	54	55	51	NA	NA	NA	NA	NA
Australia[(b)]	4 559	3 198	4 600	4 300	3 130	3 390	3 560	3 560
Brazil	500	550	550	532	537	573	507	479
Canada[(c)]	1 844	1 824	1 934	1 842	2 381	3 420	3 352	3 450*
China	2 350	2 290	2 280	2 260	2 240	2 220	2 240	2 250
Czechia	1 557	1 556	1 546	1 066	1 067	1 060	989	905
Germany[(a)]	1 010	982	911	857	800	800	770	750
India	4 629	4 672	4 642	4 533	4 456	4 456	4 352	4 223
Iran, Islamic Rep of*[(d)]	280	280	280*	280*	280*	280*	280*	280*
Kazakhstan[(e)]	20 801	20 684	21 186	20 825	20 558	21 392	22 066	22 100*
Namibia*[(f)]	2 858	3 231	3 319	2 754	2 716	2 843	2 993	3 100*
Niger*	3 011	NA	NA	NA	NA	NA	NA	NA
Russia	6 263	6 163	6 103	6 002	6 099	7 148	7 106	7 617
South Africa	NA	NA	NA	NA	NA	NA	NA	NA
Ukraine	4 275	3 701	3 741	3 721	3 642	3 828	3 943	4 000
United States[(g)]	234	155	NA	125	91	183	506	750*
Uzbekistan[(f)]	7 340	7 387	7 500	7 700	8 372	8 958	9 459	9 700
Total	**61 565**	**56 728**	**58 643**	**56 797**	**56 369**	**60 551**	**62 123**	**63 164**

* Secretariat Estimate. NA = Data not available.

(a) Employment related to decommissioning and mine rehabilitation only. (b) Olympic Dam does not differentiate between copper, uranium, silver and gold production. Employment has been estimated for uranium-related activities. (c) Employment at mine sites and head offices. (d) The Islamic Republic of Iran last reported for the 2020 edition of the Red Book, including employment for 2018 and 2019 (preliminary). Secretariat-prepared country reports and estimates were included for the 2022 and 2024 editions. (e) Total number of Kazatomprom employees reported from 2017 onward. (f) Country reported only employment directly related to uranium production, a subset of employment related to existing production centres. (g) US data withheld in 2020, to avoid disclosure of individual company data.

Table 1.21 shows employment directly related to uranium production (excluding head office, research and development, pre-development activities, etc.) in selected countries. Figures show that total employment increased by close to 12%, owing primarily to substantial increases reported by Uzbekistan, Kazakhstan, Ukraine, Canada, the United States, Australia, Namibia and Russia. Overall productivity increased from a global average of 1.6 tU/person-year in 2022 to 1.8 tU/person-year in 2024, largely due to the near doubling of production from Canada, the country with the highest uranium production per person-year, as the two largest high-grade mines are now back in full operation.

Table 1.21. **Employment directly related to uranium production and productivity 2022-2024**

(as of 1 January 2025, for listed countries)

Country	2022		2023		2024		
	Production employment (person-years)	Production (tU)	Production employment (person-years)	Production (tU)	Production employment (person-years)	Production (tU)	Productivity (tU per person-yr)
Australia[(a)]	2 170	4 555	2 350	4 686	2 470	4 656	1.9
Brazil	197	43	103	91	103	85	0.8
Canada[(b)]	1 930	7 380	2 192	10 986	2 316	14 327	6.2
China	1 430	1 550	1 420	1 728	1 430	1 956	1.4
Czechia	555	26	554	24	500	17	0.0
Kazakhstan	6 934	21 279	7 484	21 112	7 820	23 270	3.0
Namibia*	2 716	5 612	2 843	6 986	2 993	7 332	2.4
Niger*	NA	2 020	NA	1 130	NA	959	NA
Russia	4 668	2 508	4 749	2 710	4 740	2 738	0.6
South Africa*	NA	200	NA	132	NA	235	NA
Ukraine	1 267	120	1 927	350	1 780	329	0.2
United States[(c)]	NA	75	73	19	395	260	0.7
Uzbekistan	8 372	3 561	8 958	4 050	9 459	5 200	0.5
Total	**30 239**	**48 929**	**32 653**	**54 004**	**34 006**	**61 364**	**1.8**

* Secretariat estimate. NA = Data not available.

(a) Olympic Dam does not differentiate between copper, uranium, silver and gold production. Employment has been estimated for uranium-related activities. (b) Employment at mine sites only. (c) 2022 US direct uranium production employment data withheld, to avoid disclosure of individual company data.

With the improved uranium market outlook continuing to support increased activity in the uranium industry, employment is expected to continue to increase over the longer term, as idling mines restart, production expands and new projects planned in multiple countries are successfully completed. This growth will be partially offset by production efficiencies gained through new methods and innovations, as well as by gradual workforce reductions in countries focussed solely on reclamation (i.e. Czechia and Germany) as mine remediation progresses.

Production methods

Historically, uranium had been produced mainly using open-pit and underground mining techniques, coupled with conventional uranium processing. Other mining methods include ISL; co-product or by-product recovery from copper, gold and phosphate operations; heap leaching and in-place leaching (also referred to as stope or block leaching). Stope/block leaching involves the extraction of uranium from broken ore without removing it from an underground mine, whereas heap leaching involves the use of a leaching facility on the surface after the ore has been mined. Small amounts of uranium are also recovered from mine water treatment and environmental restoration activities.

Over the past two decades, ISL mining, which uses either acid or alkaline solutions to extract the uranium directly from the deposit, has become increasingly important. The uranium dissolving solutions are injected into and recovered from the ore-bearing zone using a system of wells. ISL technology is currently being used to extract uranium from sandstone deposits only and in recent years has become the dominant method of uranium production.

The distribution of production by type of mining from 2022 through 2025 is shown in Table 1.22. The category "other methods" includes recovery of uranium from water treatment during reclamation and decommissioning activities, production from processing refinery wastes and alternate feed materials, and ore produced by the Surface Access Borehole Resource Extraction (SABRE) mining method at the McClean Lake mine in Canada.

ISL technology continues to dominate uranium production, largely because of the rapid growth of this low-cost method of production in Kazakhstan, and to a lesser extent in Australia, China, Russia and Uzbekistan. World uranium production by ISL amounted to 55% of total global production in 2024, followed by underground mining at 26% and open-pit mining at 14%. Mine closures, start-ups and restarts of idled facilities typically explain short-term changes in distribution. For example, the restart of the previously idled McArthur River mine in Canada brought back approximately 7 000 tU/yr of underground production starting in 2023.

Table 1.22. **World uranium production by production method (2022-2025)**

(as of 1 January, 2025, per cent)

Production method	2022	2023	2024	2025 preliminary
Open-pit mining	15.9	15.4	13.8	13.6
Underground mining	18.0	23.5	26.1	23.6
ISL	59.8	55.4	55.2	57.7
In-place leaching	0.0	0.0	0.0	0.0
Co-product/by-product	6.1	5.6	4.7	4.5
Heap leaching	0.2	0.1	0.1	0.1
Other*	0.1	0.0	0.1	0.5
Total	**100.0**	**100.0**	**100.0**	**100.0**

*Other includes uranium recovered from: mine water treatment as part of mine reclamation (Czechia, Hungary and Romania); processing of alternate feed materials at the White Mesa mill (United States); and ore produced by the SABRE mining method at the McClean Lake mine (Canada).

Projected production capabilities

To assist in developing projections of future uranium availability, Member countries were asked to provide projections of production capability through 2050 (Table 1.23). Projections for 2030 to 2050 are included for *existing and committed production centres* (A-II columns) and for *existing, committed*, *planned and prospective production centres* (B-II columns) in the <USD 130/kgU category for countries that are either currently producing uranium or have plans and the potential to do so in the near future. Note that both the A-II and B-II scenarios are supported by currently identified (RAR and IR) resources, in the <USD 130/kgU category for all but two countries, whereas India reports resources on a cost unassigned basis and Pakistan resources are reported only in the <USD 260/kgU category. Also note that actual production seldom, if ever, matches full production capability.

Table 1.23. **World uranium production capability to 2050**

(as of 1 January 2025, tonnes U/year, from identified recoverable resources at costs up to USD 130/kgU)

Country	Uranium production capability projections									
	2030		2035		2040		2045		2050	
	A-II	B-II	A-II	B-II	A-II	B-II	A-II	B-II	A-II	B-II
Argentina**	0	0	0	580	0	730	0	700	0	700
Australia	6 890	NA	6 890	NA	4 150	6 890	4 150	6 890	2 800	6 890
Botswana*	0	0	0	1 100	0	1 100	0	1 100	0	1 100
Brazil(a)	0	1 370	0	2 630	0	2 630	0	2 630	0	680
Canada^^	14 190	28 920	13 850	23 690	6 920	13 270	6 420	6 420	0	6 000
China*	2 000	2 400	2 000	3 000	1 500	3 500	1 000	3 500	0	3 500
Czechia(b)	40	40	30	30	20	20	10	10	10	10
Finland	200	200	200	200	200	200	200	200	200	200
India*(c)	960	1 300	1 300	1 300	1 300	1 300	1 300	1 300	1 300	1 300
Iran, Islamic Rep of*	70	80	70	80	70	80	70	80	70	80
Kazakhstan^	26 000	29 000	14 000	23 000	9 000	14 000	7 000	12 000	4 000	10 000
Malawi***	1 000	NA	1 000	NA	0	0	0	0	0	0
Mauritania*	0	770	0	770	0	770	0	385	0	0
Mongolia***	0	2 500	0	2 500	0	2 500	0	2 500	0	2 500
Namibia*	9 700	12 450	7 400	10 150	6 300	9 050	6 300	9 050	2 000	4 750
Niger*(d)	3 400	3 700	3 400	6 700	3 400	6 700	2 000	5 300	1 500	4 800
Pakistan*(c)	59	59	45	45	45	45	45	45	45	45
Russia^	1 700	3 700	1 600	3 900	1 500	2 800	1 000	6 000	600	6 000
South Africa*	1 000	1 000	1 000	3 000	1 000	3 000	1 000	3 000	1 000	3 000
Tanzania*	0	0	0	3 000	0	3 000	0	3 000	0	0
Ukraine	1 500	1 700	1 700	2 000	2 000	2 500	2 000	3 000	2 000	3 500
United States*	1 500	2 400	350	2 400	350	2 400	200	2 400	0	2 400
Uzbekistan**	4 000	7 000	2 500	4 000	0	0	0	0	0	0
Total	**74 209**	**98 589**	**57 335**	**94 075**	**37 755**	**76 485**	**32 695**	**69 510**	**15 525**	**57 455**

A-II = Production capability of existing, idled and committed centres, supported by identified resources recoverable at <USD 130/kgU.

B-II = Production capability A-II plus planned and prospective centres, supported by identified resources recoverable at <USD 130/kgU.

* Secretariat estimates for all years. Table not reported by country. ** Secretariat estimate for 2035 to 2050, as values for those years were NA in table reported by country. *** Secretariat estimate for 2040 to 2050, as values for those years were NA in table reported by country. ^ Secretariat estimate for 2045 to 2050, as values for those years were NA in table reported by country. ^^ Secretariat estimate for 2050, as 2050 values were NA in table reported by country.

(a) A-II category is 0 at costs up to USD 130/kgU. Engenho mine is currently producing, but at cost >USD 130/kgU. (b) Production from remediation. (c) Production costs not stated but considered high. (d) Subsequent to the July 2023 coup, in June 2024, Niger authorities withdrew the permit to exploit the Imouraren deposit, and in July 2024 withdrew the mining rights for the Madaouela project, raising uncertainty regarding these prospective production centres (included in B-II).

Of the 23 countries listed in Table 1.23, only Australia, Brazil, Czechia, Finland and Ukraine reported projected production capabilities fully to 2050. Canada reported production capability through 2045, and Kazakhstan and Russia reported through 2040, whereas Malawi and Mongolia only reported to 2035. Argentina and Uzbekistan reported only for 2030, and no estimates of production capabilities were received from any of the other 11 countries listed in the table. As a result, numerous Secretariat estimates are incorporated in the table.

The projected total production capability (rounded to nearest 500 tU) for 2030 is 74 000 tU for existing and committed production centres (A-II), and 98 500 tU when also including planned and prospective centres (B-II). Reported 2024 production (similarly rounded) was 62 000 tU with 66 000 tU expected for 2025 production. Thus 2025 expected production is 89% of 2030 A-II production capability. For comparison, in previous editions where calculated, expected production typically ranged between 90% and 75% of production capability. Recognising that demand and expected supply for 2030 is anticipated to grow from 2025 expected production, it seems evident that some of the planned and prospective capability will certainly be required prior to 2030 as the A-II capability will not be sufficient.

The significantly higher estimate of B-II capability represents the prospective and planned projects that have not yet been firmly committed. During the market environment of the prior decade of oversupply and mine closures, prospective projects were indefinitely delayed, and no new projects were committed. In the few years since the market recovery began, activity on these pre-existing deferred projects has increased again and work on newer projects also continues (see updates in earlier section titled *Current activities and recent developments*). With many of these projects anticipating FID within the next few years, a clearer picture of expected timeframes will emerge.

Projections beyond 2030 show generally decreasing global production capabilities as A-II category estimates decline in response to depletion of resources at existing and committed production centres. B-II production capability remains relatively flat through 2035, before demonstrating a lagged decline due to assumed development of projects and their subsequent resource depletion.

Recent committed mines and expansions

As expected, following a prolonged period of low market prices, production cuts at existing facilities, and the resulting excess production capability, there were limited new production plans unveiled in the decade after the Fukushima Daiichi Nuclear Power Plant accident, and the list of committed new mines and expansions (Table 1.24) had become rather thin. Since the first production from the Husab mine in Namibia in 2016, no new major developments were completed until the start-up of commercial production in 2024 at areas 6 and 7 of the Budenovskoye deposit in Kazakhstan. There are three projects in progress that have already been underway for the past few years and since the uranium price recovery of the past few years, three other projects have been added to the list in this edition of the Red Book, based on information from country reports or company announcements up to the end of 2025.

Table 1.24. **Recent committed mines and expansions**

(as of 1 January 2025, nominal production capacity, tonnes U/year in parentheses)

Country	Production centre	2025	2026	2027	2028	2029	2030
China	Ordos	C (N/A)					
Finland	Terraframe (Talvivaara)[1]	C (200)					
Niger	Dasa[2]		C (1 400)				
Russia	Priargunsky (Mine 6)					Ex (2 300)	
United States	Shirley Basin		C (385)				
United States	Velvet-Wood[3]/Shootaring Canyon Mill			C (1 150)			

C = Committed. Ex = Expansion. N/A = Data not available.

1) By-product of nickel, cobalt and zinc production. 2024 startup, with first commercial production in 2025.

2) Underground development started in November 2022, with commercial production expected to begin in 2026.

3) Restart of Velvet-Wood mine last operated in 1984. Also, currently re-permitting Shootaring Canyon Mill, last operated in 1982.

In Finland, the uranium recovery plant at the Talvivaara deposit was completed in June 2024, clearing the way for start-up of by-product recovery of uranium, with first commercial production expected in 2025 and subsequent ramp-up to 200 tU/yr full capacity by 2026. In Russia, construction of the surface complex and infrastructure elements of new mine No. 6 at the Priargunsky production centre began in 2018. Completion, now expected for 2029, will increase annual production capacity of this operation by 2 300 tU. In Niger, construction of the surface infrastructure and underground development of the Dasa mine started in 2022, and in 2024 development had reached the ore zone and earthworks for construction of the processing plant were carried out. Project development continues, with first uranium production now expected in 2026, followed by ramp up to the 1 400 tU/yr planned capacity.

China reported that development of the Ordos ISL project commenced in 2024. In July 2025, exactly one year after breaking ground on the project, first uranium production was reported from Ordos, which is expected to become the country's largest capacity uranium production centre (WNA, 2025b). In the United States, as the industry had previously reached a state of almost complete shutdown, much of the recent activity and announcements are re-opening projects of previously idled uranium mines, that are covered in a later table and subsection of this report. Two projects are identified as new operations or expansions and are included in Table 1.24. In March 2024, Ur-Energy Inc. announced a 24-month project to build out the Shirley Basin ISL mine as a 385 tU/yr capacity satellite plant, with loaded resin to be trucked to their existing Lost Creek facility for processing (Ur-Energy, 2024). In October 2025, Anfield Energy Inc. commenced development of the Velvet-Wood uranium-vanadium project, that they plan to advance concurrently to bringing the Shootaring Canyon Mill to production-ready status, including increasing the licensed production capacity to 1 150 tU/yr (WNA, 2025c). Although there was previous mining at the Velvet deposit, this ceased in 1984, and the Shootaring Canyon Mill was placed on standby in 1982. Given that more than 40 years have passed, this project is considered as a new operation, not as an idled mine.

Planned and prospective mines and expansions

An impressive list of planned and prospective mines could be brought into production through 2050 (Table 1.25). The potential production rates range from a few hundred tU/yr to approximately equalling the output of the world's largest uranium mine. Listed projects are across 17 different countries, with the countries hosting relatively more substantive production rate projects including Australia, Botswana, Brazil, Canada, Mauritania, Mongolia, Namibia, Niger, Russia, Tanzania, the United States and Zambia.

There are, however, many differences between the projects on the list. Some are in jurisdictions (at country level, or at state/province level) that are not supportive of uranium mining. Some jurisdictions are riskier from a geopolitical or security basis, and as the events of 2023 in Niger serve to illustrate, outlooks can change quickly. Some planned mines are currently being actively advanced and are awaiting only final regulatory approvals and FID to graduate from planned to committed status. In the case of Canada for example, both the Arrow and Phoenix projects are anticipated to get the go-ahead in the first half of 2026. On the other hand, some prospective mines have effectively been "on the list" for many years but are not being actively advanced. Since few of these have a firm date for first production, most will not be developed unless uranium market prices, or uranium demand, remain at levels justifying the investments. Each planned or prospective mine has its own unique technical, environmental and financial parameters that will determine the market signals or other uranium demand criteria required to commit the project for development.

Table 1.25. **Planned and prospective uranium mines**
(as of 1 January 2025 with updates to December 2025*)

Country	Mine	Type	Nominal production capacity (tU/yr)	Status	Starting year
Argentina	Cerro Solo	OP	250	Prospective	NA
	Sierra Pintada	OP	150	Prospective	NA
	Ivana (Amarillo Grande)	OP	580	Prospective	NA
	Laguna Salada	OP	300	Prospective	NA
Australia	Yeelirrie	OP	3 265	Prospective	NA
	Kintyre	OP	2 290	Prospective	NA
	Mulga Rock	OP	1 345	Prospective	NA
	Wiluna	OP	500	Prospective	NA
Botswana	Letlhakane	OP	1 100	Prospective	NA
Brazil	Santa Quitéria	OP	1 950	Planned	2030
	Caetité Expansion	OP	680	Prospective	2035
Canada	Arrow[(a)]	UG	11 900	Planned	NA
	Phoenix[(a)]	ISL	4 600	Planned	NA
	Triple R[(b)]	UG	5 800	Planned	NA
	Midwest[(c)]	OP	2 300	Prospective	NA
	Gryphon	UG	2 900	Prospective	NA
	Millennium	UG	2 750	Prospective	NA
	Kiggavik	OP/UG	3 000	Prospective	NA
	Heldeth Túé	ISL	800	Prospective	NA
Denmark/Greenland[(d)]	Kvanefjeld	OP	425	Prospective	NA
India	Rohil[(e)]	UG	NA	Prospective	2030
Mauritania	Tiris	OP	770	Planned	2027
Mongolia	Badrakh	ISL	3 000	Planned	2030
	Emeelt	UG	700	Prospective	NA
	Gurvansaihan	ISL	400	Planned	NA
Namibia	Etango	OP	1 350	Planned	NA
	Norasa	OP	1 460	Prospective	NA
	Tumas	OP	1 400	Planned	NA
Niger[(f)]	Imouraren	OP	NA	Prospective	NA
	Madaouela	OP	950	Prospective	NA
Romania	Tulghes Grinties[(e)]	UG	NA	Prospective	2028
Russia	Elkon	UG	5 000	Prospective	2040
Tanzania	Mkuju River	OP	3 000	Planned	NA
Ukraine	Safonivske	ISL	150	Planned	NA
United States[(g)]	Dewey-Burdock	ISL	290	Prospective	2028
	Moore Ranch	ISL	1 155	Prospective	NA
	Reno Creek	ISL	770	Prospective	NA
	Jab & Antelope	ISL	770	Prospective	NA
	Burke Hollow	ISL	385	Planned	NA
	Goliad	ISL	385	Prospective	NA
	Churchrock	ISL	385	Prospective	2029
	Crownpoint	ISL	385	Prospective	2029
	Roca Honda	UG	1 040	Prospective	NA
	Sheep Mountain	OP/UG	575	Prospective	NA
Zambia	Muntanga	OP	840	Planned	NA
	Lumwana	OP	650	Prospective	NA
Total			**72 695**		
Subtotal – Planned			35 545		
Subtotal – Prospective			37 150		

* As noted in country reports (as of 1 January 2025) or from public data up to December 2025. NA = Data not available. (a) Environmental assessment permitting process well advanced. (b) Environmental assessment permitting process recently started (EIS submitted in Mar 2024). (c) Alternative mining methods under investigation. (d) Government passed a law prohibiting exploration and exploitation of uranium as of December 2021. (e) Prospective mine reported in country report (Red Book 2026), without production capacity information. (f) Subsequent to political change in July 2023, Niger authorities in June 2024 withdrew the permit to exploit the Imouraren deposit, and in July 2024 withdrew the mining rights for the Madaouela project. (g) The list of United States potential new mines was compiled from various company public disclosures. The list of projects is not expected to be exhaustive, nor is it intended to capture planned restarts of previously operating production centres.

The total planned and prospective nominal production capacity of approximately 72 500 tU/yr (Table 1.25) lends confidence that with appropriate sustained market signals, total world annual production capacity could increase substantially in the medium to longer term. However, this is not to suggest that total production capacity could be increased by this amount. The uranium resources base and related mine life of these potential projects, staged replacement of depleting uranium resources as other mines close, competition for labour and other project development resources, and access to capital are only some of the factors that will impact the rate of global production capacity growth.

While there is uncertainty surrounding the development of prospective and planned production centres, the number of potential projects listed in Table 1.25 underscores the availability of uranium deposits of commercial interest. Since these potential mines span several stages of approvals, licensing and feasibility assessments, it can reasonably be expected that some will take several years to be brought into production and others may never be. Notwithstanding the time it takes to bring new deposits into production, some of these prospective mine developments will be required to replace production centres that reach the end of mine life and meet anticipated demand growth.

Idled mines

In response to the oversupply and low prices of the decade-long uranium bear market after the Fukushima Daiichi Nuclear Power Plant accident, producers were motivated to respond by means of reducing production. While some producers did so, others opted to close operations entirely until market conditions improved sufficiently to justify reopening. These temporarily closed operations, referred to as idled mines (Table 1.26), are defined as those with associated identified uranium resources and processing facilities that have all the necessary licences, permits and agreements for operation, and have produced commercially in the past, but were not producing as of 1 January 2025.

As previously noted, the uranium market began to improve in 2020/2021. When it became clear that demand was beginning to grow, operators of idled mines began to evaluate and announce restarts. The most significant production centre previously on the list of idled mines, the McArthur River/Key Lake operations in Canada, returned to operating status in late 2022. This single restart shifted 9 600 tU/yr licensed capacity from idled status to production capability and increased global annual production by approximately 7 000 tU/yr, as of 2024. Having restarted in late 2022, McArthur River no longer appears in Table 1.26.

The bottom section of Table 1.26 lists previously idled mines restarted during 2023 to 2024, or ones that although still idled as of 1 January 2025, had a committed restart plan towards production in 2025 in progress. These restarted previously idled mine facilities, with a total of about 130 000 tU in local recoverable resources, could potentially bring over 9 000 tU annually to the market, if they each meet their listed capacity. In total, 21 000 tU/yr of production capacity that had been idled has now been (or is being) returned to operating status between 2022 to 2025.

The Langer Heinrich (Namibia) restart in early 2024 and the Kayelekera (Malawi) planned 2025 restart, together return approximately 3 300 tU/yr of African production capacity from previously idled status. Note that the listed nominal capacities are approximate and production plans do not always exactly meet these. For example, the Langer Heinrich plan is to ramp up to peak production of up to 2 300 tU/yr for 7 years of its 17-year life-of-mine plan, whereas the Kayelekera plan contemplates peak production of 923 tU/yr (i.e. higher and lower, respectively, than each of their capacity as listed in Table 1.26). In Australia, the Honeymoon ISL operation restart in 2024 removes 770 tU/yr from idled status, and the mine is now ramping up production. Meanwhile, in the United States, there has been a great deal of activity with two ISL operations in Texas (Rosita and Alta Mesa) and one in Wyoming (Lost Creek) having restarted in 2023 to 2024, three others in Wyoming (Lance, Christensen Ranch and Nichols Ranch) progressing towards 2025 planned restarts, and three underground mines in Colorado and Utah restarting in 2024 to 2025. In total the United States restarts represent 5 000 tU annual capacity if they all successfully ramp up production.

Table 1.26. **Idled mines***

(as of 1 January 2025, with some updates to December 2025**)

Country	Production centre (mine)	Type	Year idled	Production capacity (tU/yr)	Recoverable Resources (tU)
Idled mines – no announced definitive restart					
Canada	Rabbit Lake	UG	2016	2 300	27 000
China	Chongyi[(a)]	UG	2017	200	NA
	Qinglong[(a)]	UG	2018	100	NA
	Fuzhou[(a)]	UG	2022	350	NA
Namibia	Trekkopje[(b)]	OP	2013	3 000	20 030
Niger	Azelik (Somina)[(c)]	OP/UG	2014	700	9 680
	Arlit (Somair)	OP	2024	2 000	40 100
United States[(d)]	Tony M[(e)]	UG	2008	230	3 380
	La Palangana (Hobson)	ISL	2015	385	NA
	Smith Ranch/Highland	ISL	2016	2 100	12 540
	Crow Butte	ISL	2017	385	6 040
Totals				**11 750**	**118 770**
Restarted mines – recently restarted or committed pending restart in progress* **					
Australia	Honeymoon	ISL	2013	770	23 300
Malawi	Kayelekera	OP	2014	1 270	14 400
Namibia	Langer Heinrich	OP	2018	2 000	36 830
United States[(d)]	Rosita	ISL	2008	315	NA
	Sunday Mine Complex[(e)]	UG	2009	385	1 120
	La Sal, Pandora[(e)]	UG	2012	385	1 650
	Pinyon Plain[(e)]	UG	2012	385	810
	Alta Mesa	ISL	2016	570	7 850
	Ross CPP (Lance)	ISL	2019	770	20 650
	Christensen Ranch	ISL	2018	1 000	13 770
	Nichols Ranch	ISL	2020	770	3 130
	Lost Creek	ISL	2020	770	7 030
Totals				**9 390**	**130 540**

* Idled mines are those with associated identified uranium resources and processing facilities that have all necessary licences, permits and agreements for operation, and have produced commercially in the past. ** As noted in country reports (as of 1 January 2025) or from public data up to December 2025. *** Restarts (first production) range from 2023 to 2025.

NA = Data not available.

(a) China country report notes that with the recent increased uranium prices, resources expansion and advances in mining technologies, the suspended uranium production centres are considered for restart. (b) Although not fully satisfying the definition of an idled mine (no commercial production), it is included here because it produced 251 tU and 186 tU in 2012 and 2013 (respectively), as part of two pre-commercial pilot tests. A care and maintenance team regularly provides upkeep of the mine's infrastructure so that it can be recommissioned and brought on stream when market conditions are more favourable. (c) Technical difficulties contributed to decisions to stop production. In 2023-2024 China National Uranium Corporation carried out studies towards the restart of production at Azelik. (d) Information on US production centres is based on a combination of information contained in the United States country report, and company and industry available information compiled by the Secretariat. (e) Processing is at White Mesa regional mill.

The upper section of Table 1.26 lists idled mines with no committed restart announced. With the right market signals, these represent an opportunity to add further uranium production capability, albeit with some cautions. Many of these operations have now been idled for close to ten years and long shutdown periods can often complicate restarts. The Trekkopje project is not strictly an idled mine but a partially completed project, thus requiring substantial investment to bring it to operating status. Technical difficulties contributed to the decision to stop production at Azelik, whereas Arlit is idled because of political events. Taken together, it is reasonable to assume that in total, this group of remaining idled mines has the potential to add some production but likely less than the total listed production capacity (50% to 60% may be a reasonable estimate). Some of these potential restarts would require a higher sustained market price for reopening than some new projects and some may never restart.

Conclusions

Identified uranium resources recoverable at <USD 260/kgU total more than 8 100 000 tU. Of these resources, approximately 72% are recoverable at <USD 130/kgU, and 24% at <USD 80/kgU. Arguably, the <USD 40/kgU category is no longer relevant for understanding the price required to support new production; only a little over 8% of the total identified recoverable resources are reported to remain economic at this level, and very few countries continue to report in this cost category. An important exception is Kazakhstan, where about 58% of identified uranium resources are reported to be recoverable at <USD 40/kgU.

There are, however, many factors affecting the likelihood and timing of recovering these uranium resources. For example, nearly 17% of global identified resources are attributed to the Olympic Dam deposit, and as uranium is a co-product at Olympic Dam, continued recovery of these resources can be counted on with very high confidence, but the ability to modify the rate of production in response to uranium demand changes is limited. Some resources are in jurisdictions not currently favourable to uranium mining and some are in countries with no or little uranium mining experience, whereas other resources are in mining friendly jurisdictions. Political risk and stability are important factors when assessing the likelihood of resource development. Instability and high political risk can severely disrupt a country's uranium industry, as demonstrated by the events in Niger, a country that hosts nearly 6% of global identified resources. Some resources are in countries with policies that require domestic uranium production to meet all, or some of their internal demand, whereas other resources are in global supplier countries (Australia, Canada, Kazakhstan, Namibia, South Africa and Uzbekistan), or those aspiring to be.

In-ground uranium resources will be brought into production when market conditions lend confidence that a given project will return value. Conversely, poor market conditions not only hold back new supply, but also slow investment in uranium exploration, which could affect delineation of additional lower-cost resources in the longer term. Historically, significant proportions of identified resources have never been extracted, while, on average, the extraction of identified resources has taken one to two decades or more (see, for example, IAEA 2020, Figure 2.75), in addition to several decades for the delineation of undiscovered resources.

The decade after the Fukushima Daiichi Nuclear Power Plant accident (2011 to 2021) was very challenging for the uranium industry. The uranium price dropped to well below the marginal cost of production, investment in new projects largely came to a standstill, exploration was severely curtailed, and numerous operations were idled or production output reduced. The last few years have seen the beginnings of a long-awaited recovery phase. The uranium spot price that was at about USD 80/kgU (USD 30/lb U_3O_8) at the start of 2021, had climbed to about USD 130/kgU (USD 50/lb U_3O_8) by the start of 2023 and reached a peak of USD 275/kgU (USD 106/lb U_3O_8) in January 2024, ending 2024 at about USD 190/kgU (USD 73/lb U_3O_8), and ending 2025 at about USD 210/kgU (USD 82/lb U_3O_8).

The exploration and mine development expenditures and activities, and the mine production reported in this and the previous edition, capture the industry response to this improving market after a decade downturn. Exploration, mine development and production activities continue to rebound, as evidenced by the increase in global exploration and development costs, which have risen by approximately 2.5-fold over the past four years. After reaching a downturn low of USD 377 million in 2020, total reported global exploration and mine development expenditures have recovered to USD 965 million in 2024. Activity on prospective and planned projects has increased significantly with some long-stalled projects anticipating final investment decisions in the upcoming years. Fully two-thirds of the idled production capacity has been, or is in process of being, returned to production, with much of the remaining idled capacity anticipated to require significantly higher threshold prices and return less production. Production for 2024 totalled 61 924 tU, a rebound of more than 30% (14 563 tU) from the low reached in 2022.

Looking ahead, ongoing geopolitical tensions continue to shape the industry, which increase supply security considerations, in turn encouraging the build-up of domestic supplies in some nuclear generating countries, and favouring supply from reliable partners and like-minded countries. Given the global focus on climate change and the growing demand for clean energy, including carbon-free electricity, as well as rapidly growing interest in advanced and small modular reactors, growing interest in and support for nuclear energy is anticipated to continue to underpin a healthy uranium industry where a secure supply, in the medium and long term, is crucial. A strong uranium market will help to deliver new projects necessary to maintain and increase global production, to incentivise investment in exploration to replace depleted resources and identify new resources, and to support investment in research and development of new and innovative extraction techniques to unlock value from unconventional uranium resources, and improve the economics of all projects.

References

ACLED (2023), “Military Coup in Niger”, Armed Conflict Location and Event Data (ACLED) Fact Sheet, 3 August 2023, https://acleddata.com/2023/08/03/fact-sheet-military-coup-in-niger.

Bannerman Energy (2026), “Etango Strategic Financing with Leading Global Integrated Nuclear Utility, CNNC”, ASX Announcement, 12 February 2026, https://wcsecure.weblink.com.au/pdf/BMN/03055963.pdf.

Berkeley energía (2024), “Submission of Request for Arbitration initiates Arbitration Proceedings against Spain”, News Release, 28 May 2024, https://polaris.brighterir.com/public/berkeley_energia/news/rns/story/xpd0qqx.

Barthel, F. (2005), “Thorium and Unconventional Uranium Resources”, presented at the IAEA Technical Meeting on “Fissile Materials Management Strategies for Sustainable Nuclear Energy”, International Atomoic Energy Agency, Vienna, Austria, 12-15 Sep 2005.

China Nuclear Energy Association (2026), “China Achieves Kilogram-Scale Uranium Extraction from Seawater”, News article, 18 March 2026, www.china-nea.cn/site/content/53222.html.

CVMR (2025), “CVMR Corporation and the Central African Republic (CAR) Sign Landmark Mining and Refining Partnership”, Company Announcement, 29 December 2025, https://cvmr.ca/media/news/cvmr-corporation-and-the-central-african-republic-car-sign-landmark-mining-and-refining-partnership.

Deep Yellow (2025), “Mineral Resource and Ore Reserve JORC”, Company Document, 10 December 2025, https://deepyellow.com.au/wp-content/uploads/MineralResourceAndOreReserveJORC10Dec25.pdf.

Eastport Critical Metals (2026), “Foley Uranium Project”, Company Website, https://eastportcmc.com/projects/foley-uranium-project.

Elevate Uranium (2025), “U-pgrade™ Demonstration/Pilot Plant Update”, ASX Announcement, 15 December 2025, www.elevateuranium.com.au/wp-content/uploads/2025/12/3000512-1.pdf.

enCore Energy (2024a), “enCore Energy commences Uranium Production at its Second South Texas Project”, News Release, 13 June 2024, https://encoreuranium.com/news/encore-energy-commences-uranium-production-at-its-second-south-texas-project.

enCore Energy (2024b), “enCore Energy Provides Q3 2024 Results and Operational Update”, News Release, 14 November 2024, https://encoreuranium.com/news/encore-energy-provides-q3-2024-results-and-operational-update.

Energy Transition Minerals (2023), “Arbitration – Filing of the Statement of Claim”, ASX Announcement, 20 July 2023, https://investorhub.etransmin.com/announcements/4384035.

ENRG Elements (2024), Agadez Uranium Project Exploration Permits Renewed for Three-Year Period”, ASX Announcement, 16 October 2024, https://yourir.info/resources/f0ec32b09eeed656/announcements/bry.asx/6A1231330/BRY_Agadez_Uranium_Project_Exploration_Permits_Renewed.pdf.

ENRG Elements (2025), “2025 Annual Report”, ASX Announcement, 30 September 2025, https://yourir.info/resources/f0ec32b09eeed656/announcements/bry.asx/6A1287429/BRY_Annual_Report_to_shareholders.pdf.

Gao. P., Hu, Y., Shen, Z., Zhao, G., Cai, R., Chu, F., Ji, Z., Wang, X., and Huang, X. (2024), Ultra-highly efficient enrichment of uranium from seawater via studtite nanodots growth-elution cycle, Nature Communications, 15, https://doi.org/10.1038/s41467-024-50951-4.

GoviEx (2024), “GoviEx Uranium provides update on Madaouela Project”, GoviEx Uranium Press Release, 4 July 2024, https://goviex.com/site/assets/files/4896/madaouela_project_update_final_2024-07-04.pdf.

Haranga Resources (2023), “Significant Maiden High Grade Uranium Mineral Resource”, ASX Announcement, 25 September 2023, https://wcsecure.weblink.com.au/pdf/HAR/02715479.pdf.

Hangara Resources (2024), “Saraya Uranium Mineral Resource Approaches 20Mlbs eU_3O_8”, ASX Announcement, 27 August 2024, https://wcsecure.weblink.com.au/pdf/HAR/02843474.pdf.

Hangara Resources (2025), Renewal of Saraya Uranium Exploration Permit”, ASX Announcement, 15 July 2025, https://wcsecure.weblink.com.au/pdf/HAR/02967483.pdf.

IAEA (2020), “World Uranium Geology, Exploration, Resources and Production”, International Atomoic Energy Agency, Vienna, www.iaea.org/publications/^#/world-uranium-geology-exploration-resources-and-production.

IAEA (2018a), “Quantitative and Spatial Evaluations of Undiscovered Uranium Resources”, IAEA-TECDOC-1861, International Atomoic Energy Agency, Vienna, www.iaea.org/publications/12380/quantitative-and-spatial-evaluations-of-undiscovered-uranium-resources.

IAEA (2018b), “Geological Classification of Uranium Deposits and Description of Selected Examples”, IAEA-TECDOC-1842, International Atomoic Energy Agency, Vienna, www.iaea.org/publications/12346/geological-classification-of-uranium-deposits-and-description-of-selected-examples.

IAEA UDEPO (2020), “World Distribution of Uranium Deposits”, https://infcis.iaea.org/UDEPO/Statistics/ResourceByCountryAndType (accessed in December 2022).

Lion Rock Minerals (2025), “Annual Report for the Year Ended 30 June 2025”, ASX Announcement, 26 September 2025, https://clients3.weblink.com.au/pdf/LRM/02999377.pdf.

Mining Review Africa (2023), “GoviEx deal with African Energy Metals terminated”, Online Article, 5 June 2023, www.miningreview.com/uranium/goviex-reports-deal-with-african-energy-metals-terminated.

Ministry of Mining, Blue Economy and Maritime Affairs (2025), “Critical Mineral Catalogue Kenya”, Document, 2025, https://mining.go.ke/sites/default/files/Mining/Critical%20Mineral%20Catalogue%202025.pdf

NEA/IAEA (2008), *Uranium 2007: Resources, Production and Demand*, OECD Publishing, Paris, www.oecd-nea.org/jcms/pl_14356.

NEA/IAEA (2006), *Uranium 2005: Resources, Production and Demand*, OECD Publishing, Paris, www.oecd-nea.org/jcms/pl_14104 .

Neo Energy Metals (2024), "Major Uranium Acquisition Adds 90 Mlbs of Uranium and 4.2 Mozs of Gold Resources – Neo on Path to Become one of South Africa's Leading Uranium Companies", Announcement Main Market of the London Stock Exchange, 13 August 2024, https://neoenergymetals.com/assets/files/news/2024/August/Acquisition_of_90Mlb_uranium_resource_project.pdf.

Orano (2024), "Update on the situation of the Imouraren mining project in Niger", Orano Press Release, 20 June 2024, www.orano.group/en/news/news-group/2024/june/update-on-the-situation-of-the-imouraren-mining-project-in-niger.

Paladin Energy (2025), "Quarterly Activities Report", ASX Announcement, 23 July 2025, www.paladinenergy.com/wp-content/uploads/2025/08/61274224.pdf.

Peninsula Energy (2025), "Peninsula Achieves First YellowCake (Uranium) Production at Lance Project, Wyoming, USA", ASX Announcement, 16 September 2025, https://wcsecure.weblink.com.au/pdf/PEN/02993942.pdf.

Sun, Z., Chen, Z., Tai, X., and Wang, X. (2025): "Uranium extraction from seawater: methods and challenges", Science China, Vol. 68, Issue 9, https://doi.org/10.1007/s11426-025-2784-1.

TMX (2023), "African Energy Acquires Mali Project with Uranium, Copper and Silver Resources and Announces Financing", Online Article, 18 January 2023, www.newsfilecorp.com/release/151724/African-Energy-Acquires-Mali-Project-with-Uranium-Copper-and-Silver-Resources-and-Announces-Financing.

Toro Energy (2023), "Quarterly Activities Report, For period ending 31 March 2023", Toro Energy ASX Release, 28 April 2023, https://cdn-api.markitdigital.com/apiman-gateway/ASX/asx-research/1.0/file/2924-02660163-6A1147665&v=70bc033a22188bdfefb8a0b8ad3c24897ef2837d.

UEC (2025), "Uranium Energy Corp Announces Restart of ISR Uranium Production in Wyoming", News Release, 13 August 2024, www.uraniumenergy.com/news/releases/index.php?content_id=1065.

UEC (2025), "Uranium Energy Corp Achieves Key Production Milestone with Drummed Uranium Concentrates at Irigaray Plant", News Release, 19 February 2025, www.uraniumenergy.com /news/releases/index.php?content_id=1081

Ur-Energy (2024), "Ur-Energy Announces Decision to Build Out Shirley Basin Mine", 13 March 2024, www.ur-energy.com/news-media/press-releases/detail/358/ur-energy-announces-decision-to-build-out-shirley-basin-mine.

Westwater Resources (2023), "Westwater Resources, Inc. Annual Report on Form 10-K for the Fiscal Year Ended December 31, 2023", Westwater Resources, 6 March 2023, https://westwaterresources.net/investors/sec-filings.

Westwater Resources (2024), "Westwater Resources, Inc. Annual Report on Form 10-K for the Fiscal Year Ended December 31, 2023", Westwater Resources, 19 March 2023, https://westwaterresources.net/investors/sec-filings.

Wismut (2024), "Rückbau der Uranentsorgung Königstein: Nächster Abschnitt gestartet", News, 16 December 2024, www.wismut.de/kommunikation/wismut-news/detailansicht-news?tx_news_pi1%5Baction%5D=detail&tx_news_pi1%5Bcontroller%5D=News&tx_news_pi1%5Bnews%5D=232&cHash=e8cef41d38e5285762be6b426486fe4c

WNA (2024a), "Niger revokes mining permit for Imouraren project", World Nuclear News, 21 June 2024, www.world-nuclear-news.org/Articles/Niger-revokes-mining-permit-for-Imouraren-project.

WNA (2024b), "Niger government withdraws GoviEx mining rights", World Nuclear News, 5 July 2024, www.world-nuclear-news.org/Articles/Niger-government-withdraws-GoviEx-mining-rights.

WNA (2025a), "GoviEx, Niger agree roadmap to resolve Madouela dispute", World Nuclear News, 18 February 2025, www.world-nuclear-news.org/articles/goviex-niger-agree-roadmap-to-resolve-madouela-dispute.

WNA (2025b), "China's largest uranium mining project enters production", World Nuclear News, 15 July 2025, www.world-nuclear-news.org/articles/chinas-largest-uranium-mining-project-enters-production.

WNA (2025c), "Construction set to start at Velvet-Wood project", 8 October 2025, www.world-nuclear-news.org/articles/construction-set-to-start-at-velvet-wood-project.

WNA (2025d), "IsoEnergy to acquire Toro, creating diversified uranium company", World Nuclear News, 13 Oct 2025, www.world-nuclear-news.org/articles/isoenergy-to-acquire-toro-creating-diversified-u-company.

WNA (2025e), "Swedish parliament votes to allow uranium mining", World Nuclear News, 6 November 2025, www.world-nuclear-news.org/articles/swedish-parliament-votes-to-allow-uranium-mining.

WNA (2022a), "First contracts awarded for US strategic uranium reserve", Online Article, 16 December 2022, www.world-nuclear-news.org/Articles/First-contracts-awarded-for-US-strategic-uranium-r.

WNA (2022b), "US uranium producers announce contracts and production ramp-ups", Online Article, 20 December 2022, www.world-nuclear-news.org/Articles/US-uranium-producers-announce-contracts-and-produc.

Chapter 2. Uranium demand, and adequacy between supply and demand

This chapter summarises the current status and projected growth in global nuclear electricity generating capacity and commercial reactor-related uranium requirements up to 2050. The adequacy between uranium supply and demand is analysed and important developments related to the world uranium market are described.

Nuclear generating capacity and reactor-related uranium requirements

On 1 January 2025, a total of 441 commercial nuclear reactors were operational [1] globally, in 31 countries, and 64 reactors were under construction.

During 2023 and 2024, 12 reactors were connected to the grid, construction started on 17 reactors and 9 reactors were permanently shut down. Table 2.1 summarises the status of the world's nuclear power plants as of 1 January 2025. The global nuclear power plant fleet generated a total of about 2 605 TWh of electricity in 2023 and about 2 727 TWh in 2024 (see Table 2.2).

World annual uranium requirements amounted to around 64 584 tU as of 1 January 2025.

Global nuclear programmes

OECD Member countries

As of 1 January 2025, 282 reactors were operational in 17 OECD Member countries and constituted about 66% of the world's nuclear electricity generating capacity. During 2023 and 2024, a total of 11 reactors were under construction in OECD Member countries. In this same period, 6 reactors were permanently shut down in Belgium, Canada and Germany.

Up until 2021, due to economic challenges and energy policy decisions, several operating reactors, mainly in OECD Member countries, were set on a path for early decommissioning. However, in 2022 and 2023, and since then, some countries have significantly shifted their energy policies in favour of nuclear energy. This trend is driven by a combination of factors, including security of energy supply and clean energy targets. As a result, some nations are revisiting their energy strategies to incorporate or expand their nuclear capabilities.

The OECD reactor-related uranium requirements amounted to around 43 361 tU as of 1 January 2025.

1. Including reactors in suspended operation (23 units).

Table 2.1. **Nuclear power plant data summary**

(as of 1 January 2025)

Country	Operational reactors	Generating capacity (GWe net)	Reactors under construction	Reactor grid connections in 2023-2024	Reactor shutdowns in 2023-2024	Reactors using MOX	2024 uranium requirements (tU)*
Argentina	3	1.6	1	0	0		217
Armenia	1	0.4	0	0	0		67
Bangladesh	0	0.0	2	0	0		0
Belarus	2	2.2	0	1	0		355
Belgium	5	3.9	0	0	1		625
Brazil	2	1.8	1	0	0		386
Bulgaria	2	2.0	0	0	0		370
Canada	17	12.7	0	0	2		1 512
China[(a)]	58	56.9	28	4	0		10 500
Czechia	6	4.0	0	0	0		762
Egypt	0	0.0	4	0	0		0
Finland	5	4.4	0	0	0		720
France	57	63.0	0	1	0	22	7 200
Germany	0	0.0	0	0	3		0
Hungary	4	1.9	0	0	0		318
India	24	7.6	7	1	0		1 650
Iran (Islamic Republic of)	1	0.9	1	0	0		146
Japan	33	31.7	2	0	0		2 021
Korea	26	25.6	2	1	0		4 097
Mexico	2	1.6	0	0	0		248
Netherlands	1	0.5	0	0	0	1	77
Pakistan	6	3.3	1	0	0		522
Romania	2	1.3	0	0	0		210
Russia	36	26.8	6	0	1	1	4 000
Slovak Republic	5	2.3	1	1	0		394
Slovenia	1	0.7	0	0	0		140
South Africa	2	1.8	0	0	0		294
Spain	7	7.1	0	0	0		1 208
Sweden	6	7.0	0	0	0		1 121
Switzerland	4	3.0	0	0	0		476
Türkiye	0	0.0	4	0	0		0
Ukraine	15	13.1	2	0	0		1 500
United Arab Emirates	4	5.3	0	1	0		856
United Kingdom	9	5.9	2	0	0		941
United States	94	97.0	0	2	0		21 500
Total World	**441**	**398.2**	**64**	**12**	**9**	**24**	**64 584**
Total OECD	**282**	**272**	**11**	**5**	**6**	**23**	**43 361**
Total Non-OECD	**159**	**126**	**53**	**7**	**3**	**1**	**21 223**

* When not reported by the country, data are internal estimates by the Secretariat. MOX is not included in uranium requirement figures.

(a) The following data for Chinese Taipei are included in the world total but not in the total for China: one reactor in operation, 0.9 GWe net; 150 tU* as 2024 uranium requirements; no reactors under construction, none started up and two shut down during 2023 and 2024.

Source: i) Government-supplied responses to a questionnaire; ii) IAEA Power Reactor Information System (accessed March 2026), and iii) IAEA Energy, Electricity and Nuclear Power Estimated for the period up to 2050 (IAEA, 2024a, 2025).

Table 2.2. **Electricity generated at nuclear power plants 2020-2024**

(TWh)

Country	2020	2021	2022	2023	2024
Argentina	10	7	5	9	10
Armenia	3	2	3	3	3
Belarus	0.3	5	4	11	15
Belgium	33	48	42	31	30
Brazil	13	13	13	13	15
Bulgaria	16	16	16	16	16
Canada	92	96	93	85	82
China[(a)]	345	383	418	407	451
Czechia	28	31	31	30	30
Finland	22	23	24	33	31
France	339	361	279	320	362
Germany	61	65	33	7	0
Hungary	15	15	15	16	16
India	40	40	42	48	55
Iran (Islamic Republic of)	6	3	6	6	6
Japan	43	71	56	81	89
Korea	153	151	168	172	179
Mexico	11	12	11	12	12
Netherlands	4	4	4	4	3
Pakistan	10	16	22	22	23
Romania	11	10	10	10	10
Russia	202	222	223	217	216
Slovak Republic	14	14	15	18	17
Slovenia	6	5	5	5	6
South Africa	12	10	12	8	8
Spain	56	54	56	54	52
Sweden	47	51	50	47	49
Switzerland	23	19	23	23	23
United Arab Emirates	2	10	19	31	37
Ukraine[(b)]	72	86	NA	52	53
United Kingdom	46	42	44	37	37
United States	790	772	772	775	782
Total World[(c)]	**2 556**	**2 683**	**2 595**	**2 605**	**2 727**
Total OECD	**1 783**	**1 832**	**1 720**	**1 751**	**1 799**
Total Non-OECD	**773**	**851**	**875**	**854**	**928**

(a) The following data for Chinese Taipei are included in the world total, but not in the total for China: 30.3 in 2020, 26.8 in 2021, 22.9 in 2022, 17.2 in 2023 and 11.7 in 2024.

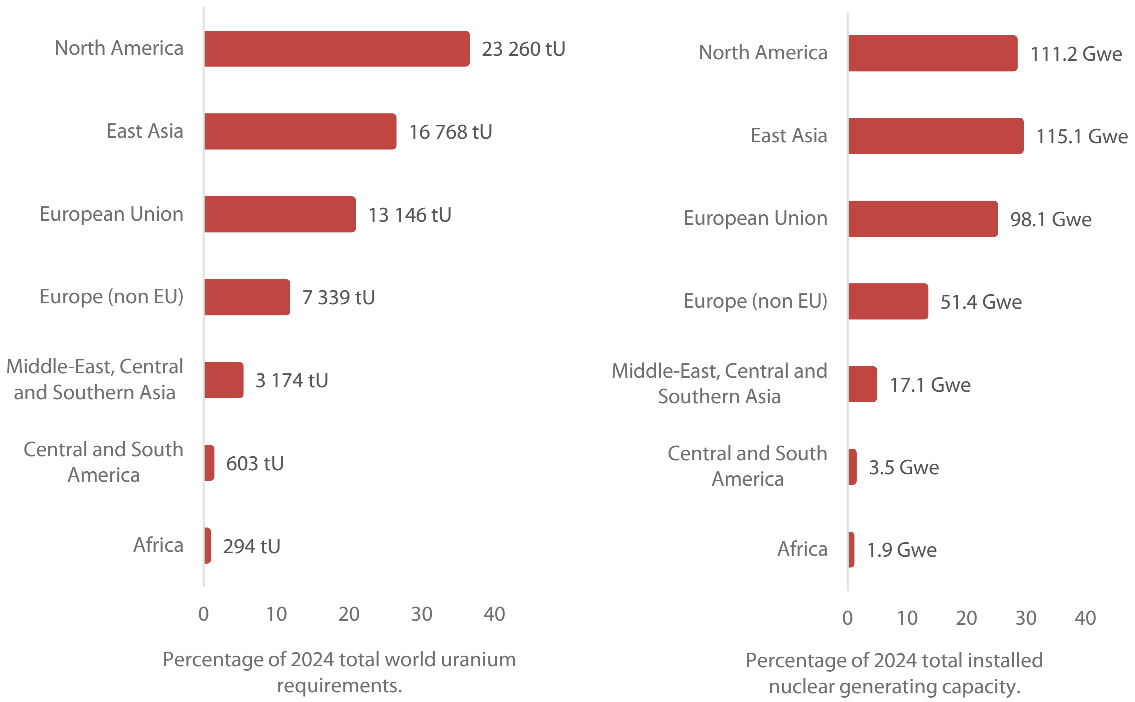
(b) Ukrainian operational data was not available for the year 2022.

(c) All missing data are internal estimates by the Secretariat.

Source: i) Government-supplied responses to a questionnaire; ii) IAEA Energy, Electricity and Nuclear Power Estimated for the period up to 2050 (IAEA, 2024a, 2025).

Figure 2.1. **World uranium requirements (64 584 tU) and total installed nuclear generating capacity (398 GWe)**

(in 2024)



European Union

The EU taxonomy Regulation (EU) 2020/852 establishes uniform criteria for determining the degree of environmental sustainability of investments. On 9 March 2022, the European Commission (EC) adopted Delegated Regulation (EU) 2022/1214, which includes criteria for classifying nuclear energy as an environmentally sustainable investment and recognises that nuclear energy can contribute to the decarbonisation of the European Union's economy.

In February 2024, the European Commission launched the Small Modular Reactor (SMR) Industrial Alliance which aims to facilitate and accelerate the development, demonstration, and deployment of small and advanced modular reactors in Europe by the early 2030s, and to ensure a strong EU supply chain, including a skilled workforce. Nuclear energy has also been recognised within the EU's broader industrial policy framework, notably through the Net-Zero Industry Act adopted in 2024, which supports the development of clean technology manufacturing capacities in Europe.

In Belgium, five nuclear reactors with a net capacity of 3.9 GWe provided approximately 42.2% of domestic electricity generation as of 1 January 2025. By early 2026, only two nuclear reactors, with a net capacity of 2 GWe, were still in operation. In 2003, Belgium had decided to phase out nuclear power by 2025, prompting the shutdown of several reactors. In September 2022, Doel 3 closed, followed by Tihange 2 in January 2023. In 2025, Doel 1 and Tihange 1 were retired in February and September, respectively. Doel 2 entered decommissioning in December 2025. The remaining two reactors, Doel 4 and Tihange 3, were set to retire in November 2025, but in March 2022, received a ten-year extension until 2032. For these remaining units, Belgium has conducted extensive inspections and maintenance, alongside increased safety measures. In May 2025, the Belgian parliament formally repealed its 2003 decision. The country will now allow long-term operation of existing reactors as well as new projects. Belgium's new energy strategy aims to maintain around 4 GWe of nuclear capacity by 2035. In addition, in 2022, the government dedicated EUR 100 million to investigate the potential of SMRs.

In Bulgaria, following the closure of four older reactors by the end of 2006, only two units remain operational at the Kozloduy Nuclear Power Plant. They provided 41.56% of domestic electricity production in 2024, a net capacity of 2 GWe. To compensate for the loss of nuclear generating capacity and to regain its position as a regional low-carbon electricity exporter, the government plans to build new reactors. In January 2023, in Bulgaria's 2053 Energy Vision, the government approved plans to construct four new nuclear reactors at the Kozloduy and Belene sites by 2053. Two AP1000 units at the Kozloduy site are proposed to be built by Westinghouse. Bulgaria's Ministry of Energy announced a partnership with Citibank to fund the new Kozloduy units in 2025. In October 2023, the decision to develop the Belene plant was reversed. In February 2024, the Bulgarian government signed an intergovernmental agreement with the United States for the construction of the Kozloduy site and Bulgaria's civil nuclear programme. In December 2024, the US Trade and Development Agency signed a grant with Bulgarian Energy Holding for a technical analysis of US-sourced SMR site evaluation and design options. More recently, in 2025, the Bulgarian Prime Minister and Minister of Energy met with GE Vernova's Chief Commercial Officer to discuss a partnership for SMR development. Bulgaria is also moving away from its past reliance on Russian nuclear fuel and, as a part of the supply diversification process, the country signed an agreement with Westinghouse to supply fuel to unit 5 at Kozloduy, and with Framatome to supply fuel for unit 6.

In Czechia, a total of six reactors across two power plants were operational on 1 January 2025, with an installed capacity of 3.97 GWe net, providing around 40.21% of domestic electricity production in 2024. Dukovany Nuclear Power Plant has 4 VVER-440 reactors, each offering about 0.5 GWe, and the newer Temelin Nuclear Power Plant has 2 VVER-1000 reactors, each offering roughly 1 GWe. Czechia is prioritising nuclear energy deployment, with the 2024 National Energy and Climate Plan outlining a new target for nuclear energy to account for 68% of the national electricity mix by 2040. Up to four new reactors, two at each site, are proposed to be built with the target date for the start of commercial operation of the first unit in 2036. Furthermore, in January 2024, the Czech government issued a decree to prompt the preparation of construction on additional nuclear reactor units at the Dukovany and Temelin sites beyond Dukovany 5 and 6. Simultaneously, Czechia is investing in extending the operating lifetime of existing reactors. In January 2024, the Czech government invited French utility company Electricité de France (EDF) and Korea Hydro and Nuclear Power (KHNP) corporation to provide binding bids for construction of up to four new units. In July 2024, KHNP was selected as the preferred bidder. More recently, as of February 2026, ČEZ announced USD 210 million to the Dukovany plant and USD 182 million to the Temelin plant for modernisation projects. Additionally, Czechia is committed to deploying SMRs. In November 2023, the government approved the Czech SMR Roadmap, where 45 potential SMR host sites were identified. A major milestone was reached when ČEZ became a shareholder in the British company Rolls-Royce SMR Limited, acquiring an approximate 20% equity stake. Following this strategic partnership, ČEZ and Rolls-Royce SMR signed an Early Works Agreement in July 2025 to start work for SMRs at Temelin. The first SMR is planned at Temelin, with a gross output of 0.5 GWe. ČEZ's goal is to have 3 Gwe from SMRs by 2050.

In Denmark, there is no nuclear energy production, but interest in deployment has increased. In May 2025, the Danish government announced in Parliament that it would undertake an analysis of the risks and benefits associated with new nuclear technologies. The review will also consider the broader implications of potentially lifting the current ban on nuclear power in Denmark.

In Estonia, there are currently no nuclear reactors, but the country is putting measures in place to prepare for deployment. In February 2024, the government presented the final report of the Nuclear Energy Working Group which concluded that the deployment of nuclear energy in Estonia is feasible and would aid in achieving climate targets and energy security. In June 2024, the Estonian parliament passed a decision that clears the way for a "Nuclear Energy and Safety Act", endorsing the preparation for potential nuclear energy deployment in Estonia. In January

2025, Fermi Energia, a private Estonian energy company, submitted an application to the Ministry of Economic Affairs and Communications, to initiate a state spatial planning process that would permit site investigations for an SMR in Estonia. The company plans to build a nuclear power plant with two BWRX-300 units.

In Finland, five units with a total generating capacity of 4.4 GWe were operational on 1 January 2025, including three units at Olkiluoto Nuclear Power Plant, owned and operated by Teollisuuden Voima Oyj (TVO) and two units at the Loviisa Nuclear Power Plant, owned and operated by Fortum Power and Heat Oy. In 2024, nuclear energy made up 39.1% of total domestic electricity production. Nuclear energy is expected to continue being a large source of domestic production and, in February 2023, the Finnish government granted a new operating licence for both units at the Loviisa site to stay in operation until 2050. The country's most recent reactor unit, Olkiluoto 3, was connected to the grid in March 2022 and regular electricity production began in May 2023, following a period of numerous delays and cost overruns. The project for the new nuclear site in Pyhäjoki to build a new reactor provided by a consortium with Rosatom was terminated in 2022. Finland is considering both new SMR builds as well as new large power plant deployments in the future. In March 2025, Finland's state-owned energy company, Fortum, concluded a feasibility and options study confirming the potential viability of new nuclear power projects. Fortum is working on preliminary preparations, aiming to enable future investment decisions on new nuclear capacity, including SMRs. In October 2023, Helen, a Finnish energy company, signed an agreement with Steady Energy to invest in SMR development for district heating. The agreement lasts until 2027 and includes joint support for reforming the Nuclear Energy Act, applying for a siting licence and technology permit, and fixing the contract price of the plant. With the agreement, Helen can procure up to ten reactors from Steady Energy, with a joint output of up to 0.5 GW. In November 2025, Helen announced three potential SMR sites in Helsinki: the Vuosaari and Salmisaari power plant areas, and the Norrberget area in western Östersundom. Steady Energy has made progress at the Salmisaari site. Following the decommissioning of the Salmisaari B coal-fired power station in Helsinki, Steady Energy is seeking to replace this energy supply with an LDR-50 SMR. In June 2025, the Finnish Radiation and Nuclear Safety Authority (STUK) completed a preliminary safety assessment on the LDR-50 SMR and as of early 2026, STUK is co-ordinating a larger international safety assessment with the joint efforts of nuclear safety authorities from Czechia, Finland, Poland, Sweden and Ukraine. Additionally, Finland's nuclear waste management company, Posiva Oy, has progressed its radioactive waste management programme, advancing development of the world's first deep geological repository for spent fuel at the Olkiluoto site, known as the Onkalo Nuclear Waste Disposal Facility. The underground construction and building technology work was completed in May 2024 and, in August 2024, Posiva Oy started the trial run of final disposal to test the equipment, systems and processes. The encapsulation plant stage of the trial was successfully completed in March 2025. Final disposal of spent nuclear fuel at Olkiluoto is expected soon but has been consistently delayed due to STUK's review. As the Olkiluoto facility is the first of its kind, final safety approval has taken longer than expected. STUK was granted a third extension on its operating licence assessment and decision until the end of June 2026. Once approved, Posiva will start final disposal.

In France, 57 reactors were operable, with a total capacity of 63 GWe as of 1 January 2025. In 2024, nuclear energy accounted for approximately 67% of total electricity production. In February 2022, France announced plans to build six new EPR-2 units by 2050, and to consider building a further eight to maintain its energy security and to meet climate goals. In 2023, France abandoned the objective to reduce the share of nuclear power to 50% by 2035, instead, planning to maintain it at more than 50% by 2050. In May 2023 repairs to welds in the Flamanville 3 EPR were completed. Fuel loading started in May 2024 and in December 2024 it was connected to the grid, adding 1.65 GWe (gross) of nuclear energy capacity. In March 2025, the Conseil de Politique Nucléaire confirmed the state-backed preferential loans for six new EPR2 reactors, which will be constructed by Électricité de France (EDF) and represent 9.6 GWe of total capacity. At the end of 2025, EDF announced an estimate that the construction of the six reactors will total around EUR 72.8 billion. France also seeks to start deploying SMRs. Furthermore, the French government's third Multiannual Energy Programme, published in February 2026, outlined a nuclear production target of 380-420 TWh per year between 2030-2035, an increase from the former target of 360-400 TWh.

In Germany, there is currently no nuclear energy production. Following the Fukushima Daiichi Nuclear Power Plant accident in 2011, the German Cabinet announced that it was accelerating the nuclear phase-out by permanently shutting down the reactors. The Grohnde, Gundremmingen C and Brokdorf power plants were permanently shut down in 2021, and the three most recently built facilities – Isar 2, Emsland and Neckarwestheim 2 – were to be permanently shut down by the end of 2022. In November 2022, the German parliament voted that Germany's three remaining nuclear power reactors, still operating in 2022, should continue operating until mid-April 2023, to ensure the security of electricity supply. As a consequence of this decision, all of the remaining German reactors were shut down on 15 April 2023. Despite turning away from nuclear fission, Germany is increasing its investment in nuclear fusion research. In late 2025, the German cabinet approved the government's Fusion Action Plan, intended to accelerate commercial fusion deployment. It is expected that by 2029, Germany will have invested about USD 2.3 billion in fusion research and pilot projects.

In Greece, there are no nuclear reactors for electricity production, but interest in nuclear power is growing. In June 2025, Prime Minister Mitsotakis expressed interest in exploring nuclear energy options, focussing on SMRs, potential applications for maritime propulsion and participation in the European Nuclear Alliance.

As of 1 January 2025, in Hungary there were four operational VVER reactors at the Paks Nuclear Power Plant (1.9 GWe net capacity). These reactors accounted for 47% of the country's electricity generation in 2024. In January 2020, the government approved the new National Energy Strategy 2030, and the National Energy and Climate Plans 2030. The preservation of nuclear generation capacity by replacing and extending the lifespan of existing units at the Paks site is one of the key strategic measures. Progress is continuing with the Paks II project, to construct two new Russian-designed VVER-1200 reactors. The unit 5 and 6 Paks II reactors will be constructed by Rosatom and will offer 2.2 GWe. Paks unit 5 is currently under construction and unit 6 is planned. Hungary is also investing in extending the lifetime of existing reactors and, in December 2022, parliament approved plans enabling potential lifetime extensions of the four reactors at Paks up to 70 years, subject to regulatory approval. In 2024, the Hungarian Parliament adopted an amendment to the Atomic Energy Act, which simplified the licensing process for new projects. The European Commission originally approved State aid for the Paks II nuclear project, but in September 2025 the European Court of Justice annulled this decision. In November 2025, the US Treasury Department issued a general authorisation for certain transactions related to the Paks II project, ensuring exemption from US sanctions. Hungary is also interested in potentially deploying SMRs in the future. All of Hungary's nuclear fuel supply is currently contracted from TVEL, in Russia. In October 2024, Framatome signed a long-term fuel supply contract for Hungary's four existing reactors at the Paks Nuclear Power Plant, starting in 2027.

In Italy, there are no reactors in operation. However, the 2024 National Integrated Plan for Energy and Climate outlined the potential for nuclear energy by 2050, generated by both SMRs and advanced reactors. Nuclear deployment is dependent on essential legislative and regulatory reforms. In 2025, the Council of Ministers approved a draft law to reintroduce nuclear power, emphasising the use of best available technologies, including SMRs, and mandating the establishment of an independent authority for regulation.

In Latvia, there were no reactors as of the end of 2024, but the country is taking steps to explore the potential role of nuclear energy. In 2024, the Ministry of Climate and Energy published a report outlining possible scenarios for developing nuclear power in Latvia. In May 2025, the Cabinet of Ministers instructed the Ministry of Climate and Energy to initiate negotiations with Estonia on co-operation in nuclear regulation and potential nuclear power plant development.

In Lithuania, there are no nuclear reactors, but in June 2024 an amendment of the National Energy Independence Strategy envisaged the possible deployment of up to 1.5 GWe of SMR capacity in the longer term.

In the Netherlands, 2.8% of the country's domestic electricity production came from one nuclear reactor, with a capacity of approximately 0.5 GWe as of 1 January 2025. Nuclear power is set to make up a larger portion of their energy mix in coming years. Up to four new reactors have been proposed with a total capacity of up to 5 GWe. The government of the Netherlands aims to cut carbon emissions by at least 49% by 2030, compared to 1990 levels, and in its draft Climate Fund for 2024, it allocated a total of EUR 320 million for various nuclear projects, including the construction of two new large reactors and the development of SMRs. In 2025, the Dutch government began preparing the selection of technology and financing for the two future reactors, which will likely be located at the Borssele site. In 2024, the Environment and Planning Act introduced changes for the Authority for Nuclear Safety and Radiation Protection, including simplifying the procedure for Environmental Impact Assessments (EIAs). The Netherlands has also allocated funds for SMR feasibility programmes and safety studies, while engaging with international developers.

In Poland, there is no nuclear capacity as of 2026, but following the government's recommitment to launching a nuclear programme in 2021 (outlined in the Energy Policy of Poland until 2040), nuclear deployment is ramping up. The government has successfully laid the groundwork for nuclear deployment, targeting the construction of two nuclear power plants. A total of 6 units with a combined capacity of 6-9 GWe should be constructed by 2043. The construction of three Westinghouse AP1000 units in Pomerania at the Lubiatowo-Kopalino site, is due to begin in the late 2020s, with commissioning of the first unit in the mid-2030s, followed by connection to the grid of subsequent reactors every 2-3 years. In December 2023, a decision-in-principle was granted by the Polish government for the construction of up to 24 BWRX-300 SMR reactors at six possible sites, with plans to build the first block of SMRs in the 2030s.

In Romania, two Canadian Deuterium Uranium (CANDU) pressurised heavy water reactors (PHWRs) at the Cernavoda Nuclear Power Plant provided 19% of the electricity generated in the country in 2024, with a capacity of 1.3 GWe net. Nuclearelectrica, the state-owned utility that operates the Cernavoda Nuclear Power Plant, has announced plans to refurbish unit 1 of the plant in order to extend its operational lifetime for another 30 years. The project to complete Cernavoda units 3 and 4 is now also proceeding, and Nuclearelectrica has estimated that units 3 and 4 will start commercial operation in 2030s. In November 2024, during the COP 29 climate conference, an engineering, procurement and construction management contract was signed with the FCSA Joint Venture – comprising Fluor, AtkinsRéalis, Ansaldo Nucleare and Sargent & Lundy Energie – for the completion of units 3 and 4 of Romania's Cernavoda Nuclear Power Plant. In October 2020, an intergovernmental agreement was signed with the US, by which the US intends to support the construction of two new Cernavoda reactors and help refurbish unit 1. A similar agreement was signed with Canada in 2021. In March 2019, a Memorandum of Understanding was signed with NuScale Power to evaluate the potential for SMRs in Romania. In November 2021, Romania announced the potential roll-out of SMRs in the country by the end of the decade. The VOYGR-6 power plant, developed by NuScale Power, is proposed to be built at the former coal plant site at Doicești, within the Muntenia region. It will encompass six SMRs, each at 77 MWe, for a total of around 462 MWe. The final investment decision for the project was approved by shareholders in February 2026, moving the project to the implementation phase.

In the Slovak Republic, five reactors were operational as of 1 January 2025, with a net capacity of 2.3 GWe. They provided 60.6% of the country's electricity in 2024. Two reactors are located at the Bohunice site and three are at the Mochovce site, with a fourth underway. Mochovce 3 made its initial grid connection on 31 January 2023, adding 0.44 GWe of capacity, while Mochovce 4, with the same capacity, is still under construction. Additionally, in May 2024, the Slovak government officially approved plans to build another unit at the Bohunice power plant (1.2 GWe). In late 2025, Robert Fico, the Prime Minister of the Slovak Republic, approved an intergovernmental agreement with the US for the construction of the new unit at Bohunice. In early 2026, the government selected Rothchild & Co as the financial advisor for this project. In October 2024, the Slovak Republic received a USD 5 million grant for SMR projects under the US Department of State's NEXT project, building on earlier support provided through the Project Phoenix, intended to support the Slovak Republic as it searches for and selects potential future SMR sites. In January 2026, the study assessing the potential and readiness for SMR development at four key sites– Bohunice, Mochovce, Vojany and US Steel Košice - determined that all four sites were suitable for SMR deployment. Slovenské Elektrárne commented on this development, stating that SMRs could be operational in the Slovak Republic in the 2030s. They have also taken steps to diversify their nuclear fuel supply to enhance energy security.

In Slovenia, the single nuclear reactor in operation (Krško, with 0.70 GWe capacity) is jointly owned and operated with Croatia by Nuklearna Elektrana Krško (NEK), and produced 35% of Slovenia's domestic electricity in 2024, although a proportion of this is contractually allocated to partially meet Croatia's electricity requirements. The Krško reactor began commercial operation in 1983 and was granted a 20-year lifetime extension to 2043. An ambitious programme of safety upgrades at the Krško plant was rolled out after the Fukushima Daiichi Nuclear Power Plant accident. Slovenia is also considering adding a second unit at Krško, known as JEK2.

In Spain, seven operational nuclear reactors with a total net capacity of 7.1 GWe generated 20% of the domestic electricity supply in 2024. In March 2021, the government approved the National Energy and Climate Plan, which included the full gradual phase-out of nuclear energy between 2027 and 2035. Despite political debate regarding fully abandoning nuclear, the phase-out policy is still in place. In late October 2025, a request was made to extend the lifetime of the two Almaraz reactor units until 2030, as debate about phase-out has increased, but the closure dates currently still stand. In May 2020, the State Company for Radioactive Waste and Decommissioning, Empresa Nacional de Residuos Radiactivos (ENRESA), applied for the phase 1 dismantling authorisation of the Santa Maria de Garoña Nuclear Power Plant. In Granada, the IFMIF-DONES facility, a large fusion materials research facility, is under construction following a Multilateral International DONES Agreement.

In Sweden, six operational reactors (with 7 GWe net capacity) provided about 30% of domestic electricity supply in 2024. At the end of 2019, Ringhals 2 was shut down after 44 years of operation and the Ringhals 1 reactor finally ceased operation on 31 December 2020. For the remaining reactors, operation is planned for around 60 years, with potential extensions under consideration. In 2023, Sweden updated its energy target to replace the "100% renewable" electricity by 2040 with a "100% fossil-free" electricity target. In November 2023, the Swedish government announced plans for the country's nuclear energy expansion. The country intends to build two large-scale units by 2035 and the equivalent of ten new reactors, including SMRs, by 2045. In addition, Studsvik, a Swedish nuclear company, has also entered into a partnership to explore the use of SMRs for data centres at their licensed nuclear site.

North America

North America continues to rely on nuclear power as a key component of its electricity system. Recent developments include reactor life extension programmes, new nuclear projects and increasing the prospective deployment of SMR technologies.

In Canada, 17 reactors were operational as of 1 January 2025. They produced 12.7 GWe, which translates to 13.4% of the country's total electricity production in 2024. In March 2024, the Canadian government reaffirmed its ambition to scale nuclear capacity, support SMR deployment and become a leader in new technologies. In the Clean Electricity Regulations finalised in December 2024, the Canadian government introduced binding pollution limits for fossil-fuel based electricity and highlighted its commitment to decarbonised energy, including nuclear energy, to achieve a net-zero grid by 2050. In 2023, the government announced plans to start pre-development work and add up to 4.8 GWe of new large-scale nuclear capacity at Bruce Power's existing site. This would be the first new large-scale nuclear plant in Canada in over 30 years. This project is currently in the public consultation phase. A CAD 26 billion refurbishment plan for Ontario's nuclear reactors will see the sequential refurbishment of four units at the Darlington site and six units at the Bruce site. The refurbishment of the Darlington Nuclear Generating Station began with work on the first reactor in 2016 and was completed in early 2026, with all four units now refurbished and licensed for operation into at least the 2050s. The Bruce site refurbishments are expected to be completed by 2033, extending the plant's operational lifespan to 2064. Bruce Power is also pursuing opportunities to optimise the output of existing nuclear units, with a target to reach 7 GWe of peak output, a 0.45 GWe increase over current capacity, by the 2030s, through asset optimisation and by leveraging new technologies. Ontario's third operating nuclear power plant, Pickering, was originally scheduled to shut down in 2020, but the Canadian Nuclear Safety Commission (CNSC) extended the plant's licence to at least 2026. In January 2024, the Canadian government announced plans to refurbish units 5-8 and, in January 2025, the Ontario government approved a CAD 4.1 billion investment for early engineering and procurement. If final approval is granted by the end of 2026, the refurbishment is expected to be completed by the mid-2030s and will extend the operational lifespan for additional 30 years, maintaining over 2 GWe. Canada is also moving forward with the first grid-scale SMR project in the G7. In January 2023, Ontario Power Generation (OPG), GE Hitachi, Atkins Realis and Aecon signed a contract to develop, engineer and construct a BWRX-300 SMR at OPG's Darlington New Nuclear Project site. The unit is expected to be constructed by late 2028 and start supplying power to the grid in 2029, with a capacity of 0.3 GWe. In July 2023, an announcement was made to build three additional BWRX-300 units at the Darlington site, with these units expected to be connected to the grid between 2034 and 2036. In October 2025, the federal budget announced up to CAD 2 billion investment from the Canada Growth Fund to support the construction phase. The reactor is the first of four units planned, which will collectively produce 1.2 GWe once operational.

In Mexico, the two units at the Laguna Verde Nuclear Power Plant (a total of 1.6 GWe net capacity) provided 4.8% of the electricity generated in the country in 2024. In July 2020, Mexico's nuclear regulator approved a 30-year extension to the operating licence of Laguna Verde 1, allowing it to operate until July 2050, and a similar application for a lifetime extension was submitted for unit 2. It was approved in 2022, granting an extension until 2055. In addition, Mexico's Ministry of Energy is contemplating adding 150 MWe of SMR capacity as outlined in its national activity plan for 2023-2037. Although Mexico's Energy Transition Law outlines that 35% of electricity should come from clean sources by 2024, 39.9% by 2033 and 50% by 2050, the country is still predominantly dependent on fossil fuels. In 2019, there was a proposal to add two additional nuclear reactors at Laguna Verde and two more at a new site on the Pacific Coast; however, no decisions have been made.

In the United States, the world's largest producer of nuclear power, 94 reactors (with 97 GWe net capacity) were operational as of 1 January 2025. These contributed 18% of total domestic electricity generated in 2024. Vogtle-3 AP1000 was connected to the grid in March 2023 and Vogtle-4 in March 2024. There have been licence renewals made to extend the lifetime of many reactors, keeping most in operation until around 2050-2060. The Palisades Nuclear Power Plant, which was expected to shut down in 2022, received over USD 1.5 billion in federal loans to support a planned restart, subject to regulatory approvals. The United States is advancing the development of SMRs and other advanced nuclear technologies, including projects such as the Natrium reactor, with the US Department of Energy investing nearly USD 2 billion to support the licensing, demonstration, and construction of this advanced reactor towards around 2030. Since 2013, about a dozen US reactors have closed, attributed to low wholesale electricity prices driven by cheap natural gas and increased renewable generation. These factors made nuclear plants financially uncompetitive. However, this trend reversed as federal and state policies have increasingly supported nuclear power and increased subsidies, tax credits and market reforms. Notably, in August 2022, the Inflation Reduction Act was enacted with provisions to support existing and new nuclear developments with investment and tax incentives for both large existing units and newer advanced reactors, as well as funding for developing the domestic supply chain of HALEU fuel and hydrogen production. In 2024, the Prohibiting Russian Uranium Imports Act came into force. This legislation prohibits the import of Russian-produced unirradiated LEU as well as unirradiated LEU that has been obtained in lieu of banned uranium, until the end of 2040. Recognising the critical role of Russian uranium in the global nuclear industry, the law grants waivers to US nuclear plants and utilities to prevent reactor shutdowns and for national security. This waiver process is valid until 1 January 2028, and it establishes annual import limits, starting at 476 metric tonnes in 2024 and decreasing annually. In May 2025, a series of Presidential Executive Orders was introduced to modernise nuclear regulation, support the restart of closed reactors, accelerate the deployment of SMRs and advanced reactors, and increase installed nuclear capacity to 400 GWe by 2050, notably to meet rising demand from data centres and artificial intelligence.

East Asia

East Asia remains the region with some of the strongest prospects for nuclear expansion worldwide, principally driven by the rapid growth of nuclear capacity in China. Simultaneously, recent shifts in energy policy in Japan and Korea have renewed government support for nuclear power, driven by the recognition of its ability to ensure energy security and low-carbon electricity.

In China, 58 operational reactors, with a total installed capacity of 56.9 GWe, provided about 4.5% of the national electricity production in 2024. In November 2025, an additional reactor, Zhangzhou unit 2, was connected to the grid with 1.1 GWe capacity. A total of 28 reactors were under construction as of 1 January 2025. China has the world's largest nuclear construction programme. In 2024, China approved 11 new nuclear reactors for construction, following the approval of 10 reactors in 2023. In particular, China is expanding nuclear power construction in its coastal regions. China is relying heavily on domestic technologies, with nuclear construction usually using the Hualong One and CAP1000 designs, allowing for large-scale construction to be faster and cheaper. China is also investing in the development of SMRs and other advanced technologies. Construction of the ACP100 SMR demonstration project at the Changjang site on Haninan Island is nearing completion, with the unit expected to begin operation by the mid-2020s. In addition, the Shidao Bay demonstration plant, a new high-temperature gas-cooled reactor (HTGR), recently entered commercial operation. China seeks to reach 150 GWe by 2035 for energy security, carbon reduction and a reduced reliance on coal. As China aims to increase its installed nuclear capacity, it is also aiming to become self-sufficient with respect to nuclear fuel supply and it has initiated several domestic projects, often in co-operation with foreign suppliers, to meet this goal.

In Japan, there were 33 existing reactors with 31.7 GWe net capacity as of 1 January 2025. However, only 14 reactors were operating, contributing about 10% of domestic electricity generation. Before 2011, nuclear power made up 30% of domestic electricity generation, but since the accident at the Fukushima Daiichi Nuclear Power Plant in March 2011, Japan significantly reduced nuclear operations. As of early 2026, of Japan's 33 reactors, 19 were in suspended operation, representing around 19 GWe of net capacity. This has caused Japanese utilities to import large amounts of oil and natural gas for electricity generation, driving electricity prices and greenhouse emissions upward. Nevertheless, the finalisation, in 2015, of a new long-term energy policy that envisions nuclear power contributing 20-22% of electricity generation by 2030 represented an important step for a sustained nuclear comeback. After over a decade, Japan is investing in restarting reactors and exploring opportunities to build new ones. In February 2025, the 7th Strategic Energy Plan was published, reaffirming the role of nuclear power in achieving the government's target of around 20% of electricity generation by 2030. The plan also outlined a commitment for public and private sectors to work together to ensure a sustainable nuclear fuel supply, building on Japan's decision to add uranium to its list of critical minerals in 2024. In December 2022, the Japanese government adopted a plan to secure a stable electricity supply while working towards carbon neutrality. It entails maximising the use of its existing nuclear fleet (by restarting as many of its existing reactors as possible and extending the lifespan of ageing units), coupled with the development of advanced reactors. The new policy also allows for reactors to operate for more than 60 years (compared to the 40-year limit previously). Reactors that have restarted are also required to construct bunkered backup control centres within five years of regulatory approval to restart. The Nuclear Regulation Authority (NRA) approved 20-year licence extensions for Takahama 3 and 4 in May 2024, and for Sendai 1 and 2 in November 2023. A 20-year licence extension was granted to Tokai 2 BWR in November 2018, to Takahama units 1 and 2 in June 2016, and to Mihama 3 in November 2016. Sendai 1 and 2 were the first reactors to restart, in 2015, and by the end of 2024 a total of 14 reactors had resumed operation. Currently, two reactors, one ABWR reactor at Ohma by J-Power and one at Shimane by Chugoku Electric, are under construction and will together provide 2.65 GWe of nuclear capacity. Japan is also advancing the development of SMRs and other advanced nuclear technologies.

In Korea, 26 operational reactors with 25.6 GWe net, produced around 31.7% of the total electricity generated in 2024. As of January 2025, two reactors (Saeul units 3 and 4), were under construction and will increase Korea's nuclear power capacity by 2.68 GWe. In 2025, construction of Shin-Hanul unit 3 also started. Shin-Hanul unit 1 was connected to the grid in mid-2022, followed by the Shin-Hanul unit 2 at the end of 2023. In 2017, Korea had originally announced an energy transition policy outlining a long-term phasing out of nuclear power. However, the newly elected government in 2022 reversed this decision, instead setting a target for nuclear energy to provide a minimum of 30% of electricity in 2030 and 35% by mid-to-late 2030s. Korea reaffirmed this goal in February 2025, with the approval of the 11th Basic Plan for Long-Term Electricity Supply, outlining a target for nuclear power to account for 35.2% of the electricity mix by 2038, representing 28.3 GWe. The plan also details the construction of one 0.7 GWe SMR by 2035/2036 and two APR1400s by 2037/2038, representing a total potential capacity increase of about 3.4 GWe. Korea continues to promote its APR1400 reactor technology internationally, especially following the successful deployment of the Barakah nuclear power plant in the UAE. Additionally, Korea has strongly emphasised nuclear exports as part of its strategy. The government's 10th Electricity Plan (2022-2036) also set a target to export ten new nuclear power units by 2030.

Although Mongolia does not currently have nuclear generating capacity, it has signalled an interest in the use of SMRs.

Europe (non-EU)

This region is undergoing strong growth, with several nuclear reactors under construction. Many countries in this region continue to support nuclear power and overall growth in nuclear generating capacity is expected.

In Armenia, their single operational reactor (Metsamor 2, with 0.4 GWe capacity) provided 30.8% of the total domestic electricity generated in 2024. In 2015, the nuclear power plant began a large-scale life extension maintenance programme with the help of Rosatom. In October 2021, the Armenian Nuclear Regulatory Authority (ANRA), the national regulator, extended the operating licence to 2026. A further ten-year life extension was approved by the government in March 2023. Armenia is evaluating options for the construction of a new nuclear reactor to ensure long-term nuclear generation capacity after the eventual future retirement of Metsamor Unit 2. In August 2024, Armenia created a state-owned company dedicated to this construction project. Armenia approved an EU-funded programme under the Comprehensive and Enhanced Partnership Agreement framework to modernise nuclear safety infrastructure, improve radiation protection, and manage radioactive waste in compliance with European and international standards in November 2024. Following international best practices, Armenia's national regulatory body is drafting a new atomic energy law.

In Belarus, two reactors, Ostrovets units 1 and 2, provided 2.22 GWe of capacity as of 1 January 2025. This represented 36.4% of the total electricity generated in the country in 2024. The first reactor was connected to the grid in November 2020 and the second in May 2023. Belarus is considering the feasibility of new nuclear capacity.

In Norway, there are no nuclear reactors, but in June 2024, the Norwegian government appointed a new committee to investigate nuclear energy as a possible new energy source. The committee will conduct a broad review and assessment of various aspects of possible future nuclear deployment.

In Russia, 36 operational reactors with 26.8 GWe capacity provided about 18% of the total electricity generated in the country in 2024. Reactors are spread across 10 nuclear power plants, plus one floating nuclear power plant. Soviet-era reactors are gradually being replaced with modern designs. In January 2024, unit 2 at the Kursk nuclear power plant was permanently shut down after reaching the end of its operational lifetime. Replacement capacity is under way, with two VVER-TOI reactors under construction at the Kursk-II site. Unit 1 achieved its first grid connection on 31 December 2025 with a capacity of 1.2 GWe. In total, four reactors representing about 3.8 GWe remained under construction at the end of 2024. Russia is also advancing new nuclear technologies, including floating nuclear power plants and SMRs. In 2021, a contract was signed to build four new floating power units (FPUs), each with a capacity of up to 106 MW, to supply energy to the Baimsky Mining and Processing Plant. In March 2024 construction started on the Leningrad II-3 pressurised water reactor (PWR) unit at the Sosnovy Bor site. In April 2023, a construction licence was also granted for Russia's first land-based SMR, a water-cooled RITM-200N 55 MW reactor near Ust-Kuyga in Yakutia, which is expected to be commissioned in 2028. In December 2024, the Russian government approved a strategy for electricity infrastructure development, which aims to increase the share of nuclear energy to up to about 25% of total electricity production by 2045, with new nuclear capacity expected to total about 29 GWe by the early 2040s, including replacement capacity. At the international level, Russia continues to play a major role in nuclear markets through Rosatom, with reactor construction projects underway in several countries.

In Serbia, there are currently no nuclear reactors, however the President, Aleksandar Vuçić, stated in March 2024 that Serbia was considering the deployment of SMRs, with capacity on the order of around 1.2 GWe. In July of the same year, the government signed a memorandum of understanding with ministries, institutions, and energy sector stakeholders concerning the development and application of nuclear energy. The memorandum establishes a framework for co-operation in assessing the potential role of nuclear energy in Serbia's energy mix. In October 2024, the Ministry of Mining and Energy awarded a contract to EDF and Egis, to conduct an initial study on nuclear deployment to support technical and strategic evaluations related to a possible civil nuclear programme. In 2024, amendments to the Energy Law effectively removed the long-standing prohibition on nuclear power development that had been in place since 1989, enabling formal consideration of nuclear energy options.

In Switzerland, four operating reactors produced 27% of the electricity generated in the country in 2024, with 2.97 GWe net capacity. Switzerland's first nuclear power plant, Mühleberg, with an approximate output power of 373 MW, was permanently shut down on 20 December 2019. In 2017, a public referendum was organised for the new Energy Strategy 2050. Under the new law, permits for the construction of new nuclear power plants are prohibited. The existing nuclear power plants may remain in operation for as long as they are declared safe by the Federal Nuclear Safety Inspectorate. In August 2025, Switzerland's Federal Council presented draft legislation to lift the ban on the construction of new nuclear units. Since then, the proposal has advanced through Parliament with the Upper House approving to lift the ban in March 2026.

In Türkiye, four reactors were under construction as of 1 January 2025, with a total capacity of 4.46 GWe. The government continues to advance its nuclear development programme as its economy faces rapidly escalating electricity demand. Construction of the country's first nuclear power reactor, and the first of four VVER-1200 units at Akkuyu, started in April 2018. Construction of the second and third reactor units at Akkuyu began in 2020 and 2021, respectively. In 2021, preparations began for the construction of the fourth unit. The project is financed and built by Russia under a build-own-operate model. In March 2021, Akkuyu Nuclear, a subsidiary of Russia's Rosatom, received two loans from Sovcombank to finance the construction of the Akkuyu Nuclear Power Plant. The government of Türkiye is also considering building new nuclear units in the future. In early 2026, the government began working with the Canadian company, Candu Energy, to assess the potential deployment of CANDU reactors.

In Ukraine, 15 reactors with a combined net installed capacity of 13.1 GWe were operational on 1 January 2025. The government's support for the nuclear industry is strong, with both nuclear newbuilds and existing reactor life extensions being planned. The national energy programme envisages that nuclear energy will continue to generate about 50% of total electricity production by 2035. Ukraine is pursing the expansion of nuclear capacity at the Khmelnytskyi nuclear power plant. A key priority is the completion of units 3 and 4, based on VVER-1000 technology that have been partially constructed since the Soviet era. In February 2025, the Verkhovna Rada authorised the state operator Energoatom to purchase Soviet-designed reactor equipment for two reactor units from Bulgaria to support the completion of these reactors, each with a capacity of about 1 GWe. In parallel, Ukraine has agreed with Westinghouse to develop a fleet of 9 AP1000 reactors, starting with 2 new units at Khmelnitsky, which will be units 5 and 6 at the plant. Simultaneously, Ukraine is preparing an SMR roadmap through co-operation between Energoatom and Holtec International to deploy up to 20 SMR units and develop domestic component manufacturing. A new four-unit nuclear project has also been proposed at a potential Chyhyryn nuclear power plant site, although the project remains at an early planning stage. Since the start of the war in Ukraine in 2022, the Zaporizhzhia plant in southeastern Ukraine became the first operating civil nuclear power plant to ever come under armed attack. Ukraine had been receiving most of its nuclear services and nuclear fuel from Russia. In June 2022, an agreement was signed with Westinghouse that ensures the company will provide all fuel for Ukrainian reactors. As part of broader efforts to diversify Ukraine's nuclear fuel supply and ensure energy security amid the ongoing conflict, in 2023 the country signed a significant contract with Cameco. In 2023, Ukraine also entered into an agreement with Urenco for enriched uranium product (EUP). Ukraine has continued efforts to align its energy and nuclear-regulatory framework with European standards.

In the United Kingdom, nine operational reactors with a combined capacity of 5.88 GWe net were in operation as of 1 January 2025. They provided around 12% of total domestic electricity generation in 2024. Within the next decade, most of the current UK fleet will be shut down. Several advanced gas-cooled reactor (AGR) units have already been retired, and the remaining AGR fleet is expected to progressively shut down by around 2030. In recent years, the UK government has taken a series of actions to encourage nuclear new build. EDF and the development vehicle NNB Generation Company HPC Limited are constructing two EPRs at Hinkley Point C (3.2 GWe). The United Kingdom also entered into negotiations with EDF in relation to building two EPR units at the Sizewell C site, in Suffolk. A nuclear site licence for the Sizewell C project was granted in May 2024. The two-unit Dungeness B was shut down in June 2021, while Hunterston B-1 in Scotland ceased operations in November 2021, followed by unit 2 shutting down in January 2022. Hinkley Point B-1 and B-2 units were permanently shut down in August 2022 and in July 2022, respectively. In December 2024, EDF announced life extensions to some of the current UK Advanced Gas Cooled Reactor nuclear power plants. Heysham 1 and Hartlepool will now operate for an additional year until March 2027, while Heysham 2 and Torness will operate for an additional two years to March 2030. The government is investing more than GBP 100 million of innovation funding into advanced nuclear research and development to help the development of SMRs and advanced modular reactors (AMRs) in the United Kingdom. In 2023, the government established Great British Nuclear to accelerate nuclear deployment and oversee the selection and development of SMR projects. The UK has set a target of up to 24 GWe of nuclear capacity by 2050.

Middle East, Central and Southern Asia

Nuclear generating capacity in this region is expected to grow in the coming years as governments continue to implement plans to meet rising electricity demand without increasing greenhouse gas emissions.

In Bangladesh, an intergovernmental agreement with Russia was signed in 2011 to build two VVER-1200 reactors at the Rooppur site, with a total capacity of 2.16 GWe. The first safety-related concrete for unit 1 was poured in 2017, with the pour for unit 2 occurring in 2018. In September 2023, Bangladesh received its first shipment of fuel from Rosatom for the Rooppur Nuclear Power Plant. The first two reactors are expected to start operating in the second half of the 2020s. Additionally, the government is considering adding new nuclear capacity. Nuclear power is expected to play an important role in meeting Bangladesh's rapidly growing electricity demand.

In India, 24 reactors were operable on 1 January 2025, with a capacity of 7.6 GWe. They provided about 3.3% of domestic electricity generation in 2024. An additional reactor has since been added, Rajasthan-7, which made its first grid connection in March 2025, adding 0.63 GWe of nuclear energy capacity. This followed the Kakrapar-4 PHWR unit, which was connected to the grid in 2024. Construction of eight new reactors is in progress. Construction has progressed on indigenous PHWR reactors, including the first concrete pour for Kaiga Units 5 and 6. In March 2026, Cameco signed a new long-term agreement to supply uranium concentrate to support India's reactor fleet. Earlier concerns about India's nuclear liability legislation slowed foreign reactor investment, although recent expansion has focussed primarily on domestically developed reactor designs. Fuel loading began in March 2024 at the 500-MWe prototype fast-breeder reactor (PFBR) located at Kalpakkam, Tamil Nadu, marking a milestone and representing a second stage of the country's three-stage nuclear programme. As other countries with PHWR fleets have done, India has started the process of refurbishing its reactors to allow for extended operation. The national plan is to increase nuclear capacity to 22.48 GWe by 2031-2032. India is also exploring the development of SMRs and expanding domestic uranium production to support long-term nuclear growth.

As of 1 January 2025, the Islamic Republic of Iran had one operational 915 MW reactor (Bushehr-1). Supplied by Atomstroyexport, it provided 1.68% of domestic electricity production in 2024. A second reactor, Bushehr-2, also of Russian design, has been under construction since 2019 and is expected to start commercial operation around 2029. Initial construction work on the IR-360 unit at the Darkhowin/Darkhovain site, as well as on 5 GWe Iran-Hormoz plant, was announced in 2022 and 2024, respectively. In an effort to decrease the country's reliance on fossil fuels, Iran recently set a goal to increase nuclear capacity significantly, to reach a target of about 20 GWe of nuclear power capacity by 2040.

In Pakistan, six nuclear reactors (with 3.26 GWe net capacity) were operational as of 1 January 2025, supplying about 16.7% of domestic electricity production in 2024. Kanupp units 2 and 3, at Karachi were connected to the grid in March 2021 and March 2022. Chashma-5 (based on the Chinese Hualong One design) began construction in late 2024 and will add an additional 1.1 GWe of capacity when connected to the grid.

In the United Arab Emirates, four nuclear reactors provided 5.3 GWe of capacity, making up 21.7% of the UAE's electricity needs as of the end of 2024. In 2009, the Emirates Nuclear Energy Corporation (ENEC) announced that it had selected a bid from a Korean consortium to build the UAE's first nuclear reactors, four APR1400 reactors. All four units were built at the Barakah Nuclear Energy Plant and were connected to the grid between 2020-2024. The UAE is looking into options for further deploying nuclear energy. In November 2024, the ENEC and Abu Dhabi National Oil Company (ADNOC) signed a Strategic Collaboration Agreement involving a comprehensive technical and economic assessment of the deployment of SMRs and advanced reactor technologies, to evaluate new technologies for ADNOC and an effort to explore the use of excess heat from the Barakah Nuclear Energy Plant.

Other countries in the region, currently without nuclear power plants, have been considering the development of such facilities.

Jordan currently has no nuclear generating capacity but is strategically exploring the deployment of SMRs to support electricity generation and water desalination. Over the past decade, Jordan has signed co-operation agreements with several international nuclear technology developers to assess different reactor technologies.

Kazakhstan continues to be the world's largest uranium producer but currently has no active nuclear power generation capacity. Kazakhstan signed a preliminary co-operation agreement with Russia in May 2014 regarding the construction of a new nuclear power plant. In August 2023, the government announced that Ulken village, in the Almaty region, is considered the main option for the location of a nuclear power plant. In October 2024, a referendum was held in Kazakhstan, during which a significant majority of voters supported the construction of a nuclear power plant. In June 2025, Russia's Rosatom was selected to lead an international consortium to build Kazakhstan's first planned nuclear power plant. China is expected to play a leading role in the development of subsequent nuclear power plants there. In addition to the large nuclear power plant, the government is also considering adding SMRs to its nuclear fleet.

Saudi Arabia is seeking to build its first nuclear power plant and has solicited information from various vendors from China, France, Korea and Russia. The country plans to first construct two 1.4 GWe PWR nuclear units and then expand their nuclear fleet to 17 GWe, by 2040.

Uzbekistan currently has no nuclear power generation capacity but is developing plans to introduce nuclear energy. A national electricity development strategy, prepared in 2020 with international support, aims to substantially expand installed power generation capacity by 2030, including the introduction of nuclear power, with planned capacity of around 2.4 GWe. Uzbekistan's energy strategy aims for nuclear energy to supply around 15% of domestic electricity generation once the planned reactors are operational. In 2018, the Uzbek Agency for the Development of Nuclear Energy (UzAtom) signed an intergovernmental agreement with Russia's Rosatom to build Uzbekistan's two first VVER-1200 PWRs. In addition, in May 2024, Uzbekistan and Russia signed a contract to construct a six-unit SMR nuclear power plant with a total capacity of 330 MW. In September 2024, a protocol was signed signifying the start of works at the construction site.

Central and South America

Nuclear power in Central and South America remains limited to Argentina and Brazil. While no new reactors have entered operation in recent years, governments in Argentina and Brazil continue to support nuclear energy through lifetime extension programmes, SMR development, and long-term expansion plans. Several other countries in the region are also evaluating nuclear energy as part of future energy transition strategies. However, some countries are still hesitant about nuclear energy adoption following the Fukushima Daiichi Nuclear Power Plant accident.

In Argentina, three nuclear reactors with a total 1.6 GWe of capacity were operational as of 1 January 2025. They ccounted for about 7% of domestic electricity production in 2024. Work continues on the Carem-25 SMR at the site adjacent to the Atucha Nuclear Power Plant. While the Carem-25 SMR has been partially constructed, the project has faced major delays and funding setbacks, causing work to slow significantly. In September 2024, Atucha I entered into life-extension shutdown, which is expected to last 30 months and will extend the plant's operation by 20 years. This follows the refurbishment of the Embalse reactor, which returned to service in 2019 following a three-year upgrade programme, allowing it to operate for a further 30 years. In 2024, the government launched a new National Nuclear Plan to expand nuclear generation through SMRs, seeking to leverage its uranium reserves to achieve self-sufficiency in fuel production and position Argentina as an export country in the nuclear sector. The government of Argentina authorised the partial privatisation of Nucleoeléctrica Argentina S.A., selling 44% of the shares to private investors, while retaining the state majority ownership with 51% of shares. Argentina also maintains domestic capacity to fabricate fuel, and to develop their own research reactor technology.

In Brazil, two reactors (with 1.8 GWe net capacity) were operational on 1 January 2025. They provided about 2.3% of electricity generated in the country in 2024. Construction of the Angra-3 reactor (1.3 GWe net) resumed in 2022 after being suspended in 2015, but operations were once again suspended in 2023 due to financial and legal challenges. In 2024, Brazil made renewed efforts to restart construction, with the state-owned operator, Electronuclear, obtaining required legal and administrative approvals to resume limited construction activities. In 2025, the Ministry of Mines and Energy instructed Electronuclear and the Brazilian Development Bank to conduct updated economic and financial assessments, to inform a final investment decision on the future of the reactor. Overall, Brazil seeks to grow nuclear capacity, with the National Energy Plan 2050, issued in 2020, outlining a target of up to 10 GWe of installed nuclear capacity by 2050. Brazil has also started exploring SMR deployment.

In Colombia, there are no reactors currently in operation, but the National Energy Plan (2022-2052) introduces nuclear power, including SMRs, as a long-term option in the energy mix.

Other countries in the region, including Bolivia and Chile, do not have nuclear power plants.

Africa

Nuclear capacity remained constant in Africa, with the region's only two operational reactors located in South Africa. However, nuclear development activity is increasing, particularly with the construction of Egypt's first nuclear power plant and growing interest in nuclear energy across several African countries.

In South Africa, two reactors at the Koeberg nuclear power plant (total of 1.85 GWe net capacity) accounted for about 4% of the total electricity generated in the country in 2024. In early 2020, South Africa's government developed a nuclear energy roadmap calling for the development of up to 2.5 GWe of new nuclear capacity, including SMRs, to bolster employment, enhance energy security and reduce carbon emissions. In 2024, a procurement process for new nuclear capacity was advanced but was then paused in August 2024. In July 2024, the National Nuclear Regulator approved a 20-year extension for Koeberg-1 to operate until 2044. Unit 2 received a similar 20-year extension in November 2025.

In Egypt, as of 1 January 2025, there were no operational nuclear reactors in the country. However, four VVER-1200 units at the country's first nuclear power plant, El Dabaa, are currently under construction. Construction began on units 1 and 2 in 2022, while construction of unit 3 and unit 4 started in May 2023 and January 2024, respectively. Each reactor will offer 1.1 GWe of capacity, for a total of 4.4 GWe. Egypt's energy minister and Russia's Rosatom had previously signed several contracts, including a "turnkey" contract that provided for the supply of nuclear fuel for the plant's operating period.

Although no other countries in Africa have nuclear power plants, several have expressed interest, in recent years, in developing nuclear power for electricity generation and desalination, including Algeria, Ghana, Kenya, Morocco, Namibia, Niger, Nigeria, Rwanda, Tanzania, Tunisia and Uganda.

In Ghana, there are no reactors in operation as of 1 January 2025, but preparations for the country's first nuclear power plant continue, with construction expected to begin around 2027. Two sites have been shortlisted in the Western and Central regions. One site will host a large nuclear power plant, while the other will host an SMR.

In Kenya, the start of construction of the first nuclear power plant is aimed for 2027, with initial electricity generation expected by 2034. Two coastal locations, Kilifi and Kwale, have been shortlisted as potential sites. The draft of Kenya's National Energy Policy for 2025-2034 includes nuclear energy as part of the country's strategy. Similarly, Kenya's Energy Act 2019 mandates the development of infrastructure for a national nuclear power programme and co-ordination of IAEA technical co-operation activities.

In Rwanda, a first nuclear power plant is planned to be operational by early 2030s, with SMRs being a key part of the country's strategy. A nuclear energy programme has been launched with the establishment of the Rwanda Atomic Energy Board under a 2020 Presidential Order, within the broader framework of the country's "Vision 2050" development agenda. The government has submitted a national nuclear science and technology policy, and an updated draft nuclear law, which is now under formal approval by national bodies. These measures aim to strengthen the regulatory and institutional foundation for future reactor development.

In Uganda, the government has set a goal to generate an initial 1 GWe of nuclear power by 2031. In May 2025, the government signed a contract with KHNP to perform detailed site evaluation and pre-feasibility studies. The prospective Buyende nuclear project targets up to 8.4 GWe.

Southeastern Asia

No reactors were operational in this region at the end of 2024, but several countries are considering nuclear development plans, as the region continues to experience strong economic growth. Concerns about climate change, security of energy supply and energy mix diversification, along with volatile fossil fuel prices are driving nuclear development policies, but political support has generally been weak, owing to public safety and cost concerns.

In Indonesia, there are currently no nuclear power reactors in operation, and electricity generation is dominated by coal and natural gas. In December 2022, the government announced plans to develop the country's first nuclear power plant by around 2039, with recent discussions increasingly focussing on the potential deployment of small modular reactors (SMRs).

In Malaysia, a target of 2 GWe of nuclear generating capacity was adopted in 2011, driven by an emerging gap in electricity production and the need to diversify the energy mix. However, the programme was postponed indefinitely in 2018 as a result of public distrust following the Fukushima Daiichi Nuclear Power Plant accident. Work continues through efforts to promote public acceptance, adopt the necessary regulations, sign required international treaties and obtain low-cost financing.

In the Philippines, there were no operational reactors as of the end of 2024, but the country is building a foundation for future nuclear power deployment. In 2024, the government released a Nuclear Energy Roadmap outlining plans to achieve commercial nuclear power operations by 2032, starting with approximately 1.2 GWe of capacity and expanding to around 4.8 GWe by 2050.

In June 2025, the Senate of the Philippines passed a bill to establish the Philippine Atomic Energy Regulatory Authority (PhilATOM), which will serve as the country's independent regulator for nuclear and radiation activities.

In Thailand, there are currently no nuclear reactors, and natural gas produces the majority of domestic electricity. In an earlier power development plan, Thailand planned to commission its first nuclear power plant in 2020. However, the project faced delays following Japan's Fukushima Daiichi Nuclear Power Plant accident in 2011. Currently, Thailand is considering the construction of SMRs.

In Viet Nam, there are currently no reactors, but the government had previously planned to develop two nuclear reactors at the proposed Ninh Thuan Nuclear Power Plant to meet growing electricity demand. In 2015, Rosatom and Electricity of Viet Nam signed a framework agreement for the construction of unit 1 at the proposed Ninh Thuan Nuclear Power Plant. However, shortly thereafter, in November 2016, the Vietnamese Parliament voted to abandon its nuclear programme in favour of gas and coal. In 2022, Viet Nam's Ministry of Industry and Trade proposed to consider nuclear development towards 2045. In April 2025, Viet Nam approved the revised National Power Development Plan VIII (PDP8), formally introducing nuclear energy with plans to install 4-6.4 GWe by 2030-2035 through two plants in the Ninh Thuan Province.

In Singapore, the government announced that the country is considering nuclear deployment, with a particular interest in SMRs. The Energy Market Authority and the National Environment Agency have been tasked with conducting further engagement and analyses, to guide future decisions.

Pacific

This region has no commercial nuclear capacity at present. Current policy prohibits the development of commercial nuclear energy in Australia. New Zealand also maintains a long-standing nuclear-free policy and has no plans to develop nuclear power generation.

Projected nuclear power capacity and related uranium requirements to 2050

Factors affecting nuclear capacity and uranium requirements

Reactor-related requirements for uranium over the short term are fundamentally determined by installed nuclear capacity. Since near-term capacity is made up of reactors that are either already in operation or under construction, short-term requirements can be projected with greater certainty. However, even with a fixed installed nuclear capacity, uranium requirements also depend on other factors linked to the performance and operation of installed nuclear power plants and fuel cycle facilities. These factors include fuel cycle length, enrichment level, discharge burn-up, as well as strategies employed to optimise enrichment services according to the price of natural uranium (NatU), as reflected in the level of tails assay chosen in the enrichment phase (the tails assay selected by the enrichment provider is dependent on many factors, including the ratio between natural uranium and enrichment services prices). Generally, increased uranium prices have provided an incentive for utilities to reduce uranium requirements by specifying lower tails assays at enrichment facilities, to the extent possible.

Following the Fukushima Daiichi Nuclear Power Plant accident, excess capacity in the enrichment market incentivised operators to "underfeed" enrichment facilities by extracting more ^{235}U from the uranium feedstock (lower tails assays). This reduces the amount of natural uranium required to produce contracted quantities of enriched uranium and, in turn, may create a surplus of natural uranium feedstock. In recognition of these market trends, and since the 2012 edition of the Red Book, uranium requirements for the operational lifetime of projected new reactors in this publication have been reduced from 175 tU/GWe/yr, the original assumption being a tails assay of 0.30%, to 160 tU/GWe/yr, under the new assumption of a tails assay of 0.25%, over the lifetime of the reactor. In the absence of data provided by governments, this is the uranium requirement factor which has been applied in this edition of the Red Book. These assumptions are valid for the commercial light water reactors (LWRs) currently in operation, most of which implement a once-through fuel cycle. These uranium requirements are also highly dependent on the discharge burnup of the fuel and the level of enrichment. It is important to note that new, advanced reactor technologies that may be deployed in the future, and which consider different fuels, fuel burnups and fuel cycle choices, may have different requirements.

Energy availability and capacity (or load) factors also play an important role in determining uranium requirements. Load factors of reactors in operation today tend to be around 80%. In 2024, the average energy availability factor calculated for all the reactors in commercial operation in the world was of 83.8% (IAEA, 2026).

World uranium requirements, which are defined in the Red Book as anticipated acquisitions, not necessarily consumption, are expected to increase in the coming years, as a significant amount of capacity currently under construction comes online, particularly in Asia. Installation of new nuclear capacity will increase uranium requirements, not only because of the additional reactor capacity that will have to be fuelled but also because first load fuel requirements are around 60% higher than reloads for plants in operation. The strong performance and economic competitiveness of existing plants have made their retention and improvement desirable in many countries. This has resulted in a trend to keep existing plants operating for as long as can be achieved safely and upgrading existing generating capacity where possible (i.e. up-rating and enabling long-term operation).

Projections to 2050

Projections of nuclear capacity and reactor-related uranium requirements rely on official responses from Member countries to questionnaires circulated by the NEA/IAEA to Uranium Group members [2]. Because of the uncertainty in nuclear programmes from 2024 onwards, high and low-case scenarios are provided. The low-case scenario assumes current market and technology trends continue with few additional changes in policies and regulations affecting nuclear power, and includes implementation of phase-out or reduced nuclear generation policies, if these exist. The high case assumes that current rates of economic and electricity demand growth continue. It also assumes changes in country policies towards the mitigation of climate change and recognition of nuclear power as an important contributor to decarbonisation strategies.

These projections reflect a high degree of uncertainty, since the role that nuclear power will play in the future power generation mix in some countries has not yet been determined. Over the short term, in both the low and high case, competitive challenges from other electricity generation sources, along with nuclear policy hurdles, will continue to affect nuclear growth in some regions of the world.

Several currently operating reactors, mainly in OECD Member countries, were set, up to 2021, on a path for early decommissioning due to economic challenges or policy decisions. However, since late 2021, several countries have significantly shifted their policies in favour of nuclear energy. This trend is driven by a combination of factors, including concerns regarding security of energy supply and the urgency of addressing climate change. In those countries, nuclear power is seen as a critical component in ensuring energy security, reducing carbon emissions and maintaining stable energy supplies. As a result, numerous nations are revisiting their energy strategies to incorporate or expand their nuclear capabilities.

The low-case scenario projects an increase in global nuclear capacity from around 398 GWe at the beginning of 2025 to approximately 565 GWe by 2050, representing a 42% increase. Both low- and high-case scenarios indicate that most of the added capacity will be concentrated in East Asia.

2. When data is not provided by Member countries, estimations are made by the NEA/IAEA Secretariat. These estimations consider scenarios published in the NEA report *Nuclear Energy Outlook* (NEA, 2026).

Table 2.3. **Installed nuclear generating capacity to 2050***

(GWe net)

Region	2023	2024	2025 low	2025 high	2030 low	2030 high	2035 low	2035 high	2040 low	2040 high	2045 low	2045 high	2050 low	2050 high
European Union	100.5	98.1	97.5	98.0	81.8	99.0	76.5	105.3	78.1	129.5	81.7	145.3	73.0	158.5
North America	111.1	111.2	112.8	112.8	113.5	115.7	115.7	126.9	115.7	144.7	116.0	175.6	114.9	205.4
East Asia	112.5	115.1	121.2	128.5	154.6	186.9	185.9	204.4	216.2	258.0	221.1	296.1	226.0	335.1
Europe (non-EU)	52.3	51.4	55.1	56.3	62.2	63.2	73.1	75.8	83.2	87.6	96.4	102.4	90.4	106.7
Central and South America	3.5	3.5	3.5	3.5	4.7	4.7	5.0	7.7	5.6	10.8	6.2	14.3	6.5	17.9
Middle East, Central and South Asia	15.0	17.1	17.6	22.0	25.2	25.2	31.2	33.0	42.3	52.4	45.3	64.3	46.2	73.7
Southeastern Asia	0.0	0.0	0.0	0.0	0.0	0.0	0.7	5.8	0.7	5.9	0.9	6.2	1.0	6.5
Africa	1.9	1.9	1.8	1.8	4.0	4.0	6.2	7.4	6.3	9.9	6.6	11.7	7.0	12.6
Pacific	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
World Total	**396.7**	**398.2**	**409.5**	**423.0**	**446.0**	**498.7**	**494.3**	**566.2**	**548.2**	**698.7**	**574.3**	**815.8**	**565.0**	**916.3**

* NEA/IAEA estimate based on government-supplied responses to a questionnaire and data established by a group of experts (IAEA/NEA), and published in NEA, 2026. Because of rounding, totals may not add up.

The current high-case scenario projects a global growth factor of around 2.3 compared to 2024 installed capacity, largely driven by East Asia's expansion, with world nuclear capacity expected to reach 916 GWe by 2050. By 2035, the high-case scenario projects a 42% increase over 2024 levels, suggesting that significant expansion efforts are already underway, and more are anticipated in several countries (see Table 2.3). Compared to the Red Book 2024 projections, this edition forecasts a 1% decrease in the low-case scenario and a 1% increase in the high-case scenario, by 2050.

Nuclear capacity projections vary considerably from region to region. The East Asia region is projected to experience the largest increase and could result in total capacity of between 226 GWe and 335 GWe, in the low and high cases, respectively. In terms of new capacity, this would represent an increase of between about 96% and 190%, compared with a capacity of around 115 GWe at the end of 2024.

Other regions projected to experience significant nuclear capacity growth include the Middle East and the Central and Southern Asia regions, notably with India's ambitious expansion plan and several potential newcomer countries (Kazakhstan, Saudi Arabia and Uzbekistan). In the high-case scenario, nuclear capacity in non-EU member countries on the European continent is projected to increase considerably, with 106 GWe of capacity projected by 2050 in the high case, more than doubling 2024 capacity. More modest growth is projected in Africa, Central and South America and the Southeastern Asia regions.

For North America, the projections see nuclear generating capacity increasing by 2050 in the low case to around 115 GWe and to around 205 GWe in the high case.

As in the case of nuclear capacity, uranium requirements vary considerably from region to region, reflecting projected capacity increases and possible inventory building. Annual uranium requirements are projected to be largest in the East Asia region, where increased installed nuclear generating capacity (particularly in China) drives most of the growth in uranium needs. World reactor-related uranium requirements by the year 2050 are projected to increase to a total of between around 85 000 tU/yr in the low case and around 144 000 tU/yr in the high case (see Table 2.4).

Table 2.4. **Annual reactor-related uranium requirements to 2050***

(tonnes U per year)

Region	2023	2024	2025 low	2025 high	2030 low	2030 high	2035 low	2035 high	2040 low	2040 high	2045 low	2045 high	2050 low	2050 high
European Union	13 848	13 146	12 608	16 026	10 714	16 830	10 260	17 342	10 114	21 166	10 783	24 322	10 070	26 561
North America	21 662	23 260	17 668	24 042	17 768	18 125	18 125	19 899	18 125	22 730	18 176	27 515	17 988	32 149
East Asia	16 699	16 768	16 463	20 563	24 185	31 465	31 204	34 361	34 588	41 272	35 375	47 368	36 161	53 611
Europe (non-EU)	7 336	7 339	7 529	7 729	8 379	9 559	11 441	12 058	10 992	12 364	10 949	12 582	10 714	13 919
Central and South America	566	603	581	581	1 119	1 119	913	1 431	1 281	2 285	1 125	2 951	1 173	3 382
Middle East, Central and South Asia	2 810	3 174	2 813	3 527	4 024	4 024	4 988	5 281	6 776	8 382	7 255	10 286	7 384	11 784
Southeastern Asia	0	0	0	0	0	0	105	926	119	951	139	994	158	440
Africa	294	294	294	294	646	646	998	1 176	1 006	1 587	1 056	1 866	1 117	2 010
Pacific	0	0	0	0	0	0	0	0	0	0	0	0	0	0
World Total	63 216	64 584	57 956	72 762	66 835	81 768	78 034	92 474	83 001	110 738	84 857	127 884	84 765	143 857

* NEA/IAEA estimate (rounded to nearest whole number). Because of rounding, totals may not add up.

Figure 2.2. **Projected nuclear generating capacities to 2050**

(low and high projections)

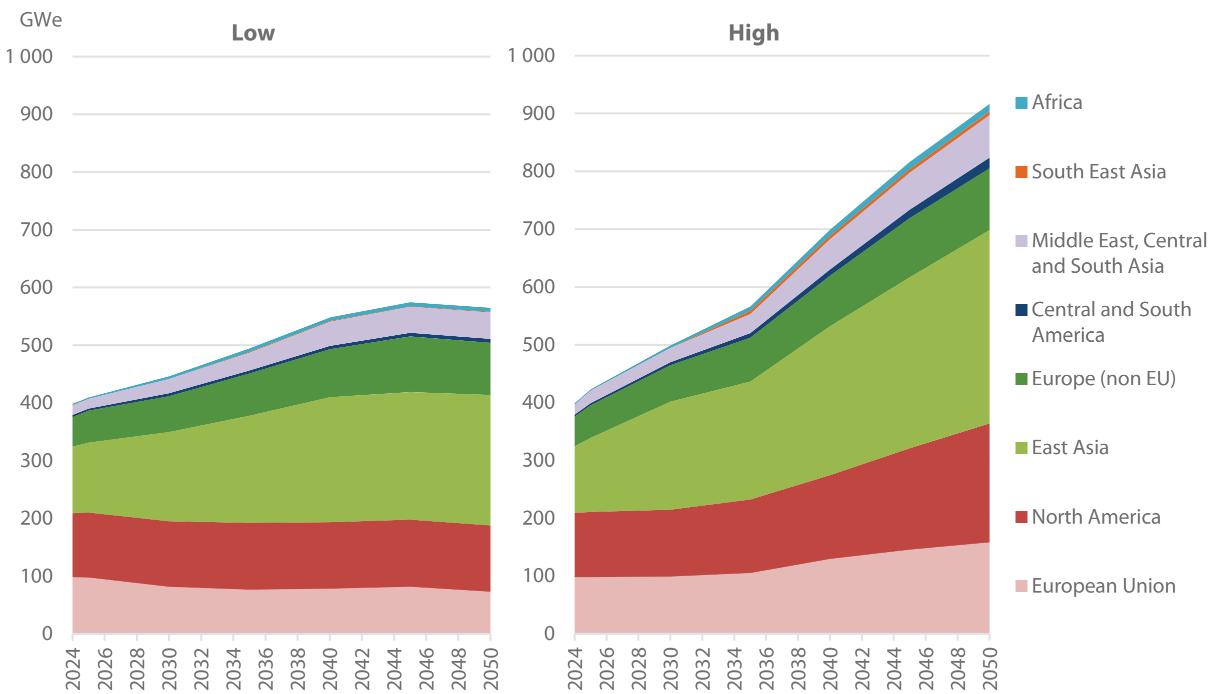
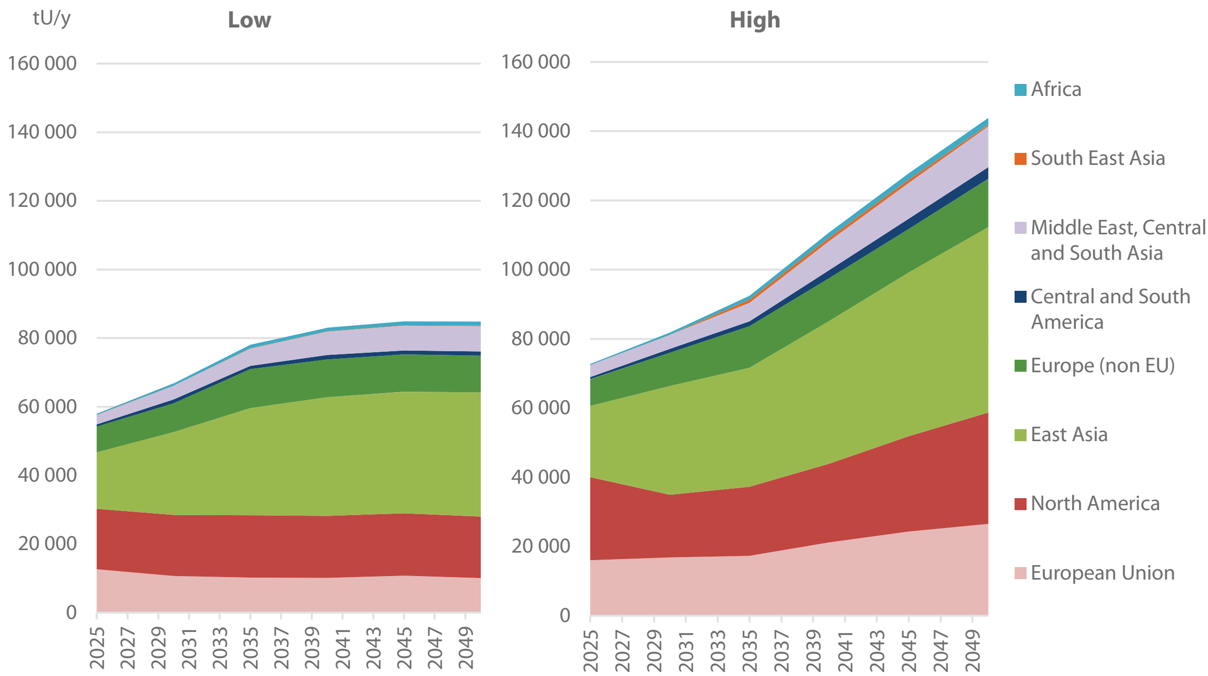


Figure 2.3. **Projected annual reactor-related uranium requirements to 2050**
(low and high projections)



Uranium supply and demand adequacy

Uranium supply, sourced from both primary production and secondary supply, has consistently met demand for decades, with no shortages reported since the last edition of this report. However, geopolitical uncertainties persist, raising concerns about potential future disruptions to international nuclear fuel supply chains. In response, several OECD member countries are exploring diversification strategies to secure their energy supply.

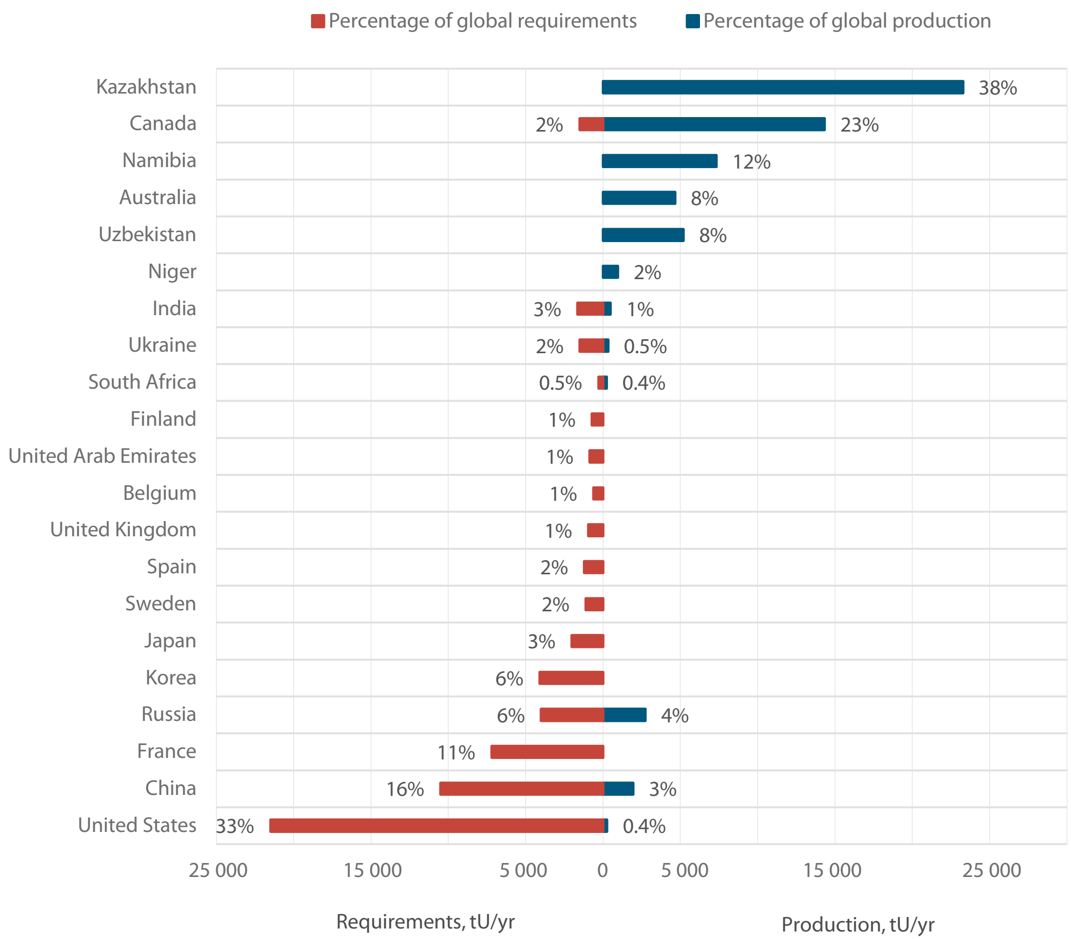
As of end of 2024, of all countries with installed nuclear generating capacity, only Canada produced enough uranium to meet its domestic requirements (see Figure 2.4). All other countries with nuclear power rely on imported uranium or secondary sources, making international trade of uranium a crucial and established component of the market. Given the uneven geographical distribution between producers and consumers, the safe and secure shipment of nuclear fuel must continue without unnecessary delays and impediments. The challenges some producing countries face regarding international shipping requirements and transfers to international ports have always been a concern, and these are now heightened further by the current geopolitical situation.

Primary sources of uranium supply

Uranium was produced in 18 countries in 2023 and 2024, with total global production amounting to 54 563 tU in 2023, 61 924 tU in 2024 and with 66 074 tU forecasted for 2025 (see Table 1.18).

Figure 2.4. **Uranium production and reactor-related requirements for major producing and consuming countries (percentages of total shown)**

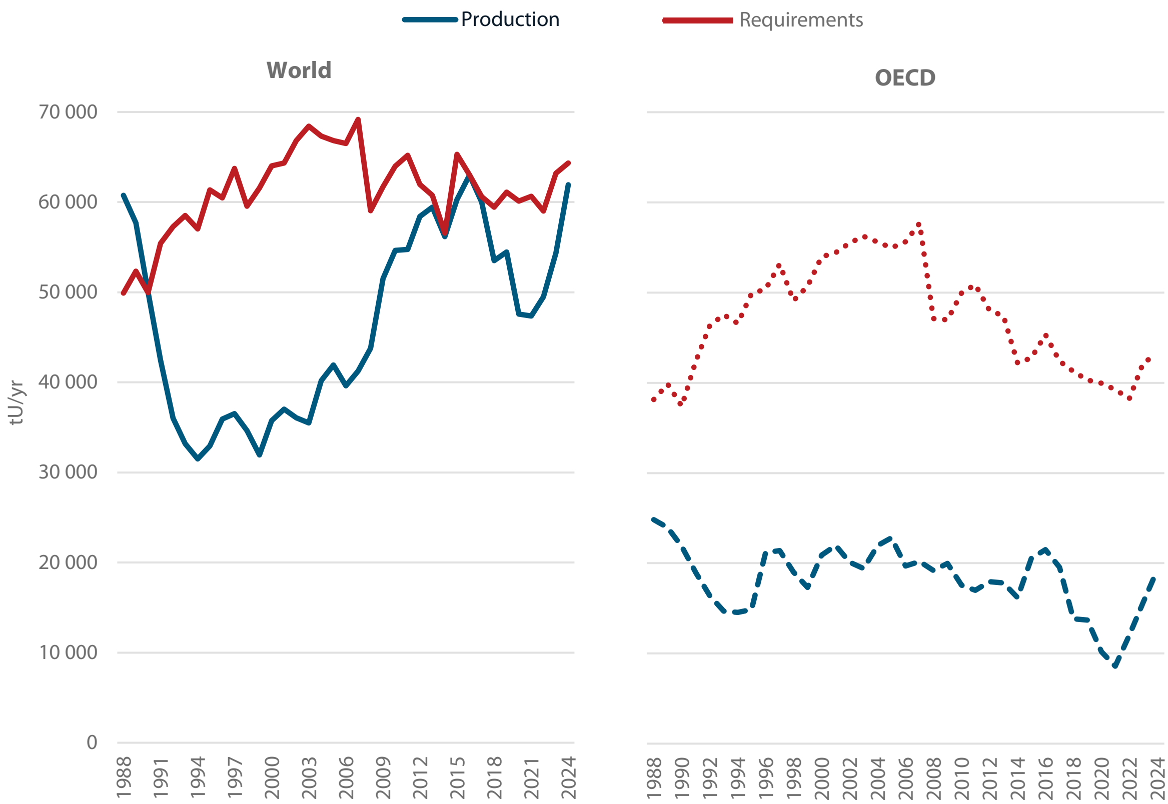
(2024 data)



Kazakhstan remained the world's largest producer of uranium, being responsible for around 38% of world uranium production in 2024. The top six producing countries in 2024 (Kazakhstan, Canada, Namibia, Uzbekistan, Australia and Russia, by order of production) accounted for around 93% of world production, and over 99% of world uranium production took place in the top 10 uranium producing countries (the above named six countries and China, Niger, India and Ukraine, by order of production).

Because of the availability of secondary supplies, primary uranium production volumes have been significantly below world uranium requirements for some time. In recent years, this gap has started to narrow. In 2024, world uranium production (61 924 tU) represented around 96% of 2024 world reactor requirements (64 584 tU), a 9% increase compared to 2022 values. In OECD Member countries, the gap between production and requirements has narrowed in the past years; however, production remains insufficient to meet demand. In 2024, OECD Member countries' production of 19 263 tU provided only around 44% of their requirements (43 361 tU), which is 14% more, compared to 2022 values. Remaining reactor requirements were met by imports and secondary sources.

Figure 2.5. **OECD and world uranium production and requirements 1988-2024**



Secondary sources of uranium supply

Uranium is unique among energy fuel resources in that, historically, there have been considerable periods where a significant portion of demand has been supplied by secondary sources. These secondary sources include stocks and inventories of natural and enriched uranium, both civilian and military in origin; nuclear fuel from the reprocessing of spent reactor fuels and from surplus military plutonium; underfeeding; and uranium produced by the re-enrichment of depleted uranium.

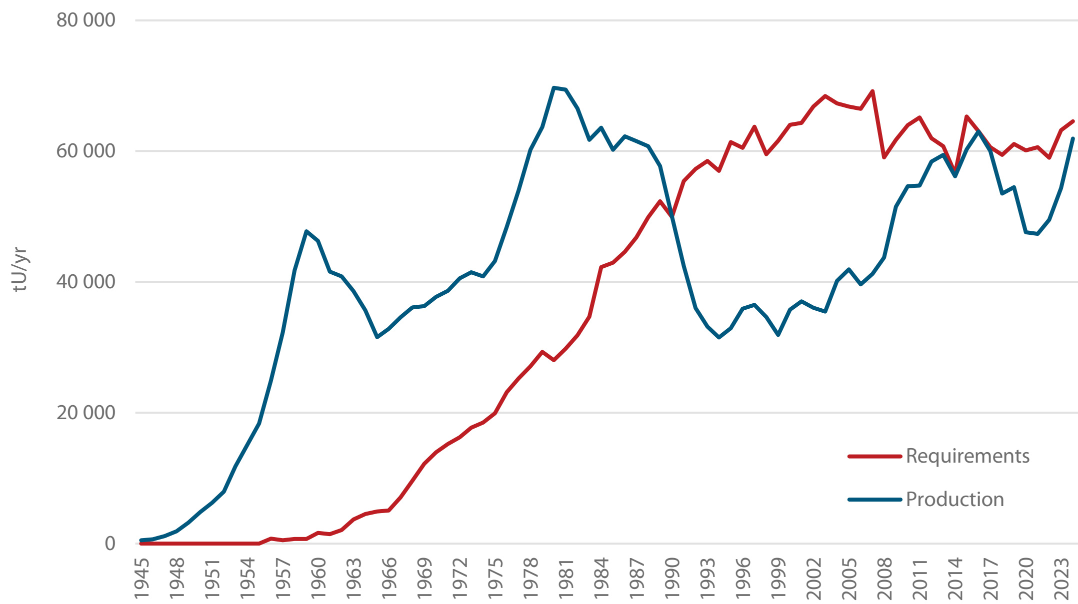
Despite the importance of secondary uranium supplies, information on the size of these stocks remains limited, as many countries, due to commercial and security factors, do not disclose detailed data on stockpiles held by producers, consumers or governments.

Natural and enriched uranium stocks and inventories

From the beginning of commercial exploitation of nuclear power in the late 1950s to 1990, uranium production consistently exceeded commercial requirements (see Figure 2.6). This was mainly the consequence of a lower than projected growth rate of nuclear generating capacity combined with high levels of production for strategic purposes. This period of overproduction created a stockpile of uranium potentially available for use in commercial power plants. After 1990, production fell well below demand and secondary supplies fed the market. Since 2008, requirements increased slightly before declining again, owing to unplanned reactor closures in Germany and Japan following the Fukushima Daiichi Nuclear Power Plant accident in 2011. Over this period, uranium production generally increased and partially closed the gap between production and reactor requirements, up to around 2018. Thereafter, producers responded to the sustained uranium market downturn by temporarily shutting some operations and scaling back uranium production at other mines, causing a slight gap between supply and demand to reappear. The drop in 2020 production is also due to the COVID-19 pandemic, when occupational health and safety considerations forced mines to suspend operations temporarily. As the uranium market began to improve in 2020-2021, operators of idled mines started to evaluate and announce production restarts. Owing to these restarts, the gap between uranium requirements and primary supply has begun to narrow once again.

Figure 2.6. **World annual uranium production and requirements**

(1945-2024)

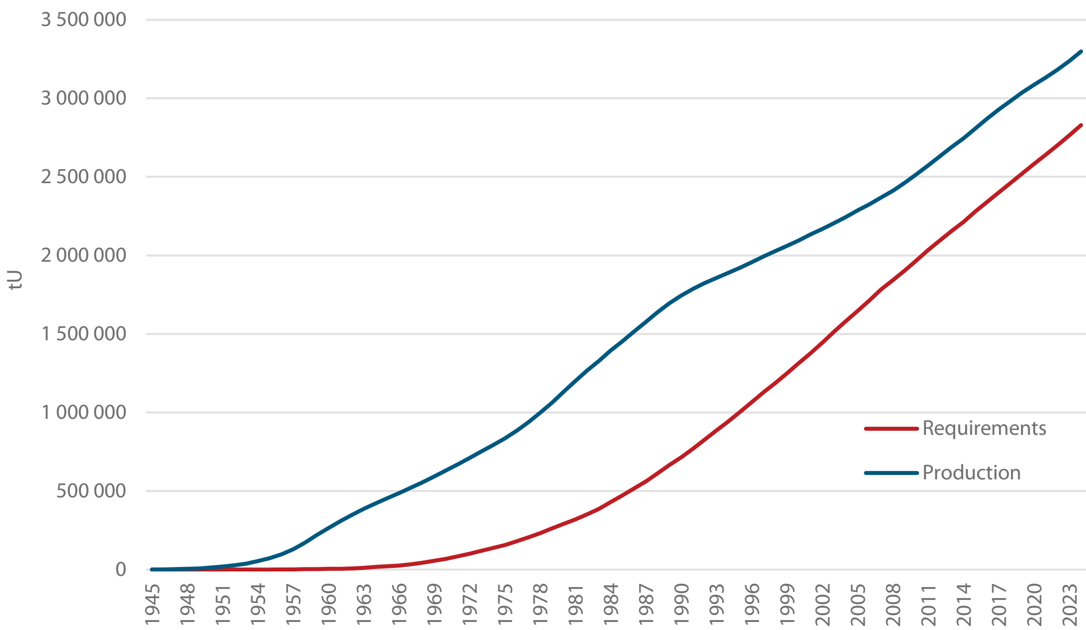


Following the political and economic changes in Eastern Europe and the former Soviet Union in the early 1990s, steps were taken to move towards the development of an integrated global commercial market. More uranium is now available from the former Soviet Union, most notably from Kazakhstan, but also from Russia and Uzbekistan. Despite these developments and more information being available on the amount of uranium held in inventory by utilities, producers and governments, uncertainties remain regarding the size and the mobility of these inventories, as well as the availability of uranium from other potential secondary supply sources. Although it is still too early to analyse the long-lasting consequences with respect to the global uranium market, the geopolitical crisis triggered by the war in Ukraine has created additional barriers to the exchange of Russia's stocks in the international market. In May 2024, the United States passed the Prohibiting Russian Uranium Imports Act, which bans the import of Russian-produced LEU until the end of 2040. Recognising the importance of Russian uranium in the global nuclear industry, the law provides waivers for US nuclear plants/utilities to prevent reactor shutdowns and for national security, valid until 1 January 2028. These waivers set annual import limits, dictated by the allowances in the Russian Suspension agreement, starting at 476 metric tons in 2024 and decreasing each year.

Data from past editions of this publication, along with information provided by member countries, give a rough indication of the maximum level of the potential inventories commercially available when considering cumulative production and requirements for uranium at the global level. This leaves an estimated remaining stock of around 468 840 tU, which is a rough estimate of the upper limit of what could potentially become available to the commercial sector (see Figure 2.7). This base of already mined uranium has essentially been distributed into two sectors, with the majority used and/or reserved for the military, and the remainder used or stockpiled by the civilian sector. However, since the end of the Cold War, increasing amounts of uranium, previously reserved for strategic purposes, have been released to the commercial sector, although this trend is not anticipated to continue.

Figure 2.7. **World cumulative uranium production and requirements**

(1945-2024)



Civilian inventories include strategic stocks, inventory pipelines and commercial stocks available to the market. In recent years, material held by financial investors in the form of physical uranium trusts has been an increasingly significant part of the inventory. Utilities are believed to hold most commercial stocks because many operate in jurisdictions with policies that require them to carry the equivalent of one to several years of natural uranium requirements. Despite the importance of this secondary source of uranium, information about the size of these stocks is limited as few countries provide detailed information on stockpiles held by producers, consumers or governments.

In the United States, at the end of 2024 (still reported as preliminary data), total commercial inventories (utilities, traders and producers' stocks) were 64 400 tU (EIA, 2025). Around 75% of the commercial inventories were held by owners and operators of commercial reactors.

In the European Union, uranium inventories (no longer including UK inventories) held by utilities at the end of 2024 totalled 39 898 tU, equivalent to more than three years' fuel supply, and up almost 6% since the previously reported value in 2023 (see Table 2.5).

Questionnaire responses received during the compilation of this edition revealed little about national inventory policies in the East Asia region. Based on import statistics, it is estimated (WNA, 2025) that as of 1 January 2025, China had an accumulated inventory of 147 000 tU, while India held an inventory of about 15 000 tU. The depletion of secondary supply has led many countries to hold on to their existing inventories.

Table 2.5. **Uranium inventories held by EU and US utilities 2015-2024**

(tonnes natural U equivalent at the end of the year)

Year	Inventories held by EU utilities	Inventories held by owners and operators of US nuclear power plants
2015	51 892	46 589
2016	51 514	49 217
2017	49 004	47 635
2018	45 342	42 759
2019	42 912	43 385
2020	42 396	41 024
2021	36 810*	41 732
2022	35 710*	39 388
2023	37 655*	42 311
2024	39 898*	48 620[(a)]

Source: ESA Annual Report 2020, 2021, 2022, 2023 and 2025; US EIA Uranium Marketing Annual report 2020, 2021, 2022, 2023, 2024 and 2025.

* Note: EU data no longer includes UK inventories, as of 2021 figures.

(a) Preliminary data.

In recent years, commercial entities other than utilities have been holding quantities of uranium for investment purposes. Although commercially confidential, variable and largely dependent on uranium price dynamics, the US Energy Information Administration notes that US-based traders and brokers held about 13 430 tU at the end of 2024 (EIA, 2025), which represents a more than sixfold increase compared to the same levels at the end of 2015.

Large stocks of uranium, previously dedicated to the military in both the United States and Russia, have become available for commercial applications, bringing a significant secondary source of uranium to the market. Despite the programmes outlined below, the remaining inventory of HEU and natural uranium held in various forms by these governments is significant, although official figures on strategic inventories are not available. If additional disarmament initiatives are undertaken to further reduce strategic inventories, several years of global supply of uranium for commercial applications could be made available. By contrast, a renewed expansion of military programmes in response to heightened geopolitical tensions could place additional pressure on uranium resources, as material would need to be secured for both civilian and military purposes.

HEU from Russia

Russia and the United States signed a 20-year, government-to-government agreement in February 1993 for the conversion of 500 t of Russian HEU from nuclear warheads to LEU suitable for use as nuclear fuel (referred to as the Megatons to Megawatts agreement). Centrus, formerly the United States Enrichment Corporation (USEC), was the executive agent for this agreement and purchased the enrichment component of the LEU, about 5.5 million SWU per year, from Techsnabexport (TENEX) of Russia. Under a separate agreement, the natural uranium feed component of the HEU purchase agreement was sold under a commercial arrangement between three western corporations (Cameco, Areva and Nukem) and TENEX. Deliveries under this government-to-government agreement were completed at the end of 2013.

HEU from the United States

Public reporting indicates that the United States Department of Energy (DOE) holds surplus HEU. The US National Nuclear Security Administration (NNSA) conducted an HEU down-blending offering for tritium (DBOT) programme in the fiscal years 2019-2025. In 2024, the associated down-blending contract was extended through 2027.

Fuel banks

Efforts by governments and international agencies have resulted in actions to create nuclear fuel banks – another form of inventory.

Driven by rising energy needs, non-proliferation and waste concerns, governments and the IAEA have made several proposals aimed at strengthening non-proliferation, by establishing multilateral enrichment and fuel supply centres.

In December 2010, the first LEU reserve was inaugurated in Russia at the International Uranium Enrichment Centre in Angarsk under IAEA auspices. This LEU reserve is comprised of 120 t LEU in the form of UF_6 enriched to 2%-4.95% ^{235}U. Under IAEA safeguards, the reserve will be made available to IAEA Member States whose supplies of LEU are disrupted for reasons unrelated to technical or commercial issues. The LEU reserve is not intended to distort the functioning of the commercial market, but rather to reinforce existing market mechanisms of Member States.

Also in December 2010, the IAEA Board of Governors authorised the IAEA Director-General to establish an LEU bank as a mechanism of last resort for Member States in case the supply of LEU to a nuclear power plant is disrupted due to exceptional circumstances that disable securing the fuel from the commercial market or any other supply arrangement. The IAEA reserve is a backup mechanism to the commercial market if an eligible Member State's supply of LEU is disrupted and cannot be restored by commercial means. In August 2015, Kazakhstan signed an agreement with the IAEA to host the IAEA LEU bank at the Ulba Metallurgical Plant, which entered into force on 31 January 2017. The IAEA LEU bank is a physical reserve of up to 90 metric tons of low-enriched uranium suitable to make fuel to power a typical light water reactor for three years. In 2018, the IAEA signed contracts to purchase LEU, paving the way towards the establishment of the IAEA LEU Bank in 2019. The IAEA LEU Bank was established and became operational on 17 October 2019. The establishment and operation of the IAEA LEU bank is fully funded by voluntary contributions. Donors have provided a total of USD 150 million to establish and operate the IAEA LEU Bank for at least 20 years.

Nuclear fuel produced by reprocessing spent reactor fuels and surplus weapons-related plutonium

The constituents of spent fuel from nuclear power plants are a potentially substantial source of fissile material that could displace primary uranium production. When spent fuel is discharged from a commercial reactor, it is potentially recyclable since more than 90% of the original material is essentially made up of uranium-238, along with the plutonium and remaining uranium-235. The recycled plutonium can be reused in reactors licensed to use mixed oxide (MOX) fuel. The uranium recovered through reprocessing of spent fuel, known as reprocessed uranium (RepU), is not routinely recycled; rather, it is stored for future reuse.

The use of MOX fuel has not significantly impacted global uranium demand. This is because only a relatively small number of reactors utilise MOX fuel, and even those reactors do not typically use MOX to fuel 100% of the reactor's core.

As of January 2025, there were 24 reactors, or around 5% of the world's operating fleet, that used MOX fuel, in France, Russia and the Netherlands (see Table 2.1). Reprocessing and MOX fuel fabrication facilities exist or are under construction in France, India, Japan and Russia. China is also building a pilot plant, to be operational in the mid-2020s, that will be capable of processing about 200 tonnes of heavy metal per year.

Following on basic research and MOX fuel fabrication for experimental reactors by the Japan Atomic Energy Agency (JAEA), Japan Nuclear Fuel Ltd (JNFL) began testing plutonium separation at the Rokkasho reprocessing facility in 2006. Japanese utilities began using MOX initially in fuel manufactured overseas. The use of imported MOX fuel was to be followed by the use of MOX produced at JNFL's MOX fuel fabrication facility (JMOX) adjacent to the Rokkasho reprocessing plant. JMOX construction began in 2010. Under the latest schedule, the start of operation is expected around late 2020s.

Annual MOX production in France varies below the licensed capacity of 195 tHM, in accordance with contracted quantities. Most of the MOX production is used to fuel French nuclear power plants (a total of about 125 t/yr; 1 000 tNatU) and the remainder is delivered abroad under long-term contract arrangements.

A MOX fuel fabrication facility established by Mining and Chemical Combine (MCC) Zheleznogorsk, a Rosatom subsidiary, was officially started in 2015. Russia's BN-800 fast reactor at the Beloyarsk Nuclear Power Plant has been fully loaded with MOX since September 2022.

The Euratom Supply Agency (ESA) reported that the quantity of plutonium contained in the MOX fuel loaded into nuclear power plants in the EU was 6 934 kg in 2024, which is about 45% more than in 2023 (ESA, 2025). Use of plutonium in MOX fuel reduced natural uranium requirements in the EU by an estimated 605 tU in 2024. In the 1996-2024 period, MOX fuel use in EU reactors has displaced a cumulative total of 27 231 tU through the use of 252.9 t of Pu (ESA, 2025). Since the great majority of global MOX use occurs in Western Europe, this figure provides a reasonable estimate of the impact of MOX use worldwide on uranium requirements during that period. Responses to the questionnaire provide some additional data on the production and use of MOX (see Chapter 3).

Uranium recovery through reprocessing of spent fuel, known as RepU, has been conducted in the past in several countries, including Belgium and Japan. It is now routinely undertaken only in France and Russia, principally because the production of RepU requires dedicated conversion, enrichment and fabrication facilities. Available datasets indicate that it represents less than 1% of projected annual world requirements. Reprocessing could become a more significant source of nuclear fuel supply in the future if China successfully commercialises the process. It was reported that China planned to move beyond conducting research and development of reprocessing and recycling technologies, to build and operate a large-scale commercial facility with a capacity of about 800 tHM/yr in order to achieve maximum utilisation of uranium resources, given the country's rapidly rising requirements.

MOX produced from surplus weapons-related plutonium

In September 2000, the United States and Russia signed the Plutonium Management and Disposition Agreement that committed each country to dispose of 34 t of surplus weapons-grade plutonium at a rate of at least 2 tonnes per year in each country, once production facilities are in place. Both countries agreed to dispose of the surplus plutonium by fabricating MOX fuel suitable for irradiation in commercial nuclear reactors.

In the United States, the MOX fuel was to be fabricated at the DOE's Savannah River complex in South Carolina. The DOE's NNSA awarded a contract for construction of the Mixed Oxide Fuel Fabrication Facility (MFFF) in 2001, and construction was officially started in 2007. In mid-2013; however, it was reported that the project had encountered technical difficulties and was running over budget. Since 2014, the project has seen progressive cuts to its funding as the DOE's National Nuclear Safety Administration embarked on a review of its plutonium disposition strategy. The DOE NNSA terminated the MOX project in October 2018 after Russia – which had agreed to dispose of the material in fast reactors – suspended the agreement in October 2016.

Uranium produced by re-enrichment of depleted uranium tails [3] *and uranium saved through underfeeding*

Depleted uranium stocks represent a significant source of uranium that could displace primary production. However, the re-enrichment of depleted uranium has been limited since it is only economic in enrichment plants with spare capacity and low operating costs.

The world stock of depleted uranium in 2024 is around 2 million tonnes, with approximately 50 000 tonnes of depleted uranium added yearly to already substantial stockpiles in the United States, Europe and Russia (WNA, 2025). Following the construction of new centrifuge enrichment facilities and declining demand since the Fukushima Daiichi Nuclear Power Plant accident, spare enrichment capacity is currently available globally, and it has been reported that tails assays are being driven downward at enrichment facilities to underfeed the centrifuge plants and create additional uranium inventory.

EU enrichers are now putting in place long-term strategies to manage enrichment tails remaining from enrichment activities, including deconversion of UF_6 to the more stable form U_3O_8. Currently, within the EU, deconversion takes place in France. Outside the EU, Urenco's tails management facility at Capenhurst, in the United Kingdom, became operational in 2019.

In Russia, TVEL's JSC Electrochemical Plant (ECP) in Zelenogorsk, in the Krasnoyarsk Region, has an annual installed capacity of ten thousand tonnes. The plant is supplied by Orano under the contracts signed in 2005 (for the first unit) and in 2019 (for the second W2-ECP unit, currently under construction).

In the United States, the DOE and the Bonneville Power Administration initiated a pilot project to re-enrich approximately 9 000 tonnes of the DOE's enrichment tails inventory. The project produced low-enriched uranium for use at Northwest Energy's 1.2 GWe Columbia generating station. In mid-2012, Northwest Energy and USEC, in conjunction with the DOE, developed a new plan to re-enrich a second portion of the DOE's high assay tails. The resulting LEU is to be used to fuel Northwest Energy's Columbia generating station through late 2020s.

GE-Hitachi Global Laser Enrichment proposed to build and operate a tails processing plant using SILEX laser enrichment technology on land adjacent to the closed Paducah gaseous diffusion enrichment plant in the United States. Successful development of laser enrichment could potentially result in an additional supply of uranium to the market in the longer term. Commercial operations are expected to commence in the late 2020s. Some other commercial enrichment providers (e.g. Urenco) have also indicated that depleted uranium tails may be re-enriched using centrifuge technology where economically viable.

Underfeeding

The potential for *underfeeding* of enrichment plants is also a source of secondary supply. Underfeeding reduces the amount of uranium required to produce contracted quantities of enriched uranium and, in turn, creates a stockpile of uranium that can be sold. It is estimated that global underfeeding and depleted uranium re-enrichment can contribute up to about 8 000 tUeq of supply per year (WNA, 2025).

In recent years, secondary supply has shown a downward trend resulting from the end of the "Megatons to Megawatt" agreement. The share of global secondary supply for uranium is currently around 6% (4 000 tU/yr) and is likely to decrease to about 4% (5 000 to 6 000 tU/yr) by 2040 (WNA, 2025).

3. Depleted uranium is the by-product of the enrichment process, with less ^{235}U than natural uranium. Normally, depleted uranium tails contain between 0.25% and 0.35% ^{235}U compared with the 0.711% proportion of ^{235}U found in nature.

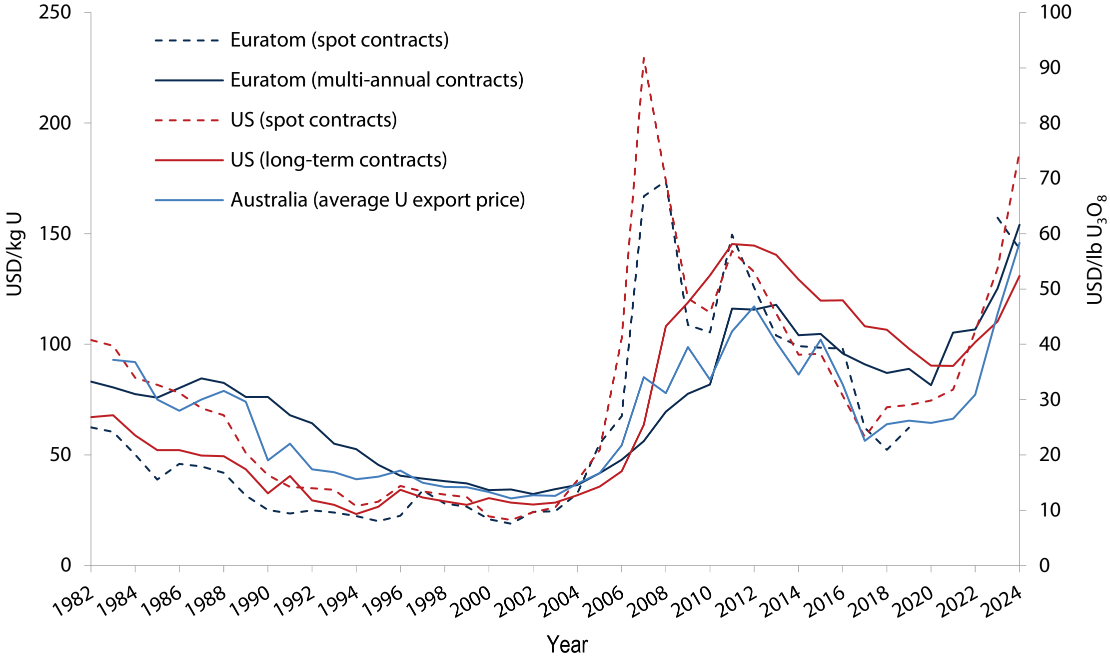
Uranium market developments

Uranium prices

Some national and international authorities (Australia, the United States and Euratom), publish price indicators to illustrate uranium price trends for both long-term and short-term (spot price) contract arrangements. Australian data record average annual prices paid for exports, whereas Euratom (ESA) and US data show costs of uranium purchases in a particular year. Canada and Niger published export prices for several years, but neither continue to do so. Figure 2.8 displays this mix of annual prices reported for both short-term and longer-term purchases and exports.

Figure 2.8. **Uranium prices for short- and long-term purchases and exports**

(1982-2024)



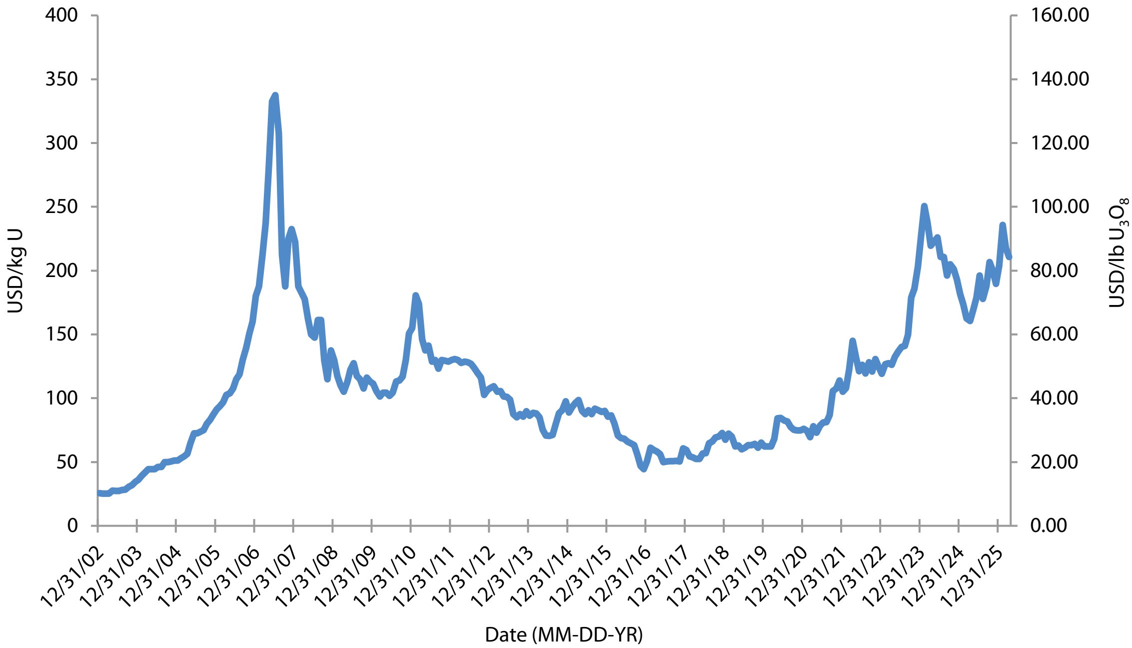
Sources: ESA, 2025; EIA, 2025; Department of Industry, Science and Resources, 2025.

The overproduction of uranium, which lasted through 1990 (see Figure 2.6), combined with the availability of secondary sources, resulted in uranium prices trending downward from the early 1980s through the mid-1990s, bringing about significantly reduced expenditures in many sectors of the world uranium industry, including exploration and production. The bankruptcy of an important uranium trading company resulted in a modest recovery in prices from late 1994 through mid-1996, but low prices returned shortly thereafter. Beginning in 2002, uranium prices started to increase, eventually rising to levels not seen since the 1980s. They then rose more rapidly through 2005 and 2006, with spot prices reaching a peak through 2007 and 2008, and then fell off rapidly, recovering somewhat in 2011 and declining again in 2012 up until 2017 and 2018 (see Figures 2.8 and 2.9). In contrast, EU and US long-term price indices (that reflect the contract arrangements made earlier, often under different price regimes) continued to rise until 2011, before levelling off in 2012 and then declining until 2020 and 2021. Since then, the long-term uranium price has recovered, exceeding the levels seen in early 2010s in the case of the EU long-term prices, and reaching levels not seen in over a decade in the case of US long-term prices. The Australian average export price has generally followed the trend of other long-term price indices, but with greater variation since it is a mix of spot and long-term contract prices.

In addition to this information from government and international sources, spot price indicators for immediate or near-term delivery (less than one year), which typically amount to 15% to 25% of all annual uranium transactions, are provided by the industry trade press, such as TradeTech and the Ux Consulting Company LLC (UxC) (see Figure 2.9).

Figure 2.9. **Uranium spot price dynamics**

(TradeTech and UxC average trend, 2002-2025)



Source: Trade Tech (www.uranium.info) and UxC.

Note: The Exchange value is Trade Tech's judgement of the price at which spot and near-term transactions for significant quantities of natural uranium concentrates could be conducted, as of the last day of the month.

A variety of factors have been advanced to account for the spot price dynamics between 2003 and 2024, including problems experienced in nuclear fuel cycle production centres that highlighted dependence on a few critical facilities in the supply chain, as well as changes in the value of the US dollar, the currency used in uranium transactions. The expected expansion of nuclear power generation in countries such as China, India and Russia, combined with the recognition by many governments of the role that nuclear energy can play in enhancing security of energy supply, contributed to the strengthening market through 2007. Market speculation helped accelerate upward price movement at that time. The downturn in the spot price since June 2007 began with the reluctance on behalf of traditional buyers to purchase at such high prices and the global financial crisis that stimulated sales by distressed sellers needing to raise capital.

In late 2007, the uranium spot price began a gradual decline that settled in 2009 in a range between USD 40/lb U_3O_8 (USD 104/kgU) and USD 50/lb U_3O_8 (USD 130/kgU). Proposed US government inventory sales appeared to offset rising demand as government programmes in China and India, to increase nuclear generating capacity, began to be implemented. In the second half of 2010, the spot price began to rally once again on news that China was active in the long-term market, stimulating speculative activity on perceptions of tightening supply-demand. However, the Fukushima Daiichi Nuclear Power Plant accident precipitated an initial rapid decline in price. Projects to increase uranium production implemented before the accident, resulted in increasing production even as demand weakened and the market became saturated with supply, putting further downward pressure on prices through to the end of 2019. In addition, these excess uranium inventories and the decline in uranium needs as a result of the substitution of enrichment (underfeeding) contributed to the downturn in uranium prices. Significant uranium production cuts were made during 2018-2019 (e.g. McArthur River mine in Canada), contributing to high spot purchasing levels as producers and traders bought material to cover near-term delivery commitments. The significant rise in the spot price seen in March and April 2020 was precipitated largely by additional curtailments to primary production brought on by the COVID-19 pandemic. Numerous mines suspended operations, both due to the imposed restrictions and under voluntary preventative measures. The next surge in the uranium spot price was triggered by the start of the war in Ukraine in 2022. Due to increased geopolitical risks, many utilities relying on Russian-sourced enriched uranium started to look for alternative supplies. The increase in spot uranium prices in 2022 was also influenced by the potential sanctions on Russian uranium and logistical issues associated with the war in Ukraine. Indeed, in May 2024, the United States passed the Prohibiting Russian Uranium Imports Act, which bans the imports of low-enriched uranium from Russia.

Apart from geopolitical factors and their impact on the supply chains, another driver that has affected the rise in prices in the last couple of years is the growing interest, worldwide, in nuclear energy and thus the anticipation of increased uranium demand. This is due to the recognition of the importance of nuclear energy in achieving clean energy targets. In December 2023, more than 20 countries made a joint declaration during the 28th Conference of the Parties of the United Nations Framework Convention on Climate Change (COP28) in Dubai to triple installed nuclear capacity by 2050. This declaration, now signed by 38 countries, marks a significant milestone in the history of nuclear energy by officially calling for the acceleration of deployment of low-emission technologies, including nuclear energy, to help achieve carbon neutrality.

The uranium market could be further affected by developments on both the demand and supply side. Asia is one of the most critical markets for new reactors, and new uranium production will be needed in the coming decades. Additional demand factors include Japanese restarts and successful global new builds, led by governments' decisions to increase nuclear power capacity on the road to net zero emissions and energy security. Some of the key considerations on the supply side in the shorter-term include trade policy interventions, and voluntary re-orientations away from Russian uranium; constraints on supply growth due to project delays, permitting challenges and the time required to restart idled capacities; Kazakhstan's supply disruptions due to shortages of sulfuric acid; and a conflict-related disruption of exports from Niger.

Policy measures in the EU and uranium prices

Since its establishment in 1960 under the Euratom Treaty, the Supply Agency of the European Atomic Energy Community (ESA) has pursued a policy of diversification of sources of nuclear fuel supply to avoid overdependence on any single source. Within the European Union, all uranium purchase contracts by EU end users (i.e. nuclear utilities) must be concurred by the ESA. Based on its contractual role and its close relations with industry, the ESA monitors the market with a particular focus on supplies of natural and enriched uranium to the EU. The ESA continues to stress the importance of maintaining an adequate level of strategic inventory and using market opportunities to increase inventories, where possible. It also recommends that utilities cover the majority of their needs under long-term contracts with diverse suppliers, and it continues to promote transparency and predictability in the market.

In response to the start of the war in Ukraine in February 2022, the European Commission published the REPowerEU Plan, which advocates for a rapid reduction of dependence on Russian fuels, including nuclear fuel, and states the importance of diversification options for member states reliant on Russian nuclear fuel (ESA, 2023).

Uranium purchased for EU reactors came from diverse sources in 2024 (ESA, 2025). The top four providers amounted to more than 84% of all uranium purchased by EU utilities. In decreasing order of percentage of uranium provided, these were: Canada (34%), Kazakhstan (24%), Russia (16%) and Australia (10%). No uranium of European origin was delivered to EU utilities (ESA, 2025).

Since uranium is sold mostly under long-term contracts and the terms are not made public, the ESA traditionally publishes two categories of natural uranium prices on an annual basis, i.e. multi-annual and spot, both being historical prices calculated over a period of many years. With at least some uranium market participants seeking greater price transparency, the ESA introduced a new natural uranium multi-annual contracts index price (MAC-3) in 2009. This index price, developed to better reflect short-term changes in uranium prices and to more closely track market trends, is a three-year moving average of prices paid under new, multi-annual, long-term contracts for uranium delivered to EU utilities in the reporting year (see Table 2.6).

Table 2.6. **ESA average natural uranium prices**

(2011-2024)

Year	Multi-annual contracts		Spot contracts		New multi-annual contracts (MAC-3)	
	EUR/kgU	USD/lb U_3O_8	EUR/kgU	USD/lb U_3O_8	EUR/kgU	USD/lb U_3O_8
2011	83.45	44.68	107.43	57.52	100.02	53.55
2012	90.03	44.49	97.80	48.33	103.42	51.11
2013	85.19	45.32	78.24	39.97	84.66	43.25
2014	78.31	40.02	74.65	38.15	93.68	47.87
2015	94.30	40.24	88.73	37.87	88.53	37.78
2016	86.62	36.88	88.56	37.71	87.11	37.09
2017	80.55	35.00	55.16	23.97	80.50	34.98
2018	73.74	33.50	44.34	20.14	74.19	33.70
2019	79.43	34.20	55.61	23.94	80.00	34.45
2020	71.37	31.36	***	***	75.51	33.17
2021	89.00	40.49	***	***	92.75	42.19
2022	101.28	41.02	***	***	76.19	30.86
2023	115.79	48.16	149.28	60.46	103.56	41.95
2024	142.26	59.23	132.32	55.09	155.50	64.74

Source: ESA, 2025.

Note: *** In 2020, 2021 and 2022, the ESA spot price was not calculated because there were not enough transactions (less than 3) to calculate the index.

Before 2021: data for EU-27 + UK.

Since uranium is priced in US dollars, fluctuation of the EUR/USD exchange rate influences the level of the price indices calculated. The average EUR/USD rate in 2024, according to the European Central Bank, stood at 1.08, which was 3% higher than in the previous year.

Supply and demand to 2050

Comparison of uranium production and requirements to 2050

Market conditions are the primary driver of decisions to develop new or expand existing primary uranium production centres. Since the last edition of this report, uranium market fundamentals strengthened markedly, and plans for increasing production capability continued through 2025. A number of countries, notably, Brazil, Canada, Mauritania, Mongolia, Namibia, Tanzania, Ukraine, United States and Zambia, have plans for additions to future production capability (see Table 1.25). Some other countries, notably China, Finland, Niger, Russia and United States, are working towards increasing uranium production in the near future (see Table 1.24). These developments are important, as global demand is projected to increase in the longer term, and the share of secondary sources is expected to decline.

After the long pause in nuclear development following the Fukushima Daiichi Nuclear Power Plant accident, along with the continuing decline of market prices and the downturn from the COVID-19 pandemic, uranium production levels started to recover, reaching about 62 000 tU in 2024, an increase of about 25% compared to 2022 production levels. Following improved market conditions, some mines in care and maintenance have been reactivated to ensure supply to a growing global nuclear fleet. Canada's McArthur River mine was restarted in November 2022, after being idled for four years. In Namibia, after being placed in care and maintenance in 2018, the Langer Heinrich Mine achieved its first concentrate production and drumming in March 2024. In Australia, the Honeymoon ISL operation was restarted in 2024. In Malawi, the Kayelekera mine achieved first production following restart in the second half of 2025. In addition, in the United States, several ISL and underground uranium operations have restarted since 2023 or are progressing towards restart, contributing to a gradual recovery of domestic production capacity.

In 2024, the nuclear industry continued to experience severe geopolitical disruptions. The ongoing war in Ukraine caused significant fuel supply concerns and led to a uranium market transformation that continues to this day. Moreover, following political changes in July 2023, Niger authorities revoked Orano's (France-based) permit to exploit the Imouraren deposit in June 2024 and withdrew the mining rights from GoviEx Uranium (Canada-based) for the Madaouela project in July 2024, creating significant uncertainty about planned and prospective production centres.

Within this context, and despite uncertainties and challenges in securing investment for mine development, producers have expanded production capacity in recent years. At the same time, governments are establishing the necessary frameworks, such as legislation and regulations, in countries that have not previously hosted uranium production.

Should uranium demand rise as projected (see Figure 2.10), producers may still face significant challenges in bringing new production facilities online. Recent years have shown that many of these challenges can be unpredictable, including geopolitical factors, such as instability in Niger, the war in Ukraine and global events, such as pandemics. Furthermore, technical difficulties at certain facilities, stricter regulatory requirements and growing expectations from host governments – such as higher taxes and contributions to regional socio-economic development – could further delay the timely development of new mines or uranium production centres.

To ensure a steady supply of uranium and support the development of new resources in the medium to long term, it is crucial to initiate new projects with an understanding of the typically long lead times associated with mine development. Future projects would also benefit from targeted research and innovation efforts aimed at improving uranium exploration methods and developing new, advanced processing techniques.

The gap between uranium production and requirements that has existed since the 1990s has consistently been bridged by drawing down secondary supplies. Around 2014, producers nearly closed this gap between global production and reactor needs, although this was also due to a temporary reduction in demand caused by reactor closures and the idling of reactors in Japan following the Fukushima Daiichi Nuclear Power Plant accident. More recently, as market conditions improve, and the cuts and disruptions from the COVID-19 pandemic in 2020 recede, the gap between global production and reactor requirements has begun to narrow. Projections in this publication point, however, towards this gap increasing again in the coming years. This is largely due to the recent changes in nuclear energy policies worldwide which now anticipate significant nuclear energy growth at the global level in the high-case scenarios.

The availability and mobility of secondary sources, particularly the level of available stocks and how long they will last before depletion, is one of the key uncertainties that may impact the uranium market. The possibility that a portion of the potentially large inventories, including military stockpiles, will continue to enter the market, while not anticipated, cannot be discounted. These uncertainties may complicate investment decisions regarding new production capabilities. Nevertheless, as secondary sources of uranium are generally expected to follow a downward trend due to inventory depletion, reactor requirements will increasingly need to be met by primary production.

Figure 2.10 illustrates the comparison between projected uranium requirements for both low- and high-demand scenarios, and low- and high-production scenarios, up to 2050:

- **Low-production scenario**: If all existing and committed mines operate at or near their stated production capacity (low production scenario A-II [4]), low demand is expected to be met until 2032. However, for high demand, a production shortfall is anticipated to emerge as early as 2025.
- **High-production scenario**: If planned and prospective production capabilities are included (high-production scenario B-II [5]), high demand could be met by primary production until 2035. In this scenario, low demand would be satisfied until 2039.

It should also be noted that actual mine production typically reaches on average no more than 85% of a mine's nominal production capacity. Global production has historically fluctuated between approximately 75% and 90% of nominal production capacity over the past few decades.

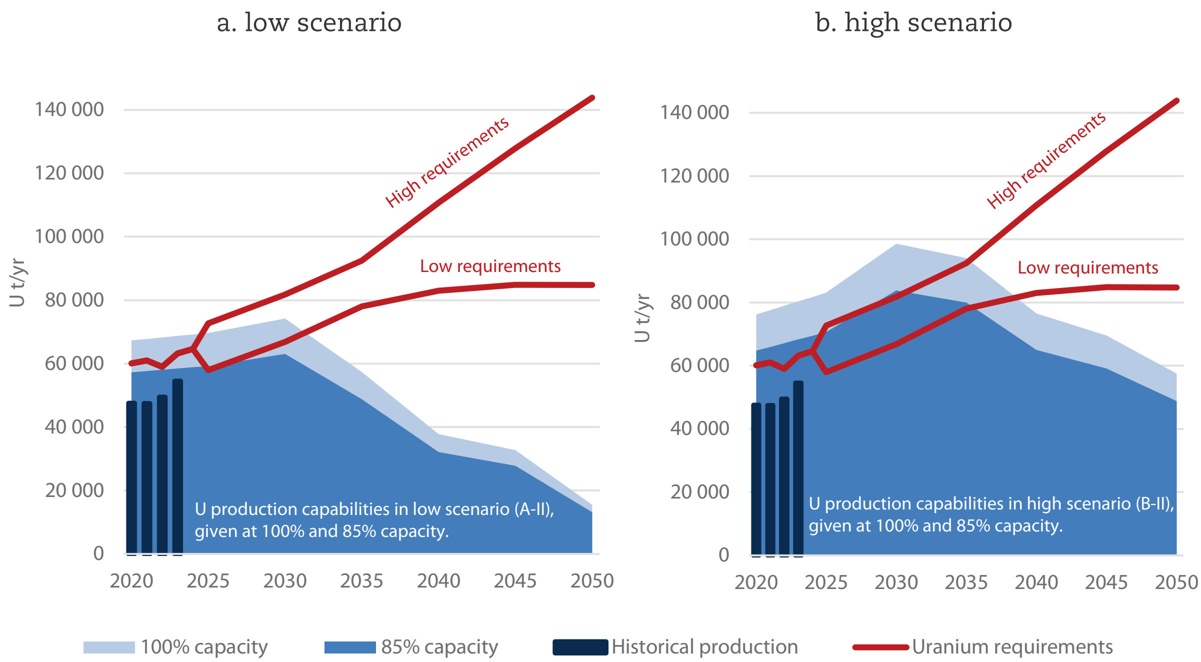
Projections beyond 2030 generally show decreasing global production capabilities as A-II and B-II category estimates decline in response to the depletion of resources at existing, committed, and development of planned and prospective production centres.

Figure 2.10 also provides an overview of long-term production and demand adequacy, assuming global mine production operates at 85% of capacity. For reference, actual production figures for recent years (2020-2024) are shown in bar form. Under the low production scenario (A-II), the existing gap is largely expected to persist in both the high and low demand cases. In the high production scenario (B-II), the persistent gap is projected to appear around 2031 for high demand and around 2036 for low demand. These production and demand gaps will need to be addressed with secondary supplies in the short term, and by developing new projects in the medium to long term.

It should however be noted that prices are unlikely to remain constant across different demand scenarios. In a high-requirement scenario, increased demand would drive higher prices, encouraging greater production. Conversely, lower demand in a low-requirement scenario would likely lead to reduced prices and production levels. While detailed modelling of these dynamics is beyond the scope of this report, and therefore not reflected in the comparisons of supply and demand scenarios presented here (which aim solely to assess the adequacy of supply relative to potential future demand), the authors acknowledge the interdependent relationships between prices, demand and production, as well as the influence of price elasticity.

4. As defined in Chapter 1, A-II production capabilities projected for 2030 to 2050 include *existing and committed production centres* in the <USD 130/kgU category.
5. As defined in Chapter 1, B-II production capabilities projected for 2030 to 2050 include *existing, committed, planned and prospective production centres* in the <USD 130/kgU category.

Figure 2.10. **Projected world uranium production capability to 2050 (supported by identified resources at a cost of <USD 130/kgU), compared with reactor requirements**



Source: Tables 1.23 and 2.5, NEA, 2023, NEA, 2018c.

Figure (a) illustrates the A-II case (production capability of existing, idled and committed centres supported by RAR and inferred resources recoverable at <USD 130/kgU).

Figure (b) illustrates the B-II case (production capability of existing, idled, committed, planned and prospective centres supported by RAR, and inferred resources recoverable at <USD 130/kgU).

Both figures illustrate two production capacities per case: the light shaded area represents 100% of production capacity, the darker shade represents 85% of the production capacity. The dark blue bars show the production values for 2020-2024.

Note: the figures do not include the secondary supply forecast, which has, in the past, filled the gap between primary production and demand.

Similarly, the resource base is influenced by market dynamics. Higher demand and prices typically incentivise increased exploration, leading to the identification of additional resources. Although these interactions are not explicitly modelled here, the authors recognise their significance and their potential to shape the resource base over time. The relationships between demand, prices, exploration efforts, and resource availability underscore the complex and dynamic nature of the supply-demand balance.

In-ground uranium resources will be brought into production when market conditions lend confidence that a given project will return value for investors and operators. Conversely, poor market conditions not only hold back new supply, but also slow investment in uranium exploration, which could affect the delineation of additional resources in the longer term. Historically, significant proportions of identified resources have never been extracted while, on average, the extraction of identified resources has taken one to two decades or more than originally planned (see, for example, IAEA 2020, Figure 2.75). To be able to meet future demand in the case of significant growth of nuclear energy, uranium prices will need to be sustained at a level that is adequate to justify the development of existing resources. Investment in exploration will also be necessary to identify additional resources, and funding for research and development to create innovative, cost-effective extraction techniques for unconventional, low-grade uranium deposits will be required.

Despite the reported additions to production capacity, both the low- and high-demand scenarios indicate it will be crucial to identify new resources, and to bring new facilities online in the coming years. Long lead times for establishing new production centres are expected, particularly in today's risk-averse investment market, and considering complex and lengthy regulatory processes in many uranium mining jurisdictions. Coupled with complex geopolitical challenges and prospective technical difficulties in the development of new mines and mill facilities, efforts must be made today to ensure an adequate supply of uranium is available in the medium term. Given that it can take several decades for a new discovery to reach production, the timely development of new projects is essential to prevent future supply disruptions.

Strong and sustained uranium demand market conditions are vital for attracting the necessary investment into the industry. As significant new nuclear generating capacity is added, additional resources of economic interest are likely to be identified with additional investment and exploration efforts.

Cumulative uranium consumption vs. uranium resource base (all cost categories considered)

Looking at whether the global uranium resource base is sufficient to meet the growing demands of nuclear power through 2050 and beyond requires focussing on the fundamental question: Is there enough uranium to support future expansion of nuclear energy? This question assumes that most of the world will continue to use a once-through fuel cycle, which remains the dominant approach today.

To provide clarity, cumulative uranium requirements under a high-growth scenario are compared with the currently identified geological uranium resource base. This comparison considers both the period leading up to 2050 and the implications for the remainder of the century.

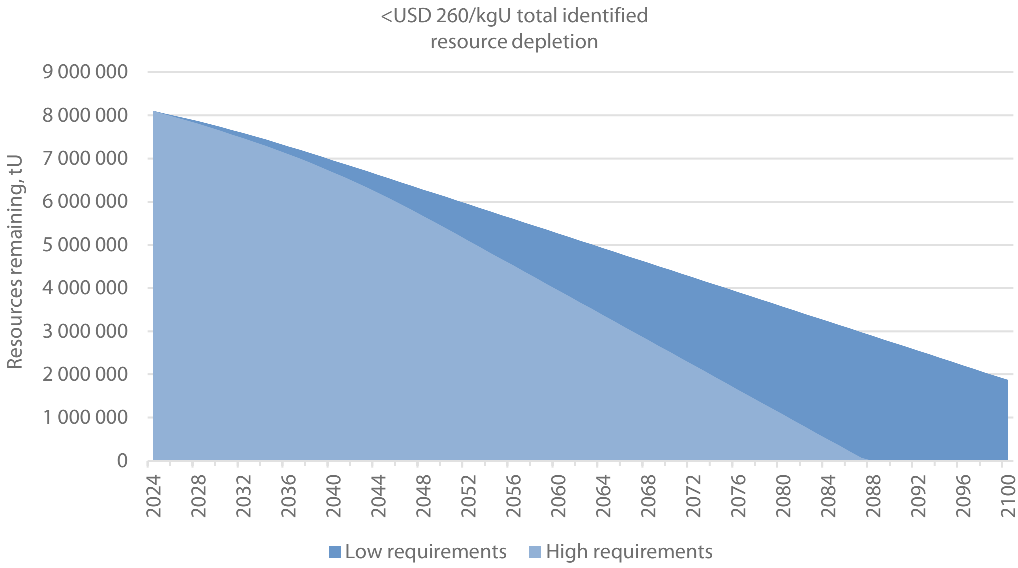
As of 1 January 2025 (see Table 1.1), the identified recoverable uranium resource base, approximately 8.1 million tonnes, is sufficient to meet the projected expansion of nuclear capacity through 2050, even under the high-growth scenario. However, achieving these high-demand projections would require about 2.7 million tonnes of natural uranium by 2050. To put this into perspective, this amount is roughly equivalent to 80% of the total quantity of uranium mined globally since the deployment of civilian nuclear power.

Looking beyond 2050, even if nuclear capacity is simply maintained at 2050 levels until the end of the century – an assumption consistent with the expected lifespan of newly built reactors – the quantity of natural uranium required for both low- and high-growth scenarios would likely exceed most of the currently identified uranium resource base of approximately 8.1 million tonnes. Figure 2.11 illustrates this, showing the progression of cumulative uranium requirements as a percentage of the total resource base. In the high-growth scenario, cumulative uranium requirements would reach 100% of the identified resource base at a cost of <USD 130/kgU by the 2070s, while in the low-growth scenario, this would occur by the 2090s.

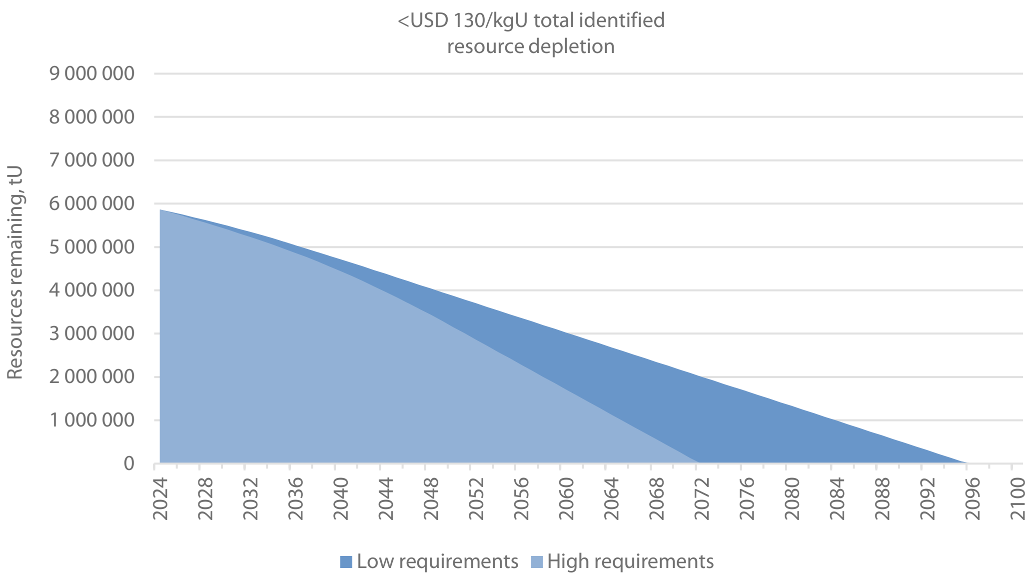
While current uranium resources are sufficient to meet nuclear power demand through mid-century, expanding or even sustaining capacity beyond 2050 would require mobilising uranium quantities comparable to most of today's entire known resource base, all before the 2100s. These estimates are based on the currently known identified conventional recoverable resource base. Additional sources of uranium could come from undiscovered (around 7.5 million tonnes estimated in this edition) or unconventional resources, but significant time, effort and investment will be needed to access them and bring them into production. This highlights the urgent need for further exploration, resource development and reconsideration of the once-through fuel cycle as the default approach for a growing global nuclear fleet.

Figure 2.11. **Projected resource utilisation under low- and high-demand scenarios, assuming capacity is maintained from 2050 to 2100, shown as tonnages of total identified recoverable resources remaining at costs below (a) USD 260/kg U and (b) USD 130/kgU**

(a)



(b)



The long-term perspective

Global uranium demand is primarily driven by the number of operating nuclear reactors, historically tied to electricity demand. However, the future role of nuclear energy may increasingly need to consider both electricity production and non-electric applications, such as heat generation. The expansion of global nuclear capacity and the adoption of novel nuclear technologies – including SMRs and AMRs, and their associated fuel cycles – will largely depend on government policies and the effective management of various factors. These include economics, safety, energy security, supply chain resilience, waste disposal, environmental concerns and the technological readiness of these new applications. In this context, nuclear energy's role in future low-carbon energy mixes remains a central topic in global energy policy discussions.

All credible models show that nuclear energy has an essential role in decarbonisation and climate change mitigation as an established, large-scale, low-carbon energy source. Achieving net zero by 2050 is not possible without a significant contribution from nuclear power. However, the nuclear industry requires clear, consistent policy support for both existing and new capacity development, as well as the inclusion of nuclear power in clean energy incentive schemes. Long-term assurances of uranium supply availability are equally essential. Nuclear energy is a reliable and dispatchable source of heat and electricity. For these reasons, along with mounting concerns about energy security, coupled with incentives for all types of clean power generation, demand for nuclear energy is expected to continue to grow and may, in fact, accelerate.

Beyond net zero ambitions, energy security concerns have come to the forefront due to the ongoing war in Ukraine. This geopolitical situation has impacted the global nuclear fuel supply market, with many Western utilities looking to reduce reliance on Russian fuel and services.

Interest in SMRs is growing in both established nuclear countries and emerging nuclear markets, globally. Numerous reports (notably NEA, 2024a) highlight the progress in SMR design, technology, technical feasibility, economic viability and factors influencing their competitiveness. SMR designs are currently at various stages of development, from conceptual design to licensing and construction.

Technological advancements will significantly influence the long-term future of nuclear energy and uranium demand. These innovations aim to address economic, safety, security, non-proliferation and waste management challenges, while enhancing uranium resource efficiency. The introduction of advanced reactor designs, including Generation IV reactors, could enable the use of alternative nuclear fuels and more efficient consumption of fissile resources. Fast neutron reactors, in particular, hold the potential to maximise natural uranium utilisation.

Several national and international initiatives, such as the Generation IV International Forum and the IAEA's International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO), are actively working on the development of these advanced technologies. In the long term, new reactor designs, coupled with reprocessing and recycling infrastructures for used nuclear fuel, have the potential to transform the nuclear fuel landscape and significantly enhance overall nuclear fuel efficiency.

Conclusion

As reported in this edition, sufficient uranium resources exist to support the continued use of nuclear power and significant growth in nuclear capacity for electricity generation through 2050, and beyond. Uranium requirements from emerging nuclear applications, such as SMRs – including both electric and potentially non-electric uses, such as industrial decarbonisation and district heating – will need to be considered once there is greater clarity on these novel applications.

Given the limited maturity and geographical reach of uranium exploration worldwide, there is considerable potential for discovering new resources of economic interest. Recent years have clearly demonstrated that, with adequate investments, new uranium resources can be readily identified, developed and mined. However, it is essential that consumers and producers ensure that the necessary framework conditions for uranium exploration, mining, processing and transportation are in place. This includes pricing mechanisms that provide sufficient market visibility to support the long-term investments required for these developments. A strong uranium market, characterised by sustained prices at an adequate level, will be crucial for developing resources in time to meet future uranium demand, which is projected to more than double by 2050 in the high scenario outlined in this edition.

When comparing projected annual uranium production to requirements, it appears likely that the existing demand-supply gap in the uranium market, which has persisted for three decades, might continue into the next decade if significant nuclear capacity growth occurs worldwide.

Given the long lead times between resource discovery and production (i.e. 15 to 20 years), identifying new projects in the near to medium term will be essential to prevent potential supply disruptions.

Considering both the low and high nuclear capacity scenarios to 2050 presented in this edition, and assuming their 2050 capacity is maintained for the rest of the century, the quantities of uranium required by the global fleet, based on the current once-through fuel cycle, would likely surpass the currently identified uranium resource base in the highest cost category by the 2120s.

Additionally, there are sizeable unconventional uranium resources, such as phosphate deposits and black schists/shales, that could extend the period during which the known uranium resource base could support global energy demand using current technologies. However, further research, innovation and investment are required to better define the scope of these unconventional resources, and to develop cost-effective extraction methods.

The development and deployment of advanced reactor and fuel cycle technologies could also significantly enhance the efficiency of uranium use in the long term, in particular, the adoption of advanced reactors and closed fuel cycles with fuel recycling could potentially extend the availability of nuclear energy from uranium fission for thousands of years.

While sufficient physical uranium resources exist to meet demand for nuclear power generation at both current and increased levels through 2050 and beyond, significant exploration and investment will be needed to identify and develop new mining projects in a timely manner. This will be necessary to ensure sufficient supply is available to meet demand at reasonable prices.

References

Department of Industry, Science and Resources (2025), Commonwealth of Australia Resources and Energy Quarterly, https://www.industry.gov.au/sites/default/files/2025-06/resources-and-energy-quarterly-june-2025.pdf.

EIA (2025), *Uranium Marketing Annual Report 2024*, Energy Information Administration, Washington, DC, www.eia.gov/uranium/marketing.

EIA (2024), *Uranium Marketing Annual Report 2023*, Energy Information Administration, Washington, DC, www.eia.gov/uranium/marketing.

EIA (2023), *Uranium Marketing Annual Report 2022*, Energy Information Administration, Washington, DC, www.eia.gov/uranium/marketing.

EIA (2022), *Uranium Marketing Annual Report 2021*, Energy Information Administration, Washington, DC, www.eia.gov/uranium/marketing.

EIA (2021), *Uranium Marketing Annual Report 2020*, Energy Information Administration, Washington, DC, www.eia.gov/uranium/marketing.

EIA (2020), *Uranium Marketing Annual Report 2019*, Energy Information Administration, Washington, DC, www.eia.gov/uranium/marketing.

ESA (2025), *Annual Report 2024*, Euratom Supply Agency, Luxembourg, https://euratom-supply.ec.europa.eu/publications/esa-annual-reports_en.

ESA (2023), *Annual Report 2022*, Euratom Supply Agency, Luxembourg, https://euratom-supply.ec.europa.eu/publications/esa-annual-reports_en.

ESA (2022), *Annual Report 2021*, Euratom Supply Agency, Luxembourg, https://euratom-supply.ec.europa.eu/publications/esa-annual-reports_en.

ESA (2021), *Annual Report 2020*, Euratom Supply Agency, Luxembourg, https://euratom-supply.ec.europa.eu/publications/esa-annual-reports_en.

ESA (2020), *Annual Report 2019*, Euratom Supply Agency, Luxembourg, https://euratom-supply.ec.europa.eu/publications/esa-annual-reports_en.

IAEA (2025), *Energy, Electricity and Nuclear Power Estimates for the Period up to 2050*, RDS-1 2025 edition, International Atomic Energy Agency, Vienna.

IAEA (2024), *Energy, Electricity and Nuclear Power Estimates for the Period up to 2050*, RDS-1 2024 edition, International Atomic Energy Agency, Vienna.

IAEA (2026), World Energy Availability Factors by Year (database), Power Reactor Information System (PRIS), www.iaea.org/pris.

IAEA (2020a), *Advances in Small Modular Reactor Technology Developments*, 2020 edition, International Atomic Energy Agency, Vienna, https://aris.iaea.org/Publications/SMR_Book_2020.pdf.

IAEA (2020c), *Climate Change and Nuclear Power 2020*, International Atomic Energy Agency, Vienna, www.iaea.org/publications/14725.

IAEA (2019b), *Guidance on Nuclear Energy Cogeneration*, 2019, International Atomic Energy Agency, Vienna, www.iaea.org/publications/13385.

IEA (2022), *Nuclear Power and Secure Energy Transitions*, International Energy Agency, Paris, www.iea.org/reports/nuclear-power-and-secure-energy-transitions.

IEA (2021a), *World Energy Outlook*, International Energy Agency, Paris, www.iea.org/reports/world-energy-outlook-2021.

IEA (2021b), *Net Zero by 2050: A Roadmap for the Global Energy Sector*, International Energy Agency, Paris, www.iea.org/reports/net-zero-by-2050.

IEA (2020), *World Energy Outlook: 2020*, International Energy Agency, Paris, www.iea.org/reports/world-energy-outlook-2020.

IEA (2019), *Nuclear Power in a Clean Energy System*, International Energy Agency, Paris, www.iea.org/reports/nuclear-power-in-a-clean-energy-system.

IEA (2017), *World Energy Investment 2017*, International Energy Agency, Paris, www.iea.org/reports/world-energy-investment-2017.

NEA (2024a), *The NEA Small Modular Reactor Dashboard: Second Edition*, OECD Publishing, Paris, www.oecd-nea.org/jcms/pl_90816.

NEA (2024b), *High Assay Low Enriched Uranium: Drivers, Implications and Security of Supply*, OECD Publishing, Paris, www.oecd-nea.org/jcms/pl_96126.

NEA (2023), *Uranium 2022: Resources, Production and Demand*, OECD Publishing, Paris, www.oecd-nea.org/jcms/pl_79960.

NEA (2022), *Meeting Climate Change Targets. The Role of Nuclear Energy*, OECD Publishing, Paris, www.oecd-nea.org/jcms/pl_69396.

NEA (2021a), *Small Modular Reactors: Challenges and Opportunities*, OECD Publishing, Paris, www.oecd-nea.org/jcms/pl_57979.

NEA (2021b), *Nuclear Energy Data 2021*, OECD Publishing, Paris, www.oecd-nea.org/jcms/pl_69894.

NEA (2020a), "Building Low-Carbon Resilient Electricity Infrastructures with Nuclear Energy in the Post-COVID-19 era", *NEA Policy Brief*, OECD Publishing, Paris, www.oecd-nea.org/jcms/pl_34623.

NEA (2020b), *Unlocking Reductions in the Construction Costs of Nuclear: a Practical Guide for Stakeholders*, OECD Publishing, Paris, www.oecd-nea.org/jcms/pl_30653.

NEA (2019), *Nuclear Energy Data 2019*, OECD Publishing, Paris, www.oecd-nea.org/jcms/pl_23514.

NEA (2018a), *The Cost of Decarbonisation: System Costs with High Shares of Nuclear and Renewables*, OECD Publishing, Paris, www.oecd-nea.org/jcms/pl_15000.

NEA (2018b), *The Full Costs of Electricity Provision*, OECD Publishing, Paris, www.oecd-nea.org/jcms/pl_14998.

NEA (2018c), *Uranium 2018: Resources, Production and Demand*, OECD Publishing, Paris, www.oecd-nea.org/jcms/pl_15080.

NEA (2016), *Small Modular Reactors: Nuclear Energy Market Potential for Near-term Deployment*, OECD Publishing, Paris, www.oecd-nea.org/jcms/pl_14924.

NEA (2015), *Nuclear Energy: Combating Climate Change*, OECD Publishing, Paris, www.oecd-nea.org/jcms/pl_14914.

US Office of Nuclear Energy (2020), "What is High-Assay Low-Enriched Uranium (HALEU)?", www.energy.gov/ne/articles/what-high-assay-low-enriched-uranium-haleu (accessed November 2020).

WNA (2025), *The Nuclear Fuel Report Global Scenarios for Demand and Supply Availability 2025-2040*, World Nuclear Association, London.

WNA (2023), *The Nuclear Fuel Report Global Scenarios for Demand and Supply Availability 2023-2040*, World Nuclear Association, London, www.world-nuclear.org/our-association/publications/global-trends-reports/nuclear-fuel-report.

WNA (2022), *The Nuclear Fuel Report Global Scenarios for Demand and Supply Availability 2021-2040*, World Nuclear Association, London.

WNA (2019), *The Nuclear Fuel Report Global Scenarios for Demand and Supply Availability 2019-2040*, World Nuclear Association, London.

Chapter 3. National reports on uranium exploration, resources, production, demand and the environment

Introduction

This chapter presents the national submissions on uranium exploration, resources and production. These reports have been provided by the official government organisations (see Appendix 1) responsible for the control of nuclear raw materials in their respective countries, although the details are the responsibility of the individual organisations concerned. In countries where commercial companies are engaged in exploration, mining and production of uranium, the information is first submitted by these companies to the government of the host country and may then be transmitted to the NEA or the IAEA at the discretion of the government concerned. In certain cases, where an official national report was not submitted, and where it was deemed helpful for the reader, the NEA/IAEA has provided additional comments or estimates to complete this report. In such cases, "NEA/IAEA estimates" are clearly indicated. This chapter contains 46 country reports on uranium exploration, resources, production and reactor-related requirements, 39 of which were prepared from officially reported government data and narratives, and 7 that were prepared by the Nuclear Energy Agency (NEA) and International Atomic Energy Agency (IAEA).

It should be noted that exploration activities may be currently ongoing in a number of other countries that are not included in this report. In addition, uranium resources may have been identified in some of these countries. It is believed, however, that the total of these resources would not significantly affect the overall conclusions of this report. Nevertheless, the NEA and IAEA encourage the governments of these countries to submit an official response to the questionnaire for the next edition of the Red Book.

Additional information on the world's uranium deposits is available in the IAEA online database *World Distribution of Uranium Deposits – UDEPO* [1]. UDEPO contains information on location, ranges of uranium tonnage and average grade, geological type, status, operating organisations (in case the deposit is being mined), and other technical and geological details about the deposits.

1. See IAEA (n.d.), World Distribution of Uranium Deposits – UDEPO, www-nfcis.iaea.org.

Algeria

Uranium exploration and mine development

Historical review

Uranium exploration in Algeria has been ongoing for over 50 years, beginning with a mineral prospecting programme in the Hoggar region (1969-1973) which lead to the discovery of the first uranium deposits in the Hoggar Precambrian crystalline basement (Timgaouine-Abankor-Tinef).

These results, obtained through ground radiometric surveys and geological mapping, quickly identified the uranium resource potential of the Hoggar region, which overall has favourable geological and metallogenic characteristics for mineral deposits.

An aeromagnetic-spectrometric survey of the entire country, carried out in 1971, provided the initial incentive and direction for uranium exploration. The processing of the data collected from this survey identified potential regions for further uranium prospecting, including the Eglab, Ouggarta, and Tin Seririne sedimentary basins (Southern Tassili where the Tahaggart deposit was discovered), as well as individual areas in Tamart-n-Iblis and Timouzeline.

While these developments were taking place, uranium prospecting entered a new phase (1973-1981), primarily aimed at and focussed on the assessment of uranium reserves and the development of previously discovered deposits.

Despite a pronounced slowdown in prospecting activities in the phase that followed (1984-1997), work undertaken near previously discovered deposits, and in other promising areas, revealed indications of uranium mineralisation and radiometric anomalies in the Amel and Tesnou zones, located to the northwest and north of the Timgaouine region, respectively.

Surveys conducted in the Tin Seririne Basin (Tassili South Hoggar) provided a basis on which to undertake geologic mapping and revealed the distribution of uranium-bearing minerals in Paleozoic sedimentary formations.

Recent and ongoing uranium exploration and mine development activities

In 2017 and 2018, the Geological Service of Algeria, in collaboration with the United States Geological Survey, carried out preliminary prospecting work for undiscovered mineral resources (diamond, Au, PGE-Cr, Cu-Ni-PGE-Cr and Mo-Cu) in the Eglabs region, including uranium resources related to granites, calcretes, alkaline rocks and carbonatites.

No uranium exploration or mine development work was carried out between January 2019 and January 2025. All exploration programmes are currently on standby.

Uranium resources

Identified conventional resources (reasonably assured and inferred resources)

There are two geological types of reasonably assured resources in Algeria: upper Proterozoic vein deposits in western Hoggar, and a deposit linked to the Precambrian basement and its Paleozoic sedimentary unconformity in central Hoggar. The first type includes vein deposits linked to faults crossing the Pan-African Batholith in the Timgaouine region, represented by the Timgaouine, Abankor and Tinef deposits in southwestern Ahaggar.

The second type is unconformity-related, represented by the Tahaggart deposit. It is associated with a weathering profile (Regolith) developed at the interface between the Precambrian basement and the Paleozoic cover, and to conglomerates at the base of the Paleozoic sedimentary sequence in the Tin Seririne Basin (southeast of Hoggar). It is worth noting that the uranium mineralisation discovered in the Ait Oklan-El Bema (north Hoggar) region has not been assessed in terms of uranium resources.

Undiscovered conventional resources (prognosticated and speculative resources)

Algeria does not report any resources in any category other than reasonably assured resources.

Uranium production

Historical review

Algeria does not produce uranium.

Regulatory regime

Mining activities related to raw materials for nuclear energy and environmental protection aspects to be taken into account for such activities are governed, among others, by:

- Law No. 03-10 of 19 July 2003 on the protection of the environment for sustainable development.
- Law No. 14-05 of 24 February 2014, relating to mining activities.
- Law No. 19-05 of 17 July 2019 on nuclear activities.

Algeria decided to regulate activities related to the research, production and peaceful use of nuclear energy with the adoption of Law No. 19-05 of 17 July 2019 on nuclear activities.

The law sets objectives such as the protection of human health, the environment and future generations against potentially harmful effects related to the use of ionising radiation, while respecting the principles of radiological protection, and nuclear safety and security, in compliance with Algeria's commitments under international treaties and conventions. It applies to activities related to nuclear materials and ionising radiation sources, nuclear and radiological installations, radioactive waste, and uranium and thorium ores.

The measures to be put in place by operators, importers, transporters and holders of radioactive materials to achieve these objectives, including exposure limits, accident prevention measures, or systems to control access to facilities or to combat illicit trafficking in nuclear materials, will be set by regulation.

By application of this law, the National Authority for Nuclear Safety and Security (NNSSA) was created under the supervision of the Prime Minister by executive decree (No 21-148 of 20 April 2021) and is currently operational. The Atomic Energy Commission (COMENA) will continue to provide aid and assistance to the NNSSA.

National policies related to uranium

From a mining perspective, in a world market dominated in the short- and medium-term by a small number of producers, it is currently not economically feasible to exploit uranium resources in Algeria.

Algeria's uranium resources can only be exploited in a sustainable manner within the framework of an integrated development of the nuclear sector and its main applications. The latter includes nuclear power generation and seawater desalination plants, together with applications in medicine, agriculture, water resources and industry.

Regarding the current situation in the global energy market, Algeria is working towards the integrated development of the uranium sector, ranging from exploration to production and encompassing research and development, training and long-term nuclear power generation prospects.

The development of the uranium production cycle and its applications would require the acquisition of technical expertise, which can only be achieved through ambitious research, development and training programmes. Through its nuclear research centres, Algeria currently has the appropriate tools to undertake work in the future, either alone or through bilateral or multilateral co-operation. It is in a spirit of openness and transparency that Algeria applied itself to the task of putting in place the most favourable and appropriate institutional and regulatory framework with which to pursue the energy development of the country, including a Mining Act, Environmental Protection Act, an Oil and Gas Act and, recently, a Civil Nuclear Activities Act. The latter establishes the regulatory framework for mining activities relating to radioactive minerals, from exploration to mine rehabilitation, including the management of radioactive mining waste.

To improve the mining sector and boost research, exploration and development, the government amended Law 01-10 (of 3 July 2001) by promulgating Law 14-05 on 24 February 2014. This mining law aims to create better conditions for the revival of the sector through adequate funding for research and exploration of new economically viable mining deposits, including uranium.

Uranium stocks

None.

Reasonably assured conventional resources by production method

(in situ tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Unspecified	0	0	0	26 000
Total	0	0	0	26 000

Reasonably assured conventional resources by processing method

(in situ tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Unspecified	0	0	0	26 000
Total	0	0	0	26 000

Reasonably assured conventional resources by deposit type

(in situ tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Proterozoic unconformity	0	0	0	2 000
Granite-related	0	0	0	24 000
Total	0	0	0	26 000

Mid-term production projection

(tonnes U/year)

2025	2030	2035	2040	2045	2050
0	N/A	N/A	N/A	N/A	N/A

Installed nuclear generating capacity to 2050

(MWe net)

2023	2024	2025		2030		2035		2040		2045		2050	
		Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
0	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Argentina

Uranium exploration and mine development

Historical review

Uranium exploration in Argentina, and the subsequent development of uranium resources, began in the 1950s by the National Atomic Energy Commission (CNEA). Since then, several areas of uranium mineralisation – particularly volcanic-related, sandstone, granite-related and surficial deposit types – have been discovered and resources have been evaluated. As of the beginning of the 2000s, in addition to CNEA, junior and provincial mining companies, and senior industrial producers have been involved in uranium exploration projects that are at different stages of progress. While exploration activity has shown fluctuations over time; overall, it has remained steady, supported today by environmental monitoring and the use of modern exploration techniques. Prospects for identifying new resources remain favourable.

For more detailed historical information, please refer to previous editions of the Red Book.

Recent and ongoing uranium exploration, and mine development activities

As of 2025, the CNEA holds several exploration licences in Argentina, including requested and conceded exploration permits, statements of discovery and mines. They are located in the provinces of Salta, Catamarca, La Rioja, Mendoza, La Pampa, Río Negro, Chubut and Santa Cruz.

In recent years, government-led exploration has slowed down and drilling has been limited. The main focus has been on geological, radiometric, geophysical, geochemical, radon emmanometry and environmental studies in areas located in the Cañadón Asfalto Basin (Chubut Province), the Neuquén Basin (Río Negro and La Pampa Provinces), Meseta Sirven (Santa Cruz Province), the Pampean Ranges (La Rioja and Catamarca Provinces), Precordillera (La Rioja Province) and the Salta Group Basin (Salta Province).

The most relevant CNEA deposit in the advanced exploration stage is Cerro Solo (Chubut Province), with identified recoverable resources of 9 230 tU (<USD 260/kgU). Work there has included laboratory testing to define hydrometallurgical extraction of uranium and molybdenum minerals, environmental monitoring and baseline surveys in compliance with provincial regulations. In this regard, hydrological, palaeontological, socio-economic, air quality, flora and fauna, pedological and archaeological studies have been completed, while a radiometric/radiological baseline is underway and a natural acidic drainage survey is planned to be carried out in 2025-2026. At present, a technical programme is being developed to advance the Cerro Solo Project, which includes the Cerro Solo, El Ganso and Puesto Alvear mines. The work plan considers: information validation; update of the environmental impact assessment; preparation of the geological study, conceptual definition of the project, and feasibility study for the Cerro Solo mine; detailed/advanced exploration of the El Ganso and Puesto Alvear mines, and of the less-explored sectors of the Cerro Solo mine. Additionally, in collaboration with the National Mining Secretariat, a financing model is being developed with the aim of attracting private investment and creating a state-private joint venture for future uranium production.

Exploration slowed during the COVID-19 pandemic when activities focussed mainly on data analysis, technical reports and limited laboratory work; fieldwork was minimal. In 2022, exploration intensified and a drilling programme of six holes for a total of 1 197 metres was completed in the Neuquén Basin, while in 2023 a single hole of 171 metres was drilled in the same basin. In parallel, 65 exploration trenches with a total of about 228 metres were excavated in the Meseta Sirven area of Santa Cruz, under a co-operation agreement with Fomicruz S.E. New investment projects were also launched for exploration in the Cañadón Asfalto Basin, the Deseado Massif and nearby areas of influence, and the Neogene and Quaternary deposits of the Puna and Pampean Ranges, with some activities scheduled to begin in 2026.

Regarding the private sector, during the 2021-2025 period, uranium exploration and related development activities were reported by Blue Sky Uranium Corp., Ivana Minerales S.A., Consolidated Uranium Inc. (subsequently Jaguar Uranium Corp.), UrAmerica Ltd., Sophia Energy S.A., Piche Resources, Lia Energy, Owl Mines & Oil S.A. and NewEra Uranium.

From 2022 through 2024, Blue Sky Uranium Corp. concentrated its exploration activities exclusively on the Amarillo Grande project in the Río Negro Province, guided by two principal objectives. The first objective was exploration and evaluation of new targets near Ivana deposit. This work involved geological mapping, surface sampling (including soil, pit and auger samples), radiometric surveys at surface and in boreholes, and both geo-electrical and seismic geophysical studies. As a result of these efforts, four distinct drill targets were delineated. Of these, two underwent initial prospecting drill programmes, one has progressed to a more advanced evaluation stage, and one remains pending further work. In total, 4 198 metres were drilled across 83 holes using reverse circulation (RC), direct circulation (DC) and diamond drilling (DDH) methods. The second objective was to advance the Ivana deposit itself through both resource expansion and technical studies. A focussed RC drilling campaign contributed 3 346 metres across 350 holes, with the goal of extending mineralisation to the west and improving the confidence of the existing resource model. In parallel, extensive metallurgical testing was conducted on a new composite bulk sample from the deposit. The test programme assessed a range of processes, including membrane filtration, liming, uranium-vanadium separation via solvent extraction, precipitation of both elements and final calcination. The results of these studies were integrated into an updated NI 43-101 Preliminary Economic Assessment (PEA), which was completed in 2024. In 2025, Blue Sky, with its joint-venture partner Abatare Spain, S.L.U. (part of the Corporación América Group), founded the new operating company Ivana Minerales S.A. which is advancing the Ivana uranium-vanadium deposit. Ivana Minerales completed a drilling programme comprising 4 959 metres of RC drilling in 328 shallow holes along with ongoing engineering work, to support a Pre-feasibility/Feasibility report for the Ivana Deposit. In addition to work at Amarillo Grande, Blue Sky Uranium began expanding its exploration footprint in 2023 and 2024. In Neuquén Province, the company initiated early-stage technical work on the newly acquired Chihuidos Project, which consists of a set of exploration permits. In Mendoza Province, Blue Sky set up the Corcovo project and commenced initial technical evaluations.

In 2021, Consolidated Uranium Inc. acquired the Laguna Salada uranium-vanadium project in Chubut Province from U3O8 Corp. The project had been in care and maintenance since 2014. Following limited surface mapping and sampling in 2022, the project was again placed under care and maintenance in 2023. That same year, Consolidated Uranium also acquired the Huemul project in the southern Mendoza Province, an early-stage exploration property centred around Argentina's first producing uranium mine, Huemul-Agua Botada. In a subsequent development, IsoEnergy Limited acquired Consolidated Uranium's Argentine assets.

In 2024, Jaguar Uranium acquired the Argentine portfolio from IsoEnergy and also holds a purchase option on the Las Alteras Project, located in the Arroyo Perdido area of Chubut. Initially the company was focussed on resolving legal and regulatory matters with provincial governments. In 2025–2026, Jaguar Uranium is planning to invest in exploration at the La Rosada North area of the Laguna Salada project, aiming to double the project's resources, supported by hand sample encouraging results. In Mendoza, Jaguar will also advance the Huemul Project, targeting potential resources at Mina Huemul and Agua Botada, through geophysical surveys and drilling.

In September 2021, UrAmerica Ltd. reported an updated NI43-101 Technical Report for its uranium project, based on exploration work conducted between 2009 and 2013. This included 295 drill holes totalling 31 989 metres, which led to a Mineral Resource Estimate (MRE) of 27.9 million tonnes at an average grade of 310 ppm U_3O_8, containing in situ 19.1 million pounds of U_3O_8 (7 346 tU). The resources are hosted in three deposits, situated between 40 and 140 metres below the surface and ranging from 1 to 15 metres in thickness. The geology and mineralisation suggest the project is suitable for extraction using the in situ leaching (ISL) method. In addition to the defined resource, UrAmerica has identified four exploration targets with the potential to host up to an additional 65 million pounds of U_3O_8 (25 000 tU) at average grades ranging from 285 to 362 ppm, either as extensions of existing deposits or as new bodies. Looking ahead, UrAmerica's exploration and development plans for 2025 to 2027 focus on expanding and upgrading current resources, confirming the suitability of ISL for extraction, assessing the project's economic viability and advancing towards potential uranium production.

Sophia Energy S.A. resumed exploration at its Sofía project in the Meseta Sirven region, Santa Cruz Province, in mid-2023 after the interruption caused by COVID-19. Since then, over 300 km of radiometric data have been collected, defining 12 areas of interest with strong uranium anomalies. Trenching programmes included 15 trenches in 2023 (≈60 m), 40 trenches in 2024 (≈160 m), and a major campaign of 200+ trenches (≈800 m) underway since early 2025. In early 2025, Sophia partnered with FOMICRUZ S.E., the provincial mining company, to jointly assess resources across their properties. Nearly 400 samples were analysed, with ~25% grading from 250 to 1 000 ppm U, some reaching up to 2 500 ppm U, and ~75% showing vanadium contents from 250 to 1 000 ppm V, with several samples exceeding 1 000 ppm V. Exploration is now focussed on two priority targets, with the objective of defining resources from 1 000 to 1 500 tU.

Since 2022, Piche Resources has been advancing uranium exploration in the San Jorge Basin, Chubut Province, through its Sierra Cuadrada project (37 tenements covering 1 013 km²). Work has included mapping, scintillometer surveys and drilling, which identified several near-surface uranium mineralised zones and highlighted potential for larger deposits at depth. With permitting and an Environmental Impact Assessment completed, the project is now positioned for further exploration and development.

Between 2022 and 2024, Lia Energy, Owl Mines & Oil S.A., and NewEra Uranium launched early-stage uranium exploration in Argentina, aiming to consolidate mineral rights in prospective sedimentary basins. Activities have focussed on compiling and reinterpreting historical data, defining new targets, and, in NewEra's case, applying modern satellite imagery techniques. Lia Energy is active in Chubut, Mendoza and Neuquén; NewEra in Mendoza and Neuquén; and Owl Mines & Oil in Chubut. All three companies plan to progress to surface exploration programmes in 2025–2026.

The information about private exploration expenditures must be taken as only partially complete since the industry is not required to report these expenditures to the government.

Uranium resources

Identified conventional resources (reasonably assured and inferred resources)

As of 1 January 2025, the total identified recoverable resources of Argentina are 33 650 tU at <USD 130 /kgU, comprising the seven projects listed in the table below. At the highest production cost category of <USD 260/kgU, there is no substantial variation and total recoverable identified resources amount to 34 700 tU.

Compared to the previous Red Book report, there is a small reduction in total resources of 600 tU. This difference is explained by an updated NI 43-101 report of the Ivana/Amarillo Grande deposit (Blue Sky Uranium Corp.) that was issued in 2024 and resulted in a decrease of inferred resources from 7 200 tU to 1 210 tU, partially offset by an increase of reasonably assured resources from 0 to 5 390 tU.

In 2025, the CNEA initiated a review and reassessment project of the identified uranium conventional resources owned by the National State.

Identified recoverable uranium resources (RAR+IR) in Argentina

(as of 1 January 2025)

Deposit (ownership)	Province	Type	RAR tU <USD 130/kgU	Inferred tU <USD 130/kgU
Sierra Pintada (CNEA)	Mendoza	Volcanic-related	3 900	6 110
Cerro Solo (CNEA)	Chubut	Sandstone	4 420	3 760 (4 810)*
Don Otto (CNEA)	Salta	Sandstone	180	250
Laguna Colorada (CNEA)	Chubut	Volcanic-related	100	60
Laguna Salada (Jaguar Uranium Corp.)	Chubut	Surficial	1 860	1 120
Meseta Central (UrAmerica Ltd)	Chubut	Sandstone	-	5 290
Ivana/Amarillo Grande (Blue Sky Uranium Corp.)	Río Negro	Sandstone (surficial)	5 390	1 210
Subtotal			15 850 tU	17 800 tU (18 850 tU)*
Total Identified resources			33 650 tU (34 700 tU)*	

* tU for production cost category of <USD 260/kgU.

Undiscovered conventional resources (prognosticated and speculative resources)

There are 13 800 tU of prognosticated resources associated with five sandstone-type deposits in the Cerro Solo and the Sierra Cuadrada uranium districts of Chubut Province (Cerro Solo, El Ganso, Puesto Alvear, El Molino, Sierra Cuadrada Norte and Arroyo Perdido). Additionally, 6 900 tU of prognosticated resources have been evaluated in other provinces at the Catriel (6 000 tU; sandstone type; Río Negro Province), El Gallo (600 tU; intrusive type; La Rioja Province) and Laguna Sirven (300 tU; surficial type; Santa Cruz Province) deposits. In 2024, new prognosticated resources of 570 tU have been evaluated at the Maggi deposit (intrusive type; La Rioja Province). Therefore, total prognosticated in situ resources account for 21 270 tU in the <USD 260/kgU cost category.

To assess the uranium favourability and estimate the potential resources by the application of quantitative McCammon and Deposit Size Frequency (DSF) methods, also used in the US National Uranium Resource Evaluation (NURE) programme, the country was divided into 61 investigation units. These units, which cover 1 450 000 km^2 in total, were delineated on the basis of the geotectonic setting as well as petrological, mineralogical and geochemical characteristics. Speculative uranium in situ resources amount to 56 100 tU according to a review of the resource assessment which had been previously evaluated at 79 500 tU (Red Book 2024). These studies belong to five units considered to have high uranium potential (i.e. Salta Group Basin, Pampean Ranges, Paganzo Basin, San Rafael Basin and Chubut Group Basin). Sandstone, volcanic-related and granite-related uranium deposit types have been taken into consideration in this approach.

In addition, qualitative methodologies based on spatial modelling and mineral system concepts have been applied to determine uranium exploration targets in several geological units (Salta Group Basin, Pipanaco Salt Flats/Aimogasta Basin, Paganzo Basin, Western Precordillera and Western Flank of the Pie de Palo Range, Pampean Ranges, Ambargasta Salt Flats, Sumampa Ranges, Deseado Massif and related areas). Other prospective studies have been conducted, notably related to uranium from phosphates (unconventional resources) and granite-related uranium deposits in the framework of IAEA Coordinated Research Projects. Preliminary studies have been carried out for the assessment of the uranium potential of phosphate rocks and testing uranium extraction from low-grade phosphate ores. Interpretation of new studies on uranium mineralisation from several uranium sites of interest has improved the metallogenetic understanding of the granite-related deposits and the exploration guidelines.

In 2025, the CNEA initiated a review and reassessment project of the undiscovered uranium conventional and unconventional resources owned by the National State.

Uranium production

Historical review

From 1952 to 1997, Argentina produced 2 582 tU in the form of ammonium diuranate ("yellowcake"), intended to meet domestic Argentinian demand. Seven production centres and a pilot plant processed (not simultaneous) uranium ore from about 13 deposits, distributed throughout the country. Eighty-two per cent of uranium was produced by open-pit and 18% by underground mining method. Heap-leaching with ion-exchange resins extraction was the main processing technique applied for yellowcake production. Regarding the geological deposit types, 64% of uranium was produced from volcanic-related, 26% from sandstone and the remaining 10% from granite-related deposits.

In the late 1990s, the decline in the price of uranium made domestic production no longer competitive and the decision was made to shut down the last facility that was in operation, the San Rafael Mining-Milling Complex, which was placed on standby in 1997. No uranium has been produced since then, either privately or by the state.

Status of production facilities, production capability, recent and ongoing activities, and other issues

Regarding the prospects of domestic production, it is considered that uranium projects with identified resources and a higher degree of maturity, such as Sierra Pintada, Cerro Solo, Laguna Salada, Meseta Central and Ivana (Amarillo Grande), must complete the resource delineation and advance the technical studies for comprehensive recovery of uranium and other associated metals of economic interest, notably vanadium and molybdenum.

A large portion of the identified uranium resources in Argentina is in the Chubut and Mendoza provinces, where uranium mining and processing is constrained by current legislation. It will be necessary to interact adequately with society to generate a more positive perception towards mining activity in these provincial domains. Should legislation be amended in these regions, there is the potential to resume development and ultimately mining and processing of these identified uranium deposits. Production from these mines would positively contribute to clean energy initiatives and provide positive economic benefits to the National State.

In 2025, the CNEA hosted an IAEA Integrated Uranium Production Cycle Review (IUPCR) mission based on the Milestones approach, with a focus on Milestone 2, which addresses preparations for restarting uranium production in Argentina. The review assessed the 16 aspects related to the development of the national infrastructure for the uranium production cycle.

Ownership structure of the uranium industry

In Argentina, the uranium industry is mainly owned by the government. Private sector participation exists only in the exploration phase, although legislation provides for the participation of both state and private sectors in uranium exploration and production activities.

Employment in the uranium industry

In connection with the uranium production industry, currently most of the employees are working on environmental monitoring, care and maintenance, and remediation tasks at the Sierra Pintada Mining-Milling Complex.

Uranium production centre technical details

(as of 1 January 2025)

	Centre #1	Centre #2
Name of production centre	Sierra Pintada Mining-Milling Complex	Cerro Solo
Production centre classification	Prospective (reopening)	Prospective
Date of first production	NA	NA
Source of ore:		
Deposit name(s)	Sierra Pintada	Cerro Solo
Deposit type(s)	Volcanic-related (synsedimentary)	Sandstone (paleochannel)
Recoverable resources (tU)	6 000	4 500-5 000
Grade (% U)	0.107	0.15-0.20
Mining operation:		
Type (OP/UG/ISL)	OP	OP
Size (tonnes ore/day)	550	600
Average mining recovery (%)	90	85-90
Processing plant:		
Acid/alkaline	Acid	Acid
Type (IX/SX)	IX	SX
Average process recovery (%)	78	80-85
Nominal production capacity (tU/year)	150	250-300
Plans for expansion	Yes	NA
Other remarks	Production started in 1976 and ceased in 1997. Remediation activities are underway.	Pre-feasibility in standby stage.

	Centre #3	Centre #4
Name of production centre	Ivana (Amarillo Grande)	Laguna Salada
Production centre classification	Prospective	Prospective
Date of first production	NA	NA
Source of ore:		
Deposit name(s)	Ivana	Guanaco, Lago Seco
Deposit type(s)	Sandstone (+/-Surficial)	Surficial
Recoverable resources (tU)	6 350	2 450
Grade (% U)	0.0317	0.009
Mining operation:		
Type (OP/UG/ISL)	OP	OP
Size (tonnes ore/day)	6 300	12 000
Average mining recovery (%)	97	82
Processing plant:		
Acid/alkaline	Alkaline	Alkaline
Type (IX/SX)	SX	IX
Average process recovery (%)	85	94
Nominal production capacity (tU/year)	580	300
Plans for expansion	NA	NA
Other remarks	Preliminary Economic Assessment Stage	Preliminary Economic Assessment Stage

Future production centres

To date, Sierra Pintada, Cerro Solo, Ivana and Laguna Salada have been considered as prospective uranium production centres. San Rafael and Cerro Solo centres belong to the CNEA and technical details have been provided by internal and external reports. Ivana and Laguna Salada centres belong to Ivana Minerales S.A. (JV by Blue Sky and Corporación América Group) and Jaguar Uranium, respectively, and their technical details have been provided in the NI 43-101 Preliminary Economic Assessment (PEA) reports filed to date.

Production and/or use of mixed oxide fuels

Argentina neither produces nor uses MOX fuel in its nuclear power plants.

Production and/or use of re-enriched tails

In Argentina there is no production or use of re-enriched tails.

Environmental activities and socio-cultural issues

The CNEA is undertaking the Uranium Mining Environmental Restoration Programme (PRAMU) and the Sierra Pintada Mining-Milling Complex Remediation Project.

The aim of the PRAMU is to restore the environment as much as possible in every area where uranium mining and milling activities have taken place. The main activities include: wide legacy site characterisation, radiological and environmental control, and remediation engineering of the environmental liabilities. PRAMU seeks to improve the conditions of the legacy sites to ensure the long-term protection of people and the environment

The Córdoba and Los Gigantes sites (Córdoba Province) have advanced detailed engineering projects underway. The sites being studied are Huemul (Mendoza Province), Pichiñán (Chubut Province), Tonco (Salta Province), La Estela (San Luis Province) and Los Colorados (La Rioja Province), where environmental baseline studies are being developed. All these sites are the subject of periodic radiological and environmental monitoring. At the Malargüe site (Mendoza Province), environmental restoration work was completed in 2017, together with the construction of a recreation space for the community. From that date, a post-closure environmental and radiological monitoring programme was initiated.

In 2019, the Remediation Project at Sierra Pintada obtained the Environmental Impact Statement, through Resolution No. 259/19, for the remediation of priority environmental liabilities: mine water and solid waste (Phase 1). Other than remediation tasks, radiological control and environmental monitoring, including surface water, groundwater, air pollution, open-pit water and sediments, are being implemented.

In 2025, the Mining-Milling Complex was granted an Extended Shutdown Licence by the Nuclear Regulatory Authority (ARN) for Class II facilities, valid for ten years.

Regulatory regime

In Argentina, production permits are subject to both national and provincial legislation. Currently, environmental studies are being undertaken on three major uranium production projects.

The CNEA is required to comply with all legislation that is in force and is under the control of various national, provincial and local (state) institutions.

Argentina's provinces have legislation limiting certain aspects of mining activities (e.g. use of certain substances, open-pit mining). The local regulations co-exist with national legislation related to mining activities and environmental protection.

National regulations

- Law No. 1 919 (1886): "National Mining Code" reformed in 1995, which in Title XI (Articles 205 to 212) refers to uranium and thorium as nuclear minerals.
- Law No. 24 585 (1995): "Amending the Mining Code regarding environmental protection". It establishes the requirement to submit an environmental impact assessment (EIA) prior to each stage of development of a mining project. It sets the maximum acceptable limits of various effluent parameters in water, air and soil.
- Law No. 25 675 (2002): "General Environmental Law". It establishes minimum standards for achieving sustainable management of the environment, the preservation and protection of biodiversity and the implementation of sustainable development.

Mendoza provincial regulations

- Resolution No. 778/96 (1996) of the General Department of Irrigation (DGI) regulates all activities that potentially affect surface water and groundwater quality in the province.
- Law No. 3 790 (1971), created the Mining General Direction with specific functions related to the administration, control and promotion of the mining industry in all its phases throughout the province.
- Law No. 7 722 (2007) prohibits the use of chemicals such as cyanide, mercury, sulphuric acid and other toxic substances typically used in metalliferous mining, including prospecting, exploration, exploitation and industrialisation of metal ores obtained by any extraction method in the province.
- Law No. 9 529 (2024): "Mining Procedures Law". It establishes the Mining Procedure Code, outlining specific procedures and regulations for mining rights. This law aims to modernise and streamline mining procedures, increasing transparency and environmental controls.

Chubut provincial regulations

- Law XVII-No. 68, formerly Law 5 001 (2003), prohibits open-pit metal mining in the province, as well as the use of cyanide in mining production processes. It also specifies the need for zoning in the province for the exploitation of mineral resources with an approved production model required for each case.
- Resolution 08/25 of the Ministry of Hydrocarbons (2025) specifically excludes ISR mining from the province's ban established by the Provincial Law XVII N° 68. This decision reflects the province's recognition of ISR as a safer and more sustainable method.

Rio Negro provincial regulations

- Law No 5 702 (2023) approves the new Mining Procedures Code.
- Resolution No 139/24 (2024) of the Mining Authority approves the integral guide to elaborate the sworn statement of good practices and the protocol of community engagement.

Uranium requirements

As of 1 January 2025, the country has three heavy water reactors in commercial operation: Atucha I (Buenos Aires province), with an installed gross capacity of 362 MWe, fed with slightly enriched U (0.85% U-235), and Embalse (Córdoba province) and Atucha II (Buenos Aires province), both operated with natural uranium fuel and installed gross capacities of 656 MWe and 745 MWe, respectively. With a total installed capacity of 1 763 MWe, nuclear power has a 7-9% share in the national electricity matrix, with natural uranium requirements of approximately 200-220 tU per year.

Between 2016 and 2018, Embalse was out of the electricity generation system for refurbishment tasks designed to extend its operating time frame by 30 years, which also increased its output by an additional 35 MWe. In 2019, the refurbished unit successfully reached criticality and obtained a commercial operation licence for its second life cycle.

In October 2022, Atucha II was shut down due to mechanical failure inside the reactor pressure vessel. The event did not pose a risk to the safety of people or the environment. In August 2023, after completing repairs and safety tests, it was restarted under the supervision of the Nuclear Regulatory Authority.

In September 2024, Atucha I entered life extension shut down, which is expected to last 30 months and extend the plant's operation by 20 years.

Additionally, the Argentine demonstration reactor CAREM (32 MWe gross) is under construction.

The expansion of the nuclear power network has also been proposed, which would be covered by the development and construction of pressurised light water SMRs.

A pilot plant for uranium enrichment located in the Pilcaniyeu Technological Complex (Bariloche) was operated in the 1980s and early 1990s before deactivation in 1995. A restart project was launched in 2006 and operations resumed in March 2014, enabling Argentina to produce enriched uranium by gaseous diffusion technology. The plant has a capacity of 20 000 SWU/year and in 2015 enriched about 600 kg of UF_6. The CNEA is currently engaged in the development of other enrichment technologies, such as ultra-centrifuges and lasers.

Supply and procurement strategy

In 1992, due to low prices in international markets, uranium concentrates began to be imported from South Africa, eventually leading to the closure of local production in 1997. Since then, there has been no production of uranium in Argentina and uranium requirements for operating nuclear power plants have been met with raw material imports from abroad (i.e. Uzbekistan, Czechia, Canada, Kazakhstan, Namibia).

Nucleoeléctrica Argentina S.A., operator of the domestic nuclear power plants, implements the uranium supply strategy and is responsible for guaranteeing a uranium fuel stock of at least two years for Argentina's operational nuclear power plants. Dioxitek S.A. converts the imported UOC into UO2 of nuclear purity ceramic grade eligible for fuel fabrication.

In addition, the fuel fabrication company (Conuar S.A.) imports a few tonnes of low-enriched uranium (LEU) every year, which is required for manufacturing slightly enriched uranium (SEU: 0.85% ^{235}U) fuel for Atucha I.

At present, both government and industry are carrying out exploration projects with the intention of restarting domestic uranium production to achieve the goal of self-sufficiency in uranium supply in a foreseeable future.

Uranium policies, uranium stocks and uranium prices

National policies relating to uranium

The Nuclear Activity Law (1997) establishes the roles of the CNEA and the Nuclear Regulatory Authority. It also provides for the participation of the public and private sectors in uranium exploration and development activities.

The National Mining Code (amended in 1995) establishes that nuclear minerals (uranium and thorium) can be explored and exploited by both the national government and the private sector with legal licences issued by a Competent Provincial Authority. The national government has the first option to purchase the uranium and thorium produced in Argentina, and the export of nuclear minerals depends upon first guaranteeing domestic supply and control of the destination of the material. The government also regulates development activities to ensure practices comply with international environmental standards.

Uranium stocks

Uranium stocks consist of 134 tU in the form of uranium concentrates, 73 tU contained in purified natural UO_2, and additional 5 tU contained in natural UO_2 and LEU scraps.

Uranium prices

Since 1997, uranium needs have been entirely met with purchases on the spot market through international tenders, without subscribing to medium- or long-term supply contracts.

Uranium exploration and development expenditures and drilling effort – domestic

(In USD)

	2022	2023	2024	2025 (expected)
Private* exploration expenditures	6 947 000	1 354 500	1 408 500	9 425 400
Government exploration expenditures	868 000	773 000	356 000	253 000
Private* development expenditures	0	0	0	0
Government development expenditures	0	0	0	0
Total expenditures	7 815 000	2 127 500	1 764 500	9 678 400
Private* exploration drilling (m)	5 683	3 000	4 960	10 895
Private* exploration holes drilled	387	80	1 246	451
Private* exploration trenches (metres)	0	60	160	925
Private* tranches (number)	0	15	40	225
Government exploration drilling (metres)	1 197	171	0	0
Government exploration holes drilled	6	1	0	0
Government exploration trenches (m)	0	228	0	0
Government trenches (number)	0	65	0	0
Private* development drilling (m)	0	0	0	0
Private* development holes drilled	0	0	0	0
Government development drilling (m)	0	0	0	0
Government development holes drilled	0	0	0	0
Subtotal exploration drilling (m)	6 880	3 171	4 960	10 895
Subtotal exploration holes drilled	393	81	1 246	451
Subtotal development drilling (m)	0	0	0	0
Subtotal development holes drilled	0	0	0	0
Total drilling (m)	6 880	3 171	4 960	10 895
Total number of holes drilled	393	81	1 246	451

* Expenditures made by private companies. Government expenditures refer to those corresponding to majority government funding.

Reasonably assured conventional resources by production method

(recoverable tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	<USD 390/kgU	Recovery factor (%)
Underground mining (UG)	0		180	180	180	72
Open-pit mining (OP)	0	7 250*	15 670**	15 670**	15 670**	72-76.7-82.45
Total	0	7 250	15 850	15 850	15 850	

* 1 860 tU, recovery factor: 76.7%; 5 390 tU, recovery factor: 82.45%.

** 8 420 tU, recovery factor: 72.0%; 1 860 tU, recovery factor: 76.7%; 5 390 tU, recovery factor: 82.45%.

Reasonably assured conventional resources by processing method

(recoverable tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	<USD 390/kgU	Recovery factor (%)
Conventional from OP	0	7 250**	11 770***	11 770***	11 770***	72.0-76.7-82.45
Heap leaching* from UG	0	0	180	180	180	72.0
Heap leaching* from OP	0	0	3 900	3 900	3 900	72.0
Total		7 250	15 850	15 850	15 850	

* A subset of open-pit and underground mining, since it is used in conjunction with them.

** 1 860 tU, recovery factor: 76.7%; 5 390 tU, recovery factor: 82.45%.

*** 4 520 tU, recovery factor: 72.0%; 1 860 tU, recovery factor: 76.7%; 5 390 tU, recovery factor: 82.45%.

Reasonably assured conventional resources by deposit type

(recoverable tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	<USD 390/kgU	Recovery factor (%)
Sandstone	0	5 390*	9 990**	9 990**	9 990**	72.0-82.45
Volcanic-related	0		4 000	4 000	4 000	72.0
Surficial	0	1 860	1 860	1 860	1 860	76.7
Total		7 250	15 850	15 850	15 850	

* 5 390 tU, recovery factor: 82.45%.

** 4 600 tU, recovery factor: 72.0%; 5 390 tU, recovery factor: 82.45%.

Inferred conventional resources by production method

(recoverable tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	<USD 390/kgU	Recovery factor (%)
Open-pit mining (OP)	0	2 330*	12 260**	13 310***	13 310***	72.0-76.7-82.45
Underground mining (UG)	0	0	250	250	250	72.0
Unspecified	0	0	5 290	5 290	5 290	72.0
Total	0	2 330	17 800	18 850	18 850	

* 1 120 tU, recovery factor: 76.7%; 1 210 tU, recovery factor: 82.45%.

** 9 930 tU, recovery factor: 72.0%; 1 120 tU, recovery factor: 76.7%; 1 210 tU, recovery factor: 82.45%.

*** 10 980 tU, recovery factor: 72.0%; 1 120 tU, recovery factor: 76.7%; 1 210 tU, recovery factor: 82.45%.

Inferred conventional resources by processing method

(recoverable tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	<USD 390/kgU	Recovery factor (%)
Conventional from OP	0	2 330**	6 150***	7 200****	7 200****	72.0-76.7-82.45
Heap leaching* from UG	0	0	250	250	250	72.0
Heap leaching* from OP	0	0	6 110	6 110	6 110	72.0
Unspecified	0	0	5 290	5 290	5 290	72.0
Total	0	2 330	17 800	18 850	18 850	

* A subset of open-pit and underground mining, since it is used in conjunction with them.

** 1 120 tU, recovery factor: 76.7%; 1 210 tU, recovery factor: 82.45%.

*** 3 820 tU, recovery factor: 72.0%; 1 120 tU, recovery factor: 76.7%; 1 210 tU, recovery factor: 82.45%.

**** 4 870 tU, recovery factor: 72.0%; 1 120 tU, recovery factor: 76.7%; 1 210 tU, recovery factor: 82.45%.

Inferred conventional resources by deposit type

(recoverable tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	<USD 390/kgU	Recovery factor (%)
Sandstone	0	1 210*	10 510**	11 560***	11 560***	72.0-82.45
Volcanic-related	0	0	6 170	6 170	6 170	72.0
Surficial	0	1 120	1 120	1 120	1 120	76.7
Total	0	2 330	17 800	18 850	18 850	

*1 210 tU, recovery factor: 82.45%.

**9 300 tU, recovery factor: 72.0%; 1 210 tU, recovery factor: 82.45%.

***10 350 tU, recovery factor: 72.0%; 1 210 tU, recovery factor: 82.45%.

Prognosticated conventional resources

(in situ tonnes U)

Cost ranges			
<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	<USD 390/kgU
0	20 100	21 270	21 270

Speculative conventional resources

(in situ tonnes U)

Cost ranges			
<USD 130/kgU	<USD 260/kgU	<USD 390/kgU	Unassigned
0	56 100	56 100	0

Historical uranium production by production method

(tonnes U in concentrate)

Production method	Total through end of 2022	2023	2024	Total through end of 2024	2025 (expected)
Open-pit mining[1]	1 859	0	0	1 859	0
Underground mining[1]	723	0	0	723	0
Total	2 582	0	0	2 582	0

1. Pre-2018 totals may include uranium recovered by heap and in-place leaching.

Historical uranium production by processing method

(tonnes U in concentrate)

Processing method	Total through end of 2022	2023	2024	Total through end of 2024	2025 (expected)
Conventional	753	0	0	753	0
Heap leaching	1 829	0	0	1 829	0
Total	2 582	0	0	2 582	0

Historical uranium production by deposit type

(tonnes U in concentrate)

Deposit type	Total through end of 2022	2023	2024	Total through end of 2024	2025 (expected)
Volcanic-related	1 600	0	0	1 600	0
Sandstone	729	0	0	729	0
Granite-related	253	0	0	253	0
Total	2 582	0	0	2 582	0

Mid-term production projection

(tonnes U/year)

2025	2030	2035	2040	2045	2050
0	0	NA	NA	NA	NA

Mid-term production capability

(tonnes U/year)

2025				2030			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
0	0	0	0	0	0	0	0

2035				2040			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
NA	NA	NA	NA	NA	NA	NA	NA

2045				2050			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
NA	NA	NA	NA	NA	NA	NA	NA

Net nuclear electricity generation

	2023	2024
Nuclear electricity generated (TWh net)	8.96	10.45

Installed nuclear generating capacity to 2050

(MWe net capacity)

2023	2024	2025		2030		2035		2040		2045		2050	
		Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
1 641	1 641	1 641	1 641	1 641	1 641	1926	2 781	2 496	3 921	3 066	5 346	3 066	6 771

Annual reactor-related uranium requirements to 2050

(tonnes U)*

2023	2024	2025		2030		2035		2040		2045		2050	
		Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
180	217	175	175	476	476	266	415	626	876	465	1 125	465	1 114

* First core loads for planned new reactors are included in the U requirements data. There are no plans to build an inventory (stockpile) of U.

Australia

Introduction

Australia has maintained involvement in the uranium industry since the industry's inception, and remains one of the world's largest producers and exporters of uranium. The majority of Australia's significant uranium deposits were discovered between 1969 and 1980 when exploration expenditures were relatively high. Since 1985, following the greenfield discovery of the Kintyre deposit in Western Australia by Conzinc Rio Tinto of Australia (CRA), exploration budgets for uranium have generally declined. However, despite the lack of major recent greenfield discoveries, Australia's uranium resource base has grown. This is due to significant brownfield extensions to known resources, and some new occurrences with similar geology delineated proximally to known deposits.

Discovered by Western Mining in 1975, and owned and operated by BHP since 2005, the Olympic Dam mine in South Australia is the world's largest single uranium resource, with continuous production since 1988. In addition to Olympic Dam, mining has occurred at Mary Kathleen and Westmoreland in Queensland; Radium Hill, Mount Painter, Wild Dog, Honeymoon, Beverley, Beverley North and Four Mile in South Australia; along with Ranger, Nabarlek and Rum Jungle, in the Northern Territory.

Most of Australia's uranium resources occur in two main types of deposits: breccia complex deposits, such as Olympic Dam, or unconformity-related deposits, such as Ranger or Kintyre. Other categories include sandstone uranium deposits, such as Honeymoon; surficial (calcrete) deposits such as Yeelirrie or Centipede; and metasomatite, metamorphic, volcanic or intrusive deposits.

During the reporting period, Australia had three operating mines that produce uranium: Olympic Dam, Four Mile and Honeymoon, all in South Australia. Total uranium production for 2024 from the three operating mines amounted to 4 656 tU.

A review of the history of uranium exploration, development and production in Australia is provided in Australia's Uranium Resources, Geology and Development of Deposits, available at: www.ga.gov.au/webtemp/image_cache/GA9508.pdf.

Recent and ongoing uranium exploration, and mine development activities

Mineral exploration in Australia is undertaken exclusively by commercial entities. However, quality geoscientific databases and information systems are maintained and made available by the Federal Government and the correct state or territory governments, augmenting Australia's favourable geological settings.

Exploration expenditure for uranium increased in 2024 to AUD 71.3 million from AUD 55 million in 2023 and AUD 21.7 million in 2022.

South Australia

South Australia has five approved uranium mines: Olympic Dam, Honeymoon, Beverley, Beverley North and Four Mile. Olympic Dam, Four Mile and Honeymoon produced uranium in 2024. Mining at Beverley and Beverley North has ceased and the sites are working towards closure, with both mines used to transport and process uranium concentrates from the Four Mile Mine.

- Olympic Dam

BHP Ltd's breccia-hosted, iron oxide copper-gold (IOCG), Olympic Dam deposit is Australia's largest uranium mine. In 2024, it contributed approximately 60% of Australia's uranium production as a by-product to primary copper production. Plans for a large expansion at Olympic Dam have been scaled back. Instead, BHP plans to steadily increase production capacity under its existing approvals, and in 2018, underground operations commenced in the "Southern Mining Area" of the resource.

- Oak Dam

BHP Ltd is currently exploring the Oak Dam, copper, gold, silver, uranium and IOCG deposit, located 65 km southeast of Olympic Dam. The copper-gold resource at Oak Dam commences at 800 m below the surface and, as of 28 April 2024, BHP had completed approximately 158 km of exploration drilling. BHP consider that further exploration is required to better understand the resource potential of Oak Dam and, to do this, they have applied to the South Australian Department for Energy and Mining requesting approval for a Retention Lease (RL) and Miscellaneous Purposes Licences (MPLs) for the Oak Dam Underground Access Project. This project will enable efficient, underground exploration drilling to better define the resource and support future investment decisions. The work is expected to take approximately 10 years.

In August 2024, BHP published a first-time Inferred Mineral Resource at Oak Dam of 1.34 billion tonnes at grades of 0.66% copper and 0.33 g/t gold, at a 0.2% Cu cut-off grade.

- Four Mile

The Four Mile mine is located approximately 550 km north of Adelaide. It is operated by Quasar Resources Pty Ltd using in situ leaching (ISL or ISR) to extract uranium from sandstone deposits. Uranium is extracted at Four Mile West, Four Mile East and Four Mile North, with Four Mile North East under continued delineation drilling. Uranium-bearing resin from Four Mile is pumped to the Beverley processing plant for elution, precipitation and drying as uranium concentrate.

- Honeymoon

Operated by Boss Energy Ltd, the sandstone-type Honeymoon deposit, was in care and maintenance from 2013 until it recommenced production in early 2024. This restart followed a positive Enhanced Feasibility Study released by Boss Energy Ltd in June 2021. Uranium extraction from the host sandstone units is undertaken using in situ leaching (ISL or ISR). The Honeymoon project, comprising Honeymoon, Gould's Dam and Jason's deposits, has identified resources of 23 306 tU. During 2024, Boss Energy Ltd completed infill drilling at the Gould's Dam and Jason's deposits, as well as new exploration drilling at the Cummins Dam prospect.

- Samphire

The Samphire Project, comprising the Blackbush and Plumbush uranium deposits, is located 20 km south of Whyalla in regional South Australia, with Alligator Energy Ltd being the tenement holder of a RL. Drilling for an ISR field recovery trial for uranium extraction began in late 2025 at the Blackbush deposit. Outcomes of the trial and further exploration will determine if an application for mining will be sought by the company.

Western Australia

In 2017, the state government announced a ban on future uranium mining leases but noted that it would not prevent development of projects that had previously received State Ministerial approval. Prior to the decision to ban uranium mining, environmental approvals had been issued for four uranium mining projects: Mulga Rock (Deep Yellow Ltd, formerly Vimy Resources Ltd), Wiluna (Toro Energy Ltd), Yeelirrie and Kintyre (both Cameco Australia Pty Ltd). These projects are subject to legally binding State Ministerial approval conditions and were required to have been substantially commenced within five years from the date of the approval.

Cameco Australia's Yeelirrie and Kintyre projects as well as Toro Energy's Wiluna project did not meet the requirement of "substantial commencement" and their environmental approvals expired in January 2022.

Vimy Resources submitted a mining proposal for Mulga Rock under the *Western Australian Mining Act 1978,* in 2020. The Mining Proposal was approved in September 2021, consistent with conditions of the primary approval granted by the Minister for Environment. In November 2021, Vimy Resources formally notified the Western Australian government of "substantial commencement" of this project.

- Mulga Rock

The sandstone-type Mulga Rock resource is wholly owned by Deep Yellow Ltd, following a merger between Vimy Resources Ltd (the previous owner) and Deep Yellow in August 2022. The Mulga Rock project is located 240 km east of Kalgoorlie in Western Australia and consists of four deposits: Ambassador and Princess (Mulga Rock East), Emperor, and Shogun (Mulga Rock West). The project will involve shallow open-pit mining of the four polymetallic deposits where commercial grades of uranium occur in sandstone-hosted carbonaceous material. It has a 15-year mine life and is anticipated to produce 1 346 tU annually.

In January 2018, Vimy Resources released a definitive feasibility study (DFS) for the Mulga Rock project and, in September 2021, the Western Australian Department of Mines, Industry Regulation and Safety approved the Mulga Rock mining proposal and associated mine closure plan.

In 2024, Deep Yellow announced a 26% increase of the uranium resource at their Mulga Rock East project (Ambassador and Princess deposits) and planned to undertake a revised DFS starting in mid-2025 that they hoped to complete by mid-2026. Production is planned to begin in 2029.

- Yeelirrie

The surficial calcrete-hosted Yeelirrie uranium deposit is wholly owned by Cameco Australia Pty Ltd, and is located about 420 km north of Kalgoorlie and 70 km southwest of Wiluna, in Western Australia. It is one of the world's largest surficial uranium deposits and is, therefore, suited to open-pit mining with minimal drilling or blasting required. Cameco acquired the Yeelirrie project from BHP Ltd in 2012.

It is estimated that average production from the Yeelirrie project would be nearly 3 300 tU per annum over 19 years, utilising open-pit mining and alkaline leach processing technology.

The Yeelirrie Uranium Project received environmental approval from the Commonwealth Government in April 2019. However, the environmental approval that was granted by the Western Australian government in January 2017, has since expired.

- Kintyre

The unconformity-related Kintyre uranium deposit is wholly owned by Cameco Australia Pty Ltd, which acquired the 30% interest that was held by Mitsubishi Development Pty Ltd, in 2018. Kintyre is located in the East Pilbara region of Western Australia, approximately 260 km northeast of Newman at the western edge of the Great Sandy Desert. Although there is no outcrop, the Kintyre resource is suited to open-pit mining with the uppermost parts of the resource 50 m below surface. It is estimated that average production from the Kintyre project would be around 2 290 tU per annum, with an estimated mine life of 15 years.

In 2015, Cameco Australia secured Commonwealth and state environmental approval for the Kintyre project that has since expired.

- Wiluna Uranium Project

Toro Energy Ltd is the sole owner of the Wiluna Uranium Project, which is a surficial calcrete-hosted regional resource located 30 km from the town of Wiluna in central Western Australia. Wiluna comprises six deposits: Centipede, Lake Way, Millipede, Lake Maitland, Dawson Hinkler and Nowathanna. The first four (listed above) deposits collectively make up the Wiluna Uranium

Project, while the Dawson Hinkler and Nowathanna deposits are regarded as advanced exploration prospects.

Mining at Wiluna is planned as shallow strip excavation to a maximum depth of 15 metres. The project proposes to use alkaline agitated leaching in tanks at elevated temperatures to process the ore. Since 2022, Toro Energy has been investigating the potential of developing the Lake Maitland uranium deposit as a stand-alone mining and processing operation that would also produce vanadium as a by-product. It is estimated that average production from the Wiluna uranium project would be around 500 tU per annum and 340 t of vanadium pentoxide (V_2O_5), with an estimated mine life of 16 years.

Mining of the Centipede and Lake Way uranium deposits, including the construction of a processing facility at Centipede, received environmental approval from the Western Australian government in 2012 and the Commonwealth Government in 2013. Toro expanded the Wiluna project proposal, which encompasses the Lake Maitland and Millipede resources, and received Commonwealth and state environmental approval in 2017, with the state environmental approval now expired.

Northern Territory

- Ranger

After 40 years of uranium production, and a total of approximately 112 000 tU, mining operations at the Ranger mine ceased on 8 January 2021. The Ranger mine, operated by Energy Resources of Australia Ltd. (ERA; majority owner Rio Tinto with 98.43%) is located in the Pine Creek Inlier and is classified as an unconformity-related deposit. In 2012, Pit 3 mining operations ceased, with production from 2013 being maintained through stockpiled ore material. Activities ceased at Ranger Pit 1 in 1994 and it has since been filled, capped and revegetated. Active rehabilitation of the mine area is expected to be completed in 2035 followed by approximately 25 years of monitoring.

Queensland

Queensland hosts more than 80 known sites that contain valuable amounts of uranium, mainly in the remote northwestern area of the state. In March 2015, the Queensland government announced that it intended to reinstate a ban on uranium mining, which was originally appealed in 2012. Currently, Queensland allows uranium exploration but not mining.

New South Wales

Uranium exploration was prohibited in New South Wales for 26 years until 2012, when the state government overturned the ban. However, while uranium exploration is currently permitted, the ban on uranium mining remains in place.

Victoria

Uranium exploration and uranium mining are prohibited in Victoria.

Tasmania

Uranium exploration and uranium mining are permitted in Tasmania, but the state does not have significant resources.

Uranium resources

Identified conventional resources (reasonably assured and inferred resources)

On 1 January 2025, Australia's total uranium reasonably assured resources (RAR) recoverable at a cost of <USD 130/kgU, amounted to 1 283 428 tU (2 031 670 tU in situ) and inferred conventional resources totalled 418 182 tU (655 905 tU in situ).

Estimated mining and processing losses were deducted from commercial uranium resource reports for individual deposits submitted under the Australian Joint Ore Reserves Committee (JORC) Code. For deposits where this information is not available, an overall mining and milling recovery factor was applied as recommended in the 2025 Red Book Questionnaire. Overall recovery factors range from 58% to 95%.

The 2025 national total for RAR in the <USD 130/kgU category increased by 3.8% from the previous country report. This moderate rise is the result of uranium resource increases at Olympic Dam and Mulga Rock. A drop of 3.9% for Australia's inferred uranium resources between reporting periods in the <USD 130/kgU category can be directly attributed to a decrease in the inferred resources at Olympic Dam of nearly 6%.

Although there are more than 30 deposits with identified resources recoverable at costs of <USD 130/kgU, the vast majority of Australia's resources are within the following three individual deposits: Olympic Dam mine in South Australia, Jabiluka in the Alligator Rivers Region of the Northern Territory and Yeelirrie in Western Australia. At the Olympic Dam mine, uranium is a by-product of copper mining, with gold and silver also recovered.

Undiscovered conventional resources (prognosticated and speculative resources)

Geoscience Australia does not make estimates of Australia's undiscovered uranium resources.

Unconventional resources and other materials

Geoscience Australia does not make estimates of Australia's unconventional uranium resources.

Uranium production

Historical review

Uranium produced in Australia is exported to countries in North America, Asia and Europe, and is used as fuel in nuclear power stations to generate electricity. The current phase of Australian uranium production commenced in 1976. Exports are approximately 6 400 (tU) per annum (averaged over ten years), or around 12% of the global market.

A review of the history of uranium production in Australia is provided in Australia's Uranium Resources, Geology and Development of Deposits, available at: www.ga.gov.au/webtemp/image_cache/GA9508.pdf.

Status of production capability, and recent and ongoing activities

As of 1 January 2025, Australia had three operating uranium mines, Olympic Dam (BHP Ltd), Four Mile (Quasar Resources Pty Ltd) and Honeymoon (Boss Energy Ltd), all in South Australia. Total uranium production from these mines in 2024 was 4 656 tU.

Olympic Dam

Olympic Dam's production of payable metal in concentrate for 2024 was 2 704 tU, a decrease of 271 tonnes from 2023. Olympic Dam contains well over one million tonnes of uranium resources, making it the largest single uranium deposit in the world. It is also the only known breccia complex deposit that has significant economic resources of uranium.

Olympic Dam produces copper cathode, refined gold and silver bullion, along with uranium oxide. The BHP-owned underground mine utilises long-hole open-stopping technology and cemented aggregate fill, with integrated metallurgical processing. While uranium production is planned to remain stable in the near term, it is anticipated that output may increase over time through incremental production efficiency gains and infrastructure investment.

Beverley/Beverley North

The sandstone-type Beverley resources, located east of the Flinders Ranges in South Australia, began operations in 1990. Production from Beverley, operated by Heathgate Resources Pty Ltd, started in late 2000, making it Australia's first operating ISR mine.

The Beverley and Beverley North mines were in care and maintenance from early 2012 and 2018, respectively, and both moved to closure in 2020. Rehabilitation of old production wellfields will continue over the next decade.

Four Mile

The Four Mile resource, which is operated by Heathgate Resources on behalf of Quasar Resources Pty Ltd, comprises several significant sandstone uranium deposits, Four Mile East, Four Mile West and Four Mile North. The initial phase of operations consisted of pumping uranium-bearing solutions to the nearby satellite ion-exchange plant at the Pannikan deposit. The resin produced was initially trucked to the Beverley processing plant for elution but, as of October 2019, it is pumped via trunk lines for precipitation and drying of the uranium concentrates. In 2025 an additional trunkline has been installed between Four Mile and the Beverley Processing Plant. Uranium production from the Four Mile Mine in 2024 amounted to 1 814 tU.

Honeymoon

Boss Energy Ltd's Honeymoon uranium ISR mine began production in 2011 but ceased operations in 2013, owing to low uranium prices. Originally owned by Uranium One, it was acquired by Boss Resources in 2015 (now Boss Energy Ltd). Honeymoon recommenced mining in early 2024 and produced 138 tU in the year.

Uranium production centre technical details

(as of 1 January 2025)

	Centre #1	Centre #2	Centre #3	Centre #4
Name of production centre	Olympic Dam	Four Mile[(a)]	Honeymoon	Mulga Rock
Production centre classification	Existing	Existing	Recommenced mining in 2024	Planned
Date of first production (year)	1988	2014	2011	Not known
Source of ore				
Deposit name(s) or district name	Olympic Dam	Four Mile	Honeymoon, Gould's Dam, Jason's	Princess, Shogun, Ambassador, Emperor
Deposit type(s)	Polymetallic Fe-oxide breccia complex	Sandstone	Sandstone	Sandstone
Recoverable resources (tU)	1 358 700	14 680[(a)]	23 306	37 550
Grade (% U)	0.048	0.29	0.15	0.08
Mining operation				
Type (OP/UG/ISL)	UG	ISR	ISR	OP
Size (tonnes ore/day)	29 600	NA	NA	NA
Average mining recovery (%)	85	NA	NA	95
Processing plant				
Acid/alkaline	Acid	Acid	Acid	Acid
Type (IX/SX)	SX	IX	IX	
Size (tonnes ore/day)	1 400	NA	NA	NA
Average process recovery (%)	68	85	85	87
Nominal production capacity (tU/year)	2 800	1 700	960	1 346
Plans for expansion (yes/no)	yes	no	no	no

(a) The recoverable resources stated for the Four Mile mine are only current to December 2018. Subsequent production at Four Mile from 2019 to 2024 has been approximately 10 700 tU.

	Centre #5	Centre #6	Centre #7
Name of production centre	Yeelirrie	Wiluna	Kintyre
Production centre classification	Prospective	Prospective	Prospective
Date of first production (year)	Not known	Not known	Not known
Source of ore			
Deposit name(s) or district name	Yeelirrie	Centipede, Lake Way, Millipede, Lake Maitland	Kintyre
Deposit type(s)	Surficial (Calcrete)	Surficial (Calcrete)	Proterozoic unconformity
Recoverable resources (tU)	39 409	22 700	18 253
Grade (% U)	0.13	0.09	0.53
Mining operation			
Type (OP/UG/ISL)	OP	OP	OP
Size (tonnes ore/day)	NA	NA	NA
Average mining recovery (%)	NA	NA	NA
Processing plant			
Acid/alkaline	Alkaline	Alkaline	Alkaline
Type (IX/SX)	IX	IX	NA
Size (tonnes ore/day)	NA	NA	1 700
Average process recovery (%)	80	80	80
Nominal production capacity (tU/year)	3 265	500	2 290
Plans for expansion (yes/no)	no	yes (vanadium)	no

Ownership of uranium production

Australia's uranium mines are owned and operated by a range of domestic and international companies:

- The Olympic Dam mine is fully owned by BHP Ltd, listed on the Australian Stock Exchange (ASX: BHP).
- The Four Mile mine is fully owned by Quasar Resources Pty Ltd, but operated by sister company Heathgate Resources Pty Ltd. Both Quasar Resources and Heathgate Resources are owned by General Atomics (United States).
- The Honeymoon mine is fully owned and operated by Boss Energy Ltd, listed on the Australian Stock Exchange (ASX:BOE)

Secondary sources of uranium

Australia does not produce or use mixed oxide fuels, re-enriched tails or reprocessed uranium.

Environmental activities and socio-cultural issues

Environmental approvals

Australia's Commonwealth and state, or territory, legislative framework require proponents of uranium mines to undertake rigorous and comprehensive environmental impact assessment processes that incorporate public comments on the proposal. A Commonwealth assessment is conducted under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). An EPBC Act assessment is usually undertaken bilaterally with the correct state and territory authorities. An environmental assessment is required for modifications to existing projects along with new proposals, ensuring that strict requirements for environmental, heritage and nuclear safeguards are maintained.

Social factors are also considered in the approvals processes. In particular, Aboriginal Land Rights and Native Title legislation seek to ensure that the concerns and cultural needs of Aboriginal people are respected.

Site rehabilitation

The Ranger mine, operated by Energy Resources Australia, ceased uranium production on 8 January 2021. The Ranger project area continues to undergo extensive rehabilitation work that is expected to be completed in 2035. An updated Ranger mine closure plan was released by ERA in October 2024, with the objective to rehabilitate the disturbed regions of the project area to a condition similar to the environment of the surrounding Kakadu National Park. The closure plan also includes a monitoring programme for 25 years after the rehabilitation programme is completed. The total cost of rehabilitation is predicted to be AUD 2.4 billion.

Regulatory activities

Radiological protection matters arising from uranium mining in Australia are principally the responsibility of the states and territories where mining occurs. The Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) is responsible for developing Australia's national radiological protection framework as laid out in the Radiation Protection Series (RPS), which are implemented through jurisdictional legislation and licence conditions.

ARPANSA's RPS includes a pivotal background document, RPS F-1 *Fundamentals for Protection Against Ionising Radiation* (2014), and several codes and guides relating to uranium mining and associated processes:

- *RPS 9 Code of Practice and Safety Guide for Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing (2005); RPS 15 Safety Guide for the Management of Naturally Occurring Radioactive Material (NORM) (2008);*
- *RPS 16 Safety Guide for the Predisposal Management of Radioactive Waste (2008);*
- *Guide for Classification of Radioactive Waste (RPS G-4);*
- *RPS 9.1 Safety Guide for Monitoring, Assessing and Recording Occupational Radiation Doses in Mining and Mineral Processing (2011);*
- *Radiation Protection Series C-2 (Rev. 1);*
- *RPS G-1 Guide for Radiation Protection of the Environment (2015);*
- *Code for Radiation Protection in Planned Exposure Situations.*

ARPANSA continues to develop frameworks that guide radiological protection best practice and works closely with industry representative bodies through consultative processes. ARPANSA also administers the Australian National Radiation Dose Register (ANRDR) for the storage and maintenance of dose records of workers occupationally exposed to ionising radiation. Since 2013, ANRDR has complete coverage of the uranium mining and milling industry in Australia with all operations submitting relevant dose records.

A Radon Progeny Technical Coordination Group was established with representation from the uranium mining industry, state regulators and ARPANSA to develop a national approach to radon progeny dose assessment, to address proposed changes in international recommendations. This included a programme of measurements in Australian uranium mines. This work has been published as an Advisory Note on the ARPANSA website: *New dose coefficients for radon progeny: Impact on workers and the public*, and is available at: www.arpansa.gov.au/understanding-radiation/sources-radiation/radon/new-dose-coefficients-radon-progeny-impact-workers.

The Australian government released the 2016 edition of the *Leading Practice Sustainable Development Program for the Mining Industry (LPSDP)* of that year. The latest edition consists of a 17-book series with several updated handbooks and two new handbooks – *Community Health and Safety* and *Energy Management in Mining*. Further information on the Leading Practice handbooks can be found at www.industry.gov.au/data-and-publications/leading-practice-handbooks-for-sustainable-mining.

Uranium requirements

Australia has no commercial nuclear power plants and has very limited domestic uranium requirements. An Open Pool Australian Lightwater (OPAL) research reactor is operated by the Australian Nuclear Science and Technology Organisation (ANSTO) at Lucas Heights, south of Sydney, New South Wales. The OPAL reactor was opened in 2007, with the capacity to produce commercial quantities of radioisotopes utilising low-enriched uranium (LEU) fuel.

Uranium policies, uranium stocks and uranium prices

National policies

Australian policy states that Australian uranium can only be exported to countries with which Australia has a nuclear co-operation agreement, to be used for peaceful purposes. They must also have safeguards agreements with the International Atomic Energy Agency (IAEA), including an Additional Protocol. Australia's network of safeguards agreements now totals 25.

The Australian government supports the development of a sustainable Australian uranium mining sector in line with the world's best practice environmental and safety standards.

The regulatory framework governing uranium mining and exploration in Australia varies between Commonwealth, state, and territory jurisdictions. Uranium exploration and mining are permissible in South Australia and the Northern Territory. In Western Australia, uranium exploration is permissible, but uranium mining is prohibited, except for projects that were approved prior to 2017 and have since demonstrated "substantial commencement". In New South Wales and Queensland, uranium mining is prohibited but exploration is permissible. Victoria prohibits uranium exploration and mining.

Australia's moratorium on nuclear power has been in effect since 1998. The Australian Government is supporting Australia's energy transformation through its Powering Australia plan, focussed on firmed renewables. Further processing of uranium is prohibited in Australia under two Commonwealth laws (noting state and territory laws also apply to these activities):

- *The Australian Radiation Protection and Nuclear Safety Act 1998* prohibits enrichment of uranium, reprocessing spent fuel and construction of nuclear power plants.
- The *Environment Protection and Biodiversity Conservation Act 1999* requires approval from the Minister for the Environment to undertake uranium mining and milling activities, and bans enrichment of uranium and reprocessing of fuel.

Regulation 9 of Australia's *Customs (Prohibited Exports) Regulations 1958*, provides that the export of goods listed in Schedule 7 of the Regulations is prohibited unless permission is obtained from the Commonwealth Minister administering the *National Radioactive Waste Management Act 2012*, or their authorised person. Goods listed in Schedule 7 include minerals, ores, concentrates, and other material containing more than 500 parts per million of uranium and thorium combined.

Uranium stocks

For reasons of confidentiality, information on producer stocks is not available.

Uranium prices

The average price of uranium exported from Australia in 2024 was USD 66.14/lb U_3O_8 with exports governed by a combination of contract specifications. Average export prices for the last five years are listed in the table below.

Average export prices for Australian uranium oxide 2019–2024

Average export value	2019	2020	2021	2022	2023	2024
AUD/lb U_3O_8	42.81	48.47	43.63	59.49	80.96	100.53
USD/lb U_3O_8	30.05	33.48	32.79	41.25	53.75	66.14

Uranium exploration and development expenditures, and drilling effort – domestic

(AUD millions)

	2022	2023	2024	2025 (expected)
Private* exploration expenditures	21.7	55.0	71.3	50.0
Government exploration expenditures	0	0	0	0
Private* development expenditures	NA	NA	NA	NA
Government development expenditures	0	0	0	0
Total expenditures	21.7	55.0	71.3	50.0
Private* exploration drilling and trenches	NA	NA	NA	NA
Government exploration drilling and trenches	0	0	0	0
Private* development drilling	NA	NA	NA	NA
Government development drilling	0	0	0	0
Subtotal exploration drilling (metres)	NA	NA	NA	NA
Subtotal development drilling (metres)	NA	NA	NA	NA
Total drilling (metres)	NA	NA	NA	NA
Total number of holes drilled	NA	NA	NA	NA

* Non-government.

Conventional reasonably assured resources by production method

(recoverable, tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	<USD 390/kgU
Underground mining (UG)	NA	NA	88 706	96 479	96 479
Open-pit mining (OP)	NA	NA	133 059	155 573	155 573
In situ recovery (ISR)	NA	NA	34 435	43 017	43 017
Co-product and by-product	NA	NA	1 027 228	1 067 378	1 067 378
Total	NA	NA	1 283 428	1 362 447	1 362 447

Conventional reasonably assured resources by processing method

(recoverable, tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	<USD 390/kgU
Conventional from UG	NA	NA	1 115 934	1 163 857	1 163 857
Conventional from OP	NA	NA	133 059	155 573	155 573
In situ recovery (ISR)	NA	NA	34 435	43 017	43 017
Total	NA	NA	1 283 428	1 362 447	1 362 447

Conventional reasonably assured resources by deposit type

(recoverable, tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	<USD 390/kgU
Proterozoic unconformity	NA	NA	78 151	80 990	80 990
Sandstone	NA	NA	75 600	85 487	85 487
Polymetallic Fe-oxide breccia complex	NA	NA	1 027 228	1 067 724	1 067 724
Granite-related	NA	NA	322	322	322
Intrusive	NA	NA	0	13 873	13 873
Volcanic-related	NA	NA	2 433	4 826	4 826
Metasomatite	NA	NA	29 281	29 699	29 699
Metamorphic	Na	NA	0	4 894	4 894
Surficial	NA	NA	70 413	74 632	74 632
Total	NA	NA	1 283 428	1 362 447	1 362 447

Conventional inferred resources by production method

(recoverable, tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	<USD 390/kgU
Underground mining (UG)	NA	NA	44 056	48 216	48 216
Open-pit mining (OP)	NA	NA	24 275	112 157	112 157
In situ recovery (ISR)	NA	NA	16 890	39 629	39 629
Co-product and by-product	NA	NA	332 961	396 711	396 711
Total	NA	NA	418 182	596 713	596 713

Conventional inferred resources by processing method

(recoverable, tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	<USD 390/kgU
Conventional from UG	NA	NA	377 017	444 927	444 927
Conventional from OP	NA	NA	24 275	112 157	112 157
In situ recovery (ISR)	NA	NA	16 890	39 629	39 629
Total	NA	NA	418 182	596 713	596 713

Conventional inferred resources by deposit type

(recoverable, tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	<USD 390/kgU
Proterozoic unconformity	NA	NA	37 491	54 417	54 417
Sandstone	NA	NA	34 446	70 714	70 714
Polymetallic Fe-oxide breccia complex	NA	NA	332 961	396 711	396 711
Granite-related	NA	NA	0	28	28
Intrusive	NA	NA	0	7 717	7 717
Volcanic-related	NA	NA	0	1 089	1 089
Metasomatite	NA	NA	8 424	11 902	11 902
Metamorphic	NA	NA	0	14	14
Surficial	NA	NA	4 860	54 121	54 121
Total	NA	NA	418 182	596 713	596 713

Prognosticated conventional resources

(in situ tonnes U)

Cost ranges		
<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
NA	NA	NA

Speculative conventional resources

(in situ tonnes U)

Cost ranges		
<USD 130/kgU	<USD 260/kgU	Unassigned
NA	NA	NA

Historical uranium production by production method

(tonnes U in concentrates)

Production method	Total through end of 2022	2023	2024	Total through end of 2024	2025 (estimate)
Open-pit mining	132 533	0	0	132 533	0
Underground mining	838	0	0	838	0
In situ recovery (ISR)	20 488	1 755	1 952	24 195	2 595
Co-product/by-product	86 330	2 931	2 704	91 965	2 800
Total	240 189	4 686	4 656	249 531	5 395

Historical uranium production by processing method

(tonnes U in concentrates)

Processing method	Total through end of 2022	2023	2024	Total through end of 2024	2025 (estimate)
Conventional	219 701	2 931	2 704	22 5336	2 800
In situ recovery (ISR)	20 488	1 755	1 952	24 195	2 595
Total	240 189	4 686	4 656	249 531	5 395

Historical uranium production by deposit type

(tonnes U in concentrates)

Deposit type	Total through end of 2022	2023	2024	Total through end of 2024	2025 (estimate)
Proterozoic unconformity	125 119	0	0	125 119	0
Sandstone	20 488	1 755	1 952	24 195	2 595
Polymetallic Fe-oxide breccia complex	86 330	2 931	2 704	91 965	2 800
Metasomatite	7 531	0	0	7 531	0
Intrusive	721	0	0	721	0
Total	240 189	4 686	4 656	249 531	5 395

Ownership of uranium production in 2024*

Domestic		Foreign		Totals	
private		Government/private			
(tU)	(%)	(tU)	(%)	(tU)	(%)
2 842	61	1 814	39	4 656	100

* These figures are estimated based on public ownership information. For reasons of confidentiality, government vs. private ownership information is not available; there is no Australian government production ownership. Estimated by proportioning domestic private ownership and foreign private ownership for each uranium mining company, by its production for 2024.

Uranium industry employment at existing production centres

(person-years)

	2022	2023	2024	2025 (expected)
Total employment related to existing production centres	3 130	3 390	3 560	3 560
Employment directly related to uranium production	2 170	2 350	2 470	2 470

Mid-term production projection (tonnes U/year)

(tonnes U/year)

2025	2030	2035	2040	2045	2050
5 540	6 890	6 890	6 890	6 890	6 890

Mid-term production capability (tonnes U/year)

2025				2030			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
NA	NA	5 540	NA	NA	NA	6 890	NA

2035				2040			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
NA	NA	6 890	NA	NA	NA	4 150	6 890

2045				2050			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
NA	NA	4 150	6 890	NA	NA	2 800	6 890

Botswana *

Uranium exploration and mine development

Historical review

A surge in the uranium price in the 1970s led to exploration activities in Botswana by various foreign and local companies. Large airborne radiometric surveys were followed by ground surveys, soil sampling, trenching and drilling. However, the thick sand cover in many parts of the country hindered exploration activities. Exploration effectively ceased in the early 1980s with the slump in uranium prices. No deposits of economic interest were discovered in this early phase of exploration, but significant mineralisation was identified in the Karoo sandstones and surficial calcretes, particularly in the east-central part of the country.

Rising uranium prices in 2005 renewed interest in uranium exploration by junior Australian companies and, by 2011, there were 168 uranium prospecting licences registered in Botswana.

A-Cap Energy Ltd (formerly known as A-Cap Resources) had been exploring in Botswana since 2004, following up on mineralisation discovered by Falconbridge in the 1970s in the Serowe area, and further discovering significant mineralisation at the Letlhakane project. Intensive drilling resulted in A-Cap reporting Botswana's first JORC compliant uranium resource in 2008 of just over 100 000 tU, at an average grade of 129 ppm U (0.0129% U).

Impact Minerals Ltd, another Australian junior company, acquired permits around A-Cap's areas in early 2008. Exploration activities began in 2009 with airborne radiometric surveys, followed by field reconnaissance, mapping and drilling, leading to the discovery of four prospects in Karoo siltstones and sandstones. In addition to sandstone-hosted mineralisation, there were discoveries of uranium-bearing alaskitic rocks, similar to those found at Rössing in Namibia, and mineralisation related to Proterozoic sedimentary and basement rocks with similarities to the unconformity-related deposits in Australia and Canada. Impact Minerals was also exploring prospective deposits in eastern Botswana, including Lekobolo, with uranium mineralisation down to 45 m. Further south, it had the Shoshong and Ikongwe prospects in calcrete.

At the end of 2012, A-Cap's prospecting licences for uranium covered 5 000 km^2, while Impact Minerals Ltd controlled 26 000 km^2. The two companies drilled a total of 12 462 m in 95 reverse circulation holes during 2011, but no drilling was reported in 2012. Both companies completed regional ground gravity surveys and Impact Minerals Ltd completed a soil geochemical survey over an area of 250 km^2 at the Ikongwe prospect.

In May 2013, Impact Minerals Ltd announced the sale of four prospecting licences to a local company, Sechaba Natural Resources, but this was not completed due to licensing delays. In 2014, Impact Minerals Ltd put its uranium exploration on hold and the majority of their prospecting licences within the Botswana uranium project licences were not renewed.

The Letlhakane uranium deposit has been the focus of detailed technical work for A-Cap since 2010, resulting in the February 2013 release of a positive scoping study. A thorough examination of all aspects of the resource has led to a greater understanding of the framework

* Report prepared by the NEA/IAEA, based on the Red Book 2024 and A-Cap Energy Ltd and Lotus Resources Ltd public reports.

and grade distribution of uranium mineralisation, and the use of appropriate mining techniques to maximise the economics of the deposit.

Uranium mineralisation, hosted predominantly in carbonaceous mudstones and siltstones, occurs in relatively thin (0.5-5 m), laterally extensive lenses with lower-grade material separating higher-grade ore horizons. The nature of the ore combined with shallow, flat-lying and soft strata lends itself well to open-pit extraction methods. This information has resulted in a resource estimation that is smaller than previously reported, but with higher grades.

A drilling programme was completed in September 2014, focussing on shallow high-grade zones where initial optimisation runs delineated possible early pits. The drilling programme was designed to test the continuity and mine scale variability of mineralisation in three main project areas (Kraken, Gorgon and Serule West), and to provide data for further resource modelling and mine planning. This drilling yielded excellent results, and confirmed the presence and continuity of high-grade mineralisation within these areas.

A drill optimisation study has also been completed, focussed on the Kraken area where infill drilling had previously been completed. Holes were then excluded to define pre-infill drilling grids at 400 m spacing, 200 m spacing, as well as patterns of 100 x 100 m and 50 x 100 m. The results from the Kraken area concluded that the drilling defines the resource at 200 m spacing and only small variations in grade and contained metal occur when infill drilling is subsequently conducted.

A follow-up infill drilling programme was successfully completed in November 2014 and in September 2015, A-Cap announced an upgrade of Letlhakane JORC compliant resources for all deposits.

Resources reported by A-Cap Energy Ltd, compliant with the JORC 2012 code (September 2015)

Cut-off (U ppm)	Total indicated			Total inferred			Total		
	Mt	U (ppm)	Contained U (tU)	Mt	U (ppm)	Contained (tU)	Mt	U (ppm)	Contained U (tU)
85	197.1	167	32 890	625.0	172	107 740	822.1	171	140 630
170	59.2	274	16 230	209.7	272	57 010	268.9	272	73 240
255	22.2	393	8 730	81.6	378	30 890	103.8	382	39 620

In August 2015, a mining licence application was submitted to the Botswana Department of Mines. The application was based on the results of a technical study and financial modelling, assuming open-pit mining and heap leaching processing, to produce 1 440 tU/yr over a mine life of 18 years. A detailed programme of process test work including acid column leaching, solvent extraction and ion exchange, was completed. Uranium recoveries varied from 60.5% to 77.7%, depending on the mineralisation type.

In 2017, A-Cap completed in-house processing studies with the objective of reducing acid consumption and increasing recovery. Acid soluble uranium analysis was performed on 296 samples. Results showed spatial and mineralogical relationships with high acid consumption in the Kraken and Gorgon South areas, exhibiting an increase in acid consumption with depth. Optimisation studies identified savings of up to 26% of acid consumption.

Exploration activities were suspended in 2018, due to an unfavourable uranium price outlook. In 2018-2019 A-Cap continued to attend to the requirements of the Letlhakane Uranium Project's mining licence, including meeting reporting requirements, maintenance of the mining licence boundary, radiation inspectorate compliance and engaging with the community to update them on the project's status. The Department of Mines confirmed that the mining licence and all prospecting licences continue to be in good standing.

Recent and ongoing uranium exploration, and mine development activities

On July 13 2023, A-Cap Resources Ltd and Lotus Resources Ltd agreed to merge via a scheme of arrangement, whereby Lotus acquired 100% of the A-Cap shares. The deal closed in December 2023.

In May 2024, Lotus completed a pit constrained resource estimate to better understand the potential size and economics of the Letlhakane Project. The resource estimate was 155.3 Mt at 345 ppm U_3O_8 (293 ppm U) for 118.2 Mlb U_3O_8 (45 460 tU). It was based on a 200 pm U_3O_8 (170 ppm U) cut-off grade.

	Ore (Mt)	Grade (ppm U)	Uranium (tU)
Indicated	46.1	287	13 230
Inferred	109.2	295	32 230
Total	155.3	293	45 460

From June to September 2024, Lotus conducted a drilling campaign in order to upgrade Inferred Resources to Indicated and Measured status. A total of 145 RC holes and 19 diamond core holes have been completed, totaling 12 106 m.

Results of the 76 infill holes (6 563 m) drilled at Gorgon West have significantly improved the confidence in the uranium resources within this area. At Gorgon West, the higher-grade intercepts and thicker intercepts are generally found in the northwest of the deposit.

Results of the 77 infill holes (4 160 m) drilled at Serule West show thicker intercepts in the shallower southeast portions of the deposit. In addition to the infill drill programmes, Lotus conducted an 11 holes drilling exploration campaign in the western portion of the mining lease, to test an area outside the defined mineral resource, where previous drilling had identified uranium mineralisation. All exploration drill holes intersected mineralisation.

In December 2024, Lotus released an updated 200 pm U_3O_8 cut-off grade resource estimate for the Letlhakane deposit that incorporated results of the completed drill programme. The revised resource estimate was 142.2 Mt at 363 ppm U_3O_8 (308 ppm U) for 113.7 Mlb U_3O_8 (43 730 tU), including 56.8 Mlb U_3O_8 (21 850 tU) of indicated resources and 56.9 Mlb U_3O_8 (21 880 tU) of inferred resources. Drilling has also identified further resource opportunities which Lotus plans to assess in future drilling campaigns.

	Ore (Mt)	Grade (ppm U)	Uranium (tU)
Indicated	71.6	305	21 850
Inferred	70.6	310	21 880
Total	142.2	308	43 730

In 2024, Lotus conducted metallurgical test work on ore samples from the Letlhakane deposit. Uranium recovery test results, by type of ore, are: primary ore 70-75%, oxide 70-75% and mudstone 80%.

The prospect of using ISL to recover uranium from the Gorgon sector of Letlhakane deposit was also investigated by completing field pump tests to assess the permeability of the ore body. ISL prospectivity appears limited based on the results of the initial field permeability tests. However, alternative targets within the deeper Gorgon sector may have the potential for greater permeability than initially measured.

Uranium resources

Identified conventional resources (reasonably assured and inferred resources)

As of December 2024, Letlhakane total identified in situ resources amounted to 43 730 tU at an average grade of 308 ppm U, based on a 170 ppm U cut-off grade, in the <USD 130/kgU cost category. Within this resource, 21 850 tU belong to the RAR category and 21 880 tU to the inferred category.

A decrease of resources reported in 2024, compared to resources reported in previous editions of the Red Book (based on an estimation completed in 2015), is mainly due to:

- new drilling information;
- a cut-off grade of 85 ppm U was used for 2015, vs. 170 ppm U in 2024;
- 2024 reporting is constrained by an optimal pit shell.

Undiscovered conventional resources (prognosticated and speculative resources)

The key feature for uranium mineralisation in Botswana is the presence of highly radiogenic granitoid suites, most relating to the Pan-African (~500 Ma) magmatic event, which introduced uranium-rich source material into the upper crust. The uranium mineralisation is highly mobile, and, through leaching, uranium-bearing solutions became concentrated in reduced environments in sandstones, mudstones and carbonaceous materials in the overlying lower Karoo system.

Most calcareous sediments in the Gojwane and the Foley area, which lies on the Karoo and the Karoo-aged sediments, are presumed to host widespread and continuous uranium mineralisation. These areas are considered to have the same geology as the Letlhakane area, which hosts one of the biggest undeveloped uranium deposits in Botswana.

Impact Minerals Ltd reports "target conceptual" undiscovered resources of less than 2 000 tU; however, the uncertainty of this term, and the small amount reported, do not warrant inclusion as undiscovered resources at this time. Although undiscovered resources no doubt exist, further work is required to develop the estimates.

Drilling in 2024 identified further mineral resource opportunities which Lotus plans to assess in future drilling campaigns.

Uranium production

On 12 March 2025, Lotus presented the results of the Scoping Study for the Letlhakane Uranium Project. The Scoping Study, based on the December 2024 Mineral Resource Estimate, shows that Letlhakane can support a production of 1 100 tU per year, over a period of 10 years. Optimisation of mining costs and acid consumption demonstrates an optimal total cash cost of USD 41.1/lb U_3O_8 (USD 107/kgU).

Uranium production centre technical details

(as of 1 January 2025)

	Centre #1
Name of production centre	Letlhakane
Production centre classification	Prospective
Date of first production	NA
Source of ore:	
Deposit name(s)	Gorgon/Serule
Deposit type(s)	Secondary/calcrete
Recoverable resources (tU)	17 300
Grade (% U)	0.027
Mining operation:	
Type (OP/UG/ISR)	OP
Size (Mt ore/year)	667
Average mining recovery (%)	95
Processing plant:	
Acid/alkaline	Acid
Type (IX/SX)	Heap leaching
Size (Mt ore/year);	62.4
Average process recovery (%)	65
Overall recovery factor (%)	62
Nominal production capacity (tU/year)	1 100

Environmental activities and socio-cultural issues

An environmental and social impact assessment (ESIA) consistent with the Botswana government's requirements was completed in 2014 and submitted in May 2015 to the Department of Environmental Affairs (DEA). Studies determined that with appropriate mitigation, all environmental and social aspects during the construction and planned operations could be addressed. The ESIA findings were presented to the Serule and Gojwane Kgoltas, the Mmadindare and Paje subland Boards, and the Tonata council.

Following a comprehensive review by the DEA, A-Cap was advised in March 2016 that it had adequately identified and assessed impacts associated with the project. A four-week public review was completed, following which the environmental and social impact assessment was approved on 13 May 2016.

The 2024 Sustainability Report outlines Lotus' approach to creating sustainable value for the stakeholders, and provides a summary of the environmental, social and governance (ESG) management systems and performance.

This report details the ESG activities, and the work undertaken at Letlhakane Uranium Project. The report has been prepared with reference to the 2021 Global Reporting Initiative Sustainability Reporting Standard (GRI Standards), incorporating relevant information and data that meets the framework's requirements. Lotus has also set targets aligning with the United Nations Sustainable Development Goals (SDGs) and has reported on progress towards these goals. The report provides an update of Lotus' progress towards preparing to report climate related financial disclosures in accordance with the Australian Sustainability Reporting Standards (ASRS).

Uranium policies, uranium stocks and uranium prices

National policies relating to uranium

Botswana’s national policies and regulations regarding uranium are guided by the country’s commitment to nuclear non-proliferation and radiation safety. The government has passed legislation to ensure proper management of radioactive waste and has conducted an IAEA Integrated Regulatory Review Service to assess the country's regulatory framework against international standards.

Reasonably assured conventional resources by production method

(recoverable tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Open-pit mining (OP)	0	0	13 550	13 550	62
Total	0	0	13 550	13 550	62

Reasonably assured conventional resources by processing method

(recoverable tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Heap leaching* from OP	0	0	13 550	13 550	62
Total	0	0	13 550	13 550	62

* A subset of open-pit and underground mining, since it is used in conjunction with them.

Reasonably assured conventional resources by deposit type

(recoverable tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Sandstone	0	0	13 550	13 550
Total	0	0	13 550	13 550

Inferred conventional resources by production method

(recoverable tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Open-pit mining (OP)	0	0	13 565	13 565	62
Total	0	0	13 565	13 565	62

Inferred conventional resources by processing method

(recoverable tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Heap leaching* from OP	0	0	13 565	13 565	62
Total	0	0	13 565	13 565	62

* A subset of open-pit and underground mining, since it is used in conjunction with them.

Inferred conventional resources by deposit type

(recoverable tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Sandstone	0	0	13 565	13 565
Total	0	0	13 565	13 565

Brazil

Uranium exploration and mine development

Historical review

The Brazilian National Research Council began systematic prospecting for radioactive minerals in 1952. These efforts led to the discovery of the first uranium occurrences at Poços de Caldas (State of Minas Gerais) and Jacobina (State of Bahia). In 1955, a technical co-operation agreement was signed with the United States to assess the uranium potential of Brazil. After the creation of the National Nuclear Energy Commission (CNEN), a mineral exploration department was organised with the support of the French Alternative Energies and Atomic Energy Commission (CEA) in 1962.

In the 1970s, CNEN exploration for radioactive minerals accelerated with the addition of financial resources. Further incentive for exploration was provided in 1974 when the government opened NUCLEBRAS, an organisation with the exclusive purpose of uranium exploration and production. One of the early achievements of the government organisations was the discovery and development of the Osamu Utsumi deposit on the Poços de Caldas Plateau.

In late 1975, Brazil and Germany signed a co-operation agreement for the peaceful use of nuclear energy. It was the beginning of an ambitious nuclear development programme that required NUCLEBRAS to increase its exploration activities. This led to the discovery of eight areas hosting uranium resources, including the Poços de Caldas Plateau, Figueira, the Quadrilátero Ferrífero, Amorinópolis, Rio Preto/Campos Belos, Santa Quitéria, Lagoa Real and Espinharas (discovered and evaluated by Nuclam, a Brazilian-German joint venture).

As a result of the Brazilian nuclear development programme reorganisation of 1988, Indústrias Nucleares do Brasil S.A. (INB) discontinued uranium exploration activities in 1991. Since then, limited exploration work has been done to further define resources in Lagoa Real Province.

Recent and ongoing uranium exploration, and mine development activities

During the 2012-2017 period, exploration efforts focussed on favourable areas related to albitic metasomatites of LR 09, LR 35 and LR 36 deposits in the north part of the Lagoa Real Province. No exploration work was done during the 2018-2024 period. For 2026 a 6 000 m drilling programme is scheduled to close the grid and upgrade the resource category of the LR-08 deposit.

Uranium resources

Identified conventional resources (reasonably assured and inferred resources)

Brazil's conventional identified uranium resources are hosted in the following deposits:

- Lagoa Real (Caetité), in Bahia state, with the following 15 deposits (belonging to the Lagoa Real Province): Engenho Mine, Cachoeira Mine, LR-01, LR-02/12, LR-03, LR-04, LR-05, LR-06, LR-07, LR-08/11, LR-31, LR-33, LR-34, LR-35 and LR-36. All these deposits are classified as metasomatite type, but different production/processing methods are considered for the evaluated recoverable resources: open-pit mine with heap leaching for Engenho Mine, underground mine with conventional milling for Cachoeira Mine, and open-pit mine with conventional milling for the other deposits.
- Santa Quitéria, in Ceará state, with the Itataia, Alcantil and Serrotes Baixos deposits. These deposits are classified as metamorphite type, where phosphate is the primary

product and uranium is considered an important by-product for the evaluated recoverable resources.

- Poços de Caldas Plateau, in Minas Gerais state, with the Osamu Utsumi Mine (Cercado deposit) and Agostinho deposits. These deposits are classified as intrusive type, and the assessment of recoverable resources considers the production/processing through open-pit mine with conventional milling.
- Quadrilátero Ferrífero, in Minas Gerais state, with the Gandarela and Serra das Gaivotas deposits. These deposits are classified as paleo-quartz-pebble conglomerate type, with Au as the main mineral product, while uranium is considered as by-product for the evaluated recoverable resources.
- Amorinópolis, in Goiás state, with the Amorinópolis deposit. This deposit is classified as sandstone type, and the assessment of recoverable resources considers the production/processing through open-pit mine with conventional milling.
- Rio Preto/Campos Belos, in Goiás state, with the Rio Preto and Campos Belos deposits. These deposits are classified as metamorphite type, and the production/processing methods considered for the evaluated recoverable resources are unspecified.
- Figueira, in Paraná state, with the Figueira deposit. This deposit is classified as sandstone type, and the assessment of recoverable resources considers the production/processing through underground mine with conventional milling.
- Espinharas, in Paraiba state, with the Espinharas deposit. This deposit is classified as metasomatite type, and the production/processing methods considered for the evaluated recoverable resources are unspecified.

No additional resources were identified during the 2020-2024 period.

Undiscovered conventional resources (prognosticated and speculative resources)

Currently, there are no prognosticated resources.

Brazil's speculative uranium resources (254 394 tU) are related to the following prospects:

- Rio Cristalino exploration project, in Pará state, with the Rio Cristalino deposit, classified as sandstone type.
- Pitinga Site (mine, stockpiles and tailings), in Amazonas state, classified as intrusive type. This is not an exploration project, but a mine operated by a private company, with Sn, Nb and Ta as the main mineral products.

Uranium production

Historical review

The Poços de Caldas uranium production facility, which started production in 1982 with a design capacity of 425 tU/yr, was operated by the state-owned company NUCLEBRAS until 1988. At that time, Brazil's nuclear activities were restructured. NUCLEBRAS was succeeded by the INB and its mineral assets transferred to Urânio do Brasil S.A. With the dissolution of Urânio do Brasil in 1994, ownership of uranium production is 100% controlled by the INB, a state-owned company.

Between 1990 and 1992, the production centre at Poços de Caldas was on standby because of increasing production costs and reduced demand. Production was restarted in late 1993 and continued until October 1995. After two years on standby, the Poços de Caldas production centre was shut down in 1997 and a decommissioning programme started in 1998. This industrial facility was used to produce rare earth compounds from monazite treatment until 2006 but closed the next year for market reasons.

The Caetité Unit (Lagoa Real Province), operated by INB, is currently the only uranium production facility in operation in Brazil. This unit started its production in 1999 and operated until 2015 with a design capacity of 340 tU/yr, through the heap leaching process from the ore of the Cachoeira Mine (open-pit). The open-pit part of the Cachoeira deposit was entirely mined out in 2014; therefore, any future exploitation of this deposit can only operate as an underground mine.

Status of production facilities, production capability, recent and ongoing activities, and other issues

The Caetité Unit restarted operating in 2020, and it currently operates with a design capacity of 220 tU/yr, through the heap leaching process from the ore of Engenho Mine (also open-pit).

Between 2021 and 2024, Caetité's production levels ranged from 29 to 91 tU, while for 2025 production of 64 tU is expected.

The expansion of Caetité Unit to 680 tU/yr is progressing and production is expected to start in 2035. Planning for expansion includes production of Engenho Mine and other deposits of Lagoa Real Province (all by open-pit mine), and involves replacement of the current heap leaching (HL) process by conventional milling (agitated leaching). The overall investment in this expansion is estimated to amount to USD 120 million.

Ownership structure of the uranium industry

The Brazilian uranium industry is 100% state-owned through the INB.

Employment in the uranium industry

Employment at the existing production centre (Caetité Unit) decreased in 2024 compared with 2023. Total employment associated with existing production centres was 573 positions in 2023 and 507 positions in 2024. Employment directly linked to uranium production remained stable at 103 positions in both years.

Future production centres

The Santa Quitéria Project, a partnership between the INB and a Brazilian fertiliser producer, is progressing and the operation is scheduled to begin in 2030. This phosphate/uranium project has a design capacity of 1 950 tU/yr.

The licensing of this project involves the Brazilian Institute for the Environment and Renewable Natural Resources (IBAMA) and the National Authority for Nuclear Safety (ANSN). In the case of IBAMA, the preliminary environmental licensing decision is expected in July 2026. In the case of ANSN, the licensing is split into a non-nuclear part, involving milling and phosphate production, and a nuclear part, involving uranium concentrate production.

Uranium production centre technical details

(as of 1 January 2025)

	Centre #1	Centre #2	Centre #3
Name of production centre	Caetité	Caetité Expansion	Santa Quitéria
Production centre classification	Existing	Prospective	Planned
Date of first production	2000	2035	2030
Source of ore:			
Deposit name(s)	Lagoa Real – Engenho	Lagoa Real – Others	Santa Quitéria – Itataia
Deposit type(s)	Metasomatite	Metasomatite	Metamorphite
Recoverable resources (tU)	9 927	41 978	43 888
Grade (% U)	0.152	0.170	0.075
Mining operation:			
Type (OP/UG/ISL)	OP	OP	OP
Size (tonnes ore/year)	216 000	435 000	3 866 000
Average mining recovery (%)	100	100	100
Processing plant:			
Acid/alkaline	Acid	Acid	Acid
Type (IX/SX)	SX	SX	SX
Size (tonnes ore/year)	216 000	435 000	3 866 000
Average process recovery (%)	67	92	68
Nominal production capacity (tU/year)	220	680	1 950
Plans for expansion (yes/no)	Yes	No	No
Other remarks	[1][2]	[2][3]	[4]

[1] Caetité refers to the existing centre named Uranium Concentration Unit (URA), located in Bahia state (BA).

[2] Currently, Caetité Unit operates through the heap leaching process from the ore of Engenho Mine (open-pit). With the expansion of its processing plant, scheduled for 2027, Caetité Unit will operate through the conventional milling process from the ore of other deposits of Lagoa Real Province (also open-pit).

[3] Lagoa Real – Others refers to the following 13 deposits of Lagoa Real Province (Cachoeira Mine is not included): LR-01, LR-02/12, LR-03, LR-04, LR-05, LR-06, LR-07, LR-08/11, LR-31, LR-33, LR-34, LR-35, LR-36.

[4] Santa Quitéria refers to the prospective centre named Santa Quitéria project (PSQ), which will be located in Ceará state (CE), with uranium as a by-product from phosphate rock (open-pit).

Environmental activities and socio-cultural issues

Licences in Brazil are issued by the Brazilian Institute for the Environment and Renewable Natural Resources (IBAMA) and the National Authority for Nuclear Safety (ANSN). Previously, regulatory control of the nuclear sector was carried out by National Commission for Nuclear Energy (CNEN), but it was transferred to ANSN, which was created in 2021.

The closure of Poços de Caldas in 1997 ended the exploitation of this low-grade ore deposit that produced vast amounts of waste rock. Several studies have been carried out to characterise geochemical and hydrochemical aspects of the waste rock and tailings dam, to better establish the impact they may have had on the environment and to develop the necessary mitigation measures. A remediation/restoration plan, considering several alternatives, was submitted to the regulatory body at the end of 2012. Depending on the option adopted, the costs of implementing the remediation/restoration plan could reach USD 85 million. The INB, regulators and central government are involved in the consolidation of a work plan for the remediation.

Regulatory regime

Licences are issued by the IBAMA, according to Brazilian environment law and ANSN regulations.

Government policies and regulations established by the ANSN include basic radiological protection directives (NE-3.01 – *Diretrizes Básicas de Radioproteção*), standards for licensing of uranium mines and mills (NE-1.13 – *Licenciamento de Minas e Usinas de Beneficiamento de Minérios de Urânio ou Tório*) and decommissioning of tailing ponds (NE-1.10 – *Segurança de Sistema de Barragem de Rejeito Contendo Radionuclídeos*), as well as standards for conventional U and Th mining and milling (NORM and TENORM NM 4.01 – *Requisitos de Segurança e Proteção Radiológica para Instalações Mínero-Industriais*). In the absence of specific norms, the recommendations of the International Commission on Radiological Protection and the International Atomic Energy Agency are used.

Due to the potential future growth of the Brazilian nuclear programme, a new law, published in 2021, created an independent nuclear regulatory body, named National Authority for Nuclear Safety (ANSN), which started operations in 2025. The ANSN has taken the responsibility from CNEN related to standards, licensing, authorisation, and supervision of nuclear safety and radiological protection of nuclear ore mining activities, in addition to tailings deposits and sites of waste storage, including the supervision of research and mining of these ores.

In 2022, a new law was sanctioned, bringing the possibility of new models of association with private companies in the activities developed by INB. With this new flexibility, it will be possible to seek partners, aiming at the development of research, mining and commercialisation of nuclear ores, their concentrates and derivatives, and nuclear materials. It was already possible for a private company to participate in a situation where uranium appears as a co-product. This is the case of the Santa Quitéria Project, where phosphate is the main product and uranium is the co-product.

This new law also makes possible an association between INB and private partners for the exploration of mineral deposits that have nuclear ores, whether or not technical and economic feasibility studies indicate that the quantity of nuclear materials present is of greater or lesser economic value than other mineral materials delineated or mined in the deposit.

Uranium requirements

Brazil's present uranium requirements for the Angra 1 Nuclear Power Plant, a 609 MWe net pressurised water reactor (PWR), are about 157 tU/yr. The Angra 2 Nuclear Power Plant, a 1 280 MWe net PWR, requires 249 tU/yr. The start-up of the Angra 3 Nuclear Power Plant (a similar design to Angra 2) was scheduled initially for 2016, but construction was stopped in 2015. With the resumption of construction, Angra 3 is scheduled to be operating in 2028. Once in operation, it will add 237 tU/yr to annual domestic demand.

The national energy plan, Plano Nacional de Energia 2050 (PNE 2050), issued in 2020, is a fundamental study of long-term planning for the country's energy sector. It assesses trends in production and use of energy and evaluates alternative strategies for expanding energy supply in the coming decades. The PNE 2050 also establishes guidelines for the role of nuclear power in the national strategy, including post-Fukushima Daiichi Nuclear Power Plant accident risk perception and increasing costs, mastery of the complete nuclear fuel production cycle, and the possibility of exporting such products, taking into consideration the scale of production and competitiveness. Depending on different scenarios, nuclear generation could reach 10 GWe net in 2050.

As shown in the table on installed nuclear generating capacity to 2050, the low case considers a scenario with no additional reactors after Angra 3, while the high case considers a scenario with four additional reactors until 2050.

Supply and procurement strategy

All domestic production is designated for domestic requirements. The shortfall between demand and domestic production is met through market purchases. In the 2023-2024 period, the INB acquired a total of 397 tU.

The planned uranium production increases are designed to supply all reactor requirements, including the Angra 3 unit and all units foreseen in the planned long-term expansion of nuclear energy for electricity generation.

Uranium policies, uranium stocks and uranium prices

National policies relating to uranium

The INB, a 100% government-owned company, oversees fuel cycle activities that are conducted under state monopoly. The INB is currently working on increasing uranium concentrate production and towards the full implementation of fuel cycle activities required to meet domestic demand.

Uranium stocks

The Brazilian government does not maintain stocks of uranium concentrate or enriched uranium product.

Uranium exploration and development expenditures and drilling effort – domestic

(in BRL)

	2022	2023	2024	2025 (expected)
Industry* exploration expenditures	0	0	0	0
Government exploration expenditures	0	0	0	0
Total expenditures	0	0	0	0
Industry* exploration drilling (m)	0	0	0	0
Government exploration drilling (m)	0	0	0	0
Total drilling (m)	0	0	0	0

* Non-government.

Reasonably assured conventional resources by production method

(in situ tonnes U)*

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Open-pit mining (OP)	0	0	53 118	60 828	70-80
Underground mining (UG)	0	0	7 452	7 452	75
Co-product and by-product	81 576	81 576	81 576	81 576	65
Unspecified	0	0	4 664	4 664	75
Total	81 576	81 576	146 810	154 520	-

* Resource values may not sum to the totals due to rounding errors.

Reasonably assured conventional resources by processing method

(in situ tonnes U)*

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional from OP	77 336	77 336	130 453	130 453	65-80
Conventional from UG	4 240	4 240	11 691	11 691	65-75
Heap leaching** from OP	0	0	0	7 710***	70
Unspecified	0	0	4 664	4 664	75
Total	81 576	81 576	146 810	154 520	-

* Resource values may not sum to the totals due to rounding errors.

** A subset of open-pit and underground mining since it is used in conjunction with them.

*** Expected to be produced at Engenho Mine.

Reasonably assured conventional resources by deposit type

(in situ tonnes U)*

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Sandstone	0	0	7 632	7 632
Intrusive	0	0	16 960	16 960
Paleo-quartz-pebble conglomerate	4 240	4 240	4 240	4 240
Metamorphite**	77 336	77 336	77 760	77 760
Metasomatite***	o	0	40 218	47 928
Total	81 576	81 576	146 810	154 520

* Resource values may not sum to the totals due to rounding errors.

** Associated with the Santa Quitéria site. Operating expenditures for uranium recovery are considered (incremental cost for uranium extraction).

*** Associated with the Lagoa Real site.

Inferred conventional resources by production method

(in situ tonnes U)*

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Open-pit mining (OP)	0	0	26 321	32 793	70-80
Underground mining (UG)	0	0	6 527	6 527	75
Co-product and by-product	51 981	51 981	51 981	51 981	65
Unspecified	0	0	4 664	4 664	75
Total	51 981	51 981	89 494	95 965	-

* Resource values may not sum to the totals due to rounding errors.

Inferred conventional resources by processing method

(in situ tonnes U)*

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional from OP	43 501	43 501	69 823	69 823	65-80
Conventional from UG	8 480	8 480	15 007	15 007	65-75
Heap leaching from OP	0	0	0	6 471	70
Unspecified	0	0	4 664	4 664	75
Total	51 981	51 981	89 494	95 965	-

* Resource values may not sum to the totals due to rounding errors.

Inferred conventional resources by deposit type

(in situ tonnes U)*

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Sandstone	0	0	3 392	3 392
Intrusive	0	0	5 766	5 766
Paleo-quartz-pebble conglomerate	8 480	8 480	8 480	8 480
Metamorphite	43 501	43 501	43 925	43 925
Metasomatite	0	o	27 930	34 402
Total	51 981	51 981	89 494	95 965

* Resource values may not sum to the totals due to rounding errors.

Prognosticated conventional resources

(in situ tonnes U)

Cost ranges		
<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
0	0	0

Speculative conventional resources

(in situ tonnes U)

Cost ranges		
<USD 130/kgU	<USD 260/kgU	Unassigned
0	0	254 394

Historical uranium production by production method

(tonnes U in concentrates)

Production method	Total through end of 2022*	2023	2024	Total through end of 2024	2025 (expected)
Open-pit mining	4 329	91	85	4 504	64
Total	4 329	91	85	4 504	64

* Updated with respect to the Red Book 2022, according to a new review of historical records.

Historical uranium production by processing method

(tonnes U in concentrates)

Processing method	Total through end of 2022*	2023	2024	Total through end of 2024	2025 (expected)
Conventional	1 053	0	0	1 053	0
Heap leaching	3 276	91	85	3 452	64
Total	4 329	91	85	4 504	64

* Updated with respect to the Red Book 2022, according to a new review of historical records.

Historical uranium production by deposit type

(tonnes U in concentrates)

Deposit type	Total through end of 2022*	2023	2024	Total through end of 2024	2025 (expected)
Intrusive	1 053	0	0	1 053	0
Metasomatite	3 276	91	85	3 452	64
Total	4 329	91	85	4 504	64

* Updated with respect to the Red Book 2022, according to a new review of historical records.

Uranium industry employment at existing production centres

(person-years)

	2023	2024	2025 (expected)
Total employment related to existing production centres	573	507	479
Employment directly related to uranium production	103	103	97

Mid-term production projection (tonnes U/year)

2025	2030	2035	2040	2045	2050
60	1 490	2 630	2 630	2 630	680

Mid-term production capability (tonnes U/year)

2025				2030			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
0	0	0	0	0	1 370	0	1 370

2035				2040			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
0	1 950	0	2 630	0	1 950	0	2 630

2045				2050			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
0	1 950	0	2 630	0	0	0	680

Net nuclear electricity generation

	2023	2024
Nuclear electricity generated (TWh net)	13.31	14.86

Installed nuclear generating capacity to 2050

(MWe net)

2023	2024	2025		2030		2035		2040		2045		2050	
		Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
1 817	1 817	1 817	1 817	3 074	3 074	3 074	4 864	3 074	6 653	3 074	8 443	3 074	10 233

Annual reactor-related uranium requirements* to 2050 (excluding MOX)

(tonnes U)

2023	2024	2025		2030		2035		2040		2045		2050	
		Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
386	386	406	406	643	643	643	1 012	643	1 380	643	1 748	643	2 117

Bulgaria

Uranium exploration and mine development

Historical review

The presence of uranium mineralisation in Bulgaria, in the Buhovo ore deposit 25 km from Sofia, has been known since 1920. The first exploration activities were undertaken in 1935. More serious exploration activities, using technological research methods and economic calculations, were carried out between 1938 and 1939, with the co-operation of German specialists. The first 300 tonnes of uranium ore were mined in 1939.

During 1946-1947, Soviet geologists performed intensive geological investigations of the Buhovo ore deposit. In the spring of 1946, a joint Soviet-Bulgarian enterprise was established, but its activity ceased in 1956. The Rare Metals Bureau of the Council of Ministers was established and existed until 1992, when the government decided to cease all uranium production activities.

A large number of exploration methods were applied: geological, geophysical, technological and combined methods. Aero-gamma-ray-spectrometry, hydro-radio-geochemical and water-helium photography were used for exploration.

In total, 39 ore deposits were discovered, dozens of mines were developed across the country, and two facilities for the processing of uranium ore and production of uranium concentrate (U3O8) were built, in Buhovo and Eleshnitsa.

Bulgarian uranium deposits are small to medium in size (up to 10 000 tU), with ore grades of about 0.1% U. They have complex morphologies and irregular mineralisation. Deposits exploited via classical mining methods have complex geological structures and are situated mainly in mountain regions (Stara Planina, Rhodope massif, East Sredna Gora). The areas of the ore beds range between 250 m^2 to 20 000 m^2, with an occurrence depth of about 500 m and low metal concentration. Technical mining conditions and geological parameters resulted in a high prime cost and lower efficiency of uranium production.

The main ore deposits for underground mining are: Buhovo near Sofia; Eleshnitsa, Senokos and Simitli in southwest Bulgaria; Vinishte and Smolyanovtsi in northwest Bulgaria; Sliven in central Bulgaria; and Smolyan, Dospat and Selishte in the Rhodopa Mountains.

When sediment-hosted mineralisation was found, the acid in situ leaching (ISL) mining method was adopted [1]. It was first used in 1969 and applied mainly (90% of the time) to sandstone-hosted deposits (roll-front) using drilling systems (wellfields) for leaching, and occasionally (10% of the time) to hardrock deposits, using underground systems.

Deposits of this type were found first in regions of the Upper Thracian Valley, then also in the Struma River Valley and in the Dospat River Valley. Uranium-bearing horizons occur at 30 to 250 m below the surface. Their thickness varies from 10-12 m to 60-80 m. Uranium mineralisation is hosted by Pliocene sandstone, with a thickness varying from 0.4 m to 7-8 m.

1 International Atomic Energy Agency (2016), “In Situ Leach Uranium Mining: An Overview of Operations”, IAEA Nuclear Energy Series NF-T-1.4 report STI/PUB/1741.

Uranium grades are variable, within large limits, but with an average value of 300 ppm U (0.03% U).

In the case of hardrock deposits, the dimensions of ore bodies vary by height from 50-70 m to 500-600 m and by thickness from 2-4 m to 80-100 m. Uranium grades are between 0.03% U to 0.2-0.3% U.

Recent and ongoing uranium exploration, and mine development activities

Uranium exploration and mine development activities were terminated in 1990. No exploration has been conducted in recent years and no new exploration is expected to be conducted as of 2025.

Uranium resources

Identified conventional resources (reasonably assured and inferred resources)

As of 1 January 1991, identified conventional resources amounted to 20 565 tU in situ, which at the time were determined to be subeconomic based upon prevailing market conditions and processing technology.

A revised resource estimate was made based on a select subset of deposits using data from a Redki Metali State Company report (a final report coinciding with the termination of uranium, exploration and mining activities in 1990), and from subsequent reports submitted to the Specialised Expert Committee on Reserves and Resources (SEC), within the Ministry of Environment and Waters.

As of 1 January 2009, the remaining identified conventional uranium resources were estimated to be 19 809 tU in situ in cost category <USD 260/kgU, of which 11 908 tU were determined to be amenable to underground mining methods, and 7 901 tU amenable to ISL methods.

The 11 908 tU of in situ resources amenable to underground methods are associated with 67 different sites (locations) where insignificant quantities of uranium were detected. These deposits and their resources were considered subeconomic with little or no production potential.

The 7 901 tU of in situ resources amenable to ISL mining methods were considered potentially economic. During production in 1991, an average recovery factor of 65% was achieved, based on ISL operations at 16 sites.

To date, no official estimates of the cost of production have been performed. The stated evaluation of the identified conventional uranium resources is unchanged as of 1 January 2025. No determinations of the identified conventional resources per cost category are available.

Undiscovered conventional resources (prognosticated and speculative resources)

Prognosticated conventional resources are estimated to amount to about 25 000 in situ tU in cost category <USD 260/kgU.

Unconventional Resources and other materials

No unconventional resources have been identified.

Uranium production

Historical review

Up to 1990, about 16 500 tU were produced. Production grew from 150-200 tU/yr in the 1950s to 430 tU in 1975. The adoption of the ISL mining method for uranium production from Upper Thracian uranium deposits raised the production to 660 tU in 1989, when 70% of the uranium was ISL extracted. Ores were processed in the two hydrometallurgical plants. Uranium extraction from ISL sorbent resins and their processing was done at the Zvezda plant near Eleshnitsa. U_3O_8 was produced with 80-82% of concentration (68-70% U).

Status of production facilities, production capability, recent and ongoing activities, and other issues

At present, no production centres exist that could be operated for uranium extraction. If plans for the renewal of uranium production were considered, independent of who operates these facilities, the entire process would need to be rebuilt.

At the former uranium ore processing plant, Zvezda, an installation for ion-exchange resins is operational. This facility handle the purification of uranium-contaminated mine waters. It is a small capacity installation of some 742 m^3 of resins per year.

Since 1992, the only activities have been the dismantling of facilities, closing of mining works, re-cultivation of contaminated areas, purification of uranium-contaminated mine waters and environmental monitoring.

Ownership structure of the uranium industry

All uranium production was carried out by the state.

Employment in the uranium industry

There is currently no uranium production and no exploration or production-related employment.

Environmental activities and socio-cultural issues

Uranium production and processing ceased by Government Decree No 163 of 20 August 1992.

Remediation activities from uranium production and processing include technical liquidation, technical and biological re-cultivation, purification of uranium-contaminated mine waters and environmental monitoring of the areas affected by the uranium mining.

Presently the main part of the environment re-cultivation from the uranium mining impact is considered completed.

Uranium requirements

The Bulgarian nuclear power programme was launched in 1974 with the commissioning of the first nuclear power unit of the Kozloduy Nuclear Power Plant. The nuclear facilities are concentrated at the Kozloduy site, where six units were built (units 5 and 6 are in operation and units 1-4 are in the process of decommissioning). In 2024, nuclear power comprised about 41.6% of total electricity production in Bulgaria. With an operable nuclear power capacity of 2 160 MWe (2 VVER V-320 units at Kozloduy), uranium requirements are estimated at 370 tU/yr.

Kozloduy Nuclear Power Plant

The lifetime extension of units 5 and 6 is a priority. From 2014 to 2018, the Plant Lifetime Extension (PLEX) project was completed. The project results demonstrated the units' technical capabilities for long-term operation – until 2047 for unit 5 and until 2051 for unit 6. In 2024, according to the newly adopted amendments to the Law on the Safe Use of Nuclear Energy, the licences of nuclear facilities is open-ended, with a requirement to conduct a periodic safety review at least once every ten years.

Belene Nuclear Power Plant Project

On 11 October 2023, the Council of Ministers adopted a decision revoking a 2018 Government decision for conducting negotiations with potential investors and equipment manufacturers. With this decision, the Government instructed the Minister of Energy to take action to terminate the procedure announced by NEK EAD for the selection of strategic investors for the construction of the Belene Nuclear Power Plant. In addition, the Belene Nuclear Power Plant ceased to be an object of national importance.

The decision of the Council of Ministers is also linked to the decision of the National Assembly of 6 July 2023, with which the Minister of Energy is assigned to conduct negotiations with the Minister of Energy of Ukraine for the sale of the equipment under the Belene Nuclear Power Plant project.

At present, negotiations with the Ukrainian side for the sale of long-cycle production equipment owned by NEK EAD, intended for the Belene Nuclear Power Plant project, have not been completed.

Kozloduy Nuclear Power Plant – New Build

Kozloduy Nuclear Power Plant – New Build is a special purpose vehicle established in May 2012, to undertake the necessary actions for the construction and commissioning of a new nuclear power plant of the latest generation (III or III+) at the Kozloduy Nuclear Power Plant site, with pressurised light water reactor technology.

In August 2013, the NRA chairperson issued a permit for determining the location (site selection) for the deployment of a new nuclear power plant at the Kozloduy site.

In February 2020, the NRA chairperson issued an order that approved the site for the deployment of a new nuclear installation. Kozloduy Nuclear Power Plant – New Build is a holder of the permit by a decision of the Minister of Environment and Water from 2015 on an environmental impact assessment (EIA decision), which approved the implementation of the investment proposal for the construction of a new nuclear power plant on the approved site, Site 2.

A programme for permanent monitoring of the site, approved for the deployment of a new nuclear installation, was developed and contains activities, methods and requirements necessary to ensure the construction and implementation of a monitoring network, with a volume and content in accordance with national and international requirements.

Activities have been undertaken to complete the development of a Detailed Spatial Plan for the territory of the Kozloduy Nuclear Power Plant – New Build site.

On 2 August 2023, the Council of Ministers of the Republic of Bulgaria decided to designate the site selected by Kozloduy Nuclear Power Plant – New Build and approved by the NRA (Site 2) as a site of national importance and a national site.

On 18 December 2023, the National Assembly of the Republic of Bulgaria adopted a decision to increase the capital of Kozloduy Nuclear Power Plant – New Build to ensure future activities on the construction of a new nuclear power plant on the Kozloduy site. The National Assembly also adopted a High-Level Preliminary Schedule for the Construction of the 7th Unit of the Kozloduy Nuclear Power Plant with AP1000 technology.

On 23 February 2024, the National Assembly of the Republic of Bulgaria adopted a decision to conduct negotiations with a potential constructor included in the short list of potential constructors for engineering, construction, procurement and commissioning of a nuclear power plant at the approved site in Kozloduy, with AP1000 technology. In this decision, the main requirements are set for the implementation of a project for the construction of two new nuclear units at the site of the Kozloduy Nuclear Power Plant with AP1000 technology and the expected results of the negotiations, which will be included in the requirements for the engineering contract (phase 1).

On 29 March 2024, Kozloduy Nuclear Power Plant – New Builds EAD signed a contract with Westinghouse Energy Systems OOD – Bulgaria Branch, for the provision of services for initial engineering and design activities.

On 4 November 2024, an engineering contract (Engineering Service Contract – ESC) was signed between Kozloduy Nuclear Power Plant – New Builds EAD and a Consortium, consisting of the Bulgarian branches of Westinghouse Energy Systems and Hyundai Engineering and Construction, the main purpose of which is to support the regulatory steps for the implementation of the project for the construction of new nuclear capacities, as well as to provide the necessary data on investment and operating costs, which will serve to help make a final investment decision for the project.

On 18 February 2025, Kozloduy Nuclear Power Plant – New Builds EAD submitted an application to the Nuclear Regulatory Agency for issuance of a permit to determine the location of a nuclear facility (Unit 8). A number of documents were attached to the application, which will be subject to review and assessment of compliance with the requirements of the Safe Use of Nuclear Energy Act, and the regulations on its implementation. The submitted application is the first step in the overall licensing process for a new nuclear facility.

The project related to the construction of Units 7 and 8 of Kozloduy Nuclear Power Plant is of strategic importance both for Bulgaria and for the region of Southeast Europe. Its implementation is a key step towards ensuring the country's energy security. An environmental monitoring network and database have been developed in accordance with the requirements of the project's EIA.

Detailed information about the Kozloduy Nuclear Power Plant New Build management, staffing as well as the activities carried out by the company are available on the website (npp-nb.bg).

Supply and procurement strategy

The Kozloduy Nuclear Power Plant fuel cycle does not include the purchase of uranium, its conversion or enrichment, but only the purchase of fuel assemblies from the supplier, their interim storage at the plant site after being removed from reactor cores, spent fuel transport for reprocessing and further disposal of high-level waste. Those activities are based on an agreement between Bulgaria and Russia, as well as on commercial contracts for the supply of nuclear fuel and reprocessing of spent nuclear fuel.

In accordance with the European Energy Security Strategy, a study was conducted to explore options on diverse enriched uranium supplies for the manufacture of fuel assemblies, as well as for the identification of an alternative supplier of fuel assemblies.

The Kozloduy Nuclear Power Plant has increased burnup and achieved a reduction of spent fuel generation during its transition to a four-year fuel cycle. These design modifications have also led to a decrease in the specific consumption of natural uranium. In 2016, the Kozloduy Nuclear Power Plant made the transition to a modified fuel assembly which can reach higher burnup and has better performance. This transition will also lead to a further reduction of the generated spent nuclear fuel of up to 12.5%.

In accordance with the Kozloduy Nuclear Power Plant programme for diversification of fresh nuclear fuel supplies, a contract was signed with Westinghouse Electric Sweden (WSE) for fabrication and supply of a new type of fuel. This fuel had been licensed, and first assemblies have been loaded in the Unit 5 core in April 2024. The fuel supplies under this contract will be done in the period of 2024-2033. A contract with Framatome for supply of fresh nuclear fuel for Unit 6, was signed as well. The supplies under this contract will be performed in the period of 2026-2034.

Uranium policies, uranium stocks and uranium prices

National policies relating to uranium

There have been no changes to the legal basis related to uranium. At present, Bulgaria does not intend to renew uranium mining activities.

Uranium stocks

There have been no changes in the uranium stock levels.

Historical uranium production by production method

(tonnes U in concentrates)

Production method	Total through end of 2022	2023	2024	Total through end of 2024	2025 (expected)
Open-pit mining*	90	0	0	90	0
Underground mining*	11 985	0	0	11 985	0
In situ leaching	4 272	0	0	4 272	0
Total	16 347	0	0	16 347	0

* Pre-2022 totals may include uranium recovered by heap and in-place leaching.

Historical uranium production by processing method

(tonnes U in concentrates)

Processing method	Total through end of 2022	2023	2024	Total through end of 2024	2025 (expected)
Conventional	11 526	0	0	11 526	0
In-place leaching*	549	0	0	549	0
In situ leaching	4 272	0	0	4 272	0
Total	16 347	0	0	16 347	0

* Also known as stope leaching or block leaching.

Historical uranium production by deposit type

(tonnes U in concentrates)

Deposit type	Total through end of 2022	2023	2024	Total through end of 2024	2025 (expected)
Sandstone	8 700	0	0	8 700	0
Polymetallic Fe-oxide breccia complex	4 640	0	0	4 640	0
Granite-related	1 497	0	0	1 497	0
Metamorphite	366	0	0	366	0
Volcanic-related	1 144	0	0	1 144	0
Total	16 347	0	0	16 347	0

Net nuclear electricity generation (TWh net)

	2023	2024
Nuclear electricity generated (TWh net)	16.163	15.777

Installed nuclear generating capacity to 2050

(MWe net)

2023	2024	2025		2030		2035		2040		2045		2050	
		Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
2 000	2 000	2 000	2 000	2 000	2 000	2 000	3 000	2 000	3 000	2 000	4 000	2 000	3 000

Annual reactor-related uranium requirements to 2050 (excluding MOX)

(tonnes U)

2023	2024	2025		2030		2035		2040		2045		2050	
		Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
370	370	370	370	370	370	370	560	370	560	370	740	370	560

Canada

Uranium exploration

Historical review

Uranium exploration in Canada began in 1942, with the focus of activity first in the Northwest Territories, where pitchblende ore had been mined since the 1930s, to extract radium. Exploration soon expanded to other areas of Canada, resulting in the development of mines in northern Saskatchewan and in the Elliot Lake and Bancroft regions of Ontario during the 1950s. In the late 1960s, exploration returned to northern Saskatchewan, where large high-grade unconformity deposits were discovered in the Athabasca Basin and later developed (the first was the Rabbit Lake deposit, discovered in 1968 and brought into production in 1975). Saskatchewan is now the sole producer of uranium in Canada.

Recent and ongoing uranium exploration, and mine development activities

In 2023 and 2024, uranium exploration in Canada remained primarily concentrated on the Proterozoic unconformity targets of the Athabasca Basin in northern Saskatchewan. Exploration continued along the Patterson Lake structural corridor at the southwestern margin of Saskatchewan's Athabasca Basin, focussed on extending known deposits and zones of interest, and leading to the Patterson Corridor East discovery, in 2024. Work continued to advance the Roughrider project in the Eastern Athabasca Basin, leading to mineral resources assessments. Other reported discoveries include additional high-grade mineralisation at the Gryphon deposit and in the Pike Zone.

Outside of Saskatchewan, renewed exploration activity in Labrador's Central Mineral Belt consisted of a detailed mapping and drilling programme targeting previously identified uranium deposits. Paladin Energy Ltd consolidated 100% ownership of the Michelin project in 2023, a project which had received a 2015 exemption from Canada's Non-Resident Ownership Policy (NROP). A pre-feasibility study for the Michelin project is planned for 2025 with expected completion in 2026. In Nunavut, exploration continued in the Angikuni Basin and comprised drill programmes, surficial sampling, mapping and regional geophysics. Additional summer exploration drilling programmes in 2023-2024 occurred on multiple targets in the Thelon Basin.

While uranium deposits in the Athabasca Basin tend to have high grades (i.e. 15% U), they can be difficult to locate because they are relatively small and often occur at great depths, with little, if any, surface expression. Airborne electromagnetic (EM) techniques are used to detect graphitic zones which are often associated with uranium mineralisation. High-resolution gravity and magnetic surveys are other methods used to define underlying structure and geology. More recently, resistivity and seismic reflection surveys have been used to further define drilling targets. Drilling results are evaluated for uranium content and mineralogy, which are used as inputs into geological and geochemical modelling software to inform the next stage of exploration.

The Wheeler River project, in the southeastern Athabasca Basin, primarily owned and operated by Denison Mines Corp., is advancing towards becoming a uranium producer. The project's Phoenix deposit, planned for in situ leach (ISL) mining underwent federal and provincial environmental assessments and federal licensing. Public hearings for the Wheeler River Project were held by the Canadian Nuclear Safety Commission in October and December 2025 and construction has started.

NexGen Energy Ltd received environmental assessment approval from Saskatchewan's Ministry of Environment in November 2023, to advance the development of the Arrow deposit at its Rook I uranium property in the southwestern Athabasca Basin, where drilling confirmed the presence of high-grade uranium. The federal environmental assessment and licensing approvals process for the proposed Rook I mine were completed with public hearings held by the Canadian Nuclear Safety Commission in November 2025 and February 2026. Activities in preparation for construction are ongoing.

The provincial environmental impact statement review and the federal licensing regulatory processes commenced for Fission Uranium Corp.'s planned Patterson Lake South Project in the same area (Paladin Energy Ltd acquired Fission in December 2024).

In the eastern Athabasca Basin, Orano Canada Inc. and Denison Mines Corp. resumed mining at the McClean Lake mine in 2025 using Surface Access Borehole Resource Extraction (SABRE) technology. Denison also carried out initial field tests of in situ leach (ISL) at its Midwest project, also jointly owned with Orano. This programme included drilling 10 small-diameter boreholes at the Midwest Main deposit to assess site-specific conditions for ISL. A comprehensive database was developed from a range of geological, hydrogeological, geotechnical and metallurgical tests. The resulting data confirmed several key assumptions from a previously completed internal conceptual mining study evaluating the potential application of ISR mining at Midwest.

Domestic uranium exploration expenditures amounted to CAD 316 million in 2023, representing the highest level of annual spending in a decade, an increase of 33% from CAD 238 million in 2022. Domestic exploration expenditures further increased in 2024, to CAD 382 million and are expected to amount to CAD 559.9 million in 2025. Overall Canadian uranium exploration and development expenditures amounted to CAD 412 million and CAD 507 million in 2023 and 2024, respectively.

Uranium resources

Identified conventional resources (reasonably assured and inferred resources)

As of 1 January 2025, Canada's total identified conventional uranium resources recoverable at a cost of <USD 80/kgU amounted to 412 000 tU, an increase of 43% from the 2023 estimate of 288 000 tU. Canada's total identified uranium resources recoverable at a cost of <USD 130/kgU were 552 000 tU as of 1 January 2025, a decrease of 5% compared to the 2023 estimate of 582 000 tU. These changes are due to mining depletion and to the reclassification of resources into the <USD 80/kgU, using a cut-off grade that reflects increased uranium prices as well as increased mining and milling costs, and due to resource removal. Canada no longer reports uranium resources in the <USD 40/kgU cost category. Companies that previously reported deposits with resources in the <USD 40/kgU cost category have reassessed these deposits using a cut-off grade that reflects a price of <USD 80/kgU due to increased costs of production. Most of Canada's identified uranium resources are re-evaluated annually by the uranium mining companies.

The bulk of Canada's identified conventional uranium resources occur in Proterozoic unconformity-related deposits in the Athabasca Basin of Saskatchewan and the Thelon Basin of Nunavut. These deposits host their mineralisation near the unconformity boundary (below, above and across) in either monometallic or polymetallic mineral assemblages. Pitchblende prevails in the monometallic deposits, whereas uranium-nickel-cobalt assemblages prevail in the polymetallic assemblages. The average grade varies from 1% U to over 15% U. None of the uranium resources referred to or quantified herein are a co-product or by-product output of any other mineral of economic importance. Mining losses (~10%) and ore processing losses (~3%) were used to calculate known conventional resources, if not provided by the company.

The percentage of identified conventional uranium resources in existing or committed production centres that are recoverable at <USD 80/kgU, <USD 130/kgU and <USD 260/kgU are 94.42%, 93.1% and 74.1%, respectively. All the resources in existing or committed production centres are updated annually by the mining companies.

Undiscovered conventional resources (prognosticated and speculated resources)

Prognosticated and speculated resources have not been a part of recent resource assessments; hence, there have been no changes to report in these categories since 1 January 2001.

Uranium production

Historical review

Canada's uranium industry began in the Northwest Territories with the 1930 discovery of the Port Radium pitchblende deposit. Exploited from 1933 to 1940 for radium, the mine was reopened in 1942 in response to uranium demand for the Manhattan Project. Provincial and Territorial bans on private exploration and development were lifted in 1947 and 1948, and by the late 1950s, some 20 uranium production centres had started up in Ontario, Saskatchewan and the Northwest Territories. Production peaked in 1959 at 12 200 tU. No further defence contracts were signed after 1959, and production began to decline. Despite government stockpiling programmes, output fell rapidly to less than 3 000 tU in 1966, by which time only four producers remained. While the first commercial sales to electric utilities were signed in 1966, it was not until the mid-1970s that prices and demand increased sufficiently to promote expansions in exploration and development activity. By the late 1970s, with the industry firmly re-established, several new facilities were under development in Saskatchewan and Ontario. Annual output grew steadily throughout the 1980s, as Canada's focus on uranium production shifted increasingly to Saskatchewan. The last remaining Ontario uranium mine closed in mid-1996. Uranium production peaked at 14 039 tU in 2016, when the Cigar Lake mine reached full output, but production subsequently declined since then due to the suspension of operations at Rabbit Lake and McArthur River/Key Lake, in response to low uranium prices. Production from Cigar Lake was impacted by the COVID-19 pandemic in 2020 and 2021; however, with the resumption of operations at McArthur River/Key Lake in November 2022, Canada's uranium production has returned to record levels.

Status of production capability, and recent and ongoing activities

All active uranium production centres are in northern Saskatchewan and are operated by Cameco Corp. (Cameco) and Orano Canada Ltd (Orano). Current Canadian uranium production is below the full licensed production capacity of the uranium mills. Production in 2024 was 14 327 tU (the highest ever Canadian production), 30% above the 2023 production level of 10 986 tU and 94% above the 2022 production level of 7 380 tU, as operations at the Cigar Lake mine returned to full production and the McArthur River mine and Key Lake mill operated near full production capacity.

Cameco is the operator of the McArthur River mine, a Cameco (70%) and Orano (30%) joint venture, which is the world's largest high-grade uranium deposit. Production was idled indefinitely in January 2018 in response to low uranium demand; however, the mine resumed operations in 2022. At the mine, ground freezing is used to prevent water inflow from the overlying rock formation and the high-grade ore (>5% U) is extracted using raise bore mining with concrete used as a backfill. A high-grade ore slurry is produced by underground crushing, grinding and mixing, which is then pumped to the surface and loaded in specially designed containers that are shipped 80 km southward by road to the Key Lake mill. The remaining identified recoverable resources for the McArthur River mine are currently 153 000 tU, with an average grade of 5.4% U.

The Key Lake mill is a Cameco (83%) and Orano (17%) joint venture, operated by Cameco. The mill has produced continuously since its restart in November 2022. In 2024, uranium processed at the Key Lake mill was 7 795 tU from McArthur River ore and 20 tU from low-grade Key Lake ore (from stockpile), compared to 2023 when production included 5 163 tU from McArthur River ore and 17 tU from Key Lake ore.

The McClean Lake production centre, operated by Orano, is a joint venture between Orano (77.5%) and Denison Mines Corp (22.5%). The McClean Lake mill processes Cigar Lake ore on behalf of the Cigar Lake joint venture. Production from Cigar Lake ore reached 6 512 tU in 2024, a 12.1% increase compared to 2023 production of 5 807 tU, and a 6.1% decrease compared to 2022 production of 6 938 tU. 2023 saw a 16.3% decline compared to 2022. The McClean Lake mill started processing ore mined using SABRE technology in 2025 and, as a result, total mill production is expected to increase.

Production from the Rabbit Lake production centre, wholly owned and operated by Cameco, has been idled since mid-2016, due to low uranium prices. Production could resume when uranium prices recover. Exploratory drilling at the Eagle Point mine before operations were suspended identified resources of 27 000 tU, with an average grade of 0.63% U.

Cigar Lake is a high-grade uranium mine, with identified resources of 82 180 tU at an average grade of 11.5% U. The mine, which began operation in March 2014, is a Cameco (54.547%), Orano (40.453%) and Tokyo Electric Power Company (5%) joint venture, operated by Cameco. Ground freezing of the ore zone area is used to prevent groundwater inflow and ore is extracted using an innovative jet bore mining method with concrete used as backfill. The high-grade ore slurry from Cigar Lake is shipped by road to the McClean Lake (JEB) mill for processing. Cigar Lake production for the reporting period is as stated in the McClean Lake update above.

Ownership structure of the uranium industry

Cameco Corp. (Cameco) and Orano Canada Ltd. (Orano) are the operators of the current uranium production centres in Canada. Cameco is the owner and operator of the Rabbit Lake production centre (operations suspended since 2016), which includes the Eagle Point mine and the Rabbit Lake mill. Cameco is also the operator of the McArthur River mine and the Key Lake mill, which are joint ventures with Orano. Cameco is the majority owner and operator of the Cigar Lake mine, in which Orano and the Tokyo Electric Power Co. (TEPCO) have minority ownership. Orano is the majority owner and operator of the McClean Lake production centre in which Denison Mines Corp. has minority ownership. In December 2024, Paladin Energy Ltd. (Paladin), an Australian company, acquired Fission Uranium Corp., a Canadian junior exploration company and the owner of the Paterson Lake South (PLS) project. In March 2025, the Government of Canada granted Paladin an exemption from Canada's Non-Resident Ownership Policy (NROP) for the PLS project (Triple R deposit), which will allow it to continue to be the majority owner when a mine and mill are in operation.

Employment in the uranium industry

Employment in Canada's uranium production industry (including head office employees) totalled 2 381 in 2022, 3 420 in 2023 and 3 352 in 2024. The increase in employment at the mine and mill sites in 2024 was primarily the result of the McArthur River mine/Key Lake mill resuming operations in 2022, after being suspended since 2018, and the continued production at Cigar Lake mine and McClean Lake mill.

Uranium production centre technical details

(as of 1 January 2025)

	Centre #1	Centre #2	Centre #3	Centre #4	Centre #5	Centre #6	Centre #7	Centre #8
Name of production centre	McArthur River /Key Lake	McClean Lake	Rabbit Lake	Cigar Lake	Midwest	Wheeler River	Rook I	Patterson Lake South
Production centre classification	Existing	Idled	Idled	Existing	Planned	Planned	Planned	Planned
Date of first production	1999/1983	1999	1975	2014	NA	NA	NA	NA
Source of ore:								
Deposit name(s)	P2N et al.	JEB, McClean, Sue A-E, Caribou	Eagle Point	Cigar Lake	Midwest	Phoenix	Arrow	Triple-R
Deposit type(s)	Unconfor-mity	Unconfor-mity	Unconfor-mity	Unconfor-mity	Unconfor-mity	Unconfor-mity	Unconfor-mity	Unconfor-mity
Recoverable resources (tU)	153 000 tU	12 100 tU	27 000 tU	82 200 tU	19 000 tU	26 900 tU	130 000 tU	50 000 tU
Grade (% U)	5.4	1.1	0.63	11.5	1.52	9.7	2.6	1.5
Mining operation:								
Type (OP/UG/ISR)	UG	UG/OP	UG	UG	OP	ISR	UG	UG
Size (tonnes ore/day)	~200	NA	NA	~200	NA			
Average mining recovery (%)	NA	NA	NA	NA	NA			
Processing plant:								
Acid/alkaline	Acid	Acid	Acid	Processed at McClean Lake	To be processed at McClean Lake	Acid		
Type (IX/SX/ISR)	SX	SX	SX			ISR	SX	SX
Size (tonnes ore/day)	864	300	2 880				1 300	1 000
Average process recovery (%)	98	97	97			80.6	98	97
Nominal production capacity (tU/year)	9 600	9 200	6 500	6 900	2 300	4 600	11 900	5 800
Plans for expansion		Expansion of tailings capacity	Expansion of tailings capacity					

Future production centres

Several uranium mining projects in Saskatchewan that would feed existing mills could enter production within the next decade. Ore from Orano's proposed Midwest mine, which has received environmental approval, would provide additional feed for the McClean Lake mill. In August 2025, Denison Mine Corp., Orano's partner in the Midwest Joint Venture, released a preliminary economic assessment for mining the Midwest Deposit using ISL methods. The results, based on ISL field tests conducted in 2023 and 2024, indicate that Midwest could be among the lowest cost uranium mines in the world. Cameco has previously proposed that ore from the Millennium mine could be processed at the Key Lake mill. Cameco has also identified other deposits (Fox Lake, Tamarack) that could feed existing mills.

In the western Athabasca Basin, the Arrow deposit (NexGen Energy Ltd.) is the world's second-largest high-grade uranium deposit (130 000 tU), and the project to develop an underground mine and mill has received a Canadian Nuclear Safety Commission decision on the licence to prepare the site and construct in early 2026. The nearby Triple R deposit (Paladin Energy Ltd.) is a high-grade uranium deposit (50 000 tU), which also hosts indicated and inferred gold resources totalling 67 000 ounces, and is undergoing Canadian Nuclear Safety Commission licence application review. In the eastern Athabasca Basin, Denison Mines Corp.'s Phoenix deposit (26 900 tU) has similarly received a Canadian Nuclear Safety Commission decision, in early 2026, on the licence to prepare the site and construct for the proposed ISL mining operation. The Phoenix deposit is located in permeable sandstone above the unconformity, and ground freezing is proposed in the sandstone overlying the deposit to create the confining conditions required for ISL operations. Denison Mines Corp.'s nearby Gryphon deposit (24 000 tU) has the potential to be mined by conventional underground methods. In 2020, Denison conducted a Preliminary Economic Assessment for mining the Heldeth Túé deposit at Waterbury Lake, using ISL methods.

There is also a possibility of mines being developed outside of Saskatchewan. Orano had proposed developing the Kiggavik and Sissons deposits in Nunavut, should market conditions improve and mining become economically feasable. As noted above, Paladin Energy Ltd. announced in mid-2025 that it will conduct a pre-feasibility study for the Michelin project in Labrador.

Secondary sources of uranium

Canada does not use secondary sources of uranium. Canada does not produce or use mixed oxide fuels nor does it use re-enriched tails.

Environmental activities and socio-cultural issues

Environmental impact assessments

The Canadian Nuclear Safety Commission hearings on the federal environmental assessments related to the proposals to develop the Arrow deposit and the Phoenix deposit took place in late 2025 and early 2026. The Commission concluded that the projects are unlikely to cause significant adverse environmental effects, contingent on full implementation of mitigation, follow-up monitoring, Indigenous engagement and validation through environmental monitoring.

Saskatchewan's approval of the environmental impact statements for the proposals to develop the Arrow, Phoenix and Triple R deposits were issued in 2023, 2025 and 2026, respectively. A federal environmental impact assessment is not required for the Triple R deposit.

Effluent management

Water treatment and minor engineering works continued to be the main activities at the closed Elliot Lake area uranium mine and mill sites in 2023 and 2024. Water quality within the Serpent River Watershed has improved since the closure and decommissioning of the mines, and currently meets Ontario Drinking Water Standards.

Site rehabilitation

The Beaverlodge mine and mill located near Uranium City in northern Saskatchewan, which operated from 1952, ceased operations in 1982. This was followed by a 3-year period of active decommissioning from 1982 to 1985 after which the site transitioned to long-term care and maintenance. From 2000 to 2025 Cameco progressively transferred several Beaverlodge sites to Saskatchewan's Institutional Control Program (ICP). In May 2025, the waste facility operating licence held by Cameco Corp. was revoked, and the remaining 27 decommissioned Beaverlodge properties were either transferred to the ICP or are awaiting transfer pending Saskatchewan's approval process. The ICP was established by the province of Saskatchewan in 2007 as part of its institutional control framework, for the long-term management of decommissioned and reclaimed mine and mill sites on provincial Crown lands

In northern Saskatchewan, several mines (principally the Gunnar and Lorado mines) were operated from the late 1950s to early 1960s by private sector companies that no longer exist. When the sites were closed, there were no regulatory requirements in place to appropriately contain and treat the waste, which has led to environmental impacts on local soils and lakes. The responsibility for these sites is now held by the government of Saskatchewan and a project is currently underway to remediate these sites.

Uranium requirements

Nuclear energy continues to be a cornerstone of Canada's electricity supply, contributing 14% of the nation's total electricity generation in 2024. This role is expected to grow as Canada modernises its nuclear infrastructure and explores new technologies. Currently, uranium demand is driven by the existing fleet of CANDU reactors, many of which are undergoing refurbishment to extend their operational lives. Of the 23 CANDU pressurised heavy water reactors built in Canada, 17 are currently operational. These include 16 reactors that supply approximately 50% of Ontario's electricity and one reactor that provides about 30% of New Brunswick's electricity needs.

Looking ahead, uranium requirements will be shaped by the long-term operation of refurbished units, many expected to run beyond 2050, and potentially increased by life extension projects and the deployment of new nuclear technologies (both large- and small-scale) in Ontario, Saskatchewan, New Brunswick and Alberta.

CANDU reactors were originally designed for 30 to 35 years of operation. However, through refurbishment their lifespan can be extended by an additional 30 to 35 years. Successful refurbishment projects have already been completed at Point Lepreau in New Brunswick and Bruce A Units 1 and 2 in Ontario, with all reactors returning to service by late 2012.

Ontario's 2013 Long-Term Energy Plan initiated further refurbishments at Darlington and Bruce. At Darlington, Unit 2 was the first to be refurbished, returning to service in 2020, followed by Unit 3 in 2023 and Unit 1 in 2024. The refurbishment of the final unit (Unit 4) was completed in early 2026, ahead of schedule and under budget, marking the completion of the Darlington's full refurbishment. At the Bruce Nuclear Generating Station, Unit 6 refurbishment began in 2020 and the unit returned to service in 2023. Unit 3 began refurbishment in 2023 and returned to service in June 2026, more than seven months ahead of schedule. Unit 4 began refurbishment in 2025, with completion expected by 2028, and Unit 5 refurbishment is scheduled to begin later in 2026. The remaining units will follow, with the entire plant expected to operate until around 2064.

In parallel, Ontario Power Generation (OPG) is advancing plans to refurbish the Pickering Nuclear Generating Station's "B" units. In January 2025, the Ontario government approved a CAD 4.1 billion investment to support the project definition phase, covering early engineering and procurement. If fully approved by the end of 2026, the refurbishment would be completed by the mid-2030s, extending the station's life up to 38 years and adding over 2 000 MWe of clean electricity to the grid. Altogether the refurbishments at Darlington, Bruce and Pickering would maintain more than 12 000 MWe of existing generation capacity.

In addition to refurbishment, Bruce Power is pursuing opportunities to optimise the output of its existing nuclear units, with a target of reaching 7 000 MWe of peak output, a 450 MW increase over current capacity, by the 2030s, through a combination of asset optimisation, innovation and leveraging new technologies.

Canada's new nuclear energy momentum

Canada is entering a new era of nuclear innovation, marked by the advancement of small modular reactors (SMRs), the development of new large-scale nuclear technologies and major refurbishment projects aimed at extending the life of existing nuclear infrastructure. These developments are central to meeting the country's growing electricity demands, reducing emissions, and supporting long-term economic growth. Nuclear energy remains a top priority across Canada with projects at various stages of readiness across the provinces of Ontario, Saskatchewan and Alberta.

In April 2025, the Canadian Nuclear Safety Commission issued a licence to construct Canada's first SMR at the Darlington nuclear site, and in May 2025, Ontario approved the start of construction, making Canada the first G7 country to begin building an SMR. The GE-Hitachi BWRX-300 reactor is the first of four planned units, which will collectively produce 1 200 MW once operational. Ontario plans to build a third nuclear generating station at Bruce Power, known as Bruce C, with a proposed capacity of up to 4 800 MW. This would be the first new large-scale nuclear plant in Canada in over 30 years. Bruce Power submitted its initial project description to the Impact Assessment Agency of Canada in August 2024, and the integrated impact assessment formally commenced in 2025; the project is now in the impact assessment phase, with Bruce Power preparing its Impact Statement.

Saskatchewan's Crown Corporation SaskPower is proceeding with SMR development and focussing on the Estevan region for its location. The search has been narrowed to two candidate sites near Estevan, with final site selection expected in 2026, a decision to build targeted for 2029, and the first unit planned for completion by 2034. In August 2023, the federal government approved up to CAD 74 million in funding for SMR development in the province. This funding supports pre-engineering, environmental assessments, regulatory studies and Indigenous engagement.

Alberta has been holding public engagements to explore how nuclear energy could be integrated into the province's energy mix to provide reliable baseload power and opportunities for industrial applications, such as in the oil sands, while further reducing emissions.

Supply and procurement strategy

Approximately 1 700 tU of Canada's uranium production is used domestically to generate nuclear power. The nuclear utilities fill uranium requirements through long-term contracts and periodic spot market purchases.

Uranium policies, uranium stocks and uranium prices

National policies relating to uranium

Effective March 2025, the Provincial Government of Nova Scotia repealed the Uranium Exploration and Mining Prohibition Act which banned uranium exploration and mining in Nova Scotia since 1981. In May 2025, the Provincial Government of Nova Scotia updated its critical mineral list to include uranium.

Uranium stocks

The Canadian government does not maintain any stocks of natural uranium, and data for producers and utilities are not available. Since Canada has no enrichment or reprocessing facilities, there are no stocks of enriched or reprocessed material in Canada. Although Canadian reactors use natural uranium fuel, small amounts of enriched uranium are used for experimental purposes and in booster rods in certain CANDU reactors.

Uranium prices

In 2002, Natural Resources Canada suspended the publication of the average price of deliveries under export contracts for uranium.

Uranium exploration and development expenditures, and drilling effort – domestic

(CAD millions)

	2022	2023	2024	2025 (p)
Industry* exploration expenditures	238	316	382	560
Industry* development expenditures	91	96	125	NA
Total expenditures	329	412	507	NA
Industry* exploration drilling (m)	200 127	227 134	330 198	NA
Industry* exploration holes drilled	NA	NA	NA	NA
Industry* development drilling (m)	64 230	34 855	18 428	NA
Industry* development holes drilled	NA	NA	NA	NA
Subtotal exploration drilling (m)	200 127	227 134	330 198	NA
Subtotal exploration holes drilled	NA	NA	NA	NA
Subtotal development drilling (m)	64 230	34 855	18 428	NA
Subtotal development holes drilled	NA	NA	NA	NA
Total drilling (m)	264 357	261 989	348 626	NA
Total number of holes drilled	NA	NA	NA	NA

* Non-government.

Conventional reasonably assured resources by production method

(recoverable tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	<USD 390/kgU	Recovery factor (%)
Underground mining (UG)	0	328 738	413 129	544 495	NA	87*
Open-pit mining (OP)	0	260	18 941	63 074	NA	87*
In situ leaching acid	0	31 610	31 610	31 610	NA	87*
Total	0	360 608	463 680	639 179	NA	87*

* Mining losses (~10%) and ore processing losses (~3%) were used to calculate recoverable resources, if recovery factors were not provided by companies.

Conventional reasonably assured resources by processing method

(recoverable tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	<USD 390/kgU
Conventional from UG	0	328 738	413 129	544 495	NA
Conventional from OP	0	260	18 941	63 074	NA
In situ leaching acid	0	31 610	31 610	31 610	NA
Total	0	360 608	463 680	639 179	NA

Conventional reasonably assured resources by deposit type

(recoverable tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	<USD 390/kgU
Proterozoic unconformity	0	360 608	459 033	604 549	NA
Sandstone	0	0	4 647	4 647	NA
Metasomatite	0	0	0	29 983	NA
Total	0	360 608	463 680	639 179	NA

Conventional inferred resources by production method

(recoverable tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	<USD 390/kgU	Recovery factor (%)
Underground mining (UG)	0	51 301	77 650	153 632	NA	87*
Open-pit mining (OP)	0	0	10 376	12 979	NA	87*
In situ leaching acid	0	0	0	0	NA	87*
Total	0	51 301	88 026	166 611	NA	87*

* Mining losses (~10%) and ore processing losses (~3%) were used to calculate recoverable resources, if recovery factors were not provided by companies.

Conventional inferred resources by processing method

(recoverable tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<UD 260/kgU	<USD 390/kgU
Conventional from UG	0	51 301	77 650	153 632	NA
Conventional from OP	0	0	10 376	12 979	NA
In situ leaching acid	0	0	0	0	NA
Total	0	51 301	88 026	166 611	NA

Conventional inferred resources by deposit type

(recoverable tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	<USD 390/kgU
Proterozoic unconformity	0	51 301	84 936	139 614	NA
Sandstone	0	0	3 090	19 078	NA
Metasomatite	0	0	0	7 919	NA
Total	0	51 301	88 026	166 611	NA

Conventional prognosticated resources

(in situ tonnes U)

Cost ranges		
<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
50 000	150 000	150 000

Conventional speculative resources

(in situ tonnes U)

Cost ranges		
<USD 130/kgU	<USD 260/kgU	Unassigned
700 000	700 000	0

Historical uranium production by production method

(tonnes U in concentrates)

Production method	Total through end of 2022	2023	2024	Total through end of 2024	2025 (preliminary)
Open-pit mining*	119 566	0	0	119 566	0
Underground mining*	435 308	10 986	14 327	460 621	13 943
Other – SABRE**	0	0	0	0	308
Total	554 874	10 986	14 327	580 187	14 251

* Pre-2020 totals include ~1 000 tU recovered by in-place leaching. 2014-2017 underground mining totals include 61 tU recovered at the Key Lake mill from recycling uranium refinery wastes.

** Surface Access Borehole Resource Extraction (SABRE) is an innovative, non-entry, surface-based mining method that uses a high-pressure water jet placed at the bottom of a drill hole to excavate a mining cavity and air lift the ore cuttings to the surface.

Historical uranium production by processing method

(tonnes U in concentrates)

Processing method	Total through end of 2022	2023	2024	Total through end of 2024	2025
Conventional	553 874	10 986	14 327	579 187	14 251
In-place leaching*	1 000	0	0	1 000	0
Total	554 874	10 986	14 327	580 187	14 251

* Also known as stope leaching or block leaching.

Historical uranium production by deposit type

(tonnes U in concentrates)

Deposit type	Total through end of 2022	2023	2024	Total through end of 2024	2025 preliminary
Proterozoic unconformity	378 967	10 986	14 327	404 280	14 251
Paleo-quartz-pebble conglomerate	144 182	0	0	144 182	0
Granite-related	7 539	0	0	7 539	0
Intrusive	5 636	0	0	5 636	0
Metasomatite	18 489	0	0	18 489	0
Other/unspecified*	61	0	0	61	0
Total	554 874	10 986	14 327	580 187	14 251

* Uranium recovered at Key Lake mill from recycling uranium refinery wastes.

Ownership of uranium production in 2024

Domestic				Foreign				Totals	
Government		Private		Government		Private			
(tU)	(%)	(tU)	(%)	(tU)	(%)	(tU)	(%)	(tU)	(%)
0	0	9 012	62.9	5 315	37.1	0	0	14 327	100

Uranium industry employment at existing production centres

(person-years)

	2022	2023	2024	2025 (expected)
Total employment related to existing production centres	2 381	3 420	3 352	NA
Employment directly related to uranium production	1 930	2 192	2 316	NA

Mid-term production projection (tonnes U/year)

2025	2030	2035	2040	2045	2050
14 390	14 190	13 850	7 000	6 420	N/A

Mid-term production capability

(tonnes U/year)

2025				2030			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
14 080	14 080	14 080	14 080	14 190	28 920	14 190	28 920
2035				**2040**			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
13 850	23 690	13 850	23 690	6 920	13 270	6 920	13 270
2045				**2050**			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
6 420	6 420	6 420	6 420	NA	NA	NA	NA

Net nuclear electricity generation

	2023	2024
Nuclear electricity generated (TWh net)	84.6	81.7

Installed nuclear generating capacity to 2050

(MWe net)

2023	2024	2025		2030		2035		2040		2045		2050	
		Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
13 700	13 700	12 700	12 700	13 000	13 000	13 000	14 500	13 000	15 400	13 000	20 500	13 000	25 300

Annual reactor-related uranium requirements to 2050 (excluding MOX)

(tonnes U)

2023	2024	2025		2030		2035		2040		2045		2050	
		Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
1 564	1 512	1 645	1 645	1 689	1 689	1 689	1 908	1 689	2 040	1 689	2 705	1 689	3 327

* Uranium requirements calculated assuming 18.5 tU per TWh (net) electrical generation for CANDU reactors and 20.9 tU per TWh (net) electrical generation for other future reactors.

Total uranium stocks

(tonnes natural U-equivalent)

Holder	Natural uranium stocks in concentrates	Enriched uranium stocks	Enrichment tails	LWR reprocessed uranium stocks	Total
Government	0	0	0	0	0
Producer	NA	0	0	0	NA
Utility	NA	0	0	0	NA
Total	NA	0	0	0	NA

Chile

Uranium exploration and mine development

Historical review

Uranium exploration in Chile was initiated in the 1950s, with a review of uranium potential in mining districts with Cu, Co, Mo, Ag mineralisation conducted by the US Atomic Energy Commission. Following a delay of about ten years, activities were renewed in 1970 by the Spanish Nuclear Energy Organisation, focussing for four years on the Tambillos mining district in the Coquimbo Region.

Between 1976 and 1990, regional prospecting encompassing an area of 150 000 km^2 was conducted in co-operation with the IAEA using geochemical drainage surveys, aerial radiometry, and ground-based geology and radiometry. This work led to the detection of 1 800 aerial anomalies, 2 000 geochemical and radiometric anomalies, and the definition of 120 sectors of interest. Subsequent investigation of 84 of these sectors of interest led to the identification of 80 uranium occurrences, prompting further study of the 12 most promising prospects, preliminary exploration of these prospects and, eventually, to the evaluation of uranium resources as a by-product of copper and phosphate mining.

From 1980 to 1984, Compañía Minera Pudahuel (the Pudahuel Mining Company), in co-operation with the Chilean Nuclear Energy Commission (CCHEN), conducted drilling of the Sagasca Cu-U deposit, Tarapacá Region, leading to a technical and economic evaluation of the Huinquintipa copper deposit, in the Tarapacá Region. The Production Development Corporation (Corporación de Fomento de la Producción – CORFO) and CCHEN conducted exploration and a technical economic evaluation of the Bahía Inglesa phosphorite deposit, Atacama Region, in 1986 and 1987.

Between 1990 and 1996, CCHEN undertook geological and metallogenic uranium research, mainly in the north of the country. From 1996 to 1999, CCHEN and the National Mining Company of Chile (ENAMI) investigated rare earth elements (REE) in relation to radioactive minerals in the Atacama and Coquimbo regions. Dozens of primary occurrences were studied, with the "Diego de Almagro" Anomaly-2 chosen as a priority. The study of this 180 km^2 sector found disseminations and veins of davidite, ilmenite, magnetite, sphene, rutile and anatase, with 3.5 to 4.0 kg/t of REE oxides (REO), 0.3 to 0.4 kg/t of U and 20 to 80 kg/t of Ti. The geological resources of the ore contained in this prospect were estimated at 12 000 000 t. The metallurgical recovery of REO from these minerals was also investigated with a purpose of investigating mining resources with economic potential in the medium term.

In 1998 and 1999, CCHEN created the National Uranium Potential Evaluation Project, encompassing the activities of uranium metallogeny research and development of a geological database. The aim of this project was to set up a portfolio of research projects to improve the evaluation of national uranium ore potential. Between 2000 and 2002, a preliminary geological evaluation for uranium and REO of the Cerro Carmen prospect (2000-2002), located in Atacama Region, was completed, as part of the specific co-operation agreement between CCHEN and ENAMI. Geophysical exploration work was undertaken (magnetometry, resistivity and chargeability), defining targets with metallic sulphur minerals with uranium and associated REE.

In 2001, a project portfolio document was developed that updated the metallogeny and geological favourability for uranium in Chile. A total of 166 research projects were proposed, ranging from regional activities to detailed scientific studies, to be undertaken sequentially in accordance with CCHEN capacities. In the extractive metallurgy area, work has been ongoing since 1996, through a co-operation agreement between CCHEN and ENAMI, to develop processes to produce commercial concentrates of rare earths. High purity concentrates of light REE as well as yttrium have been obtained.

In 2003, regional reconnaissance was undertaken for uranium and REE in the Tarapacá Region, after which the CCHEN-ENAMI co-operation agreement was terminated. Through 2004, database work was continued by CCHEN, and commercial services were provided to the mining industry through 2010.

From 2008 to 2012, CCHEN completed a broad scope co-operation agreement with the National Copper Corporation (CODELCO Norte) for geological and metallurgical investigation of natural radioactive material occurrences. From 2009 to 2012, CCHEN and CODELCO Norte completed an agreement on activities to investigate recovery of uranium and molybdenum from copper ore leaching solutions.

Recent and ongoing uranium exploration, and mine development activities

No uranium exploration and mine development activities have been carried out in recent years.

Uranium resources

Identified conventional resources (reasonably assured and inferred resources)

No new uranium resources have been identified since the 2011 edition of the Red Book. Recoverable identified resources (RAR + IR) total 1 448 tU in the <USD 260 kg/U cost category.

Undiscovered conventional resources (prognosticated and speculative resources)

Prognosticated and speculative in situ conventional resources remain at 2 324 tU (<USD 260/kgU) and 2 360 tU (unassigned cost category), respectively. Undiscovered conventional resources account for a total of 4 684 tU.

Unconventional resources and other materials

Identified unconventional recoverable resources account for 1 169 tU (<USD 260/kgU), while undiscovered unconventional resources total 5 458 tU in situ. New unconventional resources have not been reported.

Identified conventional resources (reasonably assured and inferred resources)

(in situ tonnes U)

Deposit	Type	RAR	IR	Grade % U_3O_8	Rocks, hosting age
Cenozoic surficial deposits[1]	Surficial	28	41	0.023	Diatomite, volcanic ash with organic material (Pliocene – Pleistocene)
Cretaceous metasomatic[2]	Metasomatic	720	1 043	0.028-0.20	Intrusive, volcanic and metasomatic rocks (upper Cretaceous)
Cenozoic volcanic-related[3]	Volcanic-related	0	100	0.01-0.18	Magnetite and haematite tuffs. Secondary U-REE mineralisation (Oligocene Pleistocene)
Total		748	1 184		

Surface deposits:

1. Salar Grande (28 tU), Mina Neverman (?), Boca Negra (3 tU), Manuel Jesús (3tU), Mina Casualidad (?), Mina San Agustín (?), Quebrada Vítor (?), Pampa Chaca (2 tU), Pampa Camarones (4 tU), Quebrada Amarga (2 tU), Quillagua (22 tU), Prosperidad (?), Chiu Chiu (5 tU).

Metasomatic deposits:

2. Estación Romero 326 tU (Carmen and Productora prospects), Cerro Carmen prospect (1 392 tU), Agua del Sol (15 tU), Sector Pejerreyes – Los Mantos (20 tU), Tambillos district (10 tU). The following estimates were produced at the prospect of the Diego de Almagro Anomaly-2 (Cerro Carmen prospect) in 1999-2000, as a result of detailed geological and radiometry work, together with magnetometry, excavation and sampling of exploration trenches, undertaken as part of the activities of the co-operation agreement between ENAMI and CCHEN: Calculations indicate that the deposit hosts a total of 595 tU as indicated resources and797 tU as inferred resources, making a total in situ of 1 392 tU as identified resources (RAR + inferred). The cost of extracting these resources was not estimated, therefore it is not included in the identified resources tables.

Volcanogenic deposits:

3. In the El Laco iron ore deposit, produced during Cenozoic volcanism on the "altiplano" of Region II (Antofagasta), a total of 100 tU (in situ) was identified as inferred.

Uranium resources by deposit type

(in situ tonnes U)

Deposits, areas and other resources	RAR + IR	PR + SR	SR*
Surficial deposits	68	124	
Metasomatic deposits	1 763	4 060	
Volcanic-related deposits	100	500	
Unconventional deposits and resources	1 798	5 458	1 000
Deposit areas:			
1 – Surface deposits, Cenozoic	--	--	500
2 – Metasomatic deposits, Cretaceous	--	--	500
3 – Magmatic deposits, Cenozoic			250
4 – Polymetallic deposits, Cretaceous	--	--	100
Favourable areas:			
A – Acid volcanism, Tertiary	--	--	500
B – Intrusives, Jurassic-Cretaceous	--	--	500
C – Volcanic acid-sedimentary, Cretaceous	--	--	200
D – Main Cordillera, Palaeozoic magmatism	--	--	50
E – Sedimentary-volcanic, Middle Cretaceous	--	--	100
F – Nahuelbuta, Palaeozoic plutonism	--	--	300
G – Clastic sedimentary, Cretaceous-Tertiary	--	--	300
Total	3 729	10 142	4 300

* Undiscovered resources are expected to exist remotely from the known occurrences, either in the aforementioned uranium deposit areas or in favourable areas. In the case of unconventional resources, the figures correspond to uranium that could be recovered from the copper leaching plant solutions of the country's medium- and large-scale mining activities. The latter could be several orders of magnitude greater, considering that large-scale national mining, both state-owned and private, produces large reserves of minerals in projects lasting up to 20 years. CCHEN has not updated its studies on this subject.

Surficial deposits

(in situ tonnes U)

Surface deposits	RAR	IR	PR	SR	% U_3O_8	Minerals
Boca Negra		3			0.02-0.600	Silica, yellow minerals
Manuel Jesús		3			0.10-0.190	Silica, yellow minerals
Casualidad					0.018	Silica, yellow minerals
San Agustín					0.20-0.250	Silica, yellow minerals
Poconchile					0.028	Silica, yellow minerals
Quebrada Vítor					0.028	Autunite
Pampa Chaca		2			0.028	Autunite
Pampa Camarones		4	4		0.030	Autunite, shronquingierite
Salar Grande	28		100		0.023	Carnotite
Quebrada Amarga		2			0.117	Carnotite
Quillagua		22			0.165	Carnotite
Chiu Chiu		5	5	15	0.04-0.140	Yellow minerals
Total	28	41	109	15		

Metasomatic deposits

(in situ tonnes U)

Metasomatic and hydrothermal deposits	RAR	IR	PR	SR	% U_3O_8	Minerals
Anomaly-2, Diego de Almagro (Cerro Carmen prospect)	595	797	1 400	1 500	0.03-0.10	Davidite, sphene, Ilmenite, anatase
Agua del Sol	15			50	0.02-0.06	Davidite
Sierra Indiana			15	15	0.02-0.08	Davidite
Estación Romero						
Carmen	20	10		50	0.01-0.12	Davidite
Productora	60	236	300	500	0.01-0.28	Autunite, torbernite
Tambillos	10			100	0.01-0.20	Uraninite, pitchblende
Pejerreyes – Los Mantos	20			130	0.01-0.05	Davidite, aut., torbernite
Total	720	1 043	1 715	2 345		

Volcanic-related deposits

(in situ tonnes U)

Volcanogenic deposits	RAR	IR	PR	SR	% U_3O_8	Minerals
Acid and intermediate volcanism, Regions I to III						Not investigated
El Laco sector, Region II		100	500			Aut., torbernite, REE
El Perro sector, Region III						Not investigated
Total		100	500			

Unconventional resources and other materials*

(in situ tonnes U)

Mines, prospects, materials	RAR	IR	PR	SR	% U_3O_8	Minerals
Copper-uranium paleochannels						
Sagasca – Cascada[1]	164				0.0046	Crisocola, U
Huinquintipa[2]	46				0.0030	Crisocola, U
Chuquicamata Sur[3]	950				0.0007	Crisocola, U
Quebrada Ichuno[4]				25	0.0060	Crisocola, U
El Tesoro[5]				50	0.0070	Crisocola, U
North Chuquicamata (oxides zone)[6]				1 000	0.0008	Oxides Cu, U
Gravel from Chuquicamata oxides plant[7]				2 000	0.0008	Oxides Cu, U
Seams of high-temperature copper						
Algarrobo – El Roble[8]			513		0.0400	Sulph., Cu, U
Carrizal Alto[8]				500	0.0250	Sulph., Cu, U
Tourmaline breccias[8]						
Campanani[8]						
Sierra Gorda[8]				60	0.0020	Sulph., Cu, U
Los Azules[8]			5			
Cabeza de Vaca[8]				5		
Uranium-bearing phosphorites						
Mejillones			1 300		0.0026	Colophane – U
Bahía Inglesa[9]	638				0.0062	Colophane – U
Total	1 798		1 818	3 640		

* Note: The figures shown in this table represent historical data and are not current. Studies need to be done to validate or eliminate these figures.

1. The Sagasca deposit is exhausted and the Cascada deposit (continuation of the mineralised body) is practically exhausted; however, new explorations in the area have found new mineralised bodies, so the figure could vary substantially.
2. Huinquintipa currently forms part of the Collahuasi Project, a contractual mining company belonging to Anglo American Plc and Xstrata Copper, a division of the Swiss mining company Xstrata Plc, each of which has a 44% stake. The remaining 12% belongs to JCR, a consortium of Japanese companies led by Mitsui & Co., Ltd. The oxidised mineral reserves amount to 53 million tonnes, for which copper extraction and production began in 2000 and was estimated to last for 20 years. The figures shown in the foregoing table could rise by a factor of between 10 and 20.
3. Chuqui Sur: Although this deposit is not exhausted, the surcharge makes it expensive to operate, so the uranium resources contributed to the Chuquicamata Division oxides plant could be zero. Accordingly, the figures indicated above could decrease significantly.
4. Quebrada Ichuno has not been studied and there are only preliminary works, so the figure mentioned above is maintained.
5. The uranium resources assigned to the El Tesoro mine correspond to preliminary geological reconnaissance data obtained in 1983. This deposit is currently a nationally important mining centre, 70% owned by Antofagasta Minerals S.A., which belongs to Antofagasta Plc, and 30% owned by the Marubeni Corporation of Japan. Its mineral reserves amount to 186 million tonnes, with a useful life of 21 years. Preliminary samples suggest uranium contents of between 5 and 200 ppm, with an average of between 15 and 20 ppm. Investigating this uranium source could change the figure indicated above substantially.
6. The "Chuquicamata Norte" prospect currently corresponds to the Radomiro Tomic mining centre, with reserves of 970 million tonnes of minerals that could be leached from copper and a useful life of 22 years. A programme of activities is currently being developed to recover uranium and molybdenum.
7. Estimations performed in the 1970s assigned a potential of 1 000 tU that could be recovered from copper leaching solutions obtained from the gravels of the old oxides plant of the Chuquicamata copper mine. This project began its activities in 1998 and was planned be active for 12 years. By the end of the period, it was estimated to produce 467 000 t of fine copper. Recovery of uranium from these leaching solutions has not been researched.

   In addition to the uranium resources present in the leaching solutions from the aforementioned mines, there are other large copper deposits in the large-scale mining sector, whose leaching solutions have not been researched. An example is El Abra. This deposit, owned by Phelps Dodge Mining Co (51%) and CODELCO Chile (49%), started production in 1996 of 800 million tonnes of its copper minerals for a 17-year period.
8. These figures have historical value only and as geological background data. The low copper content of these districts and the small volume of their reserves make it difficult to recover their uranium content.
9. No experiments have been done to recover uranium from the uranium content in marine phosphorites. The only deposit currently being exploited is Bahía Inglesa, in Region III (Atacama), which produces a solid phosphate concentrate of direct use as fertiliser. In 2001, Compañía Minera de Fosfatos Naturales Ltda., (BIFOX LTDA.), which operates the aforementioned mine, began producing phosphoric acid, which would make it possible to recover uranium from the mother solutions.

Unconventional resources and other materials

(in situ tonnes U)

Deposit	RAR	IR	PR	SR	% U	Mineral
Unconventional	1 798	0	1 818	3 640	0.0008-0.1	Leaching solution 7 to 15 g/m^3 Oxide plants gravel Cu silicate and oxides, 20-70 ppm Sulphur oxide veins of 500-1 000 ppm
Total	1 798	0	1 818	3 640		

Speculative resources in uranium geological favourable areas

Growing knowledge of the distribution of uranium mineralisation in Chile has made it possible to define four areas of uranium occurrence and seven favourable areas, five of which have occurrences of uranium, collectively accounting for potential resources of 3 300 tU.

Areas of uranium occurrences, accounting for ~1 350 tU:

1. Upper Cenozoic surface deposits – potential in SR: 500 tU.
2. Upper Cretaceous metasomatic deposits – potential in SR: 500 tU.
3. Upper Cenozoic magmatic and hydrothermal deposits – potential in SR: 250 tU.
4. Upper Cretaceous polymetallic and uranium deposits – potential in SR: 100 tU.
5. Tertiary volcanogenic deposits – potential not investigated.

Areas favourable for uranium occurrences, accounting for 1 950 tU (only minimum potential is indicated owing to a lack of research):

A. Acid volcanism and tertiary-quaternary alluvial deposits, Main Cordillera, Regions I and II – potential: 500 tU.

B. Intrusive Jurassic and Cretaceous rocks, Coastal Range, Regions I and II – potential: 500 tU.

C. Acid volcanism and upper Cretaceous clastic sedimentary rocks; Central Valley, Regions II and III – potential: 200 tU.

D. Paleozoic magmatism, Main Cordillera, Region IV – potential: 50 tU.

E. Sedimentary-volcanic rocks of the Middle Cretaceous period, neogenic intrusives, Main Cordillera, Regions VI, VII and Metropolitan Region – potential: 100 tU.

F. Nahuelbuta Range, Paleozoic plutonism, Regions VIII and IX – potential: 300 tU.

G. Acid and intermediate sedimentary clastic volcanism, Tertiary, Main Cordillera, Regions VII, VIII and IX – potential: 300 tU.

Undiscovered conventional resources (prognosticated and speculative resources)

Deposit	Type	Prognosticated tonnes U	Speculative tonnes U	Grade % U	Rocks hosting age
Diatomite, volcanic ash with organic material[1]	Surficial	109	15		Pliocene – Pleistocene
Intrusive, volcanic and metasomatic rocks[2]	Metasomatic	1 715	2 345	0.025-0.17	Upper Cretaceous
Tuffs with high magnetite and haematite content. Mineralisation of secondary REE minerals observed[3]	Volcanic-related	500	0*	0.085-0.15	Oligocene – Pleistocene
Total		2 324	2 360*		

* 2 360 tU represents the speculative resources as tabulated and summed across the Surficial deposits, Metasomatic deposits and Volcanic-related deposits tables. However, it does not take into account an additional 940 tU of speculative resources (for a total of 3 300 tU) indicated elsewhere in the report (see section "Speculative resources in uranium geological favourable areas" and table "Uranium resources by deposit type").

1. Salar Grande (100 tU), Pampa Camarones (4 tU), Chiu Chiu (20 tU).

   No new uranium prospecting has been done in the area of Cenozoic surface deposits.

2. Diego de Almagro Anomaly-2 (1 400 tU); Diego de Almagro Alignment (1 500 tU); Agua del Sol (50 tU), Sierra Indiana (30 tU), Sector Estación Romero: Carmen prospect (50 tU) and Productora Prospect (800 tU), Tambillos district (100 tU), Sector Pejerreyes – Los Mantos (130 tU).

   In 1999-2000, at the Diego de Almagro Anomaly-2 (Cerro Carmen prospect), 1 400 tU was assigned as prognosticated and speculative undiscovered resources. The regional alignment that controls the mineralisation of this prospect extends 60 km to the north-west. This structure, visible in satellite images, involves other mining districts for which a potential of 1 500 tU of speculative resources is assigned.

3. In 1999-2000, data held by CCHEN was reviewed as part of the National Uranium Potential Evaluation Project. It was concluded that the acidic and intermediate volcanism present in a broad area of the Main Cordillera stretching from Regions I to III constituted an inclined plane dipping towards the west, ending in a lagoon environment situated in a central depression, with a similar condition occurring to the east. This volcanism covered the pre-volcanic landscape, preserving the surface drainage courses (now paleochannels). The leaching of these volcanic rocks contributed large amounts of uranium into the lagoon systems, paleochannels and other structures in which solutions circulate. This process is represented by extensive layers of calcilutites, diatomites (Pampa Camarones), layers of salt (Salar Grande), argillites, limestones, limolites and volcanic ash (Quillagua, Prosperidad, Quebrada Amarga, Chiu Chiu), with uranium contents ranging between 100 and 1 000 ppm. These uranium occurrences and mineralisations have been classified historically as "surface deposits". There are also paleochannels with copper and associated uranium (the Sagasca, Cascada, Huinquintipa, Quebrada Ichuno, Chuqui Sur, El Tesoro deposits and others). Within the volcanic area, uranium mineralisation (torbernite and autunite) has been discovered in volcanic structures containing iron (El Laco and El Perro). This environment is considered to have great potential and requires further research. In structures associated with the U mineralisation indicated above, 500 tU is assigned as EAR-II (now prognosticated).

Uranium production

Historical review

The uranium present in copper oxide ores could be recovered from the leaching solutions. A pilot-level trial was conducted in the Chuquicamata Division between 1976 and 1979, obtaining 0.5 t of yellow cake from copper-rich solutions containing 10 to 15 ppm U (0.001 to 0.0015% U), which was sent for purification at the CCHEN metallurgy pilot plant at the Lo Aguirre nuclear centre. The production of copper oxide minerals has quadrupled in Chile over the last decade.

The copper mining industry, particularly large-scale mining, has strategic (sub-economic) uranium potential in the large volumes of copper oxide leaching solutions. These resources are assigned a potential of 1 000 tU in mining centres not included in the previous table. However, no background studies have been performed to confirm these figures, either as mining resources or in terms of the volumes of solutions treated annually, so the information should be treated as unverified. Over the last decade, private firms, both domestic and foreign, have explored 12 "exotic copper" deposits in Chile, which correspond to paleochannels filled with gravel, mineralised with copper silicates, oxides and sulphates, as a result of the natural leaching of porphyry copper deposits or other contribution areas. These mineralised bodies contain variable uranium contents ranging between 7 to 116 ppm (0.007 to 0.016% U). The leaching solutions in the plants that treat these copper oxide minerals display uranium levels of up to 10 ppm. This uranium content is technically recoverable using ion-exchange resins, at a likely production cost of over USD 80/kgU.

There has been no experience in recovering uranium from phosphorites in Chile. The only deposit currently being worked is Bahía Inglesa in Atacama Region, which produces a solid phosphate concentrate used directly as fertiliser. In 2001, Compañía Minera de Fosfatos Naturales Ltda. (Bifox Ltda.) began producing phosphoric acid from this deposit, opening the potential of recovering uranium from the acid.

Status of production capability, and recent and ongoing activities

Other than the trial production mentioned above, no uranium has been produced in Chile.

Environmental activities and socio-cultural issues

The CCHEN runs a permanent programme to disseminate information on peaceful uses of nuclear energy, attached to the Office of Dissemination and Public Relations (Oficina de Difusión y Relaciones Públicas).

Regulatory regime

In Chile, there is no regulatory framework for uranium production cycle activities.

Uranium requirements

Since 1998, Chile has been self-supplying the RECH-1 nuclear research reactor with MTR fuel assemblies based on U_3Si_2 (uranium silicide).

The Fuel Element Manufacturing Plant has transferred 51 fuel assemblies with LEU uranium from the Russian Federation (uranium metal), 21 fuel assemblies with LEU uranium from the United States (uranium metal), under a repatriation contract for fuel assemblies with HEU uranium, and 2 fuel assemblies with LEU uranium from China (UF_6), a total of 74 fuel assemblies supplied as of December 2024.

Supply and procurement strategy

Should other loads of combustible elements be required, consideration will be given to purchasing enriched metallic uranium.

Uranium policies, uranium stocks and uranium prices

National policies relating to uranium

Procurement of low enriched uranium from abroad is planned to keep the RECH-1 reactor operational.

Uranium stocks

CCHEN has a stockpile of approximately 2 tonnes of natural uranium and 65 kilograms of low enriched uranium.

Reasonably assured conventional resources by production method

(recoverable tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	<USD 390/kgU	Recovery factor (%)
Unspecified	0	0	0	561	561	75
Total	0	0	0	561	561	75

Reasonably assured conventional resources by processing method

(recoverable tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	<USD 390/kgU	Recovery factor (%)
Unspecified	0	0	0	561	561	75
Total	0	0	0	561	561	75

Reasonably assured conventional resources by deposit type

(recoverable tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	<USD 390/kgU
Metasomatic	0	0	0	540	540
Surficial	0	0	0	21	21
Total	0	0	0	561	561

Inferred conventional resources by production method

(recoverable tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	<USD 390/kgU	Recovery factor (%)
Unspecified	0	0	0	887	887	75
Total	0	0	0	887	887	75

Inferred conventional resources by processing method

(recoverable tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	<USD 390/kgU	Recovery factor (%)
Unspecified	0	0	0	887	887	75
Total	0	0	0	887	887	75

Inferred conventional resources by deposit type
(recoverable tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	<USD 390/kgU
Volcanic-related	0	0	0	75	75
Metasomatic	0	0	0	782	782
Surficial	0	0	0	30	30
Total	0	0	0	887	887

Prognosticated conventional resources
(in situ tonnes U)

Cost ranges			
<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	<USD 390/kgU
0	0	2 324	2 324

Speculative conventional resources
(in situ tonnes U)

Cost ranges			
<USD 130/kgU	<USD 260/kgU	<USD 390/kgU	Unassigned
0	0	0	2 360

Reasonably assured unconventional resources by mining method
(recoverable tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	<USD 390/KGu	Recovery factor (%)
Unspecified	0	0	0	1 169	1 169	65
Total	0	0	0	1 169	1 169	65

Reasonably assured unconventional resources by processing method
(recoverable tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	<USD 390/kgU	Recovery factor (%)
Co-product/by-product	0	0	0	1 169	1 169	65
Total	0	0	0	1 169	1 169	65

Reasonably assured unconventional resources by deposit type

(recoverable tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	<USD 390/kgU
Intrusive (porphyry copper)	0	0	0	754	754
Phosphate	0	0	0	415	415
Total	0	0	0	1 169	1 169

Prognosticated unconventional resources

(in situ tonnes U)

Cost ranges			
<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	<USD 390/kgU
0	0	1 818	1 818

Speculative unconventional resources

(in situ tonnes U)

Cost ranges			
<USD 130/kgU	<USD 260/kgU	<USD 390/kgU	Unassigned
0	0	0	3 640

China (People's Republic of)

Uranium exploration and mine development

Historical review

Uranium exploration and mining in China started in the mid-1950s, mainly undertaken by the Bureau of Geology (BOG) and China Nuclear Uranium Corporation (CNUC), subsidiaries of China National Nuclear Corporation (CNNC). Before the 1990s, uranium exploration mostly focussed on granite-related or volcanic-related deposits in Jiangxi, Hunan, Guangdong, and Guangxi in east and south China. It resulted in the identification of ore deposits, such as Xiangshan, Xiazhuang, South Zhuguang, Lujing, and Miaoershan. Except for a few large deposits, most are relatively small in resources and typically mid- to low-grade, with high mining costs.

At the beginning of the 1990s, China initiated its nuclear energy programme. The demand for uranium increased very little at the beginning of the construction of nuclear power plants. Given that there was an oversupply of natural uranium in the world market during that period, China slowed its uranium exploration activities and drastically cut its uranium exploration expenditures. Also during this period, uranium exploration shifted, with a focus on ISL amenable sandstone-type deposits in Meso-Cenozoic sedimentary basins in northern China, given their better economic potential and reduced environmental impact.

In the late 1990s, as the construction of nuclear power plants ramped up, demand for uranium steadily increased. Since 2000, in order to increase uranium reserves and expand uranium production capacity, China began increasing its national investment in uranium exploration. The funding was initially directed primarily to sedimentary basins such as Yili, Turpan-Hami, Junggar, Erenhot, Ordos, and Songliao, but later expanded to include a broader range including Yine, Chaidamu, Tarim, and Hailar, among others.

Since the 1990s, Chinese enterprises have significantly increased investment in exploration. Besides CNNC, the primary organisation involved in uranium exploration in China, China National Petroleum Corporation (CNPC) has also invested in uranium exploration in Tongliao, Inner Mongolia and Qingyang, Gansu Province. Starting in 2008, China General Nuclear Power Corporation (CGN) has also carried out uranium exploration along the northern margin of Tarim Basin, Xinjiang, northern Guangdong Province, and Erenhot Basin in Inner Mongolia. Since 2013, China Geological Survey has also been carrying out uranium investigation and evaluation in the Ordos, Erenhot, Songliao, Junggar and Qadam Basins.

From 2000 to 2006, drilling activity for uranium exploration experienced a steady increase, from 40 000 metres per year to 250 000 metres per year. From 2007 to 2021, exploration drilling further accelerated, reaching an annual range of 500 000 to 600 000 metres. Since 2022, drilling efforts have continued to expand significantly, reaching 1 000 000 to 1 200 000 metres per year.

Recent and ongoing uranium exploration and mine development activities

Domestic investment in uranium exploration increased slightly during 2023 and 2024, yielding positive results in the exploration in new areas and new types of uranium deposits. The primary focus of exploration was on sandstone-type uranium deposits in northern China, where resources were expanded in the Ordos, Yili, Songliao and Yine Basins. New uranium occurrences were discovered in the Songliao, Junggar, Chaidamu and Erenhot Basins. Progress was made in the exploration of the deeper parts and periphery of the known uranium ore fields in southern China, including Xiangshan, South Zhuguang, Lujing and Miaoershan.

Uranium exploration in northern China was focussed on medium to large sedimentary basins, including from west to east the Yili, Tarim, Junggar, Turpan-Hami, Qadam, Yingen-Ergyna, Ordos, Erenhot and Songliao Basins, where systematic uranium investigation and evaluation, as well as exploration have been carried out. The investigation and evaluation process involves geologic surveys, aeromagnetic surveys, aeroradiometric surveys, radiometric surveys and electromagnetic surveys, with drilling to delineate prospects for further investigations. In northern China, uranium exploration is predominantly focussed on drilling to assess and expand the resources/reserves of ISL sandstone-type deposits, as well as to evaluate sandstone/mudstone-type deposits with low permeability to be potentially exploited by conventional mining.

In southern China, uranium exploration is primarily concentrated on volcanic-related and granite-related uranium deposits, with drilling being the primary method of exploration. Key exploration areas include the Xiangshan uranium ore field in Jiangxi Province, the Xiazhuang and Zhuguang uranium ore fields in Guangdong Province and the Miaoershan uranium ore field in Guangxi Autonomous Region. The work has led to the expansion of uranium resources, particularly in the deeper and peripheral zones surrounding existing mines.

From 2023 to 2024, a total of 2 350 000 metres of uranium exploration drilling was completed in China (1 150 000 metres in 2023 and 1 200 000 metres in 2024). To date, China has identified over 10 uranium deposits with each deposit containing resources exceeding 10 000 tU, including the super-large Mengqiguer uranium deposit in Xinjiang and the giant deposits in Nalingou in Inner Mongolia, Honghaigou in Xinjiang and Bayin Qinggeli in Inner Mongolia.

During 2023 and 2024, CNNC also invested in uranium exploration projects in Uzbekistan and Niger, which are in the early stages, with no major discoveries to date.

Uranium resources

Identified conventional resources (reasonably assured and inferred resources)

As of 1 January 2025, the identified conventional uranium resources in China totaled 485 500 tU, including 227 270 tU RAR and 258 230 tU inferred. Compared to the previous report, there is a significant increase in RAR resources by 37 000 tU and in inferred resources by 42 800 tU. Approximately 70% of all identified resources are amenable for ISL mining and 52% belong to the cost category of <USD 80/kgU. In this cost category, 93% of the resources are amenable to ISL mining and the remainder are for conventional underground mining.

The following table shows the distribution of uranium in situ resources over 20 uranium ore fields and deposits in 11 provinces or autonomous regions, as of 1 January 2025.

Undiscovered conventional resources (prognosticated and speculative resources)

China has conducted domestic uranium resource prediction and evaluation between 2008-2013 and 2020-2022, with undiscovered resources estimation at approximately 2.88 million tU. The primary target areas are for sandstone type uranium mineralisation located in the northern sedimentary basins, including the Erenhot, Ordos, Songliao, Junggar, Qaidam and Tarim basins, as well as in the deeper and peripheral regions of known deposits in southern China. The predicted resource potential is gradually being confirmed by ongoing uranium exploration, demonstrating significant uranium exploration potential within the country.

Unconventional resources and other materials

There are unconventional uranium resources associated with phosphate rocks in China, mainly distributed in Hunan, Guizhou and Sichuan Provinces. These resources generally have a relatively low grade, and uranium is considered a potential by-product of phosphate mining. Up to now, systematic assessment of unconventional uranium resources has neither been conducted, nor is data available.

Distribution of identified in situ uranium resources in China

(as of 1 January 2025)

Province	Ore field or deposit	U resources in situ, tU
Jiangxi	Xiangshan	28 400
	Ganzhou	28 900
	Taoshan	8 000
Guangdong	Xiazhuang	12 300
	Southern Zhuguang	21 300
	Heyuan	2 300
Hunan	Xiangcaodawan	7 600
Guangxi	Ziyuan	10 500
Xinjiang	Yili	66 900
	Turpan-Hami	11 600
	Sawafuqi	1 300
Inner Mongolia	Ordos	130 700
	Erenhot	90 100
	Tongliao	37 800
	Bayingebi	7 700
Hebei	Qinglong	6 700
Yunnan	Tengchong	4 300
Gansu	Longshoushan	1 900
Zhejiang	Dazhou	2 100
Sichuan	Ruoergai	5 100
TOTAL (in situ)		**485 500**

Uranium production

Historical review

The over 60-year history of China's uranium production includes both a boom in the first two decades and a decline from the late 1980s to the 1990s, with a large fluctuation in uranium production. In the early 2000s, there was a recovery in the industry and an increase in uranium production in China, driven principally by China's nuclear power plant development and the increase in the global uranium price.

Uranium production centre technical details

(as of 31 December 2024)

Production centre	Centre #1	Centre #2	Centre #3	Centre #4	Centre #5	Centre #6	Centre #7	Centre #8
Name of production centre	Fuzhou*	Chongyi*	Yining	Qinglong*	Shaoguan	Tongliao	Erenhot	Ordos
Production centre classification	Care and maintenance	Care and maintenance	Operation	Care and maintenance	Operation	Operation	Operation	Prospective
Date of first production	1966	1979	1993	2007	1967	2015	2022	2025
Source of ore:								
Deposit name(s)				Qinglong				
Deposit type(s)	Volcanic-related	Granite-related	Sandstone	Volcanic-related	Granite-related	Sandstone	Sandstone	Sandstone
Resources (tU)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Grade (% U)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Mining operation:								
Type (OP/UG/ISL)	UG	UG	ISL	UG	UG	ISL	ISL	ISL
Size (tonnes ore/day)	1 000	600	N/A	200	650	N/A	N/A	N/A
Average mining recovery (%)	92	90	N/A	85	90	N/A	N/A	N/A
Processing plant:								
Acid/alkaline	Acid	Acid	CO_2+O_2**	Acid	Acid	CO_2+O_2**	Acid	CO_2+O_2
Type (IX/SX)	IX	IX	IX	SX	IX	IX	IX	IX
Size (tonnes ore/day); for ISL (l/day or l/h)	1 000	600	N/A	N/A	N/A	N/A	N/A	N/A
Average process recovery (%)	90	84	N/A	92	90	N/A	N/A	N/A
Nominal production capacity (tU/year)	0	0	920	0	200	380	200	N/A
Plans for expansion	N/A	N/A	N/A	N/A	N/A	370	400	N/A
Other remarks	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

* The Chongyi and Qinglong centres were put under care and maintenance in 2017 and 2018; and the Fuzhou centre was put under care in 2022.

With the rapid development of China's nuclear power plants programme, demand for natural uranium for nuclear power plants was projected to increase year after year. China responded by accelerating domestic uranium mining, with an initial focus on existing uranium production centres, such Yining. Known uranium resources of operating mines supported stable and increased production. Secondly, the development of new uranium production centres based on uranium deposits with known resources and favourable technical/economic parameters, such as the Tongliao and Erlian production centres, was also accelerated. Thirdly, construction of new uranium production centres was promoted, and a series of pilot tests and feasibility studies were carried out at some recently discovered ISL sandstone-type uranium deposits with abundant resources, such as the sandstone-type uranium deposits in Cretaceous strata in the Ordos Basin.

Status of production capability

Uranium production in China has continued to increase over the last decade, reaching 1 728 tU and 1 956 tU in 2023 and 2024, respectively. China was expected to produce 2 160 tU in 2025.

As a response to production cost challenges brought on by the sustained low uranium price, Chinese uranium companies completed a reorganisation of their domestic industrial structure. This reorganisation includes the development of ISL mining in northern China, with significant expansions in production capacity in Xinjiang and Inner Mongolia. As a result, China has established a production structure that primarily relies on ISL mining in the north, while conventional mining in the south continues to supplement production. Following these reforms, China's overall uranium production capacity has increased.

As of 1 January 2025, China reports seven key production centres: Yining, Tongliao, Erenhot, Shaoguan, Fuzhou, Chongyi and Qinglong. Underground mining centres in Fuzhou, Chongyi and Qinglong were put under care and maintenance, due to high production costs. Only the Shaoguan underground production centre currently remains in operation. However, taking into account rising uranium prices, resource expansion and advances in mining technologies, the suspended underground mines are being considered for restarting. The ISL production centres in Yining and Tongliao have increased their capacity, and a new production centre has been established in Erenhot in 2022. Production at the ISL Ordos centre started in 2025. In the future, after exploration and feasibility studies are completed at new large uranium deposits, more economically viable uranium resources will be brought into production. With the adoption of new mining and processing technologies, the intensive, digitalised mining of uranium deposits will become possible, leading to a substantial increase in future production.

- The Yining ISL production centre, located in Yining City, Xinjiang Autonomous Region, mainly exploits sandstone type uranium resources in the Yili and Turpan-Hami Basins using ion-exchange hydrometallurgical process. Expanding construction of the Mongqiguer ISL project in this centre increases production capacity.
- The Tongliao production centre in Tongliao City, Inner Mongolia is an ISL mine, which exploits sandstone-type uranium resources in the southern Songliao Basin using an ion-exchange hydrometallurgical process. The ISL facilities of this centre are being expanded and production capacity will be further increased.
- The Erenhot production centre in Xilinguole County, Inner Mongolia, is an ISL mine, which exploits sandstone-type uranium resources in the Erenhot Basin, using ion-exchange processing of leaching solution. The ISL facilities of this centre are being expanded and production capacity will be further increased.

Uranium production abroad

CNNC and CGN have been involved in several international uranium projects in Namibia, Kazakhstan and Niger. CNNC is the largest stakeholder in the Rössing uranium mine in Namibia and the Azelik uranium mine in Niger, and holds an equity stake in the Langer Heinrich uranium mine in Namibia. CGN is the largest shareholder of Husab uranium mine in Namibia and holds equity stakes in the Semizbay, Irkol, Central Mynkuduk and Zhalpak mines in Kazakhstan.

The Rossing Uranium Mine in Namibia controlled by CNNC has been operating safely and steadily, with annual production reaching record highs. Through technical upgrades and additional exploration of surrounding resources, approximately 20 000 tU of new uranium resources have been identified, with the potential to double production in the future. The completion of the project's Phase IV development feasibility study has successfully extended the mine's operational life by over 10 years. In 2023 and 2024, the mine produced 2 476 tU and 2 251 tU, respectively.

The Namibian Husab Uranium Mine project, controlled by CGN, produced 4 509 tU in 2023 and 4 438 tU in 2024.

In March 2024, the CNNC-invested Langer Heinrich Uranium Mine in Namibia successfully resumed production. The production increase has proceeded smoothly, with an annual output of 632 tU.

The CNNC-controlled Azelik Uranium Mine in Niger is progressing towards restarting operations, with strong support from both project stakeholders and the local government. The feasibility study for the resumption of operations was completed in 2023-2024. Further exploration and development are also underway for CNNC-held projects in Mongolia (Gurvanbulag), Namibia (Happy Valley), and Zimbabwe (Kanyemba).

In Kazakhstan the CGN owns a 49% stake in the Semizbay-U LLP, with Semizbay and Irkol mines. Uranium production amounted to 963 tU in both 2023 and 2024. In July 2021, CGN acquired a 49% stake in the JV Ortalyk, which owns and operates the Central Mynkuduk Mine and the construction of the Zhalpak Mine. The Central Mynkuduk Mine produced 1 513 tU in 2023 and 1 659 tU in 2024, while the Zhalpak Mine produced 129 tU in 2023 and 120 tU in 2024.

Ownership structure of the uranium industry

The uranium industry in China is owned by state-owned enterprises. Fuzhou, Chongyi, Yining, Qinglong, Shaoguan, Erenhot and Ordos production centres are 100% owned by CNNC. The Tongliao production centre is a joint venture between CNNC and CNPC.

Employment in the uranium industry

China has been actively advancing the construction of large-scale sandstone uranium mining bases in the northern region. The newly expanded in situ leaching uranium extraction centres in the north are highly automated, with only a modest increase in the number of employees. Overall, the number of employees involved in uranium production in China remained stable in 2023 and 2024, with 2 220 and 2 240 workers respectively, comparable to the total in 2022.

Future production centres

In the future, China will focus on developing two major uranium production hubs in Xinjiang and Inner Mongolia regions. Plans are to build up a large uranium production centre, Ili, in Xinjiang region and Ordos, Erenhot and Tongliao centres, in the Inner Mongolia region, each targeting an annual output of over 1 000 tU. At the same time, China is actively planning several other 1 000 tU production centres, aiming to achieve continuous development within the next five years.

With breakthroughs in uranium exploration and extraction technologies, amid a steady rise in global natural uranium prices, China's temporarily suspended uranium production centres are now in a position to resume operations. Together with the significant capacity expansion of the in-situ leaching uranium centres in the northern region, China's domestic uranium production capacity is expected to double in the coming decade.

Uranium requirements

As of 31 December 2024, China's mainland had 58 commercial nuclear reactors in operation, with a total installed capacity of 60.83 GWe, ranking third in the world. The annual demand for natural uranium was approximately 10 500 tU. In 2024, the cumulative electricity generation from nuclear power in China's mainland reached 450.9 TWh, a 3.7% increase compared to 2023. China's mainland currently has a further 28 nuclear reactors (an incremental 33.70 GWe of installed capacity) under construction, maintaining the largest nuclear construction scale in the world. China will continue to adhere to the principles of "clean, low-carbon and green development" and the safe development of nuclear power, advancing nuclear power construction along its coastal regions. By 2025, China's mainland's operational installed capacity was expected to reach 70 GWe.

By 2030, the demand for natural uranium is expected to range from 16 000 to 21 400 tU. By 2035, the demand is projected to range from 20 500 to 23 100 tU.

Supply and procurement strategy

To meet the uranium demand for its nuclear power development plans, China has adopted the principle of "Facing Two Markets and Using Two Resources". It has established a diversified natural uranium supply system that includes domestic production, overseas development and international trade. China views international uranium trade as a key supplement and balancing mechanism for domestic uranium production. The country plans to strengthen commercial partnerships with major international uranium trading companies, and adopt a combination of spot and futures contracts to ensure a stable supply of natural uranium in the long term.

Uranium policies, uranium stocks and uranium prices

National policies relating to uranium

The Chinese government places great emphasis on ensuring a long-term, sustainable supply of uranium resources for nuclear power development, seeking to balance supply security with economic efficiency. Its goal is to achieve a diversified and reliable supply of nuclear fuel, while also developing appropriate commercial reserves. To support uranium exploration and development, the government has implemented several measures, including maintaining stable investment in domestic uranium exploration, encouraging private investment in uranium exploration and development, and steadily advancing the construction of overseas uranium production centres.

Uranium stocks

N/A

Uranium prices

China's uranium prices are based on international pricing mechanisms, and the majority of natural uranium sales are conducted in a market-oriented manner, primarily through long-term contracts.

Uranium exploration and development expenditures, and drilling effort – domestic

(USD millions)

	2023	2024	2025 (expected)
Industry exploration expenditures	38	47	47
Government exploration expenditures	173	173	173
Industry development expenditures	12	12	12
Government development expenditures	0	0	0
Total expenditures	223	232	232
Industry exploration drilling (m)	200 000	250 000	250 000
Industry exploration holes drilled	N/A	N/A	N/A
Government exploration drilling (m)	950 000	950 000	950 000
Government exploration holes drilled	N/A	N/A	N/A
Industry development drilling (m)	N/A	N/A	N/A
Industry development holes drilled	N/A	N/A	N/A
Government development drilling (m)	0	0	0
Government development holes drilled	0	0	0
Subtotal exploration drilling (m)	1 150 000	1 200 000	1 200 000
Subtotal exploration holes drilled	N/A	N/A	N/A
Subtotal development drilling (m)	N/A	N/A	N/A
Subtotal development holes drilled	N/A	N/A	N/A
Total drilling (m)	1 150 000	1 200 000	1 200 000
Total holes drilled	N/A	N/A	N/A

Uranium exploration and development expenditures – non-domestic

(USD millions)

	2023	2024	2025 (expected)
Industry* exploration expenditures	1	6.3	13.1
Government exploration expenditures	N/A	N/A	N/A
Industry* development expenditures	0.1	0.1	17.8
Government development expenditures	N/A	N/A	N/A
Total expenditures	1.1	6.4	30.9

* CNNC non-domestic expenditures

Reasonably assured conventional resources by production method

(in situ tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery %
Underground mining (UG)	0	5 800	57 290	62 010	N/A
In situ leaching	45 400	106 860	165 260	165 260	N/A
Total	45 400	112 660	222 550	227 270	N/A

Reasonably assured conventional resources by processing method

(in situ tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery %
Conventional from UG	0	5 800	57 290	62 010	N/A
In situ leaching	45 400	106 860	165 260	165 260	N/A
Total	45 400	112 660	222 550	227 270	N/A

Inferred conventional resources by production method

(in situ tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery %
Underground mining (UG)	0	11 300	60 700	84 990	N/A
In situ leaching	59 200	125 950	173 240	173 240	N/A
Total	59 200	137 250	233 940	258 230	N/A

Inferred conventional resources by processing method

(in situ tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery %
Conventional from UG	0	11 300	60 700	84 990	N/A
In situ leaching	59 200	125 950	173 240	173 240	N/A
Total	59 200	137 250	233 940	258 230	N/A

Historical uranium production by deposit type

(tonnes U in concentrates)

Deposit type	Total through end of 2022	2023	2024	Total through end of 2024	2025(expected)
Sandstone	N/A	1 568	1 796	N/A	2 000
Granite-related	N/A	160	160	N/A	160
Volcanic-related	N/A	0	0	N/A	0
Total	N/A	1 728	1 956	N/A	2 160

Historical uranium production by production method

(tonnes U in concentrates)

Production method	Total through end of 2022	2023	2024	Total through end of 2024	2025(expected)
Underground mining	N/A	160	160	N/A	160
In situ leaching	N/A	1 568	1 796	N/A	2 000
Total	N/A	1 728	1 956	N/A	2 160

Total production before 2010 may include uranium recovered from heap leaching and in-place leaching.

Historical uranium production by processing method

(tonnes U in concentrates)

Processing method	Total through end of 2022	2023	2024	Total through end of 2024	2025 (expected)
Conventional from UG	N/A	70	70	N/A	70
In situ leaching (ISL)	N/A	1 568	1 796	N/A	2 000
Heap leaching*	N/A	90	90	N/A	90
Total	N/A	1 728	1 956	N/A	2 160

* A subset of open-pit and underground mining, since it is used in conjunction with them.

Ownership of uranium production in 2024

Domestic				Foreign				Totals	
Government		Private		Government		Private			
Production tU	Weight %	Production tU	Weight %	Production tU	Weight %	Production tU	Weight %	Production tU	Weight %
1 956	100	0	0	0	0	0	0	1 956	100

Uranium industry employment at existing production centres

(person-years)

	2022	2023	2024	2025 (expected)
Total employment related to existing production centres	2 240	2 220	2 240	2 250
Employment directly related to uranium production	1 430	1 420	1 430	1 440

Czechia

Uranium exploration and mine development

Historical review

Uranium exploration in former Czechoslovakia began in 1946 and rapidly developed into a large-scale programme in support of the country's uranium mining industry. A systematic exploration programme including geological, geophysical, and geochemical surveys and related research was carried out to assess the uranium potential of the country. Areas with identified potential were explored in detail using drilling and underground exploration methods.

Exploration continued systematically until 1989, with annual exploration expenditures in the range of CZK 210-430 million (USD 10-20 million) and an annual drilling effort in the range of 70-120 km. Exploration was traditionally centred around vein deposits located in metamorphic complexes (Jáchymov, Horní Slavkov, Príbram, Zadní Chodov, Rozná, Olsí and other deposits), granitoids of the Bohemian massif (Vítkov deposit), and around the sandstone type deposits in northern and northwestern Bohemia (Hamr, Stráz, Brevniste, Osecná-Kotel, Hvezdov, Vnitrosudetská Pánev, Hájek and other deposits).

In 1989, the decision was made to reduce all uranium-related activities. Expenditures decreased to about CZK 150 million (USD 7 million) in 1990 and have not reached that level since. No field exploration has been carried out since the beginning of 1994.

Recent and ongoing uranium exploration and mine development activities

Recent uranium exploration activities have been focussed on the conservation and processing of previously collected exploration data from Czech uranium deposits. Advance processing of the exploration data and building the exploration database will continue in the coming years.

In 2023, only geological survey data were processed (geological documentation, final reports and archiving). Exploration expenditures were CZK 1.0 million in 2023 (approximately USD 47 000). No other exploration activities were carried out or are expected.

Uranium resources

Historically, most of the known uranium resources of Czechia occurred in 23 deposits, of which 20 have been mined out or closed. Of the three remaining deposits, Rozná and Stráz were mined. Resources at the Stráz deposit are, however, limited due to the remediation process, and resources at the Rozná deposit have already reached the limits of economic profitability. Other deposits (the Osecná-Kotel part of the Stráz bloc and Brzkov) have resources that are not mineable because of environmental concerns.

Identified conventional resources (reasonably assured and inferred resources)

As of 1 January 2025, total identified recoverable conventional resources (reasonably assured resources and inferred resources) amounted to 119 027 tU. There was a decrease of 34 tU from previous estimates as of 1 January 2023, due to the environmental remediation activities at the Stráz deposit.

In detail, the reasonably assured resources recoverable at a cost of <USD 130/kgU amounted to 724 tU. These are recoverable resources in an existing production centre at the Stráz deposits. Reasonably assured resources recoverable at a cost of <USD 260/kgU (same as <USD 390/kgU) amounted to 50 768 tU, a decrease of 34 tU, compared to the estimates as of 1 January 2023. The remaining resources of the Rozná deposit, in the amount of 187 tU, are also included in this cost category.

Inferred resources recoverable at a cost of <USD 260/kgU (same as <USD 390/kgU) amounted to 68 259 tU and are unchanged compared to estimates as of 1 January 2023. These high-cost resources are located in the Rozná deposit, and especially in the Stráz block (the Stráz, Hamr, Osecná-Kotel and Brevniste deposits), but remain unmined due to environmental concerns.

Undiscovered conventional resources (prognosticated and speculative resources)

As of 1 January 2025, total undiscovered conventional resources (prognosticated resources and speculative resources) amounted to 239 915 tU. Prognosticated resources at a cost <USD 260/kgU amounted to 222 915 tU and are unchanged from previous estimates as of 1 January 2023. These resources occur mainly (98%) in the sandstone deposits of the Northern Bohemian Cretaceous Basin (Stráz block, Tlustec block and Hermanky deposits) and to a lesser extent (2%) in the metamorphic complex of Western Moravia (Rozná and Brzkov deposits).

Speculative resources are estimated to amount to 17 000 tU and are reported in the unassigned cost category. Since these resources occur in Northern Bohemian Cretaceous sandstone deposits in a groundwater source protection zone, further exploration and evaluation are not permitted.

Uranium production

Historical review

The history of uranium mining in Czechia dates to the early 19th century. Uranium ores have been mined for the glass, ceramic and ink industries in Jáchymov since 1858.

Industrial development of uranium production in the former Czechoslovakia began in 1946. Between 1946 and the dissolution of the former Soviet Union in 1991, all uranium produced in the former Czechoslovakia was exported to the former Soviet Union.

The first production came from the Jáchymov and Horní Slavkov mines, which completed operations in the mid-1960s. Príbram, the main vein deposit, operated from 1950 to 1991. The Hamr and Stráz production centres, supplied by sandstone deposits, started operation in 1967. Peak annual national production of about 3 000 tU was reached around 1960 and production remained between 2 500 and 3 000 tU/yr from 1960 until 1989/1990, and declined thereafter. A cumulative total of 112 330 tU was produced in Czechia during the period 1946-2024, of which about 84% was produced by underground and open-pit mining methods, and the remainder was recovered by in situ leaching.

Status of production facilities, production capability, recent and ongoing activities, and other issues

Formally, only one production centre remains in Czechia. It is the ISL mining centre in Stráz pod Ralskem (Northern Bohemia), Stráz sandstone deposit, with resources of 724 tU recoverable at cost <USD 130/kgU.

At the Stráz pod Ralskem ISL mining centre, the former acid in situ leaching (~180 m underground) production centre, produced 17 tU in 2023 and 12 tU in 2024. Uranium produced at this centre is a product of environmental remediation activities that began in 1996. Production capability during remediation (without acid) has decreased because of lower uranium concentration in solutions. Production in 2025 is expected to amount to 11 tU. In the long term, a gradual decline in production is expected.

The former Dolní Rozínka centre (Rozná processing plant) produced 1 tU in 2023 and 1 tU in 2024 from water treatment only. The operation was terminated and decommissioning started as of 1 January 2017. The underground of the Rozná mine is gradually being flooded. Part of the facilities at the former production centre (Rozná mill) is maintained in operation only for the uranium extraction from mine water treatment, and expected uranium production in 2025 is 1 tU.

Uranium is also obtained from mine water treatment at the former facility, Príbram, with a total recovery of 6 tU in 2023, 4 tU in 2024 and 4 tU expected in 2025.

Ownership structure of the uranium industry

All uranium activities, including exploration, production and related environmental activities, are being carried out by the state-owned enterprise DIAMO, a mining and environmental engineering company based in Stráz pod Ralskem.

Uranium production centre technical details

(as of 1 January 2025)

	Centre #1
Name of production centre	Stráz pod Ralskem
Production centre classification	Existing
Date of first production	1967
Source of ore:	
Deposit name(s)	Stráz
Deposit type(s)	Sandstone
Recoverable resources (tU)	724
Grade (% U)	0.030
Mining operation:	
Type (OP/UG/ISL)	ISL
Size (tonnes ore/day)	-
Average mining recovery (%)	60 (estimated)
Processing plant:	
Acid/alkaline	Acid
Type (IX/SX)	IX
Size (tonnes ore/day) For ISL (kilolitre/day)	– 10 000
Average process recovery (%)	60 (estimated)
Nominal production capacity (tU/year)	20
Plans for expansion	No
Other remarks	Since 1996, production occurs through the remediation process.

Employment in the uranium industry

Total employment in the Czech uranium production centre amounted to 1 060 jobs in 2023 and 989 in 2024 (i.e. employment related to the production including head office, auxiliary divisions and mining emergency services).

Employment directly related to uranium production at Stráz pod Ralskem centre was 554 in 2023 and 500 in 2024; however, all uranium production is associated with remediation.

Future production centres

No other production centres are committed or planned in the near future. A potential production centre at the Brzkov deposit is a possibility, to be discussed in the distant future.

Secondary resources of uranium

Production and/or use of mixed oxide fuels

The Czech power utility CEZ, a.s. is the sole owner and operator of nuclear power plants in Czechia and does not use MOX fuels in its reactors.

Production and/or use of re-enriched tails

CEZ does not use re-enriched tails in its reactors.

Production and/or use of reprocessed uranium

CEZ does not use reprocessed U in its reactors.

Environmental activities and socio-cultural issues

Managing environmental activities and social issues takes place under the government programme accompanying the downsizing of the Czech uranium mining industry. These activities began in 1989. Although this programme was formally terminated in 2009, extensive environmental remediation projects and some associated social issues continue to be addressed with the help of national and EU funding.

This programme has been aimed at gradually decreasing employment to match declining uranium production and at developing alternative (mainly environmental) projects to address social issues.

In general, the environmental activities include project preparation, environmental impact assessments, decommissioning, tailing impoundments and waste rock management, site rehabilitation and maintenance, water treatment and long-term monitoring.

The key environmental remediation projects are as follows:

- Remediation of the after-effects of the ISL used in Stráz pod Ralskem that impacted a total of 266 million m^3 groundwater and an enclosure of 600 ha surface area; approximately 100 kt/yr of contaminants (total dissolved solids) are extracted from underground.
- Rehabilitation of the tailing impoundments in Mydlovary, Príbram, Stráz pod Ralskem and Rozná (a total of 18 ponds with a total area of 593.7 ha).
- Rehabilitation (including reprocessing) of the waste rock dumps in Príbram, Hamr, Rozná, Western Bohemia and other sites (a total of 376 dumps with a capacity of 44.48 million m^3).
- Mine water treatment from former uranium facilities in Príbram, Stráz, Horní Slavkov, Olsí and others, amounting to a total of approximately 12 million m^3/yr, which results in the recovery of about 5 tU annually.
- Post remediation monitoring and long-term stewardship of the mining legacy sites.

Most of the environmental expenses (about 95%) are currently funded solely by the state budget, with the remainder financed by DIAMO (5%). Since 1989, CZK 61 639 million (about

USD 2 894 million) were spent on environmental remediation projects, excluding social programmes and social security. To bring the projects to completion by approximately 2040, a further cost of CZK 60 000 million (about USD 2 817 million) is expected.

The social part of the programme (obligatory spending, compensation, damages and rent) is financed entirely by the state budget.

Expenditures related to environmental activities and social issues

(CZK millions)

	Total through end of 2022	2023	2024	Total through end of 2024	2025 (preliminary)
Uranium environmental remediation	57 142	2 032	2 465	61 639	2 509
Social programme and social security	10 650	68	0	10 718	0
Total	67 792	2 100	2 465	72 357	2 509

Uranium requirements

There are two nuclear power plants with a total of six units in operation in Czechia: the older Dukovany Nuclear Power Plant with four VVER-440 reactors, which have been uprated to 510 MWe (gross), and the newer Temelin Nuclear Power Plant with two VVER-1000 reactors, which have been uprated to 1 086 MWe (gross). The sole owner and operator of these nuclear power plants is the Czech power company CEZ, a.s.

There is a strong national consensus in Czechia on the necessity of expanding nuclear energy capacity. On 4 June 2025, a major milestone was reached with the signing of EPC and NFC contracts between Elektrárna Dukovany II (a CEZ subsidiary) and Korea Hydro & Nuclear Power (KHNP), for the construction of two new nuclear units at the Dukovany site. The agreement also includes a framework (option) for future expansion at the Temelín site. The first unit at Dukovany is expected to be commissioned by 2036.

In addition to the first unit, a second unit at the Dukovany site is planned to be commissioned shortly after the first unit in 2037/2038. CEZ is also preparing for the construction of two additional large reactors at the Temelín site, expected to be commissioned in late 2030s/ early 2040s.

CEZ has also committed to deploying small modular reactors (SMRs) as part of its long-term decarbonisation strategy. In March 2025, CEZ became a shareholder in the British company Rolls-Royce SMR Limited, acquiring an approximate 20% equity stake. This strategic partnership effectively confirms Rolls-Royce SMR as the selected technology for deployment in Czechia.

The first SMR is planned for the Temelín site (ETE), with a gross power output of 500 MWe. This project will serve as a reference for further SMR deployment – CEZ aims to build 3 GW in SMRs until 2050. To achieve this target, CEZ is preparing new nuclear sites, for example, the current coal-powered power plant site at Tušimice.

These developments are part of Czechia's broader energy transition strategy, which aims to ensure energy security, reduce greenhouse gas emissions and replace ageing coal infrastructure with low-carbon alternatives.

Total uranium requirements of both nuclear power plants have been averaging 700 tU/yr on a long-term basis, although future annual requirements will vary depending on outage planning due to the ongoing projects to implement longer fuel cycles (16 months at Dukovany and 18 months at Temelin) and implementation of western nuclear fuel. Additionally, uranium will be required for the planned SMR deployment (first unit in 2035). However, due to uncertainty in reactor and fuel design, SMR uranium requirements are not considered in table below.

Supply and procurement strategy

CEZ has been obtaining uranium on the basis of medium- and long-term contracts, as well as taking advantage of low spot market prices. CEZ has diversified the procurement of nuclear material and services (conversion and enrichment).

Uranium policies, uranium stocks and uranium prices

National policies relating to uranium

The programme to wind down the Czech uranium industry from the end of the 1980s has already been formally terminated. An extensive programme for the environmental remediation of former uranium production facilities continues.

The "State Energy Policy of the Czech Republic" (approved by Government Decree No. 362/2015 Coll.) assumes a balanced energy mix and a share of up to 50% of nuclear energy in total domestic electricity production after 2040.

To provide the necessary raw material resources, the government adopted the "Raw Materials Policy in the Field of Mineral Materials and their Resources" (updated by Government Decree No. 441/2017 Coll.), which ranks uranium among the critical super strategic raw materials in line with the European "Raw Materials Initiative". This document considers the priority use of domestic uranium resources if economically and environmentally feasible.

According to the government's "Concept of the Raw Materials and Energy Security of the Czech Republic", a feasibility study of early development at Brzkov uranium deposits was completed in 2014, as well as new technological possibilities for uranium mining that strictly respect environmental concerns.

The government of Czechia approved mining activities by DIAMO at the Brzkov deposit (Vysocina region); however, there has been significant opposition by local municipalities and strong public resistance to the resumption of uranium mining in the area.

Uranium stocks

The Czech power company CEZ maintains uranium stocks at the level of about two and a half years of forward reactor consumption in all forms of processed uranium. A substantial portion of these stocks is in the form of fabricated fuel stored at the nuclear power plant sites.

Uranium prices

Uranium prices are not available as they are commercially confidential. In general, uranium prices in supply contracts incorporate price indicators from the world market according to agreed formulas.

Uranium exploration and development expenditures, and drilling effort – domestic

(CZK millions)

	2022	2023	2024	2025 (preliminary)
Private* exploration expenditures	0.0	0.0	0.0	0.0
Government exploration expenditures	0.5	1.0	0.0	0.0
Private* development expenditures	0.0	0.0	0.0	0.0
Government development expenditures	0.0	0.0	0.0	0.0
Total expenditures	0.5	1.0	0.0	0.0

* Non-government.

Reasonably assured conventional resources by production method

(recoverable tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	<USD 390/kgU	Recovery factor (%)
Underground mining (UG)	0	0	0	1 665	1 665	90
In situ leaching acid	0	0	724	49 103	49 103	60
Total	0	0	724	50 768	50 768	

Reasonably assured conventional resources by processing method

(recoverable tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	<USD 390/kgU	Recovery factor (%)
Conventional from UG	0	0	0	1 665	1 665	90
In situ leaching acid	0	0	724	49 103	49 103	60
Total	0	0	724	50 768	50 768	

Reasonably assured conventional resources by deposit type

(recoverable tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	<USD 390/kgU
Sandstone	0	0	724	49 103	49 103
Metamorphite	0	0	0	1 665	1 665
Total	0	0	724	50 768	50 768

Inferred conventional resources by production method

(recoverable tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	<USD 390/kgU	Recovery factor (%)
Underground mining (UG)	0	0	0	459	459	90
In situ leaching acid	0	0	0	67 800	67 800	60
Total	0	0	0	68 259	68 259	

Inferred conventional resources by processing method

(recoverable tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	<USD 390/kgU	Recovery factor (%)
Conventional from UG	0	0	0	459	459	90
In situ leaching acid	0	0	0	67 800	67 800	60
Total	0	0	0	68 259	68 259	

Inferred conventional resources by deposit type

(recoverable tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	<USD 390/kgU
Sandstone	0	0	0	67 800	67 800
Metamorphite	0	0	0	459	459
Total	0	0	0	68 259	68 259

Prognosticated conventional resources

(in situ tonnes U)

Cost ranges			
<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	<USD 390/kgU
0	0	222 915	222 915

Speculative conventional resources

(in situ tonnes U)

Cost ranges			
<USD 130/kgU	<USD 260/kgU	<USD 390/kgU	Unassigned
0	0	0	17 000

Historical uranium production by production method

(tonnes U in concentrates)

Production method	Total through end of 2022	2023	2024	Total through end of 2024	2025 (preliminary)
Underground mining*	94 481	7	5	94 493	5
In situ leaching	17 808	17	12	17 837	11
Total	112 289	24	17	112 330	16

* Pre-2022 totals may include uranium recovered by heap and in-place leaching.

Historical uranium production by processing method

(tonnes U in concentrates)

Processing method	Total through end of 2022	2023	2024	Total through end of 2024	2025 (preliminary)
Conventional	91 710	0	0	91 710	0
In-place leaching*	3	0	0	3	0
Heap leaching**	125	0	0	125	0
In situ leaching	17 808	17	12	17 837	11
Other methods***	2 643	7	5	2 655	5
Total	112 289	24	17	112 330	16

* Also known as stope leaching or block leaching.

** A subset of open-pit and underground mining, since it is used in conjunction with them.

*** Includes mine water treatment and environmental restoration.

Historical uranium production by deposit type

(tonnes U in concentrates)

Deposit type	Total through end of 2022	2023	2024	Total through end of 2024	2025 (preliminary)
Sandstone	28 044	17	12	28 073	11
Granite-related*	60 913	6	4	60 923	4
Metamorphite*	23 311	1	1	23 313	1
Metasomatite	0	0	0	0	0
Lignite and coal	1	0	0	1	0
Other/unspecified	20	0	0	20	0
Total	112 289	24	17	112 330	16

* Includes uranium recovered from mine water treatment; 7 tU in 2023, 5 tU in 2024 and 5 tU preliminary in 2025.

From 1945 to 1985, historical uranium production by deposit type was derived from the statement of production centres (more than one type of deposit was processed at the only production centre).

Ownership of uranium production in 2024

Domestic				Foreign				Totals	
Government		Private		Government		Private			
(tU)	(%)	(tU)	(%)	(tU)	(%)	(tU)	(%)	(tU)	(%)
17	100	0	0	0	0	0	0	17	100

Uranium industry employment at existing production centres

(person-years)

	2022	2023	2024	2025 (preliminary)
Total employment related to existing production centres	1 067	1 060	989	905
Employment directly related to uranium production	555	554	500	464

Mid-term production projection (tonnes U/year)

2025	2030	2035	2040	2045	2050
16	20	15	15	10	10

Mid-term production capability (tonnes U/year)

2025				2030			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
0	0	40	40	0	0	40	40

2035				2040			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
0	0	30	30	0	0	20	20

2045				2050			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
0	0	10	10	0	0	10	10

Net nuclear electricity generation (TWh net)

	2023	2024
Nuclear electricity generated (TWh net)	30.4	29.7

Installed nuclear generating capacity to 2050

(MWe net)

2023	2024	2025		2030		2035		2040		2045		2050	
		Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
3 950	3 950	3 950	3 950	3 950	3 950	4 480	4 480	9 332	9 332	9 802	9 802	8 812	8 812

Annual reactor-related uranium requirements to 2050 (excluding MOX)

(tonnes U)

2023	2024	2025		2030		2035		2040*		2045**		2050***	
		Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
667	762	550	650	530	910	530	910	725	1 640	1 115	2 365	1 115	2 365

* Period 2040 already includes two new units of nuclear powerplant Dukovany II.

** Period 2045 includes additional two new units of nuclear powerplant Temelín II.

*** Period 2050 expect operation of four units in Dukovany, two units in Temelín and operation of new two units of Dukovany II and Temelín II.

Total uranium stocks

(tonnes natural U-equivalent)

Holder	Natural uranium stocks in concentrates	Enriched uranium stocks	Enrichment tails	LWR reprocessed uranium stocks	Total
Government	0	0	0	0	0
Producer	>200	0	0	0	>200
Utility	NA	NA	0	0	NA
Total	NA	NA	0	0	NA

Denmark/Greenland

Uranium exploration and mine development

Historical review

Greenland is part of the Danish Realm. Greenland enjoys autonomous authority in domestic affairs while Denmark remains constitutionally responsible for foreign affairs, defence and security. In 2009, the Act on Greenland Self-Government granted Greenland authority over its natural resources (Mineral Resources Act 2009).

Uranium exploration and assessment activities have been performed across Greenland. The earliest exploration for uranium was carried out over selected areas of southern Greenland from 1955 to 1956, leading to the discovery of radiation anomalies associated with the Kvanefjeld deposit, a large low-grade U-Th-REE deposit associated with the Mesoproterozoic Ilímaussaq layered alkaline intrusive rock complex.

Since the Kvanefjeld deposit in southern Greenland was discovered in the mid-1950s, exploration of the area continued through 1984 with various geophysical and geochemical surveys, drilling, detailed geological mapping, and test mining and assaying work. Resources through 1984 were estimated at 27 000 tU, with 16 000 tU in the "additional resources" category. Additional activities in southern Greenland included a regional exploration programme from 1979 to 1986 involving airborne gamma spectrometry, drainage geochemistry and geological studies. Three prospects were found: 1) uraninite in mineralised fractures and veins; 2) uranium-rich pyrochlore mineralisation in alkaline rocks; and 3) uraninite in hydrothermally mineralised metasediments. These prospects at the time were believed to represent 60 000 tU in the "speculative resources" category.

Following a decision in 1985 by the Danish government to exclude nuclear power from its energy sources, a policy was introduced in 1988 to ban the mining of uranium and other radioactive elements in Greenland. In 2013, the Greenland government lifted the ban on mining of uranium and other radioactive elements, generating renewed interest in evaluating the potential of Greenland's uranium resources.

In November 2016, an assessment of the uranium potential in Greenland was conducted jointly by the Geological Survey of Denmark and Greenland and the Ministry of Mineral Resources, Government of Greenland. Three uranium deposit types were considered: intrusive, sandstone-hosted and unconformity-related. The assessment concluded that intrusive and unconformity-related deposits have the highest potential for economic concentrations of uranium, and that southern Greenland has the highest potential for hosting undiscovered deposits.

Recent and ongoing uranium exploration, and mine development activities

Since 2007, Energy Transition Minerals Ltd (ETML), formerly Greenland Minerals Ltd, a publicly listed company, had conducted exploration activities for REE-U-Zn mineralisation in the Kvanefjeld area, in southern Greenland, including drilling of 57 710 m of core. The business concept encompassed uranium and zinc by-products, in addition to the main products of REE.

A mining/exploitation licence application was submitted in July 2019, including updated environmental and social impact assessments (EIA and SIA) together with a navigational safety investigation study (NSS). It was expected that uranium would be recovered from leach solutions using industry standard solvent extraction to produce approximately 500 tonnes of U_3O_8 (425 tU) per year.

The consultation period started in December 2020, and responses received to the EIA and SIA during the consultation period were to be summarised in the form of a white paper by the company. Final EIA and SIA reports were to be prepared with amendments according to the consultation comments and responses. Afterwards, the Government of Greenland was to decide on whether to accept the final EIA and SIA reports and white papers, and whether or not to grant an exploitation licence.

An April 2021 election in Greenland, however, led to a change in government whichf passed a new law prohibiting exploration and exploitation of uranium as of December 2021. Passage of this new law led ETML to request arbitration proceedings with the governments of Greenland and Denmark concerning the impact of new legislation on its exploration licence for the Kvanefjeld REE, zinc and uranium project under development in southern Greenland.

Uranium resources

Identified conventional resources (reasonably assured and inferred resources)

The Ilímaussaq igneous complex of southern Greenland hosts the REE-U-Zn-F deposit referred to as Kvanefjeld. It is a high-tonnage, low-grade uranium-enriched layered intrusive deposit, with concentrations of around 300 ppm U. Uranium was planned to be mined as a by-product from a proposed open-pit mine. ETML estimates that uranium will account for 5% of the revenue. Kvanefjeld is the only uranium deposit or occurrence in Greenland with reasonably assured uranium resources. The supply cost for uranium will be very low, as the majority of the costs will be borne by the production of the REE, the primary resource (Kvanefjeld is considered to be one of the largest REE deposits in the world). ETML has reported a uranium specific supply cost of approximately USD 13/kgU (USD 5/lb U_3O_8), which is incremental to the cost of the REE production. The total identified in situ reasonably assured conventional mineral resource inventory for Kvanefjeld is 102 820 tU. Additional in situ inferred mineral resources of 125 143 tU are estimated to be contained in 550 Mt of material in the Kvanefjeld and two other nearby zones (Sørensen and Zone 3). The established, and pilot plant tested, recovery factor of approximately 50% was used to calculate the recoverable uranium resources.

Undiscovered conventional resources (prognosticated and speculative resources)

Several uranium occurrences are known in Greenland: seven in southern Greenland, three in western Greenland and three in eastern Greenland. These include: (1) large, low-grade magmatic deposits; (2) small syn- to epigenetic pyrochlore mineralisation related to alkaline syenite and carbonatite; and (3) small, high-grade epigenetic uraninite mineralisation hosted in fracture zones. Most of these are showings and prospects, with Kvanefjeld the only one with a JORC-compliant reserve estimate.

Unconventional resources and other materials

Unknown.

Uranium production

Historical review

No uranium has been produced in Greenland. However, 4 500 tonnes of ore were transported to the Risø National Laboratory, Denmark, for test work during the 1980s. Another 30 tonnes of ore were sent in 2014 to Outokumpu, Finland, where a pilot plant operation was conducted through the FP7 EURARE project.

Reasonably assured conventional resources by production method

(in situ tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Co-product and by-product	0	0	0	102 820	50
Total	0	0	0	102 820	

Reasonably assured conventional resources by processing method

(in situ tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional from OP	0	0	0	102 820	50
Total	0	0	0	102 820	

Reasonably assured conventional resources by deposit type

(in situ tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Intrusive	0	0	0	102 820
Total	0	0	0	102 820

Inferred conventional resources by production method

(in situ tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Co-product and by-product	0	0	0	125 143	50
Total	0	0	0	125 143	

Inferred conventional resources by processing method

(in situ tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Unspecified	0	0	0	125 143	50
Total	0	0	0	125 143	

Inferred conventional resources by deposit type

(in situ tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Intrusive	0	0	0	125 143
Total	0	0	0	125 143

Ecuador

Uranium exploration and mine development

Historical review

Uranium exploration in Ecuador began in the mid-1960s with the creation of the Prospecting Department of the National Polytechnic School, which led to the first investigations for uranium and radioactive mineral occurrences in the country. During that time, the Ecuadorian Atomic Energy Commission (CEEA) was affiliated to the National Polytechnic School.

Between 1966 and 1967, the CEEA in co-operation with the International Atomic Energy Agency (IAEA; Dr James Cameron) outlined the first radioactive minerals research plan, leading to the discovery and evaluation of several radiometric anomalies between 1968 and 1970, using vehicle-borne gamma surveys. The areas investigated in the south of Ecuador in the late 1970s included Alamor, Sabanilla, Changuarhuayco, Zapotillo, Paletillas and Puyango. During the 1975-1978 period, geochemical surveys were carried out in the provinces of Azuay, Loja and Zamora Chinchipe, as well as further radiometric surveys around the Quijos river region in Napo province.

By the end of the 1970s, more than 300 radioactive anomalies had been identified as a result of 17 300 km^2 of airborne radiometric surveys in the areas of Manabí, Guayas and Cuenca, and 17 000 km^2 of vehicle-borne gamma surveys in the Cordillera, and geochemical surveys spanning 8 200 km^2 in the north, centre and south of the country.

Between 1982 and 1984, the CEEA, being responsible for uranium prospecting activities, carried out exploration in co-operation with the IAEA and the United Nations Development Program (UNDP). The areas studied included the Western and Eastern Cordilleran regions and the southwest of Ecuador. Radiometric surveys and geochemical studies of active stream sediments led to the detection of numerous anomalies. The most promising of these anomalies was found in the Puyango area (10 km^2), where the CEEA continued fieldwork that included 600 m of exploration drilling in four holes. In the 1990s, CEEA exploration programmes were suspended.

In 2008, the Ecuadorian Atomic Energy Commission (CEEA) was merged into the Ministry of Electricity and Renewable Energy, becoming the Undersecretariat of Nuclear Control, Investigations and Applications (SCIAN), later renamed the Undersecretariat of Control and Nuclear Applications (SCAN). That same year, the "Program for the Development of Uranium Resources of Ecuador" was launched.

The short- and medium-term exploration plan proposed a new organisational structure to lead work programmes, modernise equipment, and establish essential infrastructure, instruments and tools – such as laboratories, petrographic and mineralogical studies, and a technical archive on uranium prospecting in Ecuador – to support uranium exploration and geological research. A key priority was to compile and synthesise research data from previous decades and to update the regional geological understanding of uranium deposits in the country. The programme recommended the following actions:

a. Regional airborne gamma-ray spectrometry surveys;

b. Ground gamma-ray spectrometry in the Eastern and Western Cordilleras;

c. Detailed prospecting in seven anomaly clusters;

d. Uranium exploration in the El Limo–La Sota district and the Puyango deposit where U is considered as a potential by-product to V and Zn;

e. Development of a national uranium favourability, exploration and resource profile.

The programme was originally scheduled for implementation between 2010 and 2014 but has not been carried out.

In 2009, as part of the IAEA Technical Cooperation Project, “Regional Upgrading of Uranium Exploration, Exploitation and Yellowcake Production Techniques Taking Environmental Problems into Account (RLA3010)”, an expert mission on “Uranium Exploration in Ecuador” was carried out. Among other activities, the mission included technical evaluation visits to the Puyango deposit and the anomaly area No. 44 in the province of Azuay. The uranium potential of anomaly No. 44 was considered as low after the evaluation visit.

Recent and ongoing uranium exploration, and mine development activities

Between 2019 and 2021, the Geological and Energy Research Institute (IIGE), assisted by the IAEA through SCIAN´s liaison, updated and reviewed historical information on uranium exploration in Ecuador, with the objective of taking up research carried out years ago by the National Polytechnic School and the CEEA.

In 2022, through the IAEA interregional project INT2022, the IIGE benefited from training that increased the technical capacities to carry out research proposals on uranium resources in the country in the short term.

In 2020, the Universidad Técnica Particular de Loja (UTPL) carried out a geochemical survey in the Chirimoyo and Guineo micro-basins in the Puyango area, finding V, U and Zn anomalies related to black limestones, bituminous limestones and calcareous shales of marine origin (i.e. Puyango Unit). Furthermore, in 2023 a study led by this university presented partial results from the La Sota area, suggesting that U is linked to P in a geochemical P-U-HREE-Ni association.

The Geological and Energy Research Institute of Ecuador is carrying out the project “Geological investigation and availability of mineral resource occurrences at Ecuadorian territory.” During 2025 and 2026, the project plans to obtain stream-sediment geochemistry results and airborne geophysics data (magnetometry and radiometry), for the Cordillera Real and Sub-Andean Zone. The data will enable identification of potential uranium anomalous zones in these regions and provide further information on previously established anomalies, including the Puyango deposit.

In recent years, the Regulation and Control of Energy and Non-Renewable Natural Resources Agency has not reported any private or state concessions in its mining portfolio related to uranium exploration.

Uranium resources

Identified conventional resources (reasonably assured and inferred resources)

Identified conventional resources have not been declared in the country to date.

Undiscovered conventional resources (prognosticated and speculative resources)

Undiscovered conventional uranium resources have not been assessed in the country to date.

Unconventional resources and other materials

In the Puyango sedimentary deposit (V, Zn, U, Cu, Pb), tabular-shaped uranium mineralisation is hosted by the Early Cretaceous Puyango Unit, which consists of black limestone, bituminous limestone and calcareous sandstone, underlain by the Aptiense Quebrada Los Sábalos Unit composed of silicified sandstones, conglomerates, volcanoclastic sands and very fine sandstones (with fossilised tree trunks). This deposit may be considered as a potential source of uranium, where uranium metal may be recovered as a minor co- or by-product to other metals.

As of 2023, the Geophysics and Geochemistry sectors of the Department of Geosciences of the UTPL estimated mineral resources of the Puyango deposit in the sequence of black limestones and calcareous black shales, which yield 4 300 tU, 39 000 tV and 19 900 tZn of speculative resources (SR).

Uranium production

Ecuador has never produced uranium and has no plans to start production in the near future.

Uranium requirements, and supply and procurement strategy

In May 2025, the Government of Ecuador signed an agreement with the International Atomic Energy Agency (IAEA) to receive technical assistance through a programme intended for countries that are considering or planning their first nuclear power plant. The objective is to support the diversification of Ecuador's energy matrix.

Finland

Uranium exploration

Historical review

Uranium exploration in Finland has taken place in two phases. The first phase occurred between 1955 and 1988, initially conducted by domestic companies Atomienergia, Imatran Voima and Outokumpu, and from 1973 onward by the Geological Survey of Finland (GTK). The second phase (2004-2014) was carried out by foreign companies, including Areva (now Orano), Namura Finland and Mawson Resources (now Goldsky Resources).

Recent and ongoing uranium exploration

Uranium exploration in Finland is currently being reactivated. Two companies, Normetco and Swedish Minerals, have submitted several reservation notifications and exploration permit applications to the mining authority, Tukes. Normetco was acquired by the Australian company Basin Energy in 2024, and Swedish Minerals was acquired by the Canadian company, United Lithium, in January 2026. As of January 2026, Normetco had submitted exploration permit applications for the Palmottu, Temo and Löttö exploration targets, while Swedish Minerals had a granted exploration permit for the Asentolamminoja project and a pending application for the Riutta project.

Uranium resources

Identified conventional resources (reasonably assured and inferred resources)

Finland reports a total of 1 500 tU of in situ reasonably assured conventional resources, recoverable at costs of USD 80-130/kgU in the Palmottu and Pahtavuoma uranium deposits. No inferred conventional resources are reported.

Undiscovered conventional resources (prognosticated and speculative resources)

None reported.

Unconventional resources and other materials

Unconventional resources of uranium in the Talvivaara black schist-hosted Ni-Zn-Cu-Co deposit are approximately 19 400 tU (in situ) at an average grade of 0.0018% U in the measured and indicated resources of 1 061 Mt, and approximately 27 000 tU (in situ) at an average grade of 0.0018% U in the total mineral resources (measured, indicated and inferred) of 1 474 Mt, calculated from the 2024 resource update by Terrafame Oy.

Uranium production

Historical review

The Paukkajanvaara pilot-scale uranium mine in North Karelia produced about 30 tU between 1958 and 1961.

Uranium production centre technical details

(as of 1 January 2025)

	Centre #1
Name of production centre	Terrafame
Production centre classification	Existing
Date of first production	2024
Source of ore:	
Deposit name(s)	Talvivaara (Kuusilampi and Kolmisoppi)
Deposit type(s)	Black schist (metamorphosed black shale)
Recoverable resources (tU)*	8 700*
Grade (% U)	0.0018
Mining operation:	
Type (OP/UG/ISL)	OP
Size (tonnes ore/day)	41 000
Average mining recovery (%)	50
Processing plant:	
Acid/alkaline	Acid (heap leaching)
Type (IX/SX)	SX
Size (tonnes ore/day)	NA
Average process recovery (%)	90
Nominal production capacity (tU/year)	200
Plans for expansion	NA
Other remarks	Heap leaching by-product

* Overall recovery factor of 45% used in the estimate.

Status of production capability, and recent and ongoing activities

Terrafame Ltd. started the extraction of uranium as a by-product from the Talvivaara polymetallic deposit in June 2024. Talvivaara is a black schist-hosted Ni-Zn-Cu-Co deposit in Sotkamo, central Finland. Mining of the Talvivaara deposit commenced in 2008, and nickel, zinc, copper, cobalt and uranium are currently produced at Terrafame's mine site. The production process includes open-pit mining, crushing, heap leaching and metals recovery. In heap leaching, acidic aqueous leach solution is recycled through the heap until its metal content is sufficient for metals recovery. During metals recovery, copper, zinc, nickel, cobalt, and uranium are extracted and precipitated from the solution to produce metal concentrates.

In December 2022, Terrafame Ltd. decided to start preparations for the recovery of uranium based on the positive outcome of the feasibility study on uranium by-product recovery. After Ni-Co precipitation, the leach solution is directed to the uranium recovery plant for uranium extraction. Uranium is separated from the solution by solvent extraction, including uranium loading on the organic phase, scrubbing of impurities from the loaded organic using sulfuric acid, and uranium stripping from the loaded organic phase using sodium carbonate. Uranium is precipitated as uranium peroxide using hydrogen peroxide, followed by uranium concentrate drying and packaging for shipment.

The average mining recovery in heap leaching is approximately 50%, while the average process recovery at the uranium recovery plant is about 90%. Consequently, the overall uranium recovery factor is around 45%. In situ resources of the Talvivaara deposit are approximately 19 400 tU in the measured and indicated mineral resources, resulting in recoverable resources of about 8 700 tU. Terrafame's ramp-up phase to its nominal production capacity (200 tU/yr) is currently underway. The first uranium concentrates were produced in 2024, although no commercial production occurred that year. Therefore, the production tables below indicate 0 for 2024. The uranium recovery plant was expected to operate at full capacity by 2026.

Secondary sources of uranium

Production and/or use of mixed oxide fuels

Finland does not produce or use mixed oxide fuels.

Production and/or use of re-enriched tails

Re-enriched tails were not used in 2023 and 2024.

Regulatory regime

The Mining Act regulates exploration and mining activities in Finland. All licences under the Mining Act are decided by the mining authority, Tukes. An environmental permit, according to the Environmental Protection Act, is required for mining. The mine closure process is regulated by mining and environmental legislation, as well as a number of EU and other specifications.

The Radiation and Nuclear Safety Authority (STUK) is the regulatory body for uranium production, as specified in the Nuclear Energy Act and the Radiation Act. Production of uranium or thorium needs a licence from the Finnish government according to the Nuclear Energy Act. A licence application must be submitted to the government. Statements from different authorities (including STUK) are required for the decision on the licence, which is prepared by the Ministry of Economic Affairs and Employment, and decided by the government.

According to the Mining Act of 2011, an exploration licence is required for uranium exploration (e.g. for drilling and trenching). Permit applications concerning a uranium mine under the Mining Act and the Nuclear Energy Act are handled jointly and decided on in a single decision by the government. A permit for a uranium mine requires that the mining activities be in line with the overall good of society, that the municipality in question give its consent and that safety requirements be fulfilled.

STUK's regulatory control covers the radiation exposure of workers and the public, environmental monitoring, waste management, emergency preparedness, nuclear material accountancy and control, and physical protection of nuclear materials. STUK verifies that nuclear safety and security requirements are fulfilled. Radioactive tailings are regarded as nuclear waste and are subject to funding for the future costs of waste management. Uranium concentrate export, controlled by the Ministry for Foreign Affairs, is also subject to national and international safeguards control.

The environmental impact assessment procedure is applied to all uranium mining projects, without any limitations on the annual amount of the extracted resources. In addition, other legislation to be applied for mining activities includes the Water Act, the Nature Conservation Act, the Wilderness Act, the Chemicals Act, the Land Use and Building Act, the Occupational Safety and Health Act, the Waste Act, and various government decrees and decisions.

Uranium requirements

Five nuclear power plant units (three at the Olkiluoto Nuclear Power Plant and two at the Loviisa Nuclear Power Plant), with a total generating capacity of 4.4 GWe (net), are in operation. These five reactors require about 720 tU annually. Olkiluoto units are owned and operated by Teollisuuden Voima Oyj (TVO), and Loviisa units by Fortum Power and Heat Oy. In February 2023, the Finnish government granted a new operating licence, until 2050, for both units of the Loviisa Nuclear Power Plant.

Finland's fifth nuclear power plant unit, TVO's Olkiluoto 3 (EPR; 1.6 GWe net), was connected to the national grid in March 2022. TVO selected European pressurised reactor (EPR) technology for the Olkiluoto 3 unit in 2003, and the Areva-Siemens Consortium started construction in 2005. Regular electricity production at the Olkiluoto 3 unit began in April 2023.

Supply and procurement strategy

TVO procures its nuclear fuel for the Olkiluoto Nuclear Power Plant through a decentralised supply chain, entering into negotiations and making procurement contracts with each separate supplier at the various stages of the fuel production chain. There are several suppliers for each stage of the chain. Procurement operations are based on long-term contracts with suppliers. These companies have mining operations in many countries. Most of the uranium procured by TVO comes from Kazakhstan, Canada and Australia, and the nuclear fuel assemblies ordered by the company are fabricated in Germany, Spain or Sweden.

In November 2022, Fortum signed an agreement with Westinghouse for the design, licensing and supply of a new fuel type for the Loviisa Nuclear Power Plant. The first batch of Westinghouse nuclear fuel was loaded to Loviisa in August 2024. The loading of the new fuel marked a significant milestone in replacing the Russian-origin fuel assemblies with a Western alternative for the Loviisa power plant.

Uranium policies, uranium stocks and uranium prices

Nuclear energy legislation

The legal basis of the use of nuclear energy in Finland consists of the Nuclear Energy Act and the Nuclear Energy Decree. The purpose of nuclear energy legislation is to ensure that the use of nuclear energy is in line with the overall good of society, safe for people and the environment, and that its use does not enable the proliferation of nuclear weapons. The use of nuclear energy creates several obligations for the licensee. The licensee must, among other things: ensure the safety of operations, manage the nuclear waste created through the operations and assume responsibility for all nuclear waste management costs. Nuclear waste management costs are prepared for by collecting funds in advance in the price of electricity and depositing them in the National Nuclear Waste Management Fund.

The Nuclear Energy Decree, and other government decisions, have been issued based on the Nuclear Energy Act. The government decisions concern nuclear plant safety, nuclear security arrangements, preparedness arrangements, and the final disposal of operating waste and spent nuclear fuel. Based on the authorisation by the nuclear energy legislation, the STUK publishes detailed safety requirements for the use of nuclear energy. Radiation safety is regulated by the Radiation Act and the Radiation Decree. The Nuclear Liability Act stipulates that the licensee must have nuclear liability insurance that will compensate for injuries caused to outsiders by a possible nuclear accident, to the extent decreed by law.

Nuclear waste management

Spent nuclear fuel from the Olkiluoto and Loviisa nuclear power plants is stored in the water pools of the fuel storage facilities at Olkiluoto and Loviisa, until finally disposed of in the Olkiluoto bedrock in the municipality of Eurajoki. Posiva Oy, a company owned by TVO and

Fortum, is responsible for the final disposal of the spent nuclear fuel of the owners. Spent nuclear fuel from the nuclear power plants of TVO and Fortum will be packed in copper canisters and embedded in Olkiluoto bedrock at a depth of 400-450 metres. The final disposal of spent nuclear fuel is based on the use of multiple release barriers to ensure that the nuclear waste cannot be released into organic nature or become accessible to humans. The release barriers include the ceramic, solid state of the fuel, the disposal canister, the bentonite buffer, the backfilling of the tunnels and the surrounding rock.

An operating licence application for Posiva's encapsulation plant and disposal facility was submitted to the Finnish Government in December 2021. In December 2024, the Radiation and Nuclear Safety Authority (STUK) reported that it was applying for an extension until the end of 2025 from the Ministry of Economic Affairs and Employment (MEAE), in order to process the application. During 2024, the installation and commissioning phase continued with the construction of Posiva's facilities. The underground construction and building technology work was completed in May 2024. In August 2024, Posiva commenced the trial run of final disposal to test the equipment, systems and processes from encapsulation to actual final disposal, the filling of the tunnel and the closure of the tunnels by using non-irradiated copies of fuel elements. The current plan is to start final disposal of spent nuclear fuel in Olkiluoto during 2020s.

Uranium stocks

The nuclear power utilities maintain reserves of fuel assemblies from seven months to one year's use, although the legislation demands only five months' use.

Uranium prices

Due to commercial confidentiality, price data are not available.

Reasonably assured conventional resources by production method

(in situ tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	<USD 390/kgU
Underground mining (UG)	0	0	500	500	500
Open-pit mining (OP)	0	0	1 000	1 000	1 000
Total	0	0	1 500	1 500	1 500

Reasonably assured conventional resources by processing method

(in situ tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	<USD 390/kgU
Conventional from UG	0	0	500	500	500
Conventional from OP	0	0	1 000	1 000	1 000
Total	0	0	1 500	1 500	1 500

Reasonably assured conventional resources by deposit type

(in situ tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	<USD 390/kgU
Metamorphite	0	0	500	500	500
Intrusive	0	0	1 000	1 000	1 000
Total	0	0	1 500	1 500	1 500

Historical uranium production by production method

(tonnes U in concentrates)

Production method	Total through end of 2022	2023	2024	Total through end of 2024	2025 (expected)
Open-pit mining	15	0	0	15	NA
Underground mining	15	0	0	15	0
Total	30	0	0	30	NA

Historical uranium production by processing method

(tonnes U in concentrates)

Processing method	Total through end of 2022	2023	2024	Total through end of 2024	2025 (expected)
Conventional	30	0	0	30	0
Heap leaching from OP	0	0	0	0	NA
Total	30	0	0	30	NA

Historical uranium production by deposit type

(tonnes U in concentrates)

Deposit type	Total through end of 2022	2023	2024	Total through end of 2024	2025 (expected)
Sandstone	30	0	0	30	0
Black schist	0	0	0	0	NA
Total	30	0	0	30	NA

Mid-term production projection (tonnes U/year)

2025	2030*	2035*	2040*	2045*	2050*
NA	200	200	200	200	200

* Nominal by-product recovery capacity of uranium from the Talvivaara black schist-hosted Ni-Zn-Cu-Co deposit (unconventional resources).

Re-enriched tails production and use

(tonnes natural U-equivalent)

Re-enriched tails	Total through end of 2022	2023	2024	Total through end of 2024	2025 (expected)
Production	0	0	0	0	0
Use	843	0	0	843	0

Net nuclear electricity generation

	2023	2024
Nuclear electricity generated (TWh net)	32.8	31.1

Installed nuclear generating capacity to 2050

(MWe net)

2023	2024	2025		2030		2035		2040		2045		2050	
		Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
4 390	4 390	4 390	4 390	4 390	4 390	4 390	4 390	4 390	4 390	4 390	4 390	4 390	4 390

Annual reactor-related uranium requirements* to 2050 (excluding MOX)

(tonnes U)

2023	2024	2025		2030		2035		2040		2045		2050	
		Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
NA	NA	690	750	690	750	690	750	690	750	690	750	690	750

* Refers to natural uranium acquisitions, not necessarily consumption during the calendar year.

France

Uranium exploration and mine development

Historical review

Uranium exploration began in 1946, focussing on previously discovered deposits and a few occurrences discovered during radium exploration. In 1948, this exploration led to the discovery of the La Crouzille deposit, which at one time was of major importance. By 1955, additional deposits had been identified in the granite areas of Limousin, Forez, Vendée and Morvan. Prospecting activities were subsequently extended to sedimentary formations in small intra-granitic basins and terrigeneous formations derived from eroded granite mountains, mainly located both north and south of the Massif Central.

Recent and ongoing uranium exploration, and mine development activities

No domestic activities have been carried out in France since 1999.

There is no domestic ownership of uranium production, only ownership in foreign countries through operations in Canada, Kazakhstan and Niger.

During the current Red Book reporting period, the state majority-owned company Orano S.A. (formerly Areva S.A.) has been working outside France, focussing on the discovery of exploitable resources in Canada, Gabon, Kazakhstan, Mongolia, Namibia, Niger and Uzbekistan. In Canada, Kazakhstan and Niger, Orano is also involved in uranium mining operations. In addition, as a non-operator, it holds shares in several mining operations and research projects in different countries.

Since the coup in Niger in July 2023, Orano has been subject to increasing interference by the State of Niger in the governance of its Nigerien Subsidiaries (the "Nigerien Subsidiaries" meaning Somaïr, Imouraren and Cominak). This interference, which is part of a sovereigntist agenda aimed at regaining control of the country's mining activities, has led the group to confirm the loss of Orano's operational control over its Nigerien subsidiaries as of December 2024.

Uranium resources

Identified conventional resources (reasonably assured and inferred resources)

Orano no longer reports resources or reserves in France, since the historic data on which these estimates are based do not conform to modern international standards.

Undiscovered conventional resources (prognosticated and speculative resources)

No systematic appraisal has been made of undiscovered resources.

Uranium production

Status of production facilities, production capability, recent and ongoing activities, and other issues

Following the closure of all uranium mines in 2001, all ore processing plants were shut down and dismantled, and the sites reclaimed.

In France, a total of 244 sites (ranging from exploration sites to mines of various sizes), 8 mills and 17 tailing deposits (containing a total of 52 Mt of tailings) are the result of the production of about 80 000 tU. All these sites have been remediated. Monitoring continues at only the most important sites, and 17 water treatment plants were installed to clean drainage from the sites. Orano is responsible for the management of 234 of these sites.

The purpose of remediation is to:

- ensure public health and safety;
- limit the residual impact of previous activities, to as low as reasonably achievable (ALARA);
- integrate the industrial sites into landscape;
- maintain a dialogue and consultation with local populations;
- allow the reconversion of the former sites to new activities, such as tourism, industry, agriculture and energy (solar panels).

Future production centres

There are no plans to develop new production centres in France in the near future.

Secondary sources of uranium

Production and/or use of mixed oxide fuels

The annual licensed capacity of MOX fuel production in France is about 195 tHM, roughly corresponding to 1 560 tU equivalent (tNatU) using the recommended Red Book conversion factor. Actual yearly production of MOX in France varies below this licensed capacity in accordance with contracted quantities. Most of the French MOX production is used to fuel French nuclear power plants (a total of about 125 t/yr, or 1 000 tNatU) and the remainder is delivered abroad under long-term contract arrangements.

Production and/or use of reprocessed uranium

Électricité de France (EDF) produces around 1 100 tU of spent fuel annually. 95% of that used fuel is processed at the La Hague reprocessing plant operated by Orano. The reprocessed uranium, which is owned by EDF, is then stored in U_3O_8 form at Orano’s Tricastin facility.

Reprocessed uranium was recycled in EDF’s four nuclear power reactors at Cruas, from 1994 until 2013 when recycling was suspended pending the availability of a new industrial supply chain. In 2018, EDF approved the resumption of reprocessed uranium recycling, which successfully led to the loading of the first reprocessed uranium assemblies in reactor n°2 of Cruas in 2023. In 2024, all four reactors of Cruas were loaded with reprocessed uranium assemblies, while additional reactors are expected to be loaded with reprocessed uranium starting 2027.

Reprocessed uranium enables EDF to diversify its uranium supply sources, allowing for savings of around 10-15% of its natural uranium requirements. It also improves the CO2 content of the nuclear electricity generated in France and reduces the quantity of nuclear wastes by reusing 96% of the nuclear material contained in spent fuel.

Regulatory regime

In France, mines are nationally regulated according to the mining code, whereas processing plants are regulated under the legislation governing the operation of installations that present environmental risks (ICPE – *installation classée pour la protection de l'environnement*). These regulations are applied by regional environmental authorities (DREAL – Directions régionales de l'Environnement, de l'Aménagement et du Logement) on behalf of the prefect (the state representative in a particular department or region).

To open a mine, the mining company must present a report to the regional authorities that will allow them to confirm that the project will be operated in accordance with all regulations. Once this is confirmed, a public enquiry must be held. If these processes are successfully completed, the mining company will be allowed to open the mine according to the requirements laid out in an *Ordre du Préfet*. When mining is completed, the mining company must prepare a report for local authorities who can then give authorisation for decommissioning through an *Ordre du Préfet*.

After decommissioning, the mining company retains responsibility for the site, including monitoring and maintenance. In theory, according to the mining code, after remediation and a period of monitoring to verify that there is no environmental impact, the mining company can transfer the responsibility of the site to the state. However, if there is a problem, the state asks the mining company to remediate it.

There has not been a transfer of responsibility for a uranium mine from the mining company to the state because Orano, as the responsible mining company, is majority owned by the state. However, Orano is in discussions with the authorities regarding the transfer of responsibility.

The cost of mine remediation is the responsibility of the mining company. In the case of processing plants (mills), local authorities request financial guarantees for the costs of all remediation works and monitoring. A draft revision of the mining code is currently under development.

Uranium requirements

France has 57 nuclear power reactors in operation (supplying 63 GWe).

In February 2022, President Emmanuel Macron announced a plan to increase the use of nuclear power in France, including the construction of six new EPR nuclear reactors. In October 2022, a public consultation concerning France's future energy mix was initiated by the government along with a public debate regarding EDF's proposal to construct the initial two EPR reactors at the Penly site (Normandy).

In February 2023 and July 2023, President Macron convened Nuclear Policy Councils (CPN) that set up short- and long-term orientations for nuclear policy including:

- launching studies to prepare for the operation of existing power plants for 60 years and beyond, as long as all applicable safety requirements are met;
- selecting the Bugey site for the third pair of EPR2 reactors, after the Penly and Gravelines sites;
- developing small modular reactors (SMR) and innovative reactors (AMR) as part of a major investment plan called "France 2030".

In June 2023, a law aiming at accelerating the construction of new nuclear facilities near existing nuclear sites was promulgated.

In February 2024, President Macron chaired a new Nuclear Policy Council (CPN) that confirmed the French strategy for the reprocessing and reuse of used fuels, and new prospects for the complete closure of the fuel cycle through the end of the century. This policy decision led to launch a sustainability/resilience programme, extending the life of the La Hague reprocessing and Melox recycling plants beyond 2040, as well as studies for the renewal of the recycling platform at La Hague, with a new MOX fuel fabrication facility around 2040 and a new used fuel reprocessing facility by 2045-2050.

The last projects selected under the France 2030 investment plan were announced in March 2024. Eleven companies received a total of EUR 128 million to support new concepts of innovative nuclear reactors, including fission and fusion.

In December 2024, the government submitted, for public consultation, the multi-year energy programming (PPE) for the 2025-2030 and 2031-2035 periods, which focusses on accelerating the deployment of renewable energies, continued operation of the current nuclear reactors beyond 60 years, and then beyond 70 years and a new-build programme of 6 EPR2 nuclear reactors with the final investment decision expected from EDF no later than 2026. Additional analysis will be conducted to consider a further 13 GW of new nuclear capacity, equivalent to that of 8 EPR2 reactors.

Public consultation on the PPE ended in April 2025 and confirmed the main orientations regarding nuclear energy: keeping the existing nuclear fleet in operation and building new large nuclear reactors.. The PPE 3 was published in February 2026.

In 2006, Areva began work, at the Tricastin site, on construction of the Georges Besse II uranium centrifuge enrichment plant, to replace the Eurodif gaseous diffusion plant that had been in service since 1978. In 2012, production at the Eurodif plant was stopped and the facility will be dismantled in the coming years. The Georges Besse II facility successfully reached its full production capacity of 7.5 million SWUs in 2016. The most recent qualification tests carried out have confirmed the performance capabilities of the plant's equipment with its industrial facilities showing rates of efficiency of more than 99%.

Supply and procurement strategy

EDF is responsible for the procurement and security of supply of the French nuclear reactors. EDF's procurement strategy is based on four core principles: long-term supply contracts with uranium producers, diversification of the suppliers and the origins of the uranium (countries and mines), keeping inventories to manage the risk of disruption of supplies and recycling used fuel.

Orano participates in uranium exploration and production outside of France, within the regulatory framework of the host countries. Orano can also purchase uranium under short- or long-term contracts, either from mines in which Orano has shareholdings or from mines operated by third parties. Orano supplies uranium to nuclear operators worldwide, including EDF.

Uranium policies, uranium stocks and uranium prices

Uranium stocks

EDF possesses strategic uranium inventories, the minimum level of which has been fixed at the equivalent of a few years' forward consumption, to offset possible supply interruptions.

Uranium prices

Information on uranium prices is not available.

Uranium exploration and development expenditures – non-domestic

(In EUR millions)

	2022	2023	2024	2025 (preliminary)
Private* exploration expenditures	NA	NA	NA	NA
Government** exploration expenditures	24	24	25	25
Private* development expenditures	NA	NA	NA	NA
Government** development expenditures	NA	NA	NA	NA
Total expenditures	24	24	25	25

* Non-government.

** Government expenditures refer to those corresponding to majority government funding.

Historical uranium production by production method

(tonnes U in concentrates)

Production method	Total through end of 2022	2023	2024	Total through end of 2024	2025 (preliminary)
Open-pit mining[1]	5 427	0	0	5 427	0
Underground mining[1]	1 511	0	0	1 511	0
Open-pit and underground[2]	73 925	0	0	73 925	0
Co-product/by-product	115	0	0	115	0
Total	80 978	0	0	80 978	0

1. Pre-2022 totals may include uranium recovered by heap and in-place leaching.

2. Not possible to separate in historic records.

Historical uranium production by processing method

(tonnes U in concentrates)

Processing method	Total through end of 2022	2023	2024	Total through end of 2024	2025 (preliminary)
Conventional	80 863	0	0	80 863	0
Other or unspecified methods*	115	0	0	115	0
Total	80 978	0	0	80 978	0

* Includes mine water treatment and environmental restoration.

Historical uranium production by deposit type

(tonnes U in concentrates)

Deposit type	Total through end of 2022	2023	2024	Total through end of 2024	2025 (preliminary)
Sandstone	16 781	0	0	16 781	0
Granite-related	63 683	0	0	63 683	0
Metamorphite	395	0	0	395	0
Volcanic-related	1	0	0	1	0
Black shale	3	0	0	3	0
Other or unspecified	115	0	0	115	0
Total	80 978	0	0	80 978	0

Ownership of uranium production in 2024

Domestic				Foreign				Totals		
Government		Private		Government		Private				
(tU)	(%)	(tU)	(%)	(tU)	(%)	(tU)	(%)	(tU)	(%)	Country
0	0	0	0	2 360	30.195	0	0	2 360	30.195	Canada
0	0	0	0	2 634	40.453	0	0	2 634	40.453	Canada
0	0	0	0	608	63.4	0	0	608	63.4	Niger
0	0	0	0	1 218	51	0	0	1 218	51	Kazakhstan

Mixed oxide fuel production and use

(tonnes natural U-equivalent)

Mixed oxide (MOX) fuel	Total through end of 2022	2023	2024	Total through end of 2024	2025 (preliminary)
Production	26 003	86	66	26 154	100
Use	NA	NA	NA	NA	NA
Number of commercial reactors using MOX		22	22	22	22

Reprocessed uranium use

(tonnes natural U-equivalent)

Reprocessed uranium	Total through end of 2022	2023	2024	Total through end of 2024	2025 (preliminary)
Production	32 817	974	340	34 131	1 200
Use	5 300	0	132	5 432	523

Net nuclear electricity generation (TWh net)

	2023	2024
Nuclear electricity generated (TWh net)	320.4	361.7

Installed nuclear generating capacity to 2050

(MWe net)

2023	2024	2025		2030		2035		2040		2045		2050	
		Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
61 400	63 000	63 000	63 000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Annual reactor-related uranium requirements to 2050 (excluding MOX)

(tonnes U)

2023	2024	2025		2030		2035		2040		2045		2050	
		Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
7 500	7 200	7 000	NA	5 700	NA	5 000	NA	4 400	NA	NA	NA	NA	NA

Germany

Uranium exploration and mine development

Historical review

After World War II, and until reunification in 1990, exploration for uranium occurred in two separate countries in what is Germany today:

Federal Republic of Germany (FRG) before 1990

Starting in 1956, exploration was carried out in several areas of geological interest: the Hercynian Massifs of the Black Forest, Odenwald, Frankenwald, Fichtelgebirge, Oberpfalz, Bayerischer Wald, Harz, the Paleozoic sediments of the Rheinisches Schiefergebirge, the Permian volcanics and continental sediments of the Saar-Nahe region, and other areas with favourable sedimentary formations. The initial phase included hydrogeochemical surveys, car-borne surveys, field surveys and, to a lesser extent, airborne prospecting. Follow-up geochemical stream sediment surveys, radon surveys and detailed radiometric work, followed by drilling and trenching, were carried out in promising areas. During the reconnaissance and detailed exploration phases, both federal and state geological surveys were involved, whereas the actual work was carried out mainly by industrial companies.

Three deposits of economic interest were found: (1) the partly high-grade hydrothermal deposit near Menzenschwand in the southern Black Forest; (2) the sedimentary Müllenbach deposit in the northern Black Forest; and (3) the Grossschloppen deposit in northeastern Bavaria. Uranium exploration ceased in Western Germany in 1988 but by then about 24 800 holes had been drilled, totalling about 354 500 metres. Total expenditures were on the order of USD 111 million.

Former German Democratic Republic (GDR) before 1990

Uranium exploration and mining were undertaken from 1946 to 1953 by the Soviet stock company, SAG Wismut. These activities were centred around old mining locations of silver, cobalt, nickel and other metals in the Erzgebirge (Ore Mountains), and in Vogtland, Saxony, where uranium had first been discovered in 1789.

Uranium exploration had started in 1950 in the vicinity of the radium spa at Ronneburg. Using a variety of ground-based and aerial techniques, the activities covered an extensive area of about 55 000 km^2 in the southern part of the GDR. About 36 000 holes in total were drilled in an area covering approximately 26 000 km^2. Total expenditures for uranium exploration over the life of the GDR programme were on the order of 5.6 billion GDR marks.

Uranium mining first began shortly after World War II in cobalt and bismuth mines near Schneeberg and Oberschlema (a former famous radium spa). During this early period more than 100 000 people were engaged in exploration and mining activities. The rich uraninite and pitchblende ore from the vein deposits was hand-picked and shipped to the USSR for further processing. Lower-grade ore was treated locally in small processing plants. In 1950, the central mill at Crossen near Zwickau, Saxony, was brought into operation.

In 1954, a new joint Soviet-German stock company was created, Sowjetisch-Deutsche Aktiengesellschaft Wismut (SDAG Wismut). The joint company was held equally by both governments. All production was shipped to the USSR for further treatment. The price for the final product was simply agreed upon by the two partners. Profits were used for further exploration.

At the end of the 1950s, uranium mining was concentrated in the region of eastern Thuringia. From the beginning of the 1970s, the mines in eastern Thuringia provided about two-thirds of SDAG Wismut's annual production.

Between the mid-1960s and the mid-1980s, about 45 000 people were employed by SDAG Wismut. In the mid-1980s, Wismut's employment decreased to about 30 000. In 1990, only 18 000 people worked in uranium mining and milling, and the number of employees has continued to decline since that time, as remediation activities are completed.

Recent and ongoing uranium exploration, and mine development activities

There have been no exploration activities in reunified Germany since the end of 1990. Several German mining companies, however, did perform exploration abroad (mainly in Canada) through 1997.

Uranium resources

Identified conventional resources (reasonably assured and inferred resources)

Identified conventional resources were last assessed in 1993. These identified conventional resources occur mainly in the closed mines that are in the process of being decommissioned. Their future availability remains uncertain.

Undiscovered conventional resources (prognosticated and speculative resources)

All undiscovered conventional resources are reported as speculative resources in the cost category <USD 260/kgU.

Unconventional resources and other materials

None reported.

Uranium production

Historical review

Federal Republic of Germany (FRG) before 1990

In the FRG, a small (125 tonnes per year) uranium processing centre in Ellweiler, Baden-Württemberg, began operating in 1960 as a test mill. It was closed on 31 May 1989 after producing a total of about 700 tU.

Former German Democratic Republic (GDR) before 1990

Two processing plants were operated by SDAG Wismut in the territories of the former GDR. A plant at Crossen, near Zwickau in Saxony, started processing ore in 1950. The ore was transported by road and rail from numerous mines in the Erzgebirge. The composition of the ore from the hydrothermal deposits required carbonate pressure leaching. The plant had a maximum capacity of 2.5 million tonnes of ore per year. Crossen was permanently closed on 31 December 1989.

The second plant at Seelingstadt, near Gera, Thuringia, started ore processing operations in 1960, using the nearby black shale deposits. The maximum capacity of this plant was 4.6 million tonnes of ore per year. Silicate ore was treated by acid leaching until the end of 1989. Carbonate-rich ores were treated using the carbonate pressure leaching technique. After 1989, Seelingstadt's operations were limited to the treatment of slurry produced at the Königstein mine, using the carbonate method.

A total of over 200 000 tU was produced in the GDR between 1950 and 1989.

Status of production facilities, production capability, recent and ongoing activities, and other issues

There is no commercial production of uranium in Germany today. Decommissioning of the historic German production facilities started in 1989 (former FRG) and 1990 (former GDR). Between 1991 and 2020, uranium recovery from mine water treatment and environmental restoration amounted to a total of 2 631 tU. Since 1992, all uranium production in Germany has been derived from the clean-up operations at the Königstein mine. In 2020, conversion work of the water treatment facility at the Königstein mine finally ended uranium production in Germany. The existing system was adapted to future requirements, whereby the technological process phase of selective uranium separation was omitted, owing to the decreasing content of uranium and heavy metals in the flood water in recent years. Future water treatment at the Königstein mine site will still be required but without any special separation of uranium. This marks the end of uranium mining in Germany after almost 75 years.

Ownership structure of the uranium industry

The production facilities in the former GDR were owned by the Soviet-German company Wismut (SDAG Wismut). After reunification, the German Ministry of Economy inherited the ownership from SDAG Wismut. The German federal government, through Wismut GmbH, took responsibility for the decommissioning and remediation of all production facilities. The government retains ownership of all uranium recovered in clean-up operations.

In August 1998, Cameco completed its acquisition of Uranerz Exploration and Mining Ltd (UEM), Canada, and Uranerz USA Inc. (UUS), from their German parent company Uranerzbergbau GmbH (Preussag and Rheinbraun, 50% each). As a result, there remains no commercial uranium industry in Germany.

Employment in the uranium industry

All employment is engaged in decommissioning and rehabilitation of former production facilities. Employment decreased from 800 in 2022 to 770 in 2024.

Future production centres

None reported.

Uranium policies, uranium stocks and uranium prices

In accordance with the 2010 Energy Concept, the German government had decided to phase out the use of nuclear power for commercial electricity generation in stages, by the end of 2022 at the latest. The accelerated nuclear phase-out was passed into law in 2011 by a broad consensus in the German parliament – the Bundestag – with the adoption of the Thirteenth Amendment to the Atomic Energy Act. The phase-out law entered into force on 6 August 2011. In autumn 2022, the German government and the Bundestag decided to allow limited extended operation for the last three nuclear power plants until 15 April 2023, at the latest. The three nuclear power plants – Emsland in Lower Saxony, Isar 2 in Bavaria and Neckarwestheim 2 in Baden-Württemberg – finally ceased power operation on 15 April 2023. This marked the end of nuclear power use in Germany. According to the Atomic Energy Act, the nuclear power plants were to be decommissioned and dismantled immediately.

A total of 37 nuclear power plants have been built in Germany and put into commercial operation since 1962. With the shutdown of the last three nuclear power plants on 15 April 2023, the use of nuclear energy in Germany came to an end.

Reasonably assured conventional resources by production method

(recoverable tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Unspecified	0	0	0	3 000	
Total	0	0	0	3 000	

Reasonably assured conventional resources by processing method

(recoverable tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Unspecified	0	0	0	3 000	
Total	0	0	0	3 000	

Inferred conventional resources by production method

(recoverable tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Unspecified	0	0	0	4 000	
Total	0	0	0	4 000	

Inferred conventional resources by processing method

(recoverable tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Unspecified	0	0	0	4 000	
Total	0	0	0	4 000	

Historical uranium production by processing method

(recoverable tonnes U in concentrates)

Processing method	Total through end of 2022	2023	2024	Total through end of 2024	2025 (expected)
Unspecified	217 165	0	0	217 165	0
Other methods*	2 631	0	0	2 631	0
Total	219 796	0	0	219 796	0

* Includes mine water treatment and environmental restoration.

Speculative conventional resources

(in situ tonnes U)

Cost ranges		
<USD 130/kgU	<USD 260/kgU	Unassigned
0	0	74 000

Ownership of uranium production in 2024

Domestic				Foreign				Totals	
Government		Private		Government		Private			
(tU)	(%)	(tU)	(%)	(tU)	(%)	(tU)	(%)	(tU)	(%)
0	100	0	0	0	0	0	0	0	100

Uranium industry employment at existing production centres

(person-years)

	2022	2023	2024	2025 (expected)
Total employment related to existing production centres	800	800	770	750
Employment directly related to uranium production	NA	NA	NA	NA

Mixed oxide fuel production and use

(tonnes natural U-equivalent)

Mixed oxide (MOX) fuel	Total through end of 2022	2023	2024	Total through end of 2024	2025 (expected)
Production	0	NA	NA	NA	NA
Use	6 730	NA	NA	NA	NA
Number of commercial reactors using MOX		NA	NA		

Re-enriched tails production and use

(tonnes natural U-equivalent)

Re-enriched tails	Total through end of 2022	2023	2024	Total through end of 2024	2025 (expected)
Production	NA	NA	NA	NA	NA
Use	NA	0	0	0	-

Reprocessed uranium use

(tonnes natural U-equivalent)

Reprocessed uranium	Total through end of 2022	2023	2024	Total through end of 2024	2025 (expected)
Production	NA	0	0	0	-
Use	NA	NA	NA	NA	NA

Net nuclear electricity generation

	2023	2024
Nuclear electricity generated (TWh net)	7.2	0

Installed nuclear generating capacity to 2050

(MWe net)

2023	2024	2025		2030		2035		2040		2045		2050	
		Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
4 055	0	0	0	0	0	0	0	0	0	0	0	0	0

Annual reactor-related uranium requirements to 2050 (excluding MOX)

(tonnes U)

2023	2024	2025		2030		2035		2040		2045		2050	
		Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
NA	NA	0	0	0	0	0	0	0	0	0	0	0	0

Total uranium stocks

(tonnes natural U-equivalent)

Holder	Natural uranium stocks in concentrates	Enriched uranium stocks	Enrichment tails	LWR reprocessed uranium stocks	Total
Government	NA	NA	NA	NA	NA
Producer	NA	NA	NA	NA	NA
Utility	NA	NA	NA	NA	NA
Total	NA	NA	NA	NA	NA

Hungary

Uranium exploration and mine development

Historical review

The first reconnaissance for uranium started in 1952 when, with Soviet participation, material from Hungarian coal deposits was checked for radioactivity. The results of this work led to a geophysical exploration programme (airborne and surface radiometry) in 1953, covering the western part of the Mecsek Mountains. The discovery of the Mecsek deposit was made in 1954, and further work was aimed at the evaluation of the deposit and its development. The first shafts were excavated in 1955 and 1956, for the mining of sections I and II. In 1956, the Soviet-Hungarian uranium joint venture was dissolved, and the project became the sole responsibility of the Hungarian state. That same year, uranium production began. Production began to decline in the late 1980s and ended after 1998.

Recent and ongoing uranium exploration, and mine development activities

There has been no uranium exploration or mine development activity since the previous edition of the Red Book. Currently, the only way to establish a mining property is through public concession tendering, provided the government launches the tendering procedure.

Uranium resources

Hungary's reported uranium resources are limited to those of the Mecsek deposit. The ore is hosted by Upper Permian sandstones, with a thickness of up to 600 metres. During the Cretaceous period, the Permo-Triassic sandstones were folded into an anticline that makes up the framework structure of the Mecsek Mountains. The ore-bearing sandstone in the upper 200 metres of the unit is underlain by a thick layer of Permian siltstone and covered by Lower Triassic sandstone. The thickness of the green-grey ore-bearing sandstone, locally referred to as the "productive complex", varies from 15 to 90 metres. The ore minerals include uranium oxides and silicates associated with pyrite and marcasite.

Identified conventional resources (reasonably assured and inferred resources)

There has been no change regarding the identified conventional uranium resources since the previous edition of the Red Book. The last re-estimation of the resources was reported in the 2022 edition. As of 1 January 2025, the identified conventional resources amounted to a total of 22 230 in situ tU (16 673 recoverable tU), according to the Hungarian National Mineral Resource Inventory (all are Inferred Resources [IR]; no reasonably assured resources [RAR] are reported).

Undiscovered conventional resources (prognosticated and speculative resources)

The prognosticated resources amount to a total of 14 845 tU (in situ); unchanged compared to the amount reported in the previous edition of the Red Book. These resources are tributary to the former Mecsek production centre. Speculative resources have not been estimated.

Uranium production

Historical review

The Mecsek underground mine and mill, situated near the city of Pécs, was the only uranium production centre in Hungary. Prior to 1 April 1992, it was operated by the state-owned Mecsek Ore Mining Company (MÉV). The mine began operation in 1956 and produced ore from a depth of 100 to 1 100 metres, until it was ultimately shut down in 1997. During operation, it produced about 500 000-600 000 tonnes ore/yr with an average mining recovery of 50-60%. The ore processing plant had a capacity of 1 300 to 2 000 tonnes ore/day and employed radiometric sorting, agitation acid leach (and alkaline heap leaching) with ion-exchange recovery. The nominal production capacity of the plant was about 700 tU/yr.

The Mecsek mine consisted of five sections with the following history:

- section I: operating from 1956 to 1971;
- section II: operating from 1956 to 1988;
- section III: operating from 1961 to 1993;
- section IV: operating from 1971 to 1997;
- section V: operating from 1988 to 1997.

The ore processing plant became operational in 1963. Prior to its operation, 1.2 million tonnes of unprocessed ore were shipped to the Sillimae metallurgy plant in Estonia. After 1963, processed uranium concentrates were shipped directly to the former Soviet Union.

Mining and milling operations were shut down at the end of 1997 because changes in market conditions made the operation uneconomic. Throughout its operational history, total production from the Mecsek mine and mill, including heap leaching, amounted to about 21 000 tU.

Status of production capability

Since the closure of the Mecsek mine in late 1997, the only production of uranium in Hungary has been as a by-product recovery of water treatment activities (see item (3) in the next paragraph), amounting to a total of about 2-6 tU/yr. During this reporting period 3 tU/yr were recovered. Section III of the historic mine working below the water drainage horizon (formerly the main haulage adit) was completely flooded, and it is expected that Sections II-IV-V will be flooded after 2030.

Environmental activities and socio-cultural issues

Closure and large-scale site remediation activities at the Mecsek uranium production centre were carried out between 1998 and 2008. The remediation consisted of: 1) removing several hundred thousand tonnes of contaminated soil from various areas around the site to an on-site disposal facility; 2) remediation of tailing ponds and waste rock piles, by the placement of isolating soil covers; and 3) abandonment and closure of underground mine workings, as well as groundwater extraction and treatment. Although the large-scale remediation programme was completed by the end of 2008, long-term care activities, such as groundwater remediation, environmental monitoring and maintenance of the engineered disposal systems, will likely need to continue for some years.

Since July 2016, long-term care of Hungarian uranium mining and ore processing legacy sites has been under the direct responsibility of the Mining Property Utilization Company in the Public Interest (www.bvh.hu). As the legal successor of the former Mecsek mine (a state-owned venture), it is responsible for paying compensation, including damages for occupational disease, income and pension supplements, reimbursements of certified costs and dependent expenses to people formerly engaged in uranium mining. Costs associated with the environmental remediation of the Mecsek mine are provided in the following table.

Costs of environmental management
(HUF thousands)

	Pre-1998	1998 to 2008	2009 to 2024
Closing of underground spaces	NA	2 343 050	W
Reclamation of surficial establishments and areas	NA	2 008 403	W
Reclamation of waste rock piles and their environment	NA	1 002 062	W
Reclamation of heap leaching piles and their environment	NA	1 898 967	W
Reclamation of tailings ponds and their environment	NA	8 236 914	W
Water treatment	NA	1 578 040	W
Reconstruction of electric network	NA	125 918	W
Reconstruction of water and sewage system	NA	100 043	W
Other infrastructural service	NA	518 002	W
Other activities including monitoring, staff, etc.	NA	2 245 217	W
Total	5 406 408	20 056 616	W

NA = Not available. W = Withheld.

After remediation of the uranium mining and ore processing legacy sites, the annual cost of long-term care activities amounts to some HUF 600-750 million (approximately USD 1.7-2.1 million in 2025 values).

Regulatory regime

In Hungary, mining activity is supervised and the licences for the entire territory of the country are issued by the Mining Authority, which is a division of the Supervisory Authority for Regulatory Affairs. There is no specific regulation dedicated to uranium mining; the general mining law applies to uranium ore production. In the past, the regional mining offices granted uranium exploration and production licences. Currently, the only way to obtain a new uranium exploration or production right (concession) is through public tendering, provided that the government decides to start such a procedure. In addition to the mining licence or concession, several other licences have to be obtained, such as environmental and land utilisation licences.

The mining companies, including uranium ore producers, must have financial guarantees supported by detailed expense calculations to cover the mine closure and decommissioning costs. The guarantees are checked and monitored by the Mining Authority.

Since uranium is nuclear material, the Mining Property Utilization Company (MPUC), based on HAEA Decree 4/2022 (IV. 29.) in the rules of accountancy for and control of nuclear materials, has the necessary safeguards licences issued by the Hungarian Atomic Energy Authority (HAEA), and fulfils its national and international reporting and data provision obligations to the HAEA, EURATOM and the IAEA. Data reported by the Company are verified by the safeguards inspectors of the HAEA, EURATOM and the IAEA, in the course of on-site inspections.

The MPUC also has the necessary physical protection licences regarding the usage, storage and transport of the nuclear material, based on Government Decree 190/2011 (IX. 19.) on physical protection requirements for various applications of atomic energy and the corresponding system of licensing, reporting and inspection.

Uranium requirements

In January 2020, the government approved the new National Energy Strategy 2030 and the National Energy and Climate Plan, and opted for the long-term maintenance of nuclear in the energy mix. In 2024, the MVM Paks Nuclear Power Plant Ltd. (Paks Nuclear Power Plant) generated 16 017 GWh electricity, which accounted for 47.1% of gross electricity generation and 34.6% of domestic electricity consumption. The 2023 Unit Capability Factors are as follows: Unit 1: 88.3%; Unit 2: 92.2%; Unit 3: 82.2%; Unit 4: 95.9%, with the average for the plant being 89.7%.

The licensing procedure for the lifetime extension of the Paks Nuclear Power Plant from 30 to 50 years has been fully completed. Preparations are underway to further extend the operating lifetime for 20 additional years. Regarding the two new units planned (units 5 and 6), the construction licence application was issued by the Hungarian Atomic Energy Authority (HAEA) on 25 August 2022. The site preparation activities are ongoing at the site.

National policies relating to uranium

Since the shutdown of the Hungarian uranium mining industry in 1997, there have been no uranium-related policies. The Energy Mineral Resources Utilisation and Stock Management Action Plan summarises the available Hungarian uranium resources. It concludes that if uranium ore mining is profitable, the government should consider partnerships with private investors in mining, through state-owned companies. However, there is at present no government measure or action planned to facilitate mining.

Uranium stocks

The by-product ($UO_4 \cdot 2H_2O$) of the water treatment activities at the former uranium mining and ore processing site (see the environmental activities above) is stored at the mine water treatment facility until export. 6 698 kgU was exported to France in June 2024. At the end of 2024, the inventory amounted to 2 430 kgU.

Uranium prices

Uranium prices are not available as they are commercially confidential.

Uranium exploration and development expenditures, and drilling effort – domestic

(EUR)

	2022	2023	2024	2025 (expected)
Private* exploration expenditures	NA	NA	0	0
Government exploration expenditures	0	0	0	0
Private* development expenditures	NA	NA	0	0
Government development expenditures	0	0	0	0
Total expenditures	NA	NA	0	0

* Non-government.

Inferred conventional resources by production method

(in situ tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	<USD 390/kgU	Recovery factor (%)
Underground mining (UG)	0	0	0	22 230	22 230	75*
Total	0	0	0	22 230	22 230	75*

* Estimated.

Inferred conventional resources by processing method

(in situ tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	<USD 390/kgU	Recovery factor (%)
Conventional from UG	0	0	0	22 230	22 230	75*
Total	0	0	0	22 230	22 230	75*

* Estimated.

Inferred conventional resources by deposit type

(in situ tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	<USD 390/kgU
Sandstone	0	0	0	22 230	22 230
Total	0	0	0	22 230	22 230

Prognosticated conventional resources

(in situ tonnes U)

Cost ranges			
<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	<USD 390/kgU
0	0	14 845	14 845

Historical uranium production by production method

(tonnes U in concentrates)

Production method	Total through end of 2022	2023	2024	Total through end of 2024	2025 (expected)
Underground mining*	21 000	0	0	21 000	0
Co-product/by-product	93	3	3	99	3
Total	21 093	3	3	21 099	3

* Pre-2018 totals may include uranium recovered by heap and in-place leaching.

Historical uranium production by processing method

(tonnes U in concentrates)

Processing method	Total through end of 2022	2023	2024	Total through end of 2024	2025 (expected)
Conventional	20 475	0	0	20 475	0
Heap leaching*	525	0	0	525	0
Other methods**	93	3	3	99	3
Total	21 093	3	3	21 099	3

* A subset of open-pit and underground mining, since it is used in conjunction with them.

** Includes mine water treatment and environmental restoration.

Historical uranium production by deposit type

(tonnes U in concentrates)

Deposit type	Total through end of 2022	2023	2024	Total through end of 2024	2025 (expected)
Sandstone	21 093	3	3	21 099	3
Total	21 093	3	3	21 099	3

Ownership of uranium production in 2024

Domestic				Foreign				Totals	
Government		Private		Government		Private			
(tU)	(%)	(tU)	(%)	(tU)	(%)	(tU)	(%)	(tU)	(%)
3	100	0	0	0	0	0	0	3	100

Uranium industry employment at existing production centres

(person-years)

	2022	2023	2024	2025 (expected)
Total employment related to existing production centres	NA	NA	NA	NA
Employment directly related to uranium production	NA	NA	NA	NA

Net nuclear electricity generation (TWh net)

	2023	2024
Nuclear electricity generated (TWh net)	15.92	16.02

Installed nuclear generating capacity to 2050

(MWe net)

2023	2024	2025		2030		2035		2040		2045		2050	
		Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
1 916	1 916	1 916	1 916	3 100	4 284	4 284	4 284	4 284	4 284	4 284	4 284	4 284	4 284

Annual reactor-related uranium requirements to 2040 (excluding MOX)

(tonnes U)

2023	2024	2025		2030		2035		2040		2045		2050	
		Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
317	318	417	417	569	802	802	802	802	802	802	802	802	802

Total uranium stocks

(tonnes natural U-equivalent)

Holder	Natural uranium stocks in concentrates	Enriched uranium stocks	Enrichment tails	LWR reprocessed uranium stocks	Total
Government	0	0	0	0	0
Producer	2	0	0	0	2
Utility	0	0	0	0	0
Total	2	0	0	0	2

India

Uranium exploration and mine development

Historical review

The history of exploration for atomic minerals, including uranium, in India dates back to the discovery of the occurrence of monazite-bearing black sand along the southern and south-western coast of India in 1909. The first report of uranium in India was in 1913, when an occurrence of gummite (altered uraninite) and a 36-pound pure uraninite nodule was discovered from a pegmatite at Bihar.

In India, exploration for uranium is carried out by the Atomic Minerals Directorate for Exploration and Research (AMD). The AMD emerged from a dedicated wing of the Geological Survey of India (GSI) named the Rare Minerals Survey Unit (RMSU) created during the Second World War (1939-1945). Subsequently, after the promulgation of the Atomic Energy Act and the constitution of the Atomic Energy Commission (AEC) in 1948, the RMSU was brought under the AEC during 1949.

The first extensive surveys for uranium began in 1949 in the Singhbhum Shear Zone (SSZ), Eastern India and the first exploratory drilling for uranium commenced in 1951 in Jaduguda in the SSZ. Until the mid-1970s, uranium exploration was mainly confined to uranium provinces in the SSZ, Jharkhand, and in the Umra-Udaisagar area in the Aravalli Fold Belt in Rajasthan, targeting vein-type mineralisation. This resulted in the discovery of 16 low-grade uranium deposits of varying sizes in the SSZ, Jharkhand, and one deposit at Umra, Rajasthan. Exploratory mining commenced in Jaduguda as well as in Umra in 1957. Seven out of the sixteen deposits in the SSZ are under exploitation. Exploration is currently being carried out in several sectors of the 200 km long SSZ, especially in the central and southern sectors.

The introduction of airborne surveys during the late 1950s was a boon to the exploration activities of AMD. India has been one of the pioneers in using airborne surveys for uranium exploration. AMD commenced airborne surveys in 1955 with an indigenously designed and developed total gamma-ray count system to cover large areas of the country.

Uranium exploration was expanded to other favourable geological domains, which resulted in establishing several small uranium deposits such as Bodal and Bhandaritola, Chhattisgarh, in Paleoproterozoic amphibolites; Jajawal, Chhattisgarh, in Paleoproterozoic sheared migmatites of the Chhotanagpur Granite Gneiss Complex; and Walkunji, Karnataka, in basal quartz-pebble conglomerates of the Dharwar Group. There was a paradigm shift in uranium exploration strategy in the 1970s and subsequently, the Proterozoic and Phanerozoic sedimentary basins contiguous to fertile granitoid-rich provinces became potential targets for exploration.

During the mid-1970s, exploration targeted sandstone-type uranium deposits. The exploration for sandstone-type uranium mineralisation resulted in the discovery of a high-grade, medium-tonnage deposit at Domiasiat (Kylleng-Pyndengsohiong-Mawthabah) in the Cretaceous sandstones of the Meghalaya. Exploration in contiguous sectors has established several small uranium deposits.

During the mid-1980s, a low-grade, stratabound deposit, hosted by dolostones of the Vempalle Formation, was established at Tummalapalle, Andhra Pradesh, in the Proterozoic Cuddapah Basin. Since the dolostone ore was not amenable to conventional leaching procedures in vogue at that time, exploration in this sector was discontinued. However, the development of an economically viable alkali pressure leaching process rejuvenated the exploration activities in the Vempalle Formation along the southern part of the Cuddapah Basin, targeting carbonate-hosted uranium mineralisation. Intensive multi-parametric exploration carried out in Tummalapalle and adjacent sectors, led to the identification of substantial uranium resources in the southern part of the Cuddapah Basin. The Tummalapalle uranium deposit is currently under exploitation.

During the early 1990s, a near-surface deposit was discovered adjacent to the unconformity contact between basement granites and the overlying Mesoproterozoic Srisailam Quartzite at Lambapur, Telangana (formerly Andhra Pradesh). These occurrences were investigated and several exploration areas were subsequently identified. Favourable geological criteria and sustained exploration efforts resulted in establishing deposits at Peddagattu and Chitrial along the unconformity contact between the basement granites and overlying quartzites of the Srisailam Formation. Exploration in the adjacent Palnad Sub-basin identified a small deposit at Koppunuru. Exploration is continuing in the Palnad Sub-basin.

Sustained exploration in the North Delhi Fold Belt (NDFB), in parts of Rajasthan and Haryana, targeting metasomatite type uranium mineralisation, led to the discovery of the Rohil uranium deposit, Rajasthan. Exploration is being carried out in various sectors of the ~300 km "Albitite Line" in Rajasthan and Haryana. Intensive exploration in adjacent sectors of Rohil established other deposits in Jahaz and Geratiyon Ki Dhani, Rajasthan. During the late 1990s, multi-parametric exploration in the Neoproterozoic Bhima Basin led to establishing a medium-grade and small tonnage uranium deposit in Gogi, Karnataka, hosted by brecciated limestone and granite along the Gogi-Kurlagare-Gundahalli fault, located in the southern part of the basin. Sustained exploration in this geological domain has established other uranium deposits in Kanchankayi and Hulkal.

Starting in the 2010s, AMD identified substantial uranium resources. Progressive advancement through adaptation of integrated multidisciplinary exploration techniques coupled with major thrust in high-resolution heliborne and ground-based geophysical data, exploration supported by state-of-the-art hydrostatic drilling rigs and analytical equipment, has facilitated systematic planning for future augmentation of uranium resource in favourable geological domains in the country.

Recent and ongoing uranium exploration, and mine development activities

In the past few years, exploration activities have been concentrated in the following areas:

- Proterozoic Cuddapah Basin, Andhra Pradesh and Telangana;
- Mesoproterozoic Singhbhum Shear Zone, Jharkhand;
- Mesoproterozoic North Delhi Fold Belt, Rajasthan and Haryana;
- Cretaceous Mahadek Basin, Meghalaya;
- Neoproterozoic Bhima Basin, Karnataka;
- Mesoproterozoic Kaladgi Basin, Karnataka;
- Proterozoic Aravalli Fold Belt, Rajasthan:
- Mesoproterozoic Chhotanagpur Granite Gneiss Complex, Uttar Pradesh, Madhya Pradesh, Chhattisgarh and Jharkhand state;
- Cenozoic Siwalik Group, Himachal Pradesh;
- Mesozoic Satpura Gondwana Basin, Madhya Pradesh;
- Other geological domains with potential are under active exploration such as the: basement fractures surrounding the southern part of Cuddapah Basin, Andhra Pradesh; Shillong Basin, Assam; basement crystalline terrain, Arunachal Pradesh; Vindhyan, Bijawar and Chhattisgarh basins, Uttar Pradesh, Madhya Pradesh, and Chhattisgarh states; Kotri-Dongargarh belt, Chhattisgarh;

- Extensive exploration, including ground and heliborne geophysical (ZTEM, TDEM, magnetic and radiometric), ground geological, radiometric and geochemical surveys, and drilling are planned in other geological domains of the country that have the potential to host uranium mineralisation.

Proterozoic Cuddapah Basin, Andhra Pradesh and Telangana

The Cuddapah Basin (Paleo- to Neoproterozoic) of the Dharwar Craton of Southern Peninsular India is one of the major uranium provinces hosting uranium mineralisation at various stratigraphic levels. Four types of uranium mineralisation/deposits have been identified in the Cuddapah Basin: carbonate, Proterozoic unconformity, sandstone and granite-related.

- Carbonate-type uranium deposits

The southern part of the Cuddapah Basin hosts a unique, low-grade and large-tonnage uranium deposit in the dolostones of the Vempalle Formation in the Tummalapalle-Rachakuntapalle sector. This formation occurs at the lower stratigraphic sequence of the Cuddapah Basin. Uranium mineralisation has been traced intermittently over a strike length of 160 km from Reddipalle in the north, to Maddimadugu in the south-east. The vast extent of the deposit, its stratabound nature hosted by phosphatic dolostone, and point-to-point correlation with nearly uniform grade and thickness of the mineralisation over considerable lengths along the strike and dip, make the deposit unique. Two ore lodes with an average thickness of 2.30 metres and 1.75 metres, separated by a lean/unmineralised band of 1-3.0 metres, are under active exploration at vertical depths up to 1 100 metres. Sustained exploration activities over the 21 km segment within the 160 km long belt have added substantial uranium resources. Intensive exploration in the eastern extension of the Tummalapalle-Rachakuntapalle sector has established sizeable ore blocks, named Rachakunatapalle East and Gidankivaripalle. Exploration is continuing in several sectors of the 21 km belt.

- Proterozoic unconformity-type uranium deposits

The northwestern margin of the Cuddapah Basin, comprising the Meso- to Neoproterozoic Srisailam and Palnad Sub-Basins, are known for their potential for Proterozoic unconformity-uranium deposits. Intensive exploration over the past few decades in the northern part of the Srisailam Sub-Basin had established three low-tonnage, low-grade uranium deposits named Lambapur, Peddagattu and Chitrial (subtype: stratiform fracture-controlled). Exploration efforts along the northern margin of the Palnad Sub-basin have resulted in locating a low-grade and low-tonnage deposit at Koppunuru. Sustained exploration is being continued in potential sectors having a similar lithostructural setup. Substantial dimensions of uranium mineralisation occurring close to the unconformity between the basement granite and Gulcheru quartzite have been established in the Kappatralla outlier. Besides, uranium mineralisation along the unconformity contact is also established in the Sarangapalli area in Palnad Sub-Basin, where the ore lode under active exploration transgresses the basement granite, quartzite and pebbly arenite of overlying Banganapalle Formation.

- Sandstone-type uranium deposits (mafic dykes/sills in Proterozoic sandstone subtype)

The Gulcheru quartzite of the Cuddapah Supergroup, overlying the basement granitoid in the southern parts of the Cuddapah Basin, are intensely fractured, faulted and intruded by east-west trending basic dykes. Uranium mineralisation is associated with the quartz-chlorite-breccia occurring along the contact between the Gulcheru quartzite and basic dykes.

- Granite-related type uranium mineralisation

The fracture systems within the crystalline basement, proximal to the southern and south-western margins of the Cuddapah Basin, are known to host uranium mineralisation and are currently under exploration (e.g. Madhavaram-Katimayakunta, Varikuntapalle, Kamaguttapalle-Kammapalle and Sivramapuram–Pincha).

Mesoproterozoic Singhbhum Shear Zone, Jharkhand

The Singhbhum Shear Zone (SSZ) is a 200 km long, arcuate belt of tectonised rocks fringing the northern boundary of the Singhbhum craton, along the contact with the Singhbhum Group rocks. Exploration efforts since the early 1950s led to the identification of several low-grade and low- to medium-tonnage metamorphite type uranium deposits, some of which are under active exploitation. The established uranium deposits are mainly located in the central and eastern sectors of the shear zone. Intensive exploration in various sectors in the SSZ has added significant resources to the uranium inventory. Notable among them are the Singridungri-Banadungri, Rajdah, Jaduguda North-Baglasai-Mechua, Bangurdih, Kanyaluka, Turamdih and Narwapahar sectors. Intensive exploration carried out for the polymetallic mineralisation, including uranium (U-Mg-Cr-Cu-Ni-Mo-Fe-REE), has led to resource augmentation in serpentinised peridotite (Proterozoic Iron Ore Group) hosted Kudada deposit in the central part of the SSZ.

Mesoproterozoic North Delhi Fold Belt of Rajasthan and Haryana

The metasediments of the North Delhi Fold Belt, comprising the Khetri, Alwar and Bayana-Lalsot Sub-Basins in the states of Rajasthan and Haryana, are the host to several uranium occurrences. The approximately 200 km long north-northeast to south-southwest (NNE-SSW) trending "Albitite Line" passing through the Delhi Supergroup and Banded Gneissic Complex is the site for extensive sodic metasomatism and holds great potential to host metasomatite-type uranium mineralisation. Integrated exploration including litho-structural, heliborne, and ground geophysics and drilling, resulted in the discovery of a fracture-controlled metasomatite-type uranium deposit near Rohil, Rajasthan. The entire "Albitite Line" holds immense potential for the discovery of additional uranium resources. Extensive ground and heliborne geophysical surveying and drilling have been carried out in several sectors along the "Albitite Line" for the delineation of metsomatite-type uranium mineralisation. This has resulted in establishing a small tonnage uranium deposit at Jahaz, Rajasthan. Further, these exploration efforts have resulted in establishing promising new sectors in Gumansingh-Ki-Dhani, Narsinghpuri and Hurra-Ki-Dhani, in the contiguous areas of Rohil, which have similar geological settings. More recently, low grade U-REE mineralisation associated with albitised metasediments, in the form of multiple steep dipping ore lodes with varying thickness, has been established in Geratiyon Ki Dhani, Rajasthan over a 1 200 metre strike length and 470 metres of depth. The deposit is being developed by systematic exploratory drilling.

Cretaceous Mahadek Basin, Meghalaya

The Upper Cretaceous Lower Mahadek Formation, exposed along the southern margin of the Shillong plateau, Meghalaya, is a potential host for sandstone-type uranium mineralisation. This geological domain has been under exploration since the late 1970s. Substantial exploration over the years led to the discovery of seven low- to medium-grade, low- to medium-tonnage, sandstone-type uranium deposits at Domiasiat, Wahkyn, Wahkut, Gomaghat, Tyrnai, Umthongkut and Lostoin.

Neoproterozoic Bhima Basin, Karnataka

The Bhima Basin comprises calcareous sediments with minor arenaceous lithostratigraphic units of the Bhima Group, which were deposited over basement granite and have been affected by several east-west trending faults. A small-size, medium-grade, granite-related uranium deposit has been established at Gogi along the Gogi-Kurlagare-Gundahalli fault. Intensive multi-parametric exploration also established another deposit at Kanchankayi, Karnataka, adjacent to the Gogi uranium deposit. Current exploration efforts are concentrated in the east of Kanchankayi sector, around Hulkal, along the north-eastern extensions of the Gogi uranium deposit.

Palaeozoic – Mesozoic Satpura Gondwana Basin, Madhya Pradesh

The Gondwana sedimentary basins of India comprise a suitable environment for hosting sandstone-type uranium mineralisation. The lower Motur Formation of the Satpura Gondwana Basin of Central India has been identified as the potential geological domain for hosting sandstone-type uranium mineralisation. Extensive surface and subsurface exploration in the

Motur Formation has delineated significant uranium mineralisation in the Dharangmau – Kachhar sector.

Mesoproterozoic Kaladgi Basin, Karnataka

The east-west trending Meso-Neoproterozoic Kaladgi Basin is located on the northwestern margin of the western Dharwar Craton. The unmetamorphosed sediments of the Kaladgi Supergroup overlie the basement granitoids and Chitradurga schists. The northern and western extensions of the basin are covered by the Deccan Traps. The basement is comprised of schist belts with slivers of graphite-bearing meta-pelites and granites with associated tectonism. Significant surface uranium mineralisation, over a considerable extent hosted by arenites, has been identified near Deshnur. Subsurface exploration in the western part of the Kaladgi Basin led to the emergence of another prospective sector in the Suldhal-Gujanal-Malarmardi area, where Proterozoic unconformity type uranium mineralisation is hosted by the lower conglomerate, basal arenite and basement schist, close to the unconformity.

Mesoproterozoic Chhotanagpur Granite Gneiss Complex (CGGC), Uttar Pradesh, Madhya Pradesh and Jharkhand

The Chhotanagpur Granite Gneiss Complex (CGGC) forms part of the prominent Mesoproterozoic linear mobile belt in East and Central India, lying between the Narmada-Son-Brahmaputra lineaments designated as the "Central Indian Tectonic Zone" (CITZ) in the North and the Central Indian Suture (CIS) to the south. The CGGC hosts a thick pile of arkosic to psammo-pelitic metasediments that has undergone multiple phases of tectonic, plutonic, thermal and metamorphic events, which resulted in the extensive development of migmatites. The exposed rocks include banded gneisses and metasedimentary enclaves, overlain by the Mahakoshal supracrustals and sediments of the Vindhyan Supergroup in the north, and by Gondwana Supergroup in the south. Uranium mineralisation within migmatites is hosted by varied lithological units spread over a large area (350 km^2) in the Son valley crystallines, in the north-western part of the CGGC. Intensive exploration is being carried out for metamorphite-type uranium deposit in potential blocks at Kudar, Anjangira, Chundi, Jhapar, Kurludih and where the host rock is essentially an albite-rich pegmatoid leucosome mobilizate (PLM).

Cenozoic Siwalik Basin, Himachal Pradesh

The Siwalik Group constitutes a thick sequence of molasse deposits laid down in a long, narrow fore-deep, formed to the south of the rising Himalayas during the Middle Miocene to the Pleistocene. The sediments are traceable in India from Jammu in the west to the Brahmaputra Valley in the east. Multi-parametric exploration has helped in identifying numerous sandstone type uranium occurrences, spread over the entire Siwalik belt between Poonch (Jammu and Kashmir) in the west and Tanakpur (Uttar Pradesh) in the east. More than 350 uranium occurrences forming eight major clusters have been identified. The majority of these occurrences are confined to three distinct stratigraphic horizons: 1) lower part of Upper Siwaliks; 2) upper part of Middle Siwaliks; and 3) upper part of Lower Siwaliks. The important uranium zones identified are: 1) Maler in Jammu and Kashmir; 2) Astotha-Khya-Loharian; 3) Galot-Andalada–Sibal-Loharkar; 4) Rajpura-Polian; 5) Romehra in Himachal Pradesh; 6) Morni-Nathai in Haryana; 7) Naugajiya Rao-Sanbarsot-Sakhumbari Rao; and 8) Kathaul-Danaur-Kholgarh in Uttarakhand and Uttar Pradesh. Among these, the Rajpura-Polian and Sibal-Loharkar sectors, Himachal Pradesh, where sandstone type uranium mineralisation is hosted by sediments of the upper part of Middle Siwalik, are under active exploration.

Proterozoic Aravalli Fold Belt, Rajasthan

The Aravalli Supergroup (ASG) occupies the eastern part of the Aravalli Mountain Range from Nathdwara in the north to Champaner in the south, over a distance of approximately 350 km with a width varying from 40 km to 150 km. It has an arcuate form with a northeast-southwest trend in the north, north-south in Udaipur and northwest-southeast in the south. The ASG can be divided into two distinct sedimentary facies: (1) the shelf facies, comprising mafic volcanic, coarse clastics and carbonates accumulated in the epicontinental sea along the pericontinental slope, and (2) the carbonate-free deep-sea facies, comprising dominantly metapelites with bands of quartzite. The ASG has undergone polyphase deformation and witnessed three main events of magmatism. The Aravalli Fold Belt is known for its uranium metallogeny of different styles, among which metamorphite type uranium mineralisation associated with carbon phyllite is the most promising. Several anomalies have been located at the Umra, Udaisagar, Kalamagra, Haldughati, Sukher, Oda-Kevda and Undwala areas. Multi-parametric exploration is ongoing in the Umra area.

Uranium resources

Identified conventional resources (reasonably assured and inferred resources)

India's known conventional in situ uranium resources (reasonably assured and inferred resources) are estimated to be 363 198 tU (in situ), hosted in the following deposit types:

Deposit type	In situ resource (tU)	Proportion of deposits
Carbonate	213 067	58 %
Metamorphite	91 311	25 %
Sandstone	20 528	6%
Proterozoic Unconformity	18 072	5%
Metasomatite	13 711	4%
Granite-related	6 157	2%
Paleo-quartz-pebble-conglomerate	352	<1%
Total	363 198	100%

As of 1 January 2025, the known conventional in situ resources included 351 715 tU of reasonably assured resources (RAR) and 11 483 tU of inferred resources (IR). This amounts to a substantial increase in RAR, compared to what was reported for the Red Book 2024 (324 529 tU). These changes are mainly due to appreciable resource additions in the contiguous area of the stratabound carbonate type deposit in the southern part of the Cuddapah Basin, the extension areas of known metamorphite type deposits in the Singhbhum Shear Zone and metasomatite type deposits in the North Delhi Fold Belt. Inferred resources also increased, compared to what was reported in 2024 (10 466 tU).

Undiscovered conventional resources (prognosticated and speculative resources)

In parts of Andhra Pradesh, Rajasthan, Jharkhand and Karnataka, potential areas for uranium resources were re-evaluated. As of 1 January 2025, undiscovered in situ resource estimates are 148 400 tU under the prognosticated category, which is a modest increase from the 144 160 tU reported in the last edition of the Red Book, while the speculative category remains unchanged at 59 360 tU.

Uranium production

Historical review

The Uranium Corporation of India Ltd. (UCIL) was formed in October 1967, under the administrative control of the Department of Atomic Energy, Government of India. The UCIL operates six underground uranium mines (Jaduguda, Bhatin, Narwapahar, Turamdih, Bagjata and Mohuldih) and one open-pit mine (Banduhurang) in the multi-metal mineralised Singhbhum

Shear Zone located in the Singhbhum East district of Jharkhand state. The ore produced from the mines is processed in two processing plants located at Jaduguda and Turamdih. In addition to these, UCIL has also constructed a uranium mine and a processing plant in the YSR district (formerly Kadapa) of Andhra Pradesh.

Status of production facilities, production capability, recent and ongoing activities, and other issues

The total installed capacity of UCIL's three operating production plants is as follows:

- Jaduguda Plant: 2 500 t ore/day;
- Turamdih Plant: 3 000 t ore/day;
- Tummalapalle Plant: 3 000 t ore/day.

Recent and ongoing activities

Jaduguda mine

The Jaduguda uranium deposit lies within the metasediments of the Singhbhum Shear Zone. The host rocks are of Proterozoic age. There are two prominent parallel ore lenses: the Footwall lode (FWL) and the Hangingwall lode (HWL). These lodes are separated by a 100-metre barren zone. The FWL extends over a strike length of about 600 metres in a southeast to northwest direction. The strike length of HWL is about 250 metres and is confined to the eastern part of the deposit. Both the lodes have an average dip of 40 degrees towards the northeast. Of the two lodes, the FWL is better mineralised. The Jaduguda deposit has been explored up to a depth of 880 metres.

Entry to the mine is through a 640-metre-deep vertical shaft. An underground auxiliary vertical shaft, sunk from 555 metres to 905 metres, provides access to deeper levels. The cut-and-fill stoping method is practised, resulting in about 80% ore recovery. De-slimed mill tailings are used as backfill material. Ore is hoisted by skip, in stages, through shafts to surface and sent to the Jaduguda mill by conveyor for further processing.

Bhatin mine

The Bhatin uranium deposit is located 4 km northwest of Jaduguda. A major strike-slip fault lies between the Jaduguda and Bhatin deposits. Both deposits lie in similar geological settings. The Bhatin mine began production in 1986. The ore lens has a thickness of 2 to 10 m with an average dip of 35 degrees and entry to the mine is through an adit, with deeper levels accessed by inclines. Cut-and-fill stoping is practised and deslimed mill tailings from the Jaduguda mill are used as backfill. Broken ore is transported to the Jaduguda mill.

Narwapahar mine

The Narwapahar mine (about 12 km west of Jaduguda) has been operating since 1995. In this deposit, discrete uraninite grains occur within chlorite-quartz schist with associated magnetite, with several lenticular-shaped ore lenses extending over a strike length of about 2 100 metres, each with an average northeasterly dip of 30 to 40 degrees. The thickness of the individual ore lenses varies from 2.5 to 20 metres. The deposit is accessed by a 355-metre-deep vertical shaft and a 7-degree decline from the surface. Cut-and-fill stoping is practised using deslimed mill tailings of the Jaduguda plant as backfill. Ore is transported to the Jaduguda plant for processing.

Turamdih mine

The Turamdih deposit is located about 12 km west of Narwapahar. Discrete uraninite grains within feldspathic-chlorite schist form a series of ore lenses with a very erratic configuration. The mine was commissioned in 2003, and three levels (70 m, 100 m and 140 m depth) have been accessed through an 8-degree decline from surface and a vertical shaft has been sunk to provide access to deeper levels. Ore from this mine is processed at the Turamdih plant. Cut-and-fill stoping is practised using deslimed mill tailings of the Turamdih plant as backfill.

Bagjata mine

The Bagjata deposit, situated about 26 km east of Jaduguda, has been developed as an underground mine with a 7-degree decline for entry and a vertical shaft to access deeper levels. This mine was commissioned in 2008. Ore from the Bagjata mine is transported by road to the Jaduguda plant for processing. Cut-and-fill stoping is practised in the Bagjata mine and deslimed mill tailings from the Jaduguda mill are used as backfill.

Banduhurang mine

The Banduhurang deposit has been developed as a large, open-pit mine. The ore body is the western extension of ore lenses at Turamdih. The mine was commissioned in 2008 and ore is transported by road to the Turamdih plant for processing.

Mohuldih mine

The Mohuldih deposit is located in the Seraikela-Kharswan district of Jharkhand, about 2.5 km west of Banduhurang. The mine was commissioned in 2015. The ore from this mine is treated at the Turamdih plant.

Tummalapalle mine

Hosted in carbonate rock, this deposit is located in the YSR district (formerly Kadapa) of Andhra Pradesh. It is the first uranium production centre in the country located outside Jharkhand. This underground mine is accessible by three declines along the apparent dip of the ore body. The central decline is equipped with a conveyor for ore transport, and the other two declines are used as service paths. The ore is treated in the plant adjacent to the mine at Tummalapalle. The expansion of the mine and processing plant at Tummalapalle has been planned to augment uranium production.

Jaduguda mill

Ore produced at the Jaduguda, Bhatin, Narwapahar and Bagjata mines is processed in the mill located at Jaduguda. Commissioned in 1968, the mill capacity is about 2 500 t/day of dry ore. Following crushing and grinding (to 60 % passing 200 mesh), the ore is leached in pachuca tanks using sulphuric acid under controlled pH and temperature. After filtration of the pulp, ion-exchange resin is used to recover the uranium. After elution, the product is precipitated using hydrogen peroxide to produce uranium peroxide as a final product, containing about 88 % U_3O_8. The treatment of mine water and reclaiming of tailings water has resulted in reduced freshwater requirements and increased purity of the final effluent. A magnetite recovery plant is also in operation at Jaduguda, producing very fine-grained magnetite as a by-product.

Turamdih mill

Uranium ore from the Turamdih, Mohuldih and Banduhurang mines is being processed in the Turamdih mill. The mill, commissioned in 2009, can process about 3 000 t/day dry ore. The plant adopts similar processing technology as that of Jaduguda. Presently, this plant produces uranium peroxide as the final product.

Tummalapalle mill

The uranium processing plant at Tummalapalle in the YSR district (formerly Kadapa) of Andhra Pradesh is based on indigenously developed alkali leaching (under high temperature and pressure) technology. The plant was put into regular operation after capitalisation in January 2017 to process 3 000 t/day ore. Presently, this plant produces yellow cake as the final product.

Uranium production centre technical details

	Centre #1	Centre #2	Centre #3	Centre #4	Centre #5	Centre #6	Centre #7	Centre #8
Name of production centre	Jaduguda	Bhatin	Narwapahar	Bagjata	Turamdih	Banduhurang	Mohuldih	Tummalapalle
Production centre classification	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
Start-up date	1967	1986	1995	2008	2003	2008	2015	2017
Source of ore:	Uranium ore	Uranium ore	Uranium ore	Uranium ore	Uranium ore	Uranium ore	Uranium ore	Uranium ore
Deposit name(s)	Jaduguda	Bhatin	Narwapahar	Bagjata	Turamdih	Banduhurang	Mohuldih	Tummalapalle
Deposit type(s)	Metamorphite	Metamorphite	Metamorphite	Metamorphite	Metamorph.	Metamorphite	Metamorphite	Carbonate (Strata bound)
Resources (tU)	-	-	-	-	-	-	-	-
Grade (% U)	-	-	-	-	-	-	-	-
Mining operation:								
Type (OP/UG/ISL)	UG	UG	UG	UG	UG	OP	UG	UG
Size (tonnes ore/day)	542	250	1 000	500	750	3 500	500	3 000
Average mining recovery (%)	-	-	-	-	-	-	-	-
Processing plant:	Jaduguda				Turamdih			Tummalapalle
Type (IX/SX/AL)	IX/AL				IX/AL			ALKPL*
Size (tonnes ore/day)	2 500				3 000			3 000
Average process recovery (%)	-				-			-
Nominal production capacity (tU/year)	-				-			-
Plans for expansion	Narwapahar Deeper lode expansion				Construction of New Mill at Turamdih, Expansion of Turamdih Mine, Expansion of Banduhurang (West) Opencast Mine			Expansion of Tummalapalle Mine and construction of new Mill.
Other remarks	Ore being processed in Jaduguda plant				Ore being processed in Turamdih plant			Ore being processed in Tummalapalle plant

* Pressurised alkali leach.

Ownership structure of the uranium industry

In India, uranium prospecting/exploration and mining are carried out exclusively by the central government. The uranium industry is wholly owned by the Department of Atomic Energy, Government of India. The Atomic Minerals Directorate for Exploration and Research under the Department of Atomic Energy is responsible for uranium exploration programmes in India. Following the discovery and deposit delineation, economic viability is evaluated. The evaluation stage may also include exploratory mining. Once a deposit of sufficient tonnage and grade is established, UCIL initiates activities for commercial mining and production of uranium concentrates.

Employment in the uranium industry

As of 1 July 2025, about 4 137 people were engaged in uranium mining and milling activities.

Future production centres

AMD has discovered Rohil uranium deposit in Sikar district of Rajasthan. The site is 120 km northwest of Jaipur, in the state of Rajasthan. UCIL plans to establish a uranium mine and uranium ore processing plant at Rohil (Rajasthan) by 2030. UCIL has taken up pre-project activities for construction of the new mine and plant at Rohil.

Exploratory mining activities have been initiated. The development of Decline Phase-V through exploratory mining has been completed. The total length of decline developed to date is 575 metres and a vertical depth of about 82 metres. The proposed Phase-VI of decline development through exploratory mining comprises development up to the 1st level (i.e. 381.5 m RL), crosscut to intercept the ore body, drive in the ore body and a 1.5 metre diameter Ventilation borehole, which will facilitate drawing the bulk ore sample.

Environmental activities and socio-cultural issues

There are no environmental issues related to the existing uranium mines and processing plants operated by UCIL. However, provisions are made for the management of environmental impacts. The organisation responsible for this task is the Health Physics Group of the Bhabha Atomic Research Centre, located in Mumbai. It carries out environmental health monitoring for radiation, radon and dust at uranium production facilities. The Health Physics Unit operates the Environmental Survey Laboratory at Jaduguda and has establishments at all operating facilities.

Regulatory regime

In India, all nuclear activities, including mining and processing of uranium and thorium, fall under the purview of the central government and are governed by the Atomic Energy Act, 1962 (AE Act), and the rules made thereunder. The Department of Atomic Energy (DAE) oversees the development and mining of uranium, including the administration and regulation of atomic minerals notified under the Mines and Minerals (Development and Regulation) Act of 1957 (MMDR Act, 1957). Accordingly, policies of the DAE and provisions of the AE Act, and rules framed thereunder, play a key role in the prospecting, exploration and mining of uranium. The exploration and mining of uranium are governed under the provisions of the MMDR Act, 1957, as well as the rules made thereunder (i.e. Atomic Minerals Concession Rules (AMCR), 2016, and Mineral Conservation and Development Rules (MCDR), 2017). In addition, all mining activities must comply with environmental regulations and the provisions of the Mines Act, 1952. The mining, milling and processing of uranium ore require a licence under the Atomic Energy (Working of the Mines, Minerals and Handling of Prescribed Substances) Rules, 1984, and the Atomic Energy Radiation Protection Rules, 2004, wherein the procedural details for obtaining a licence and conditions of the licence have been notified.

A mining lease for uranium is granted by the state government after the mining plan is approved by the AMD as per the provisions of the MMDR Act. The Atomic Energy Regulatory Board (AERB), an independent authority, regulates the safety and other regulatory provisions under the AE Act and ensures the safety of workers, the public and the environment with respect to the radiological aspects. The AERB oversees various aspects of mining and processing of atomic minerals that are required to conform to radiological safety, siting of the mill, disposal of tailings and other waste rocks, as well as decommissioning the facility. The commissioning, operating and decommissioning of a uranium mine require compliance with the provisions under different legislation and regulations.

Uranium requirements

As of 1 January 2025, the total installed nuclear capacity in India was 8 180 MWe (gross), which comprises 20 pressurised heavy water reactors, two boiling water reactors and two light-water reactors.

Construction/commissioning of four pressurised heavy water reactors (Rajasthan Atomic Power Project 7 and 8: 2 x 700 MWe and Gorakhpur Haryana Anu Vidyut Pariyojana GHAVP 1&2: 2 X 700 MWe), four light water reactors (Kudankulam Nuclear Power Project Units 3 and 4: 2 X 1 000 MWe and Kudankulam Nuclear Power Project Units 5 and 6: 2 X 1 000 MWe) and one prototype fast breeder (500 MWe), are in progress.

Annual uranium requirements in 2025 amounted to about 1 650 tU and this would increase in tandem with increases in installed nuclear capacity.

Current domestic identified conventional uranium resources are sufficient to support 10-15 GWe installed capacity of pressurised heavy water reactors operating at a lifetime capacity factor of 80% for 40 years.

With international co-operation in peaceful nuclear energy, installed nuclear generating capacity is expected to grow significantly as more international projects are envisaged. However, the exact size of the programme, based on technical co-operation with other countries, will emerge as the projects are sanctioned progressively.

India has embarked upon an ambitious nuclear energy mission to reach a nuclear power capacity of 100 GWe by 2047, to be achieved by deploying reactors based on both indigenous technologies and with foreign co-operation. This would call for a massive increase in fuel requirements along the order of 20 000 tU per annum.

Supply and procurement strategy

Uranium requirements for pressurised heavy water reactors are being met with a combination of domestic and imported sources. Two operating boiling water reactors and two light-water reactors of VVER-type require enriched uranium and are fuelled by imported uranium. Future light-water reactors will also be fuelled by imported uranium. Regarding reactors to be set up in the future, based on both indigenous technologies and with foreign co-operation, the source of fuel for each of the reactors will be decided by the Government of India.

Uranium policies, uranium stocks and uranium prices

National policies relating to uranium

Uranium exploration, mining, production, fuel fabrication and the operation of nuclear power reactors, are controlled by the Government of India. National policies relating to uranium are governed by the Atomic Energy Act 1962 and MMDR Act 1957, and the provisions made thereunder.

Imported light-water reactors to be built in the future will be purchased with an assured fuel supply for the lifetime of the reactor.

Uranium exploration and development expenditures, and drilling effort – domestic

(Indian rupee millions)

	2022	2023	2024	2025 (expected)
Government exploration expenditures	5 263	4 948	4 437	4 950
Total expenditures	5 263	4 948	4 437	4 950
Government exploration drilling (m)	395 783	264 767	157 313	205 900
Total drilling (m)	395 783	264 767	157 313	205 900

Reasonably assured conventional resources by production method

(in situ tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	Cost range unassigned
Underground mining (UG)	NA	NA	NA	328 574
Open-pit mining (OP)	NA	NA	NA	23 141
Total	NA	NA	NA	351 715

Reasonably assured conventional resources by processing method

(in situ tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	Cost range unassigned
Conventional from UG	NA	NA	NA	328 574
Conventional from OP	NA	NA	NA	23 141
Total	NA	NA	NA	351 715

Reasonably assured conventional resources by deposit type

(in situ tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	Cost range unassigned
Proterozoic unconformity	NA	NA	NA	18 072
Sandstone	NA	NA	NA	17 638
Granite-related	NA	NA	NA	6 157
Metamorphite	NA	NA	NA	83 070
Metasomatite	NA	NA	NA	13 711
Carbonate	NA	NA	NA	213 067
Total	NA	NA	NA	351 715

Inferred conventional resources by production method

(in situ tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	Cost range unassigned
Underground mining (UG)	NA	NA	NA	9 389
Open-pit mining (OP)	NA	NA	NA	2 094
Total	NA	NA	NA	11 483

Inferred conventional resources by processing method

(in situ tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	Cost range unassigned
Conventional from UG	NA	NA	NA	9 389
Conventional from OP	NA	NA	NA	2 094
Total	NA	NA	NA	11 483

Inferred conventional resources by deposit type

(in situ tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	Cost range unassigned
Sandstone	NA	NA	NA	2 890
Paleo quartz-pebble-conglomerate	NA	NA	NA	352
Metamorphite	NA	NA	NA	8 241
Total	NA	NA	NA	11 483

Prognosticated conventional resources

(in situ tonnes U)

Cost ranges		
<USD 80/kgU	<USD 130/kgU	Cost range unassigned
NA	NA	148 400

Speculative conventional resources

(in situ tonnes U)

Cost ranges		
<USD 130/kgU	<USD 260/kgU	Unassigned
NA	NA	59 360

Historical uranium production by production method

(tonnes U in concentrate)

Production method	Total through end of 2022	2023	2024	Total through end of 2024	2025 (expected)
Open-pit mining[1]	NA	NA	NA	NA	NA
Underground mining[1]	NA	NA	NA	NA	NA
Total	NA	NA	NA	NA	NA

1. Pre-2020 totals may include uranium recovered by heap and in-place leaching.

Historical uranium production by processing method

(tonnes U in concentrate)

Processing method	Total through end of 2022	2023	2024	Total through end of 2024	2025 (expected)
Conventional	NA	NA	NA	NA	NA
Total	NA	NA	NA	NA	NA

Historical uranium production by deposit type

(tonnes U in concentrate)

Deposit type	Total through end of 2022	2023	2024	Total through end of 2024	2025 (expected)
Metamorphite	NA	NA	NA	NA	NA
Carbonate	NA	NA	NA	NA	NA
Total	NA	NA	NA	NA	NA

Ownership of uranium production in 2024

Domestic				Foreign				Totals	
Government		Private		Government		Private			
(tU)	(%)	(tU)	(%)	(tU)	(%)	(tU)	(%)	(tU)	(%)
NA	100	NA	NA	NA	NA	NA	NA	NA	100

Uranium industry employment at existing production centres

(person-years)

	2022	2023	2024	2025 (expected)
Total employment related to existing production centres	4 456	4 456	4 352	4 223
Employment directly related to uranium production	NA	NA	NA	NA

Mid-term production projection (tonnes U/year)

2025	2030	2035	2040	2045	2050
NA	NA	NA	NA	NA	NA

Mid-term production capability (tonnes U/year)

2025				2030			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
NA				NA			

2035				2040			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
NA				NA			

2045				2050			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
NA				NA			

Net nuclear electricity generation

	2023	2024
Nuclear electricity generated (TWh gross)	48.24	54.71

Installed nuclear generating capacity to 2050

(MWe gross)

2023	2024	2025		2030		2035		2040		2045		2050	
		Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
7 480	8 180	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Annual reactor-related uranium requirements to 2050 (excluding MOX)

(tonnes U)

2023	2024	2025		2030		2035		2040		2045		2050	
		Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
1 500	1 650	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Indonesia

Uranium exploration and mine development

Historical review

Uranium exploration, conducted by the National Nuclear Energy Agency of Indonesia (BATAN), started in the 1960s. At the end of 2021, BATAN merged with other research agencies to form the National Research and Innovation Agency (BRIN). Exploration continues in co-operation with the Geological Agency of the Ministry of Energy and Mineral Resources of Indonesia.

Three uranium deposit localities have been identified in Indonesia. The West Kalimantan uranium deposits (Kalan deposits) were discovered in 1973. The North Sumatra uranium deposits (Sibolga deposits) were discovered in 1980, and the West Sulawesi uranium deposits (Mamuju deposits) were discovered in 2013. From 1981 to 1991, pilot-scale mining and processing experiments were conducted at the Kalan deposit, with a plant capacity of two tonnes of ore per day. The pilot test of 964 tonnes of ore (1 000 ppm U) yielded 740.5 kg of yellowcake (U in yellowcake 60%) via solvent extraction. Environmental remediation of the plant site is ongoing (2020). The Kalan metamorphite deposit type uranium mineralisation consists of uraninite (tourmaline-sulphide association) in veins in schistose metapelites, metasiltstones and quartzites derived from a Cretaceous protolith, with thermal metamorphism associated with the intrusion of younger granites. Centimetre-to-decimetre-scale uranium-mineralised veins exhibit lithological controls, with mineralisation mobilised along schistosity planes, and tectonic controls, where mineralisation on schistosity planes has been remobilised into open, cross-cutting, younger faults and breccias. Mineralised intersections range up to 1.4 metres in thickness with a maximum grade of up to 0.28% U from the Kalan test mining tunnel. The Mamuju deposits occur in tertiary alkaline volcanic rocks. The Sibolga deposits occur in tertiary sandstones with uranium enrichments associated with black shales.

By 1996, reconnaissance surveys had covered 79% of the 533 000 km^2 identified for surveying, based on favourable geological criteria and promising exploration results. Since that year, exploration activities have focussed on Kalimantan, where the most significant indications of uranium mineralisation have been found. During 1998-1999, exploration consisted of systematic geological and radiometric mapping, including a radon survey carried out at Tanah Merah and Mentawa, Kalimantan, to delineate the mineralised zone. The results of those activities increased speculative resource estimates by 4 090 tU to 12 481 tU. From 2000 to 2002, exploration drilling was conducted at the upper Rirang (178 m), Rabau (115 m), and Tanah Merah (181 m) in West Kalimantan.

In 2003-2004, additional exploration drilling was conducted at Jumbang 1 (186 m) and Jumbang 2 (227 m). In 2005, exploration drilling was carried out at Jumbang 3 (45 m) and Mentawa (45 m); in 2006, at Semut (454 m) and Mentawa (45 m); and in 2007, at Semut (174 m). In 2008, no exploration drilling was undertaken.

In 2009, exploration drilling continued in the Kalan Area, and detailed, systematic prospecting was carried out in the Kawat area and its surroundings. General prospecting in the Bangka Belitung Province was also undertaken. Plans were adopted to expand exploration in Kalimantan and Sumatra, progressing from general reconnaissance to systematic stages to identify new uranium deposits. In 2010, efforts focussed on evaluating drilling data from the Kawat sector to re-evaluate estimates of speculative resources.

Uranium and thorium exploration in 2015 continued in the Mamuju area, West Sulawesi Province (alkaline volcanic-hosted mineralisation), and in the Ella Ilir area, West Kalimantan Province. In the Mamuju area, detailed ground radiometric mapping was conducted in the Takandeang, Taan, Ahu, Pangasaan and Hulu Mamuju sectors. Geophysical resistivity and induced polarisation surveys conducted in the Botteng and Takandeang sectors were followed by reconnaissance drilling to a total depth of 1 600 m, comprising 570 m in the Botteng sector, 830 m in the Takandeang sector, and 200 m in the Taan sector. Drilling targets were anomalous uranium occurring as stratabound and supergene enrichment in volcanic deposits. Exploration in the Ella Ilir area included geological and radiometric mapping and reconnaissance drilling to a total depth of 400 m. The drilling in this area focussed on uranium veins in schistose metapelite and metatuff.

In 2021, exploration activities were conducted in the Mamuju, Bangka Island and Melawi regions. The focus of exploration was on the southern Mamuju anomalous region and on geological radiometric-geomagnetic mapping conducted in Rantedoda. The exploration focussed on identifying the continuation of uranium deposits near the rim of the volcanic complex. Several uranium anomalies were identified and are related to stratabound volcanic horizons, hydrothermal alteration, and reductive sediment. In Bangka Island, a more detailed grid-based radon survey was conducted over the paleo-placer target, with petrographic and geochemical analyses used to confirm the deposit. In the Melawi region, radiometric and radon gas mapping were conducted to evaluate the potential for uranium deposits in a sedimentary basin.

In 2022, uranium exploration activities were conducted in co-operation with the Ministry of Energy and Mineral Resources to delineate potential rare-earth element mining areas in Melawi and Mamuju. In Melawi, exploration involved sampling laterite soils to assess the potential for uranium enrichment in the surrounding, known rare-earth placer boulder deposit at Rirang-Kalan. A review of uranium metallogeny in the Kalan basin was also conducted by sampling all primary uranium sectors, followed by laboratory analysis (XRF and Micro XRF). Also in the Melawi area, exploration was conducted at Ella Hilir, a metamorphic uranium deposit, to evaluate the potential for rare earth elements. In Mamuju, a semi-detailed, core-drilling campaign was conducted to explore for possible uranium and rare-earth element enrichment in the laterite zone of an alkaline rock. Twelve holes were drilled to a depth of 50 m, with a drill-hole spacing of 300 m. ICP-MS laboratory analysis was performed on all systematic drill-core samples, and micro-XRF scanning was used to confirm mineralisation. A further resource estimate will also be conducted in the exploration area.

Recent and ongoing uranium exploration, and mine development activities

No uranium exploration activities were conducted in 2023 and 2024. To date, no mining activity is being considered.

Identified conventional resources (reasonably assured and inferred resources)

In situ measured and indicated resources amount to 7 391 tU (<USD 130/kgU) and the total in situ inferred resources are 4 065 tU (<USD 130/kgU). Inferred resources include those from the following localities: Mamuju (2 998 tU); Taan (431 tU); Takandeang, including Salumati (165 tU) and Rantedunia (56 tU); and Aloban, including Sibolga (415 tU).

The Kalan Area comprises a number of sectors with uranium potential: Remaja, Lembah Hitam, Lemajung, Semut, Rirang, Rabau Hulu, Sarana, Tanah Merah, Amir Engkala, Jeronang, Jumbang, Ketungau, Parembang Kanan, Ririt, Dendang Arai, Bubu, and Kayu Ara. Until 2018, Indonesia had reported 2 029 tU as a measured resource from the Remaja and Lembah Hitam Sectors for the Red Book.

Undiscovered conventional resources (prognosticated and speculative resources)

Total undiscovered prognosticated and speculative resources amount to 37 292 tU. The undiscovered resources in the Kalan, Kawat, Mentawa, and Mamuju areas are 30 179 tU and are classified as prognosticated resources. Additions to the speculative resources for the Mamuju area include the Hulu Mamuju Sector in 2019 (1 096 tU) and the Ampalas Sector in 2020 (6 017 tU).

Unconventional resources and other materials

The uranium resource potential in the Bangka and Belitung areas comprise placer deposits of monazite within a tin deposit. Monazite, a uranium/thorium phosphate mineral, was deposited in the alluvium and has mostly accumulated as a tailings by-product material of tin mining. The resources from deposits on the Bangka and Belitung Islands total 25 236 tU. In Singkep, the uranium potential is in lateritic soil, with a resource of 1 100 tU. In Semelangan (West Kalimantan), uranium occurs in lateritic bauxite deposits, with resources of 624 tU. In Katingan (Central Kalimantan), monazite is a by-product of zircon mining, with resources of 485 tU. Total unconventional resources are 27 445 tU.

Uranium exploration and development expenditures, and drilling effort – domestic

(Indonesian rupiah [IDR])

	2022	2023	2024	2025 (expected)
Government exploration expenditures	2 500 000 000	0	0	0
Total expenditures	2 500 000 000	0	0	0
Government exploration drilling (m)	600	0	0	0
Government exploration holes drilled	12	0	0	0
Total drilling (m)	600	0	0	0
Total number of holes drilled	12	0	0	0

Reasonably assured conventional resources by production method

(in situ tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining (UG)	0	2 029	7 391	7 391	75
Total	0	2 029	7 391	7 391	75

Reasonably assured conventional resources by processing method

(in situ tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional from UG	0	2 029	7 391	7 391	75
Total	0	2 029	7 391	7 391	75

Reasonably assured conventional resources by deposit type

(in situ tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Metamorphite	0	2 029	7 391	7 391
Total	0	2 029	7 391	7 391

Inferred conventional resources by production method

(in situ tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining (UG)	0	0	2 998	2 998	75
Unspecified	0	0	1 067	1 067	75
Total	0	0	4 065	4 065	75

Inferred conventional resources by processing method

(in situ tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional from UG	0	0	2 998	2 998	75
Unspecified	0	0	1 067	1 067	75
Total	0	0	4 065	4 065	75

Inferred conventional resources by deposit type

(in situ tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Sandstone	0	0	415	415
Metamorphite	0	0	2 998	2 998
Volcanic-related	0	0	652	652
Total	0	0	4 065	4 065

Prognosticated conventional resources

(in situ tonnes U)

Cost ranges		
<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
0	0	37 292

Japan

Uranium exploration and mine development

Historical review

Domestic uranium exploration has been carried out by the Power Reactor and Nuclear Fuel Development Corporation (PNC), and its predecessor, since 1956. About 6 600 tU of uranium resources were discovered in Japan before domestic uranium exploration activities were terminated in 1988. Overseas uranium exploration began in 1966 with activities carried out mainly in Australia and Canada, as well as other countries such as the People's Republic of China, Niger, the United States and Zimbabwe.

In October 1998, the PNC was reorganised into the Japan Nuclear Cycle Development Institute (JNC). The Atomic Energy Commission decided, in February 1998, to terminate uranium exploration activities in 2000, and the JNC's mining interests and technologies were transferred to the private sector. In October 2005, the Japan Atomic Energy Agency (JAEA) was established by integrating the Japan Atomic Energy Research Institute and the JNC.

In April 2007, the Japanese government decided to resume overseas uranium exploration activities with financial support from Japanese companies through the Japan Organization for Metals and Energy Security (JOGMEC). JOGMEC has carried out exploration activities in Australia, Canada, Namibia, Uzbekistan and other countries, since 2007.

Recent and ongoing uranium exploration, and mine development activities

JOGMEC continues exploration activities in Namibia and Uzbekistan. Japanese private companies hold shares in companies developing uranium mines, and in those operating mines, in Canada and Kazakhstan.

Uranium resources

Identified conventional resources (reasonably assured and inferred resources)

About 6 600 tU of reasonably assured resources (recoverable) at <USD 130/kgU have been identified in Japan.

Uranium production

Historical review

The PNC established a test pilot plant with a capacity of 50 t ore/day at the Ningyo-toge mine in 1969. Its operation ended in 1982 with total production amounting to 84 tU. In 1978, a leaching test consisting of three 500 t ore vats with a maximum capacity of 12 000 t ore/yr was initiated to process Ningyo-toge ore on a small scale. The vat leaching test was terminated at the end of 1987.

Secondary sources of uranium

Production of mixed oxide fuels

Production facilities

The JAEA plutonium fuel plant consists of three facilities, the Plutonium Fuel Development Facility (PFDF), the Plutonium Fuel Fabrication Facility (PFFF), and the Plutonium Fuel Production Facility (PFPF).

The PFDF, constructed for basic research and the fabrication of test fuels, started operating in 1966. As of 1 January 2025, approximately two tonnes of MOX fuel had been fabricated in the PFDF. The PFFF had two MOX fuel fabrication lines, one for the experimental fast breeder reactor, Jōyō (FBR line), with a capability of one tonne MOX/yr and the second for the prototype advanced thermal reactor, Fugen (ATR line), with ten tonnes MOX/yr fabrication capability. The FBR line started operations in 1973, producing the initial fuel load for the experimental Jōyō sodium-cooled fast reactor. FBR line fuel fabrication ended in 1988 and Jōyō fuel fabrication was switched to the PFPF. The ATR line started operations in 1972, with MOX fuel fabrication for the Deuterium Critical Assembly in JAEA's O-arai Research and Development Center. Fuel fabrication for ATR Fugen was started in 1975 and ended in 2001. MOX fuel fabrication in both lines amounted to a total of approximately 155 tonnes.

The PFPF FBR line, constructed to supply MOX fuels for the prototype Monju FBR and the experimental Jōyō FR, has a production capability of five tonnes MOX/yr. The PFPF FBR line began operating in 1988 fabricating Jōyō fuel reloads. Fuel fabrication for the FBR Monju was started in 1989. As of 1 January 2025, approximately 16 tonnes of MOX fuels had been fabricated in the PFPF.

Use of mixed oxide fuels

Monju prototype fast breeder reactor

Monju achieved initial criticality in April 1994, and began supplying electricity to the grid in August 1995. However, during a 40 % power operation test of the plant, a sodium leak accident in the secondary heat transport system in December 1995, interrupted operation. After carrying out an investigation to determine the cause, a two-year comprehensive safety review, and the required licensing procedure, the permit for plant modification (including countermeasures to reduce the likelihood of sodium leak accidents) was issued in December 2002, by the Ministry of Economy, Trade and Industry. The JAEA completed a series of countermeasure modifications in May 2007, implemented a modified system function test until August 2007, and then conducted an entire system function test. The existing 78 slightly used and six newly fabricated fuel assemblies were loaded by 27 July 2009. Following the system start-up test, Monju was restarted on 6 May 2010. The core confirmation test was completed on 22 July 2010, and 33 freshly fabricated fuel assemblies were loaded by 18 August 2010. However, after refuelling, the in-vessel fuel transfer machine was dropped on 26 August 2010 and removed by 24 June 2011.

The government formally decided, on 21 December 2016, to decommission the Monju FBR in Fukui Prefecture. The spent nuclear fuel removal was to be completed by 2022, and preparations for dismantling the facility began in 2023. Currently, non-fuel core elements and other core elements (595 bodies in total) remaining in the reactor vessel are being unloaded. The dismantling of the facility is scheduled to be completed by 2047.

Experimental fast reactor Jōyō

The experimental fast reactor, Jōyō, attained criticality in April 1977, with the MK-I breeder core. As an irradiation test bed, the Jōyō MK-II core achieved maximum design output of 100 MW in March 1983. Thirty-five duty cycle operations and 13 special tests with the MK-II core had been completed by June 2000. The MK-III high-performance irradiation core, with design output increased to 140 MW, achieved initial criticality in July 2003. Six duty cycle operations and four special tests with MK-III core were completed. The Jōyō net operation time reached around 70 000 hours, and 588 fuel subassemblies were irradiated during MK-I, MK-II and MK-III core operations.

The new regulatory requirements for research reactors were launched on 18 December 2013. The JAEA applied to comply with the new regulatory requirements for research reactors to Jōyō with MK-IV core (100 MW) on 30 March 2017 and received permission to comply with these standards on 26 July 2023. JAEA has conducted the detailed design for safety upgrades, including seismic reinforcement and fire protection.

Uranium policies, uranium stocks and uranium prices

National policies relating to uranium

Japan has relatively scarce domestic uranium resources and therefore relies on an overseas uranium supply. A stable supply of uranium resources is to be ensured through long-term purchase contracts with overseas uranium suppliers, direct participation in mining development, and diversification of suppliers and countries.

Since the accident at the Fukushima Daiichi Nuclear Power Plant in March 2011, all operational reactors in Japan, which normally provide about 30% of electricity production, have been progressively taken out of service during scheduled refuelling and maintenance outages. As of 1 January 2025, 14 reactors are in operation: Kansai Electric Power Company's Ooi Nuclear Power Plant units 3 and 4; Takahama Nuclear Power Plant units 1, 2, 3 and 4; Mihama Nuclear Power Plant unit 3; Kyushu Electric Power Company's Genkai Nuclear Power Plant units 3 and 4; Sendai Nuclear Power Plant units 1 and 2; Shikoku Electric Power Company's Ikata Nuclear Power Plant unit 3; Tohoku Electric Power Company's Onagawa Nuclear Power Plant unit 2 and Chugoku Electric Power Company's Shimane Nuclear Power Plant unit 2.

Concerning the uranium fuel supply chain, in addition to uranium's inclusion in its list of critical minerals in 2024, the 7th Strategic Energy Policy, decided by the cabinet in February 2025, mentions that the public and private sectors will work together to ensure a sustainable fuel supply system with a certain degree of autonomy.

Uranium exploration and development expenditures – non-domestic

(JPY million [Japanese yen])

	2022	2023	2024	2025 (preliminary)
Private* exploration expenditures	N/A	N/A	N/A	N/A
Government exploration expenditures	328	413	411	1 000
Private* development expenditures	N/A	N/A	N/A	N/A
Government development expenditures	N/A	N/A	N/A	N/A
Total expenditures	328	413	411	1 000

* Expenditures made by private companies. Government expenditures refer to those related to majority government funding.

Reasonably assured conventional resources by production method

(recoverable tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining	0	0	6 600	6 600	85
Total	0	0	6 600	6 600	85

Reasonably assured conventional resources by processing method

(recoverable tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional from UG			6 600	6 600	85
Total			6 600	6 600	85

Reasonably assured conventional resources by deposit type

(recoverable tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Sandstone			6 600	6 600
Total			6 600	6 600

Historical uranium production by production method

(tonnes U in concentrates)

Production method	Total through end of 2022	2023	2024	Total through end of 2024	2025 (preliminary)
Open-pit mining[1]	39	0	0	39	0
Underground mining[1]	45	0	0	45	0
Total	84	0	0	84	0

1. Pre-2018 totals may include uranium recovered by heap and in-place leaching.

Historical uranium production by processing method

(tonnes U in concentrates)

Processing method	Total through end of 2022	2023	2024	Total through end of 2024	2025 (preliminary)
Conventional	45	0	0	45	0
Heap leaching*	39	0	0	39	0
Total	84	0	0	84	0

* A subset of open-pit and underground mining, since it is used in conjunction with them.

Historical uranium production by deposit type

(tonnes U in concentrates)

Deposit type	Total through end of 2022	2023	2024	Total through end of 2024	2025 (preliminary)
Sandstone	84	0	0	84	0
Total	84	0	0	84	0

Mixed oxide fuel production and use

(tonnes natural U-equivalent)

Mixed oxide (MOX) fuel	Total through end of 2022	2023	2024	Total through end of 2024	2025 (preliminary)
Production	684	0	0	684	N/A
Use	1 253	63	0	1 316	N/A
Number of commercial reactors using MOX	4	1	0	4	N/A

Reprocessed uranium use

(tonnes natural U-equivalent)

Reprocessed uranium	Total through end of 2022	2023	2024	Total through end of 2024	2025 (preliminary)
Production	645	N/A	N/A	645	N/A
Use	217	N/A	N/A	217	N/A

Net nuclear electricity generation (TWh net)

	2023	2024
Nuclear electricity generated (TWh net)	81.1 TWh	88.9

Installed nuclear generating capacity to 2040

(MWe net)

2023	2024	2025		2030		2035		2040	
		Low	High	Low	High	Low	High	Low	High
31 679	31 679	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Annual reactor-related uranium requirements to 2040 (excluding MOX)

(tonnes U)

2023	2024	2025		2030		2035		2040	
		Low	High	Low	High	Low	High	Low	High
N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Jordan

Uranium exploration and mine development

Historical review

Uranium exploration in Jordan started in the 1980s with work by the Natural Resource Authority (NRA). The work included an airborne gamma-spectrometric survey covering the entire Hashemite Kingdom of Jordan, and ground radiometric surveys over selected sites and exploration trenches.

During the 1990s, reconnaissance and exploration studies revealed surficial uranium deposits distributed in several areas of the country:

- Central Jordan: 1 700 trenches and over 2 000 samples from exploration were analysed for uranium using a fluorometer, which revealed the occurrence of uranium mineralisation as minute mineral grains disseminated within fine calcareous Pleistocene sediments, and as yellowish films of carnotite and other uranium minerals coating fractures of fragmented chalk or marl of Mastrichtian-Paleocene age. The results of channel sampling in three areas indicated uranium contents ranging from 120 to 1 870 ppm U (0.012% to 0.187% U) over an average thickness of about 1.3 metres, with an overburden of about 0.5 metres.
- The airborne gamma-spectrometric survey identified several other areas with radiation anomalies (Mafraq, Ruwayshid, Russeifa, Hasa-Qatrana, Dana, Wadi Al-Bahiyyah, Dubaydib, Al Awja and Wadi Sahab Alabyad) and potential for hosting uranium mineralisation. However, only three areas were covered by follow-up reconnaissance studies (Mafraq, Wadi Al-Bahiyyah and Wadi Sahab Alabyad).

In 2008, the Jordan Atomic Energy Commission (JAEC) was established, in accordance with the Nuclear Energy Law (Law No. 42) of 2007 and amendments in 2008. The JAEC is the official entity entrusted with the development and implementation of the Jordanian nuclear power programme. The exploration, extraction and mining of all nuclear materials, including uranium, thorium, zirconium and vanadium, are under the authority of the JAEC.

The Nuclear Fuel Cycle Commission of JAEC is in charge of developing and managing all aspects of the nuclear fuel cycle, including uranium exploration, extraction, production, securing fuel supply and services, nuclear fuel management and radioactive waste management. The JAEC uranium policy is to maximise sovereignty while creating value from resources and to avoid concessions to foreign companies. To attract investors and operate on a commercial basis, the JAEC created Jordan Energy Resources Inc. as its commercial arm.

In September 2008, the JAEC signed an exploration agreement with Areva S.A. (now Orano S.A.) and created the Jordanian French Uranium Mining Company (JFUMC), a joint venture created to carry out all exploration activities and which led to a feasibility study on developing resources in the Central Jordan Area. In January 2009, the JAEC signed a memorandum of understanding entitling Rio Tinto to carry out reconnaissance and prospecting in three areas (north of Al-Bahiyyah, Wadi Sahb Alabiadh and Rewashid). Exploration activities by Jordanian teams in co-operation with the China Nuclear International Uranium Corporation were carried out in two other areas (Mafraq and Wadi Al-Bahiyyah).

During 2009-2012, the JFUMC explored the northern part of the central Jordan licence area, which included geological mapping, a radiometric survey, trenching, sampling, chemical analyses, development of an environmental impact assessment and a hydrogeological study, building a database inventory, and drilling a total of 5 691 boreholes that were surveyed for gamma radiation at 0.10 m intervals. These data have been integrated to intervals of 0.50 m, which is equal to the length of the drill core samples that were assayed by Inductively Coupled Plasma (ICP) and X-Ray Fluorescence (XRF) methods, and used for calibration of the equivalent uranium (eU) data. Jordan terminated the mining agreement with the JFUMC at the end of 2012.

In 2013, the JAEC established the Jordan Uranium Mining Company (JUMCO) as a commercial arm to complete the exploration and resource estimation of the Central Jordan Uranium Deposits.

During 2013-2018, JUMCO completed exploration activities, including trenching, channel sampling and chemical analyses. In June 2018, the third JORC compliant report was issued, including estimated resources for the (CJUP) deposit in measured, indicated and inferred categories. As of February 2018, the CJUP deposit total identified resources amounted to 35 029 tU at an average grade of 137 ppm U_3O_8 (0.012% U) and 94 ppm U_3O_8 (0.008% U) cut-off grade.

Recent and ongoing uranium exploration, and mine development activities

Successful steps and major milestones were achieved in the design and engineering of the uranium extraction process during the period 2017-2022. The hydrometallurgical process developed for the Central Jordan Uranium Project (CJUP) has been successfully demonstrated to purify and concentrate uranium in the form of sodium diuranate (SDU) and uranyl peroxide (UP). A pilot-plant was constructed and fully commissioned in 2021. As of 1 January 2023, hundreds of tonnes of uranium ore were processed by heap leaching technology to produce several kilograms of uranium concentrate.

JUMCO continues to optimise the hydrometallurgical processing and operating parameters to obtain all necessary data required to complete the detailed engineering design for a commercial plant, and as input parameters for the feasibility study of the project.

Supporting this work, a state-of-the-art analytical laboratory was established in 2020 at the CJUP site. The laboratory has been equipped, in co-operation with the IAEA, with the latest high-tech analytical equipment to conduct chemical and physical analyses related to uranium processing. This is an added value to CJUP and more broadly, to other national mining projects.

Implementation of the above CJUP phases has contributed positively to building domestic capacity, technical infrastructure and training competent human resources in Jordan in certain specific specialised nuclear materials-related fields. The JUMCO team has successfully acquired the knowledge and required experience to progress further. More advanced understanding of governing process parameters is being developed. Moreover, sensitivity analysis has helped to understand the key parameters affecting the process. A systematic approach to knowledge acquisition has been adopted by JUMCO, including a regressive scientific experimental approach that was crucial to undertaking challenges and customising the developed process to match the targeted product profile.

JUMCO is planning to proceed towards the commercial production level in a sustainable and environmentally safe manner. The company is performing a pre-feasibility study (PFS) for CJUP to have better cost estimation that includes different scenarios. The PFS will be the baseline of a bankable feasibility study (BFS) in which more well-defined processes will be considered.

Details on recent and ongoing development activities are presented in the Production section.

Uranium resources

Identified conventional resources (reasonably assured and inferred resources)

As of 1 January 2025, total in situ identified uranium conventional resources in Jordan amounted to 63 019 tU, including 6 785 tU of RAR and 56 234 tU of inferred resources. All resources are of surficial geological type and mineable by open-pit mining production methods. They are located within the Central Jordan Area and the Hasa-Qatrana Area.

Central Jordan Area

JORC compliant in situ resources estimates include 6 785 tU of reasonably assured resources and 28 244 tU of inferred resources.

Hasa-Qatrana Area

In the period 2010-2011, Jordan Energy Resources Inc. (JERI) conducted exploration work at the Hasa-Qatrana area located 95 km south of Amman. The deposits exhibit strong airborne gamma anomalies and several robust ground anomalies that are attributed to the high-grade phosphorite beds. During the exploration programme, a total of 443 trenches were excavated, and 1 943 geochemical samples collected and analysed, covering seven mineralised zones. A preliminary resource estimation was carried out, resulting in total in situ inferred resources of 27 990 tU.

Undiscovered conventional resources (prognosticated and speculative resources)

Wadi Al Bahiyya

This region covers an area of about 1 600 km² and exhibits strong airborne gamma anomalies. Several ground anomalies are also identified. A particular 9 km² area was thoroughly investigated, which revealed uranium concentrations ranging from 59-133 ppm U (70 to 157 ppm U_3O_8) within the carbonate target layer that has a thickness that varies from 1.5 m to 3 m. The radioactive zone is also abundant in vanadium, with concentrations ranging from 700 to 1 500 ppm of V_2O_5.

Sahb El Abyad

In southeastern Jordan, the Sahb El Abyad area has been found to have strong airborne gamma anomalies and was explored for uranium in 2009. The area is composed mainly of late Cretaceous and Tertiary chalky marls, limestone, cherts and phosphorites. The uranium mineralisation is similar to the central Jordan region. Geochemical sampling revealed a strong correlation between uranium and phosphorous. Uranium concentration was found to be in the range 85-127 ppm U (100-150 ppm U_3O_8).

Bayer

The Bayer area, located 150 km southeast of Amman, is characterised by rocky, desert terrain. Prospecting exploration and radiometric maps show a distinct uranium anomaly in an east-west direction. The area is composed of Tertiary sedimentary rocks such as chalky marls, limestone and cherts. Airborne gamma survey in this area illustrates a substantial east-west anomaly. In addition, car-borne and foot-borne surveys have revealed uranium anomalies along the base of hills with phosphorite layers.

Mafraq

The prospecting area covers nearly 93 km². Features of robust airborne and multiple strong ground gamma anomalies mirroring the lithology of the central Jordan region. Various channels and pit samples were systematically collected for analysis. Notably, carnotite yellow stains were observed, suggesting the presence of uranium and vanadium mineralisation in this region. However, exploration activities were suspended since the area is populated and privately owned.

Dubaydib

The area is situated 350 km south of Amman and 100 km east-northeast of Aqaba. It lies in the central part of the Dubaydib Sand Formation from the Ordovician period. The target layer is composed of fine-grained sandstone and siltstone that is brown to dark brown. In 2020, prospecting studies found high mineralisation of rare earth elements (REEs), trace elements and radioactive elements in Dubaydib. The presence of REEs is accompanied by radioactive elements such as uranium and thorium.

In total, it is estimated that about 70 000 tU of speculative resources are present in carbonate rock deposits (Wadi Al Bahiyya, Sahb El Abyad, Bayer andMafraq) and sandstone deposits in the Dubaydib area.

Unconventional uranium resources and other materials

Unconventional uranium resources in Jordan amount to about 98 000 tU, related to phosphorites, and occur within the Al Risha and Eshidiyya areas.

Al Risha

The Al Risha area in northeast Jordan is located 260 km east of Amman and 26 km east of the Ar Ruweishid Municipality. It is a substantial resource of phosphorite withapproximately 750 million metric tonnes estimated in 2022. This region is characterised by the Umm Rijam Chert Formation, hosting phosphorite layers primarily within limestone formations, along with chert, chalk, chalky limestone and silicified limestone. Geophysical surveys have identified significant amounts of radioactive elements such as uranium, thorium, radium and radon in this area. Moreover, chemical analyses of collected samples have revealed notable grades of uranium within the phosphate ore, averaging 95 ppm U. The size of the deposit, and notable uranium grade, demonstrates the potential for extracting substantial quantities of uranium as a by-product to fertilisers. Total speculative uranium resources for Al Risha are about 70 000 tU.

Eshidiyya

The Eshidiyya basin is located in the southern part of Jordan, 125 km northeast of Aqaba. The upper Qatrana member of this basin is characterised by a thickness of up to three metres of friable ore-grade phosphorite. Geochemical sampling within the upper member unit revealed uranium concentrations ranging from 30 to 271 ppm U, with an average of 158 ppm U. In addition, the lower phosphorite member displays an average uranium grade of 70 ppm U. The speculative uranium resources for Eshidiyya are about 28 000 tU.

Uranium production

Historical review

Jordan has not produced uranium in the past.

In 1982, a feasibility study for uranium extraction from phosphoric acid was completed by an engineering company (Lurgi A.G. of Frankfurt, Germany) on behalf of the Jordan Fertiliser Industry Company (subsequently purchased by the Jordan Phosphate Mines Company). One of the extraction processes evaluated was originally found to be economically feasible, but as uranium prices dropped in the 1990s, the process became uneconomic and construction of an extraction plant was deferred.

In 2009, SNC-Lavalin, jointly with Prayon Technologies S.A., performed a technological and economic feasibility study for the recovery of uranium from the phosphoric acid produced at the Aqaba Fertilizer Complex. This study evaluated the internal rate of return to be 6.8%.

JUMCO is conducting research to develop optimised extraction parameters, including:

- Research on dynamic alkaline leaching of central Jordan ore, which has provided promising results of more than 90% recovery;
- Evaluation of process parameters and recovery of uranium at a laboratory scale, using 1-2 m high, 0.14 m diameter extraction columns. The results were promising with more than 85% recovery;

- Evaluation of the scale-up parameters and extraction process at a small-scale pilot-plant, using extraction columns, 6 m high and 0.5 m in diameter, for a semi-pilot scale heap leach. Recovery was in line with previous laboratory studies;
- Installation and commissioning of a pilot-scale uranium extraction plant (three cribs, 3 x 3 x 6 m) with a capacity of approximately 180 tonnes of ore that was commissioned for uranium extraction in 2021. The purpose of the pilot-scale plant is to master the developed process for extracting uranium from the local ores of central Jordan and to generate the technical data needed for finalising the detailed engineering of the commercial plant, and as input data for the bankable feasibility study;
- Mutual collaboration between Jordan and the International Atomic Energy Agency, which has enabled JUMCO to establish an on-site analytical laboratory to support the exploration and extraction activities; the laboratory was commissioned in 2020;
- Plans to build one cell heap leaching pad. This includes finalising engineering drawings, manufacturing units needed, supporting infrastructure, etc.

Recent and ongoing activities

In 2024, the Jordan Uranium Mining Company (JUMCO) initiated the design and construction of a demonstration plant for uranium heap leaching. The plant commenced operations in April 2025, with the primary objective of demonstrating JUMCO's technical and operational capabilities in managing an integrated uranium recovery facility. Additionally, the plant serves as a hands-on training platform for JUMCO's engineers and technicians. The demonstration plant is engineered to process approximately 700 cubic metres of agglomerated ore, with an anticipated annual output of around 90 kg of U_3O_8. During the operation, roughly 3 600 cubic metres of leaching solution will be circulated through the heap leach pad and subsequently processed through the ion exchange (IX) system to recover uranium via the refinery and precipitation circuits. The barren solution is recirculated to the heap, supporting continuous leaching and recovery. The IX circuit is designed to undergo several hundred loading and elution cycles, providing critical data on the behaviour and performance of the ion exchange process under near-commercial operating conditions. This extended operational phase not only validates the plant's design and performance but also builds essential process knowledge and operational expertise among JUMCO's technical staff, facilitating future optimisation and scaling efforts. All phases of the project (including engineering, construction, commissioning and operation) have been executed entirely by JUMCO's internal team, utilising 100% Jordanian expertise. The project was completed without reliance on external technical assistance, and in full alignment with internationally recognised engineering standards and best practices. This achievement underscores JUMCO's strategic commitment to developing national competencies across the nuclear fuel cycle and strengthening Jordan's role in the global nuclear industry.

Status of production capability

Jordan does not have firm plans to produce uranium. JUMCO is investigating the aspects of uranium production in the country and will prepare a bankable feasibility study as soon as other related studies are finished.

Uranium requirements

Jordan has no commercial nuclear power reactors and has very limited domestic uranium requirements. The short-term uranium requirements are based on the operation of Jordan Research and Training Reactor (JRTR). The JRTR is operated by the Jordan Atomic Energy Commission (JAEC) at the Jordan University of Science and Technology (JUST). The JRTR was commissioned in 2017 as a centre for training, education, research, and production of medical and industrial radioisotopes.

The long-term uranium requirements depend on Jordan's nuclear energy policy and post-2030 national energy strategy. JAEC is actively working towards deploying nuclear power reactors in the early 2030s, and conducting feasibility studies for a 300 MWe small modular reactor for electricity generation and water desalination in the same time frame. It is projected that the annual uranium requirement will reach approximately 50 tU.

National policies related to uranium

With Jordan's dedication to establishing a peaceful nuclear energy programme for electricity generation and water desalination, JAEC is committed to the safe, cost-effective, and sustainable development and implementation of Jordan's small modular reactor (SMR) project. This commitment includes the management of nuclear fuel for the SMR project, involving the creation of a national procurement policy and strategy to ensure cost-effectiveness, reliability, security of supply, energy security and risk-based inventory management. An integral aspect of Jordan's nuclear fuel cycle management is the targeted utilisation of the country's natural uranium resources. The future SMR project owner/operator will actively promote the procurement of indigenously supplied uranium. This approach aims to secure a local supply at a price that supports the sustainability of local uranium production, contributing to the strategic economic development of Jordan. In this regard, JAEC has resumed uranium exploration and extraction within the country, implemented by Jordan Uranium Mining Company (JUMCO) in 2013.

Uranium exploration and development expenditures, and drilling effort – domestic

(JOD millions)

	2022	2023	2024	2025 (expected)
Private exploration expenditures	0.00	0.00	0.00	0.00
Government exploration expenditures	0.00	0.00	0.00	0.00
Private development expenditures	0.00	0.00	0.00	0.00
Government development expenditures	2.04	2.22	2.50	2.60
Total expenditures	2.04	2.22	2.50	2.60

Reasonably assured conventional resources by production method

(in situ tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Open-pit mining (OP)	0	0	0	6 785	80
Total	0	0	0	6 785	80

Reasonably assured conventional resources by processing method

(in situ tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Heap leaching* from OP	0	0	0	6 785	80
Total	0	0	0	6 785	80

* A subset of open-pit and underground mining, since it is used in conjunction with them.

Reasonably assured conventional resources by deposit type

(in situ tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Surficial	0	0	0	6 785
Total	0	0	0	6 785

Inferred conventional resources by production method

(in situ tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Open-pit mining (OP)	0	0	0	56 234	80
Total	0	0	0	56 234	80

Inferred conventional resources by processing method

(in situ tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Heap leaching* from OP	0	0	0	28 244	80
Unspecified	0	0	0	27 990	NA
Total	0	0	0	56 234	80

* A subset of open-pit and underground mining, since it is used in conjunction with them.

Inferred conventional resources by deposit type

(in situ tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Surficial	0	0	0	56 234
Total	0	0	0	56 234

Speculative conventional resources

(in situ tonnes U)

Cost ranges			
<USD 130/kgU	<USD 260/kgU	<USD 390/kgU	Unassigned
0	70 000	70 000	NA

Speculative unconventional resources

(in situ tonnes U)

	Cost ranges		
<USD 130/kgU	<USD 260/kgU	<USD 390/kgU	Unassigned
98 000	98 000	98 000	NA

Kazakhstan

Uranium exploration

Historical review

Since the beginning of uranium exploration in 1944 in Kazakhstan, about 60 uranium deposits have been identified in six uranium ore provinces – Shu-Sarysu, Syrdarya, Northern Kazakhstan, Caspian, Balkhash and Ili. By the late 1970s, unique large deposits suitable for uranium mining by in situ leaching (ISL), such as Budenovskoye, Inkai, Mynkuduk, Moinkum, Kanzhugan, and North and South Karamurun, were discovered.

Recent and ongoing uranium exploration, and mine development activities

In 2021-2024, exploration was carried out at the Budenovskoye, Inkai, Northern Kharasan and Mynkuduk deposits.

JSC NAC Kazatomprom has been conducting exploration at sites No. 2 and No. 3 of the Inkai deposit since 2018. Exploration work continues at site No. 2, and pilot industrial uranium mining was planned to start at site No. 3 in 2025. Re-evaluation of uranium resources at the Western site of the Mynkuduk deposit was completed by APPAK LLC in 2023. In 2023, JV Turanium LLP completed exploration of the Northern Kharasan deposit.

In 2023, JV Katco LLC completed an analysis of the depletion of uranium reserves at site No. 1 of the Moinkum deposit, based on the results of which a revaluation of uranium reserves was made.

The 2021-2024 exploration resulted in resource additions of 77 345 tU, including: 3 890 tU at sites No. 6 and No. 7 of the Budenovskoye deposit, 4 034 tU at the Western site of the Mynkuduk deposit, 48 704 tU at site No.2 of the Budenovskoye deposit, 9 506 tU at site No.1 of the Moinkum deposit and 11 211 tU at site No. 1 of the Northern Kharasan deposit.

In 2024, licences for uranium exploration were issued to Kazatomprom for the following sites in the Shu-Sarysu uranium ore province: East-Zhalpak site, Inkai-Mynkuduk site, Budenovskoye North, Budenovskoye #5-1 and #5-3.

Uranium exploration and development expenditures, drilling volumes – outside the country

No exploration and development of uranium deposits was carried out outside of Kazakhstan.

Uranium resources

Identified conventional resources (reasonably assured and inferred resources)

As of 1 January 2025, identified in situ uranium resources available at a cost of <USD 260/kgU amounted to 1 004 696 tU, including 836 076 tU of resources amenable to ISL recovery. Total recoverable resources, with mining and processing losses taken into consideration, amounted to 886 934 tU, including 744 107 tU amenable to ISL mining.

Compared to the previous report, total identified in situ resources increased by 15 201 tU. This number includes additional resources estimated during exploration at Budenovskoye, Western Mynkuduk, Moinkum and Kharasan deposits, and resources depletion from mining in 2023 and 2024.

In Kazakhstan, 95% of identified uranium resources in the cost category <USD 40/kgU, 94% in the cost category <USD 80/kgU and 84% in the cost category <USD 130/kgU have been contracted by mining companies and the remaining resources in each cost category were not contracted or licensed as of 01 January 2025.

Prognosticated and speculative resources (P1+P2+P3)

In the reporting period, there was a minor revaluation of prognosticated and speculative resources.

Unconventional resources and other materials

There are no estimates of Kazakhstan's unconventional uranium resources and other materials.

Uranium production

Historical review

The significant growth of uranium production in Kazakhstan over the last two decades relates to the sandstone-type uranium deposits development by ISL mining. ISL is the lowest cost uranium mining method in Kazakhstan and has a minimal impact on the environment when done properly.

Production capability, and recent and ongoing activities

In 2023, uranium production amounted to 21 112 tU. In 2024, it increased by 10% and reached 23 270 tU. Uranium was produced at the Kanzhugan, Moinkum, Akdala, Mynkuduk, Inkai, Budenovskoye, North and South Karamurun, Irkol, Zarechnoye, Semizbay and Northern Kharasan deposits. All uranium deposits were mined by ISL method. Uranium production at ISL mines in Kazakhstan is carried out using sulphuric acid to produce uranium-bearing solutions. Processing of uranium-bearing solutions utilises ion-exchange sorption-elution technologies with further uranyl salts precipitation, refining and final production of U_3O_8 concentrates.

Shu-Sarysu uranium province

The development of the East Mynkuduk, Kanzhugan, and Moinkum fields (site No. 3) is carried out by the Kazatomprom-Sauran LLP. The development of the Central Mynkuduk deposit and Zhalpak deposit is carried out by Ortalyk LLP. JV Katco LLP operates two sites of the Moinkum deposit, site No. 1 (Northern) and site No. 2 (Tortkuduk). JV Inkai LLP operates the Inkai deposit site No. 1. In 2018, JSC NAC Kazatomprom obtained exploration contracts for areas No. 2 and No. 3 of the Inkai deposit. Appak LLP develops the Western site of the Mynkuduk deposit. JV Akbastau JSC operates deposit Budenovskoye (sites No. 1, No. 3 and No. 4), Karatau LLP develops site No. 2 of the Budenovskoye deposit and performs processing of solutions extracted from the sites No. 1 and No. 3 of the Budenovskoye deposit. JV South Mining Chemical Company LLP (SMCC) operates the Akdala and Inkai (site No. 4) deposits. JV Budenovskoye LLP operates the Budenovskoye deposit (sites No. 6-7).

Syrdarya uranium province

JSC NAC Kazatomprom, through the Mining Group-6 LLP, operates the North and South Karamurun deposits. The Irkol deposit is being developed by Semizbay-U LLP. Baiken-U LLP carries out uranium production at the Northern Kharasan (site Kharasan-2) deposit. JV

Turanium LLP (former Khorasan-U LLP) operates the Northern Kharasan (site Kharasan-1) deposit, and solutions processing is carried out by Kyzylkum LLP. JV Zarechnoye JSC develops the Zarechnoye deposit. Balausa LLP is working on the Bala-Sauskandykskoye uranium-vanadium deposit by open-pit methods. About 0.7 tU was mined and stockpiled as a by-product to vanadium.

Northern Kazakhstan uranium province

Stepnogorsk Mining Chemical Complex LLP stopped production at the Vostok and Zvezdnoe deposits, and the underground mine was closed in 2013. The Semizbay deposit is being developed by Semizbay-U LLP.

Uranium production centre technical details

(as of 1 January 2025)

	Centre # 1	Centre # 2	Centre # 3	Centre # 4	Centre # 5	Centre # 6	Centre # 7	Centre # 8
Name of production centre	Kazatomprom-SaUran LLP		Mining Group-6 LLP	JV South Mining Chemical Company LLP	JV Katco LLP	JV Inkai LLP	JV Zarechnoe JSC	Karatau LLP
	Taukent Mining Chemical Plant	Stepnoye Mining Group						
Production centre classification	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
Date of first production (year)	1982	1978	1985	2001	2004	2004	2007	2007
Source of ore:								
Deposit name(s)	Kanzhugan, Moinkum (sites 1, 3)	Mynkuduk (Eastern site), Uvanas	North and South Karamurun	Akdala, Inkai (site 4)	Moinkum (sites 1, 2), Tortkuduk	Inkai (site 1)	Zarechnoye,	Budenovskoe (site 2)
Deposit type(s)	Sandstone	Sandstone	Sandstone	Sandstone	Sandstone	Sandstone	Sandstone	Sandstone
Resources in situ (tU)	23 111	3 876	13 564	71 261	55 491	140 768	2 557	69 522
Grade (% U)	0.052	0.031	0.080	0.052	0.071	0.056	0.050	0.096
Mining operation:								
Type (OP/UG/ISL)	ISL	ISL	ISL	ISL	ISL	ISL	ISL	ISL
Size (tonnes ore/day)								
Average mining recovery (%)	87	90	91	90	85	85	90	90
Processing plant:								
Acid/alkaline	Acid	Acid	Acid	Acid	Acid	Acid	Acid	Acid
Type (IX/SX)	IX	IX	IX	IX	IX	IX	IX	IX
Size (kilolitre/day)	85 000	60 000	60 000	140 000	100 000	80 000	80 000	60 000
Average process recovery (%)	98.9	98.7	98.7	98.9	98.9	98.9	98.5	98.9
Nominal production capacity (tU/year)	1 000	1 300	1 000	3 000	4 000	2 500	1 000	3 200
Plans for expansion (yes/no)	No	No	No	No	No	Yes	No	Yes

Uranium production centre technical details

(as of 1 January 2025)

	Centre # 9	Centre #10	Centre #11	Centre # 12	Centre # 13	Centre # 14	Centre # 15
Name of production centre	Ortalyk LLP	Appak LLP	Khorasan-U LLP	Bayken-U LLP	JV Akbastau JSC	Semyzbai-U LLP	Budenovskoye LLP
Production centre classification	Existing	Existing	Existing	Existing	Existing	Existing	Existing
Date of first production (year)	2007	2008	2008	2009	2009	2007	2024
Source of ore:							
Deposit name(s)	Mynkuduk (Central site), Zhalpak	Mynkuduk (Western site)	North Kharasan (site 1)	North Kharasan (site 2)	Budenovskoe (sites 1, 3, 4)	Semyzbai, Irkol	Budenovskoe (sites 6, 7)
Deposit type(s)	Sandstone	Sandstone	Sandstone	Sandstone	Sandstone	Sandstone	Sandstone
Resources in situ (tU)	31 549	17 604	41 779	13 127	31 969	7 412	113 339
Grade (% U)	0.047	0.027	0.204	0.117	0.089	0.050	0.072
Mining operation:							
Type (OP/UG/ISL)	ISL	ISL	ISL	ISL	ISL	ISL	ISL
Size (tonnes ore/day)							
Average mining recovery (%)	90	90	90	90	90	87	NA
Processing plant:							
Acid/alkaline	Acid	Acid	Acid	Acid	Acid	Acid	Acid
Type (IX/SX)	IX	IX	IX	IX	IX	IX	IX
Size (kilolitre/day)	70 000	60 000	50 000	60 000	20 000	85 000	NA
Average process recovery (%)	98.5	98.9	98.5	98.5	98.9	98.6	NA
Nominal production capacity (tU/year)	2 000	1 000	1 400	2 000	600	1 200	6 000
Plans for expansion (yes/no)	Yes	No	Yes	No	Yes	No	Yes

Ownership structure of the uranium industry

In 2024, the JSC NAC Kazatomprom share of uranium production in Kazakhstan was 53% (12 286 tU). Sixty-three per cent of JSC NAC Kazatomprom is owned by the state-owned company, Samruk-Kazyna JSC national wealth fund, 12% belongs to the Ministry of Finance of the Republic of Kazakhstan and 25% of shares are traded at the London Stock Exchange. The production share of private, foreign companies in Kazakhstan amounted to 10%, while the share of foreign state-owned companies in Kazakhstan amounted to 37% of total production.

In 2024, JSC NAC Kazatomprom had shares in joint ventures with private companies from Canada, Japan, Kazakhstan and Kyrgyzstan (JV Inkai LLP, Appak LLP, Kyzylkum LLP, Khorasan-U LLP, Baiken-U LLP, JV Zarechnoe JSC), and with foreign state-owned companies from China, France and Russia (Semizbay-U LLP, JV Katco LLP, SMCC LLP, JV Akbastau JSC, Karatau LLP, JV Zarechnoe JSC, Kyzylkum LLP, Khorasan-U LLP, JV Budennovskoye LLP and Ortalyk LLP).

Employment in the uranium industry

One of the important areas of personnel policy of JSC NAC Kazatomprom, and its subsidiaries and affiliates (hereinafter referred to as Subsidiaries), is the development and training of personnel.

In order to train and re-train highly professional personnel, JSC NAC Kazatomprom and its enterprises co-operate with leading universities and colleges of the Republic of Kazakhstan, and abroad. To date, there are 32 universities in specialised areas (for details see Kazakhstan country report in the Red Book 2022).

In 2023, the social project of educational grants "Murager" was launched, aimed at supporting applicants, college graduates and elementary students in the regions of the company's presence (Turkestan, Kyzylorda and East Kazakhstan regions). Thus, the company plans to contribute to the development of the regions and increase the level of education of the local population, including the popularisation of technical specialties for the purpose of further employment at the company's enterprises.

Activities of the Center for the Development of Professional Competencies (CDPC) of JSC NAC Kazatomprom are aimed at sustainable growth of professional competencies of engineering and technical workers, and working personnel. Within the framework of the CDPC, professional development programmes for employees of mining enterprises of JSC NAC Kazatomprom have been developed and implemented in 14 profile areas of activity.

In order to preserve and facilitate transfer of knowledge in JSC NAC Kazatomprom, the School of Internal Trainers was successfully launched within which selected employees of the company and its subsidiaries are certified as internal trainers to carry out coaching activities, sharing their experience and knowledge with colleagues. Much attention is also paid to professional development programmes for employees, including compulsory training in accordance with the legislation of the Republic of Kazakhstan, and for the implementation of targeted training programmes (leadership development, lean production, corporate culture, safety culture, etc.).

In addition, there are training centres where employees of JSC NAC Kazatomprom and subsidiaries are trained in occupational, industrial, electrical and fire safety. Training is also provided in additional positions, such as a slinger, crane operation and a cradle worker, etc., with certificates issued after successful completion of the training.

The fulfilment of the licence and contractual obligations of the company and its contracting enterprises is carried out following the Code of the Republic of Kazakhstan "On Subsoil and Subsoil Use" and a number of ministerial decrees. According to the contract terms for subsoil use, the annual mandatory costs for training and retraining of personnel amounts to 1% of the annual costs of exploration and 1% of the annual costs of operation, during uranium mining.

Total employment in existing production centres amounted to 21 392 persons in 2023 and 22 066 in 2024, an approximate 7% increase from 2022 (20 558 persons). About 35% of employment is directly related to uranium production.

Future production centres

Since 2019, exploration has been conducted by NAC Kazatomprom at sections 2 and 3 of the Inkai field. The contract for uranium mining at these sections was received by NAC Kazatomprom in 2024, and then transferred to its 100% subsidiary Kazatomprom-SaUran LLP. After exploration is complete, new ISL uranium production centres will be created.

Secondary sources of uranium

Production and/or use of mixed oxide fuels

Mixed oxide (MOX) fuel is neither produced nor used in Kazakhstan.

Production and/or use of re-enriched tails

Uranium obtained through re-enrichment of depleted uranium tails is neither produced nor used in Kazakhstan.

Environmental activities and social cultural issues

Environmental activities

Subsoil users created a reclamation fund to eliminate the effects of operations on subsoil use in Kazakhstan. Contributions to the reclamation fund during the exploration and extraction of subsurface users are produced annually at a rate of at least 1% of the annual cost of exploration and production, in a special deposit account in any bank in the state.

In the framework of ecological policy in Kazakhstan, a number of measures to improve environmental protection and encourage rational use of natural resources have been implemented in recent years.

Each uranium venture in Kazakhstan realised a short-term waste management plan, which included measures to reduce their generation and accumulation. Reliable systems for monitoring the environment and radiation safety at uranium mines and production sites are in place. The purpose of environmental monitoring at the enterprises of the company is to provide reliable information about the impact of the enterprise on the environment and possible changes in adverse or dangerous situations.

Environmental safety has a significant role in the effective functioning of the system of industrial environmental monitoring.

Social and/or cultural issues

Kazatomprom’s enterprises annually implement socially significant projects aimed at the socio-economic and infrastructural development of the regions where they operate, including improving the quality of life of their employees and its subsidiaries, and dependent organisations, as well as their family members in the regions where they live.

In 2024, over 3.7 billion tenge (USD 8 million) was allocated for social and charitable initiatives. These funds were invested in infrastructure development, emergency assistance in emergency situations, support for socially vulnerable categories of the population in the form of: purchasing coal, food baskets, school supplies, New Year’s gifts, and a number of other socially significant initiatives.

Investments in external social projects in 2024 were made in the following areas:

- Infrastructure development – more than 390 million tenge (USD 850 000);
- Support in emergency situations – 3 billion tenge (USD 6.5 million);
- Charitable initiatives – more than 340 million tenge (USD 740 000).

Infrastructure development

Development of social infrastructure remains one of the key areas. In 2024, more than 390 million tenge (USD 850 000) were allocated for these purposes. Investments covered the construction of children's and sports grounds, and landscaping and street greening in populated areas of the Turkestan and Kyzylorda regions. Particular attention was paid to the design of exploration and evaluation work on groundwater, in order to provide rural districts with clean drinking water.

Emergency support

Due to the devastating floods that occurred in the western regions of Kazakhstan in the spring of 2024, Kazatomprom provided support to the victims in the shortest possible time. The total amount of emergency assistance amounted to 3 billion tenge (USD 6.5 million), which was the Company's largest contribution to overcoming the consequences of the emergency. The funds were used to restore damaged infrastructure and provide targeted assistance to the population. As part of the recovery efforts, Kazatomprom sent about 120 units of special equipment, which were used to restore infrastructure, clean up flooded areas and restore vital facilities. Ninety-three employees of the nuclear holding voluntarily went to the Atyrau and Aktobe regions, as well as to the city of Uralsk, to participate in the work to eliminate the consequences of the floods.

Charity initiatives

In 2024, more than 340 million tenge (USD 740 000) were allocated for charity projects. These funds are aimed at supporting low-income and large families, children with special needs, pensioners and veterans. As part of the implemented activities, food, coal, clothing, and school supplies were purchased and donated. Financial assistance was also provided for the treatment of sick children, to hold festive events and provide gifts. Additionally, schools were provided with technical equipment, including interactive whiteboards, LED screens and subscriptions to educational publications.

In addition to implementing socially significant projects in the regions where the Company operates, the Kazatomprom group of companies makes annual payments to the regional budgets where it operates in accordance with the terms of subsoil use contracts, transferred for the purposes of the socio-economic development of the regions and the infrastructure development.

During 2024, within the terms of the contracts for subsoil use, the Company's uranium mining enterprises transferred 3.9 billion tenge (USD 8.5 million) to regional budgets.

Expenditures on environmental activities and social-cultural issues in 2024

	KZT million
Improving technological processes, including reduction of fugitive emissions into the environment.	349
Improving the efficiency of existing dust and gas collection and water treatment plants.	7
Carrying out research activities in the field of environmental protection.	424
Implementing environmental monitoring.	310

Uranium demand

Domestic demand for natural and enriched uranium is not expected in Kazakhstan over the next decade. Construction of a nuclear power plant is under consideration.

Supply and procurement strategy

At present, the entire volume of uranium produced in Kazakhstan is exported to the world market.

National policies relating to uranium

In January 2017, due to the prolonged downturn in the uranium market, Kazakhstan's national atomic company, JSC NAC Kazatomprom, reduced Kazakhstan's uranium production by approximately 10% for 2017. In December 2017, given the challenging market conditions, and in light of continued oversupply in the uranium market, JSC NAC Kazatomprom announced further production cuts by 20% below Subsoil Use Contracts for 2018-2020. In August 2019, JSC NAC Kazatomprom announced its intention to continue to flex down production by 20%, compared to the planned levels under Subsoil Use Contracts through 2021. Likewise, in August 2020, JSC NAC Kazatomprom announced its intention to continue to cut production by 20% until 2023. In August 2024, Kazatomprom announced plans to reduce 2025 domestic production to between 25 000 – 26 500 tU from a previous target of 30 500 to 31 500 tU. A significant portion of the reduced 2025 production guidance is due to production ramp up delays at the JV Budenovskoye LLP.

On 13 November 2018, JSC NAC Kazatomprom made its stock market debut after raising USD 450 million from investors in London and Astana. JSC NAC Kazatomprom sold 15% of its stock in the dual-listing offering, which valued the company at USD 3 billion. The share of shares in free float eventually increased to 25% as a result of two secondary public offerings (SPOs) in September 2019 and June 2020.

Uranium exploration and development expenditures, and drilling effort – domestic

(KZT million)

	2021	2022	2023	2024
Industry* exploration expenditures	2 274	1 808	3 356	2 102
Government exploration expenditures	0	0	0	0
Industry* development expenditures	1 888	2 552	3 078	6 471
Government development expenditures	0	0	0	0
Total expenditures	4 162	4 360	6 434	8 573
Industry* exploration drilling (m)	205 015	188 046	107 404	38 938
Industry* exploration holes drilled	541	493	296	220
Industry exploration trenches (m)	0	0	0	0
Industry trenches (number)	0	0	0	0
Government exploration drilling (m)	0	0	0	0
Government exploration holes drilled	0	0	0	0
Government exploration trenches (m)	0	0	0	0
Government trenches (number)	0	0	0	0
Industry* development drilling (m)	488 285	899 497	347 005	501 370
Industry* development holes drilled	1 142	2 042	881	1 140
Government development drilling (m)	0	0	0	0
Government development holes drilled	0	0	0	0
Subtotal exploration drilling (m)	205 015	188 046	107 404	38 938
Subtotal exploration holes drilled	541	493	296	220
Subtotal development drilling (m)	488 285	899 497	347 005	501 370
Subtotal development holes drilled	1 142	2 042	881	1 140
Total drilling (m)	693 300	1 087 543	454 409	540 308
Total number of holes drilled	1 683	2 535	1 177	1 360

* Non-government.

Reasonably assured conventional resources by production method

(tonnes U*)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining (UG)	0	4 179	31 941	55 586	83
Open-pit mining (OP)	0	0	31 177	31 177	91
In situ leaching acid	308 386	428 138	428 138	428 138	89
Total	308 386	432 317	491 256	514 901	88

* In situ resources reported, with recovery factors provided.

Reasonably assured conventional resources by processing method

(tonnes U*)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional from UG	0	4 179	31 941	55 586	83
Conventional from OP	0	0	31 177	31 177	91
In situ leaching acid	308 386	428 138	428 138	428 138	89
Total	308 386	432 317	491 256	514 901	88

* In situ resources reported, with recovery factors provided.

Reasonably assured conventional resources by deposit type

(tonnes U*)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Sandstone	308 386	428 138	428 138	428 138
Metasomatite	0	4 179	15 925	30 299
Phosphate deposits	0	0	29 184	38 455
Lignite-coal	0	0	18 009	18 009
Total	308 386	432 317	491 256	514 901

* In situ resources reported.

Inferred conventional resources by production method

(tonnes U*)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining (UG)	0	4 896	29 144	77 137	83
Open-pit mining (OP)	0	0	2 849	2 849	91
In situ leaching acid	267 436	397 767	407 938	407 938	89
Co-product and by-product	0	1 871	1 871	1 871	91
Total	267 436	404 534	441 802	489 795	88

* In situ resources reported, with recovery factors provided.

Inferred conventional resources by processing method
(tonnes U*)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional from UG	0	4 896	29 144	77 137	83
Conventional from OP	0	1 871	4 720	4 720	91
In situ leaching acid	267 436	397 767	407 938	407 938	89
Total	267 436	404 534	441 802	489 795	88

* In situ resources reported, with recovery factors provided.

Inferred conventional resources by deposit type
(tonnes U*)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Sandstone	267 436	399 638	409 809	409 809
Metasomatite	0	4 896	29 709	72 845
Phosphate	0	0	0	4 857
Lignite-coal	0	0	2 284	2 284
Total	267 436	404 534	441 802	489 795

* In situ resources reported.

Prognosticated conventional resources
(tonnes U)

Cost ranges		
<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
85 783	113 728	113 728

Speculative conventional resources
(tonnes U)

Cost ranges		
<USD 130/kgU	<USD 260/kgU	Unassigned
186 280	186 280	N/A

Historical uranium production by production method
(tonnes U in concentrates)

Production method	Total through end of 2022	2023	2024	Total through end of 2024	2025 (expected)
Open-pit mining*	21 618	0	0	21 618	0
Underground mining*	42 549	0	0	42 549	0
In situ leaching	359 529	21 112	23 270	403 911	25 789
Total	423 696	21 112	23 270	468 078	25 789

*Pre-2010 totals may include uranium recovered by heap and in-place leaching.

Historical uranium production by processing method

(tonnes U in concentrates)

Processing method	Total through end of 2022	2023	2024	Total through end of 2024	2025 (expected)
Conventional	42 109	0	0	42 109	0
Heap leaching*	440	0	0	440	0
In situ leaching	359 529	21 112	23 270	403 911	25 789
U recovered from phosphate rocks	21 618	0	0	21 618	0
Total	423 696	21 112	23 270	468 078	25 789

* A subset of open-pit and underground mining, since it is used in conjunction with them.

Historical uranium production by deposit type

(tonnes U in concentrates)

Deposit type	Total through end of 2022	2023	2024	Total through end of 2024	2025 (expected)
Sandstone	359 529	21 112	23 270	403 911	25 789
Metasomatite	42 549	0	0	42 549	0
Phosphate	21 618	0	0	21 618	0
Total	423 696	21 112	23 270	468 078	25 789

Ownership of uranium production in 2024

Domestic				Foreign				Totals	
Government		Private		Government		Private			
(tU)	(%)	(tU)	(%)	(tU)	(%)	(tU)	(%)	(tU)	(%)
12 286	53	-	-	8 371	36	2 613	11	23 270	100

Uranium industry employment at existing production centres

(person-years)

	2021	2022	2023	2024
Total employment related to existing centres	20 825	20 558	21 392	22 066
Employment directly related to uranium production	6 710	6 934	7 484	7 820

Mid-term production projection

(tonnes U/year)

2025	2030	2035	2040	2045	2050
26 000	29 000	21 000	12 000	N/A	N/A

Short-term production capability

(tonnes U/year)

2025				2030			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
28 000	30 000	28 000	29 000	26 000	30 000	26 000	29 000

2035				2040			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
14 000	22 000	14 000	23 000	9 000	13 000	9 000	14 000

Malawi

Uranium exploration and mine development

Historical review

The Kayelekera deposit was discovered in the early 1980s by the Central Electricity Generating Board of Great Britain (CEGB). Kayelekera is a sandstone-hosted uranium deposit, located close to the north tip of the North Rukuru Basin. This basin contains a thick (at least 1 500 m) sequence of Permian Karoo sandstones preserved in a semi-graben about 35 km to the west of and broadly parallel to the Lake Malawi section of the East African Rift System. Mineralisation lies within the uppermost 150 m of the Muswanga Member, which is the upper part of the Karoo Formation. The Muswanga Member consists of a total of eight separate arkose units with intervening silty mudstones in an approximate 1:1 ratio. Such a succession is indicative of cyclic sedimentation within a broad, shallow, intermittently subsiding basin. The arkose units contain most of the uranium mineralisation. They are, on average, about 8 m thick, are generally coarse grained and poorly sorted, and contain a high percentage of fresh, pink feldspar grains. The basal arkose units are usually a quartz-feldspar pebble conglomerate. Coffinite is the principal uranium-bearing mineral and it occurs together with minor uraninite. Near-surface weathering of primary ore has produced a zone of oxide ore characterised by yellow and green secondary uranium minerals (meta-autunite and boltwoodite). Approximately 40% of the total ore occurs within reduced arkose, 30% within oxidised arkose, 10% in mixed arkose, and 20% is considered of the mudstone type.

Extensive drilling from 1982 to 1988 defined an initial inferred resource of 9 800 tU at an average grade of 0.13% U. From 1989 to 1992, geotechnical, metallurgical, hydrological and environmental activities were conducted, as well as a feasibility study to assess the viability of a conventional open-pit mining operation. This work was completed in 1991 at a total cost of USD 9 million. The CEGB study concluded that the project was uneconomic using the mining model adopted and the low uranium prices of that time, and so the project was abandoned in 1992.

In 1998, Paladin Resources Ltd (Paladin Energy Ltd as of 1 February 2000) acquired an interest in the Kayelekera Project, through a joint venture with Balmain Resources Ltd, which at that time held exploration rights over the project area. Engineering and financial evaluation work indicated a positive outcome for the project. In 2004, additional drilling was completed to improve confidence in resource estimates, and the pre-feasibility study was updated. Resource drilling and bulk sample drilling for metallurgical test work was completed in 2005 and a bankable feasibility study was then undertaken. Paladin purchased Balmain's remaining stake in the project in 2005 and became the sole owner.

Uranium exploration increased as a result of expanding resources at the Kayelekera mine and the potential for discovery of additional deposits in a similar geological setting in the Karoo Group sedimentary rocks. Between 2010 and 2012, Paladin Energy completed exploration drilling in areas to the northwest and south of the mine area with objectives of extending the existing ore body, as well as identifying and evaluating new ore bodies, including Mpata to the east and Juma to the south.

In 2006, the Livingstonia project area was explored by Globe Resources, who drilled 94 holes totalling 11 533 m. In July 2010, Resource Star did an additional 1 502 m of drilling in 13 holes to establish a JORC compliant inferred resource of 7.7 million tonnes of ore grading 0.0229% U. In 2013, Resource Star, the operator of the Livingstonia Project, reported that thickened zones of mineralisation are open to the northeast, and that the sparse drilling in the southern zone increases potential for additional mineralisation being defined.

Another potential uranium resource is the Kanyika niobium project is held by Globe Metals and Mining Limited. Uranium is an important by-product in the complex niobium and tantalum ore in a pegmatite quartz vein, hosted in Proterozoic felsic schists. Niobium and tantalum products would be produced with uranium as a by-product. In 2011-2012, Globe Metals & Mining Limited continued development of the Kanyika deposit. Total drilling, reverse circulation and diamond drilling, amounted to 40 540 m. As of December 2012, total resources amount to 68.3 Mt of ore at an average grade of 0.28% Nb_2O_5, 0.0135% Ta_2O_5 and 0.0067% U (4 550 tU).

Recent and ongoing uranium exploration, and mine development activities:

Lotus Resources Ltd (Lotus), through its subsidiary Lotus Africa Limited (LAL), acquired the Kayelekera project in March 2020 and the Livingstonia prospect in 2021. Lotus owns 85% of LAL, with the remaining 15% held by the Government of Malawi.

In early 2022, the company released an updated mineral resource estimate for Kayelekera showing measured, indicated, inferred and stockpiled resources of 46.3 million pounds U_3O_8 (17 810 tU) grading 0.05% U_3O_8 (0.0425% U). The Kayelekera resource upgrade was completed as part of evaluation studies for the Restart Definitive Feasibility Study (DFS), which Lotus released in August 2022, showing that Kayelekera could purportedly recommence production within 15 months of a Final Investment Decision (FID). The Restart DFS is underpinned by an ore reserve of 23 million pounds U_3O_8 (8 850 tU) at 0.066% U_3O_8 (0.056 %U) with the mine plan based on 96% ore reserves and 4% inferred mineral resources. In 2024, Lotus reported Kayelekera combined in situ measured, indicated and inferred resources of 17 810 tU (46.3 million pounds U_3O_8), using a cut-off grade of 0.05% U_3O_8.

Lotus Resources' regional exploration conducted in 2022 defined an inferred mineral resource estimate of 6.9 MT at 320 ppm U_3O_8, (1 870 tU) at the Livingstonia deposit, and at Chilumba deposit one of seven drillholes intersected at 38 m depth a 12 m thick uranium anomaly (best intercept 3 m at 382 ppm U_3O_8).

Uranium resources

Identified conventional resources (reasonably assured and inferred resources)

As of 1 January 2025, Malawi's total recoverable identified resources were 18 640 tU, unchanged since 1 January 2023. This is based on resources at three projects: the Kayelekera mine (14 412 tU), Livingstonia deposit (1 498 tU) (both of which are sandstone deposits), and Kanyika niobium-tantalum deposit (2 730 tU), where uranium may be produced as a by-product. During 2021 and 2022, recoverable uranium resources increased by 2 368 tU, as a result of new resource evaluations completed by Lotus Resources Ltd, for the Kayelekera and Livingstonia deposits.

Uranium production

Historical review

The Kayelekera mine is located in the Karonga District in the Northern Region of Malawi, about 600 km by road from the capital city of Lilongwe. This was the first mine to have produced uranium in Malawi. However, as a result of sustained, low uranium prices, the mine was placed into care and maintenance in February 2014.

Prior to care and maintenance, uranium production was by open pit, with an annual production of 1 270 tU. Uranium was recovered using a solvent extraction process, with sulphuric acid as the lixiviant and sulphur dioxide/air mixture as the oxidant. The plant utilised a resin-in-pulp (RIP) process that was the first in the Western world for uranium production. Transport of the product was by road to Walvis Bay in Namibia, via Zambia, with first delivery undertaken on 17 August 2009.

Ground movements in the open-pit mine, which were first noted in 2010, continue to be monitored using installed prisms and inclinometers, to provide information for timely management of emerging issues.

Status of production facilities, production capability, recent and ongoing activities, and other issues

Lotus and the Government of Malawi signed a Mine Development Agreement ("MDA") in July 2024 that guarantees a Stability Period of 10 years during which the project will not be subject to any detrimental changes to the fiscal regime.

In October 2024, the Company released the Front-End Engineering Design (FEED) programme with an accelerated restart plan for Kayelekera. The FEED study confirmed initial restart capital expenditure for first production of USD 50 million and an 8-10-month timeline to first uranium production. Highlights included:

- First production projected to start in Q3 2025;
- 10-year Life of Mine (LOM), with total production of 19.3 Mlb U_3O_8 (7 424 tU) and annual production of 2.4 Mlb U_3O_8 (923 tU) over the first seven years;
- Competitive cash costs of USD 34.5/lb U_3O_8 (USD 89.7/kg U) and AISC of USD 44.8/lb U_3O_8 (USD 116.5/kg U) during steady state (first 7 years of production).

Ownership structure of the uranium industry

Lotus Africa Limited (LAL), a company incorporated in Malawi on 1 August 2000 (Company Registration No. 5664), which owns the mining rights for Kayelekera mine, is, in turn, owned primarily by Lotus Resources Ltd, an Australian-listed public company. Lotus holds 85% of the equity in LAL and the remaining 15% interest is held by the Republic of Malawi. The mine site is covered by the Mining Licence ML0152, granted over an area of 55 km^2 and expires on 1 April 2037.

LAL also holds rights for EL502 (Juma-Miwanga), EL583 and EL595 (Livingstonia), and EL812 (Nthalire). All of these areas are important for LAL to explore for potential discovery of economic uranium resources that would extend the mine life of Kayelekera mine.

Employment in the uranium industry

Kayelekera will provide more than 450 local jobs and a Community Development Agreement signed in January 2025 will provide broad support to local communities.

Future production centres

Globe Metals & Mining submitted the environmental impact assessment for the Kanyika niobium project for public review in May 2012. According to Globe, the aim of the project is to produce niobium and tantalum products with potential production of uranium and zircon. Uranium would be produced as a by-product at a nominal rate of 60 tU/yr in the form of ammonium di-uranate. Mining will involve the extraction of ore from a single open pit, at a rate of 1.5 million tonnes per annum using conventional open-pit drill and blast, followed by truck shovel load and haul. The final open pits are expected to have dimensions in the order of 250 m in width, 2.2 km in length (north-south) and 130 m in depth. The project will produce approximately 52 million tonnes of solids to tailings over the mine life (estimated in excess of 20 years).

As of January 2023, Globe Metals and Mining had been issued with a mining licence and the Mine Development Agreement (MDA) was signed thereafter.

Uranium production centre technical details

(as of 1 January 2025)

	Centre #1	Centre #2
Name of production centre	Kayelekera	Kanyika
Production centre classification	Care and maintenance	Planned
Date of first production (year)	2009	NA
Source of ore:		
Deposit name(s)	Kayelekera	Kanyika
Deposit type(s)	Sandstone	Intrusive
Recoverable resources (tU)	14 412	2 730
Grade (% U)	0.066	0.008
Mining operation:		
Type (OP/UG/ISL)	OP	OP
Size (tonnes ore/day)	4 000	6 000
Average mining recovery (%)	75	NA
Processing plant:		
Acid/alkaline	Acid	NA
Type (IX/SX)	SX	NA
Average process recovery (%)	80	NA
Nominal production capacity (tU/year)	1 270	60
Plans for expansion (yes/no)	Yes	NA
Other remarks	Ramp up to 1 460 tU/yr	By-product

Environmental activities and socio-cultural issues

There are no updates for the current reporting period.

Uranium requirements

Malawi has no plans for nuclear power.

Uranium policies, uranium stocks and uranium prices

National policies relating to uranium

In 2010, Malawi enacted the Uranium Mining and Milling Regulations as an intermediate instrument to complement the Mines and Minerals Act, and other applicable legislation governing nuclear materials and radiation safety.

In 2011, the National Assembly passed the Atomic Energy Act, which provides for adequate protection of people and the environment against harmful effects of ionising radiation, through the implementation of the mandate to exercise regulatory control over radiation sources, and nuclear and radioactive materials. Under the same Act, the Atomic Energy Regulatory Authority (AERA) was established. AERA, among other responsibilities, regulates exploration, mining and processing of radioactive material, and utilisation of nuclear science and technology, and its applications. The Malawi Environment Protection Authority (MEPA), operating under the Ministry of Environment and Climate Change, was established following the enactment of the Environment Management Act of 2017 and is mandated to regulate environmental protection issues throughout the country

In 2024, the Mines and Minerals Act of 2023 was published, followed by the formal establishment and operationalisation of the Mining and Minerals Regulatory Authority in October 2024. The Mining and Minerals Regulatory Authority serves as the regulator for all mining activities in Malawi, including uranium mining, while the Ministry of Mining remains responsible for mining policy development.

Reasonably assured resources by production method

(recoverable tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Open-pit mining (OP)	0	0	NA	11 572	81
Co-product and by-product	0	0	0	2 205	60
Total	0	0	NA	13 777	76

Reasonably assured resources by processing method

(recoverable tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional from OP	0	0	NA	11 572	81
Other or unspecified	0	0	0	2 205	60
Total	0	0	NA	13 777	76

Reasonably assured resources by deposit type

(recoverable tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Sandstone	0	0	NA	11 572
Intrusive	0	0	0	2 205
Total	0	0	NA	13 777

Inferred resources by production method

(recoverable tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Open-pit mining (OP)	0	0	NA	4 338	81
Co-product and by-product	0	0	0	525	60
Total			NA	4 863	78

Inferred resources by processing method

(recoverable tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional from OP	0	0	NA	4 338	81
Other or unspecified	0	0	0	525	60
Total	0	0	NA	4 863	78

Inferred resources by deposit type

(recoverable tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Sandstone	0	0	NA	4 338
Intrusive	0	0	0	525
Total	0	0	NA	4 863

Historical uranium by production method

(tonnes U in concentrates)

Production method	Total through end of 2022	2023	2024	Total through end of 2024	2025 (preliminary)
Open-pit mining	4 217	0	0	4 217	0
Total	4 217	0	0	4 217	0

Historical uranium production by processing method

(tonnes U in concentrates)

Processing method	Total through end of 2022	2023	2024	Total through end of 2024	2025 (preliminary)
Conventional	4 217	0	0	4 217	0
Total	4 217	0	0	4 217	0

Mid-term production projection

(tonnes U/year)

2025	2030	2035	2040	2045	2050
0	1 000	500	0	0	0

Mid-term production capability

(tonnes U/year)

2025				2030			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
N/A	N/A	1 000	N/A	N/A	N/A	1 000	N/A

2035				2040			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
N/A	N/A	1 000	N/A	N/A	N/A	N/A	N/A

2045				2050			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Mauritania *

Uranium exploration and mine development

Historical review

The first uranium exploration project in Mauritania was carried out in 1959 by France's Atomic Energy Commission in the Ogmane anticline.

In 1972, following the discovery of surficial-type uranium deposits in Western Australia, uranium exploration was initiated in the Reguibat Range by Total Compagnie Française de Pétrole (in a joint venture with the Société Mauritanienne de Recherches Minières, the French Atomic Energy Commission, and Tokyo Uranium Development Company). The two exploration permits covered a total area of 164 000 km², divided into four blocks (Chami, Bir Hoghrein, Nouadhibou and Ghallamane). In 1975, the total area was reduced to five blocks totalling 41 000 km², and these joint ventures were modified after the founding of French Minatome SA and Compagnie Générale des Matières Nucléaires.

These joint ventures held the areas until 1983. Work on the permits was carried out between 1972 and 1975, and again in 1981, and targeted the evaluation of surficial-type deposits (Reguibat Range), as well as occurrences in the Precambrian basement, where radioactive anomalies were found associated with syenites and granites (Bir En Nar, Tigismat, Tenebdar). In 1983, all uranium exploration activities were suspended.

In 2006, Mauritania's Ministry of Petroleum, Energy and Mines began implementing a project, "*Projet de Renforcement Institutionnel du Secteur Minier (PRISM-II)*", with the US Geological Survey, to define the mineral resource potential of the country. It included delineation of areas permissive for calcrete-hosted, granite-hosted vein/shear, alkaline intrusive-hosted, unconformity-related, quartz pebble conglomerate-hosted, phosphate, sandstone-hosted and red bed-type uranium deposits. The results were published in 2013 (USGS Open-File Report 2013-1280).

In November 2006, the United Kingdom's Alba Mineral Resources, along with Mauritania Ventures Limited, started to investigate the uranium potential of areas located in north-east Mauritania. The area is considered prospective for unconformity-type uranium mineralisation. The permits cover significant areas of an unconformable contact between Early Proterozoic reworked granitic terrain and overlying sediments of Late Proterozoic to Carboniferous age. Airborne geophysics, flown on behalf of the Mauritanian government, revealed radiometric anomalies within a mapped, organic-rich unit near the base of this sedimentary sequence and coincident with its intersection with large, deep penetrating crustal shear structures. Uranium mineralisation is known in the north and north-west part of the permit area, hosted in granites and rhyolites, cut by these shear structures. On 3 November 2010, Alba Mineral Resources was notified that the mining authorities in Mauritania had withdrawn the licence, citing a lack of additional exploration activity.

In December 2007, Australia's Forte Energy NL (Forte) completed its first drilling programme in Mauritania, a 4 006 m reverse circulation programme of 41 holes of 50-150 m depth each. The drilling was carried out in the Bir En Nar area of the Zednes region and followed up on high-grade results previously obtained. Downhole radiometric logging results indicated numerous high-grade uranium intersections, including 1.55 m at 18 280 ppm U (1.83% U). The results of

* Report prepared by the NEA/IAEA, based on previous Red Books and company reports.

drilling a second group of 21 holes yielded up to 6 310 ppm U (0.63% U) over 1 m, and 576 ppm U (0.058% U) over 19 m.

Forte held several uranium exploration licences in Mauritania, including for the A 238 and Bir En Ar areas. The A 238 and Bir En Ar uranium prospects are associated with granites near Bir Moghrein in the north of Mauritania. At the A 238 prospect, the main zone of mineralisation extends over a strike length of 1.75 km, with mineralisation extending down to over 250 m from the surface with widths of over 60 m, within 50 m of the surface. Following the positive results of the 2009/10 reverse circulation (RC) drilling, a further RC drilling programme of around 11 300 m commenced in October 2010, focussing initially on anomaly A 238. Preliminary results from A 238 indicated the potential for a shallow, large-volume, medium-grade deposit. A total of approximately 10 450 m of RC and diamond core drilling has been carried out, resulting in an announcement, in June 2011, of initial JORC code compliant U resources for A 238 of 26.5 Mt at 217 ppm U (0.0217% U) for 5 730 tU (85 ppm U cut-off; 0.0085% U). After completing a further 63 holes (8 567 m) of RC drilling in 2011/12, an updated JORC resource was announced in April 2012, for A 238. The deposit remains open along strike. In 2015, Forte was delisted and its leases in Mauritania expired.

Indicated and inferred resources – A 238 and Bir En Ar uranium prospects (2012)

Deposit	Resource category	Average grade (ppm U)	Tonnes of U
A 328	Inferred	199 (0.02% U)	9 000
Bir En Nar	Indicated Inferred	751 (0.0751% U) 488 (0.0488% U)	385 385
Total	Indicated Inferred	751 (0.0751% U)* 204 (0.0204% U)*	385 9 385

* Weighted-average grade by proportional amount of tU.

Australia's Aura Energy (Aura) owns the Tiris project (previously known as the Reguibat project), which comprises several laterally extensive developments of calcrete uranium mineralisation in northern Mauritania. Between November 2010 and February 2011, Aura completed a drilling programme which covered all of Aura's wholly owned permits, as well as its joint venture permits, which totalled over 9 100 m in 2 022 holes. A JORC code-compliant uranium resource estimate, based on these drilling results, was released in 2012, with total Tiris project resources (85 ppm U cut-off) of 18 847 tU at 283 ppm U (770 tU indicated resources at 254 ppm U, and 18 077 tU inferred resources at 284 tU).

In 2014, Aura conducted a scoping study that confirmed that Tiris could be a robust project with shallow mineralisation that could be upgraded through simple beneficiation to high-grade leach feed. The study indicated that some 4 200 tU could be produced over an initial mine life of 15 years, using only 20% of the project's total 2012 mineral resource estimate. The project would require a capital investment of about USD 50 million, would have an operating cost of USD 30/lb U_3O_8 (USD 78/kgU) and a mine-life average production rate of 290 tU/yr.

Additionally, extensive radiometric surveys allowed Aura to estimate an exploration target of an additional 19 000 tU, implying a total mineral resource target of around 38 000 tU at Tiris.

In 2015-2016, Aura continued to conduct test and validation work aimed at defining optimal methods for the recovery of uranium. Additional verification/validation programmes were completed, including downhole gamma logging, disequilibrium test work, trenching of the mineralisation and detailed ground radiometric surveying.

Aura highlighted the very fine-grained nature of the uranium-bearing mineral, carnotite. This fine-grained character, together with the high, short-range grade, presents challenges in sampling. Carnotite tends to occur as small lenses, nuggets and coatings in or on the calcrete. Its distribution varies from deposit to deposit. This variability requires understanding and management in upgrading resources to measured and indicated status. In general, variability reduces as sample size increases, and for that reason, the 2015 drilling employed a larger diameter drill bit than that used in the earlier resource drilling programmes, resulting in a 50% greater sample size. However, even with the larger sample size, grade variability has still been relatively high. To test the effectiveness of gamma logging at Tiris, 63 holes that had been drilled and cased in 2015 were gamma logged. The results of this work were positive, and Aura is now using downhole gamma logging for its resource upgrade work.

In 2016, the Tiris project progressed to the feasibility study stage. In 2017, Aura continued the Tiris feasibility study, including the following activities: mining lease application, resource definition, geophysics and drilling for the definition of water resources, metallurgical test-work, simulation and flowsheet development, early-stage engineering, completion of an Environmental and Social Impact Assessment (ESIA), and a community consultation process.

In 2017, a programme of ground radiometric surveying was carried out over all Tiris uranium resource zones as well as priority exploration targets, such as Hippolyte South. The surveys were conducted on lines spaced 20 m apart. A programme to increase the proportion of Measured and Indicated Resources commenced in May 2017. This involved an extensive drilling programme on a 50 m x 50 m pattern, with each hole being gamma logged. A proportion of the holes have been drilled by large diameter triple tube diamond drilling, and the core was chemically assayed to validate the downhole gamma logging and to obtain density data throughout the zones drilled.

The Environmental and Social Impact Assessment was completed in 2017 by Earth Systems. The ESIA pays attention to issues of radiation exposure and the security of the yellowcake product. Best practice guidelines from the International Atomic Energy Agency (IAEA) and the International Commission on Radiological Protection (ICRP) have been used, complementing the applicable Mauritanian regulations and guidelines. The ESIA was approved by the Mauritanian government on 5 October 2017.

Recent and ongoing uranium exploration, and mine development activities

In April 2018, Aura undertook a programme of trenching within the Lazare North and Lazare South deposits (part of the Tiris East deposit group). A total of 11 trenches were completed, with eight in the Lazare South and three in the Lazare North deposits. Trenches were dug to a depth of 4 m. The focus of this programme was to collect representative samples for detailed test work.

On 27 August 2021, Aura released the results of a new resources estimate of the Tiris East deposits, that incorporated drill holes in the Sadi South Zone, not included in earlier resource estimates. This resulted in a total Tiris East resource estimate of 17 037 tU (2 038 tU measured resources at 200 ppm U, 5 461 tU indicated resources at 188 ppm U, and 9 538 tU inferred resources at 213 ppm U), a 2 080 tU increase compared to the 2011 estimate.

In 2021-2022, Aura completed a 10 000 m infill drilling programme with the objective of increasing confidence in the resource estimate. A new resource estimate of the Tiris project was completed in 2022. A reserve estimate, based on measured and indicated resources, using a uranium price of USD 65 /kgU and a cut off of 110 ppm U3O8 and including mining dilution, was released in 2023. Proven and probable reserves amount to 40.3 Mt of ore at an average grade of 0.0215 % U (8 680 tU). An estimate of the vanadium resource was also completed.

During the same period, Aura conducted metallurgical studies, including beneficiation pilot plant tests on the ore to upgrade the uranium concentration into a small fraction of the mined feed. Results from a simple wet screening circuit indicated an increase in uranium grade by 550%, with a mass reduction of 80% of the mined material and 90% recovery of uranium. In 2023 Aura acquired additional radiometric survey data, reviewed historical drilling results, and identified strong indications of mineralisation extensions on existing tenements that could significantly expand the current Tiris Project. Geologists identified seven new untested exploration targets, and an exploration program of 15 500 m air core drilling over approximately 78 km^2 on existing tenements was defined. From October 2023 to April 2024, 2 996 holes totaling 15 263 m were completed.

On 12 June 2024, Aura released a new resource estimate. Tiris' global mineral resources increased by 55% to 35 100 tU. An estimate of the vanadium resource was also completed (13 430 t V_2O_5).

Tiris East Resources (85 ppm U cut-off – 2021 estimate)

Deposit	Category	Ore (Mt)	Grade (%U)	U (tU)
Hippolyte	Measured	5.7	0.0191	1 077
	Indicated	6.5	0.0184	1 192
	Inferred	7.4	0.0238	1 769
Hippolyte South	Indicated	4.8	0.0163	769
	Inferred	3.1	0.0149	462
Hippolyte West	Inferred	6.3	0.0254	1 615
Lazare North	Measured	1.1	0.0241	269
	Indicated	10.6	0.0194	2 077
	Inferred	3.9	0.0178	692
Lazare South	Measured	3.4	0.0203	692
	Indicated	2.6	0.0186	500
	Inferred	9.1	0.0181	1 654
Sadi	Indicated	4.5	0.0204	923
	Inferred	14.9	0.0226	3 346
Total Tiris East	Measured	10.2	0.0200	2 038
	Indicated	29.0	0.0188	5 461
	Inferred	44.7	0.0213	9 538

Tiris East Resources (85 ppm U cut-off – 2024 estimate)

Deposit	Category	Ore (Mt)	Grade (%U)	U (tU)
Hippolyte East	Inferred	2	0.0146	308
Hippolyte North	Measured	11	0.0201	2 154
	Indicated	7	0.0202	1 423
	Inferred	9	0.0200	1 885
Hippolyte South	Indicated	5	0.0174	808
	Inferred	28	0.0153	4 231
Hippolyte West C	Inferred	4	0.0207	846
Marie	Inferred	10	0.0209	2 038
Lazare North	Measured	4	0.0247	923
	Indicated	10	0.0209	2 038
	Inferred	4	0.0254	923
Lazare South	Measured	8	0.0198	1 692
	Indicated	7	0.0184	1 192
	Inferred	6	0.0177	1 000
Sadi	Measured	11	0.0168	1 880
	Indicated	20	0.0159	3 231
	Inferred	17	0.0170	2 885
Total Tiri East	Measured	34	0.0195	6 650
	Indicated	48	0.0180	8 692
	Inferred	79	0.0178	14 115

Tiris West Resources (85 ppm U cut-off – 2024 estimate)

Deposit	Category	Ore (Mt)	Grade (%U)	U (tU)
Oum Ferkik	Inferred	22	0.0249	5 615

In December 2024, an Ore Reserve estimate was completed based on pit optimisation and mine schedules. The Tiris Uranium Project's Ore Reserve estimate increased by 49% to 62.8 Mt at 243 ppm U_3O_8 (0.021 %U), containing 33.6 Mlb of U_3O_8 (12 960 tU).

Deposit	Proved Ore Reserve			Probable Ore Reserve			Total Ore Reserve		
	Ore Mt	Grade % U	U t	Ore Mt	Grade Mt	U t	Ore Mt	Grade %U	U t
Lazare North	3.6	0.025	923	8.3	0.022	1 846	12.0	0.023	2 769
Lazare South	7.5	0.021	1 577	4.8	0.021	962	12.3	0.021	2 539
Hippolyte	7.6	0.023	1 769	7.5	0.023	1 692	15.0	0.023	3 461
Sadi	9.1	0.018	1 653	14.5	0.018	2 538	23.6	0.018	4 192
Total	27.8	0.021	5 922	35.0	0.020	7 038	62.8	0.021	12 960

In 2023 and 2024, exploration and evaluation expenses amounted to AUD 3 034 497 and AUD 5 032 482, respectively.

Uranium resources

Identified conventional resources (reasonably assured and inferred resources)

In 2012, Forte released a JORC code-compliant resource estimation for the A 328 and Bin En Ar deposits. Based on an 85 ppm U cut-off (0.0085% U), global resources for the A 328 and Bin Ar deposits totalled 385 tU in the indicated category, and 9 385 tU in the inferred category (in situ resources).

In June 2024, Aura released a new JORC code-compliant resource estimation for the Tiris project, including the Tiris East deposit group (Hippolyte, Marie, Lazare and Sadi deposits) and the Tiris West (Oum Ferkik) deposits. Based on an 85 ppm U cut-off (0.0085% U), global resources for the Tiris project total 15 342 tU in the measured and indicated categories, and 19 730 tU in the inferred category (in situ resources).

As of 1 January 2025, Mauritania's total identified resources (in situ) amount to 44 842 tU, an increase of 12 379 tU compared to 1 January 2023.

Undiscovered conventional resources (prognosticated and speculative resources)

Strong radiometric anomalies exist in Mauritania, similar to anomalies occurring with the known resources at Tiris. Aura's exploration has largely focussed on radiometric anomalies defined by regional airborne radiometric surveys. In 2016, Aura estimated an additional potential of 19 000 tU in the Tiris (Reguibat) area.

Uranium production

In 2014, Aura completed the Reguibat scoping study. Mineralisation occurs largely within 3-4 m of the land surface, in gravels and weathered granite. Most of the mineralisation occurs as single sheets with little or no cover. The material is largely unconsolidated and can be readily excavated by diggers or scrapers without blasting. The overlying waste consists of loose windblown sand. The strip ratio is anticipated to be approximately 0.25:1.

Simple washing and screening tests on the ore yielded encouraging results. Wet screening at 75 µm resulted in the rejection of 80% by weight with the retention of 91% of the uranium into the screen undersize. This represents a sevenfold upgrade factor from the 334 ppm U (0.0334% U) resource grade. These results may be explained by the extremely fine size and ready liberation of the uranium mineral, carnotite, and the large difference in particle size distribution between the carnotite and the bulk of the host rock minerals. Following a series of encouraging small-scale preliminary tests, a standard leach test on -300 µm beneficiated material confirmed earlier results, with 92% uranium extraction within 4 hours and 95% after 8 hours.

The 2014 scoping study estimated total initial capital costs for the project at AUD 50 million, with life of mine average unit operating cost estimated to be USD 30.3/lb U_3O_8 (USD 11.65/kgU). Total production of approximately 3 850 tU over the 15-year mine life was assumed, at an annual production rate of approximately 385 tU per year in years 2 and 3, followed by steady-state production rate of approximately 250 tU.

A feasibility study was undertaken in 2015, with a view to a simple truck and shovel mine on the eastern deposit, feeding an AUD 50 million plant and production at about 400 tU/yr.

On 29 July 2019, Aura released the results of a Definitive Feasibility Study, which confirmed that the Tiris uranium project is a low-cost development. The project is designed to support an open-pit mine, a 1.25 million tonnes of ore per year processing plant and supporting infrastructure. The uranium mineralisation lies largely within 3 to 5 m of the surface in a relatively soft, free-digging material containing patchy calcrete. Based on trenching and metallurgical test work to date, the mineralisation does not require blasting before mining, or crushing before beneficiation.

Three mining areas can be developed in a practical sequence to produce 310-425 tU per year through the processing plant, for 15 years. The processing facility will consist of three main sections: the beneficiation circuit, the uranium extraction circuit (alkaline leach – solid/liquid separation – ion exchange), and the uranium purification and precipitation circuit. Uranium recovery is expected to be 86.1%. Vanadium could be recovered as vanadium pentoxide (V_2O_5), through a standard precipitation and purification process. Target production is 115 t V_2O_5 per year. The cost to develop and operate the mine for ten years has been estimated at USD 66 million, or USD 2.24 per tonne of material mined. The total operating cash cost is estimated to be USD 25.43/lb U_3O_8 (USD 66.1/kgU). The all-in sustaining cost (inclusive of royalties, LOM sustaining capital, insurance and product transport) is estimated at USD 29.81/lb U_3O_8 (USD 77.5/kgU).

Two exploitation licences covering 390 km^2 were granted to Tiris Resources SA, a Mauritanian registered subsidiary of Aura Energy Limited, on 8 February 2019. The two licences cover the Eastern Tiris resources at Oued El Foule and Ain Sder. An application for a 38 km^2 exploitation licence remains pending over the smaller Western Tiris resource at Oum Ferkik.

In 2021-2022, Aura completed an Enhanced Definitive Feasibility Study of the Tiris uranium project. Compared to the 2019 study, projected annual production increased by 150% from 0.8 Mlbs U_3O_8 (310 tU) to 2.0 Mlbs U_3O_8 (770 tU). Total operating cost, including AISC, is estimated at USD 28.77/lb U_3O_8 (USD 75/kgU).

In 2024 Aura completed extensive hydrogeological studies at the Tiris Uranium Project, confirming the availability of sufficient water resources to support future operations.

On 12 July 2024, the National Authority for Radiation Protection, Safety and Nuclear Security issued the authorisation to develop, mine and produce uranium oxide concentrate at the Tiris project. Aura is planning to start uranium production in 2026-2027, with an annual production of 2 Mb U_3O_8 (770 tU) and with an expected mine life of 25 years. Total operating cost, including all-in sustaining cost, is estimated at USD 35.7/lb U_3O_8 (USD 92.8/kgU). Total initial development capital costs are estimated at USD 230 million.

Ownership structure

The project is 100% owned by Tiris Resources SARL, which is 85% owned by Aura Energy Ltd and 15% by the Mauritanian Government's Agence Nationale de Recherches Géologiques et du Patrimoine Minier (ANARPAM).

Uranium production centre technical details

(as of 1 January 2025)

	Centre #1
Name of production centre	Tiris
Production centre classification	Planned
Date of first production (year)	2027
Source of ore:	
Deposit name(s)	Lazare N and S, Hippolyte
Deposit type(s)	Calcrete
Recoverable resources (tU)	12 960
Grade (% U)	0.021
Mining operation:	
Type (OP/UG/ISL)	OP
Size (tonnes ore/year)	4.18 Mtpa
Average mining recovery (%)	90
Processing plant:	
Acid/alkaline	Alkaline
Type (IX/SX)	IX
Size (tonnes ore/day)	NA
Average process recovery (%)	88
Nominal production capacity (tU/year)	770

Reasonably assured conventional resources by production method

(recoverable tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Open-pit mining (OP)	0	0	12 270	12 270	80
Unknown	0	0	0	290	75
Total	0	0	12 270	12 560	80

Reasonably assured conventional resources by processing method

(recoverable tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional from OP	0	0	12 270	12 270	80
Unknown	0	0	0	290	75
Total	0	0	12 270	12 560	80

Reasonably assured conventional resources by deposit type

(recoverable tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Granite-related	0	0	0	290
Calcrete	0	0	12 270	12 270
Total	0	0	12 270	12 560

Inferred conventional resources by production method

(recoverable tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Open-pit mining (OP)	0	0	15 780	15 780	80
Unknown	0	0	0	7 040	75
Total	0	0	15 780	22 820	78

Inferred conventional resources by processing method

(recoverable tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional from OP	0	0	15 780	15 780	80
Unknown	0	0	0	7 040	75
Total	0	0	15 780	22 820	78

Inferred conventional resources by deposit type

(recoverable tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Granite-related	0	0	0	7 040
Calcrete	0	0	15 780	15 780
Total	0	0	15 780	22 820

Speculative conventional resources

(in situ tonnes U)

Cost ranges		
<USD 130/kgU	<USD 260/kgU	Unassigned
NA	NA	19 000

Mid-term production projections (tonnes U/year)

2025	2030	2035	2040	2045	2050
0	770	770	770	NA	NA

Mongolia

Uranium exploration and mine development

Historical review

The history of uranium exploration in Mongolia can be divided into three phases. The first phase started immediately after World War II, with investigations directed at the search for uranium contained in other, non-uranium deposits. During the period of 1945-1960, numerous uranium occurrences were discovered in the brown coal deposits of Eastern Mongolia.

The second phase of exploration covered the period between 1970 and 1990. Under a bilateral agreement between Mongolia and the former Soviet Union, specialised geological surveys were conducted by the Geological Reconnaissance Expedition of the Soviet Ministry of Geology, with a result of 1 600 radioactive anomalies and hundreds of radioactive occurrences identified by the joint expedition. Full airborne gamma-ray spectrometric surveys at a scale of 1:25 000 and 1:50 000 were conducted over 420 000 km^2, covering about 27% of Mongolian territory; at a scale of 1:200 000 over 450 000 km^2, covering about 28% of the territory; and at a scale of 1:1 000 000 over 224 000 km^2 in the Altai, Khangai mountains and Gobi Desert, covering about 14% of the Mongolian territory. The territory along the border with the People's Republic of China and the central Mongolian mountain area – about 30% of the country – was not included in these surveys. Metallogenic investigations at the scale of 1:500 000 over a 500 000 km^2 area, and more detailed geological mapping and exploration at the scale of 1:200 000-1:50 000 over 50 000 km^2 of territory in Mongolia, were also completed. This work included 2 684 000 m of surface drilling, 3 179 000 m^3 of surface trenching, and 20 800 m of underground exploration.

The third phase of exploration started in the 1990s with private stakeholder engagement, including local and foreign entities. As a result of the depressed uranium market, exploration strategies changed globally towards the exploration for low-cost uranium deposits, especially for sandstone-type. Uranium exploration was focussed on Mesozoic and Cenozoic basins in southeast Mongolia. The state-owned manufacturing enterprise, "Uranium," in co-operation with the International Atomic Energy Agency (IAEA), assessed the uranium potential of Mongolia in two phases between 1993 and 2001. The studies that were completed focussed on identifying the potential for uranium mineralisation in sedimentary and metasomatised settings.

Based on these surveys, the territory of Mongolia was classified into four uranium-bearing metallogenic provinces by Mironov (2006): Mongol-Priargun, Gobi-Tamsag, Khentei-Daur and Northern Mongolia. Each of these provinces has a different geology and hosts different deposit types. Mineral associations and ages of mineralisation also vary. Within these provinces, 13 uranium deposits, about 100 uranium occurrences, and 1 400 showings and radioactive anomalies were identified.

The Mongol-Priargun metallogenic province is located in Eastern Mongolia, coinciding with a 70 to 250 km wide continental volcanic belt that can be traced over some 1 200 km, from the Mongolian Altai to the Lower-Priargun region. This territory includes deposits and occurrences with fluorite-molybdenum-uranium associations, resulting from volcano-tectonic events. Distinct uranium mineralisation districts of the Northern Choibalsan, Berkh, eastern and central Gobi are included in this area. The Dornod ore field of Northern Choibalsan includes the uranium deposits of Dornod, Gurvanbulag, Mardaingol, Nemer and Ulaan, as well as other polymetallic and fluorite associations. The Choir and Gurvansaikhan Basins of the eastern and central Gobi uranium mineralisation district include the Kharaat and Khairkhan uranium deposits, among others.

The Gobi-Tamsag metallogenic province covers a territory 1 400 km long by 60 to 180 km wide in southern Mongolia. It is characterised by numerous uranium occurrences in terrigenous sediments. The district includes a prospective uranium deposit in the south, near the Dulaanuul and Nars deposits, and numerous other occurrences, as well as other prospective uranium-bearing sedimentary basins, such as the Tamsag, Sainshand and Zuunbayan Basins, among others.

The Henter-Daur metallogenic province (700 km long by 250 km wide) includes the Khangai and Khentii mountains. In this area, uranium occurrences in granite can be found, such as the Janchivlan ore field, which shows some promise of becoming a deposit of economic interest.

The Northern Mongolian metallogenic province is the largest (1 500 km long by 450 km wide) of the four metallogenic provinces. The northwestern part of Mongolia is characterised by a variety of minerals such as uranium, thorium and rare earth elements related to alkaline mineralisation, and uranium and thorium in metasomatites, pegmatite, magmatic and quartz schist host rocks.

Recent and ongoing uranium exploration, and mine development activities

There are two types of uranium exploration activities in Mongolia: prospecting aimed at the discovery of new deposits and the exploration of previously discovered deposits to increase resource endowments.

Four companies are conducting exploration activities in Mongolia. From 2022, most of the uranium prospecting was performed in the south Mongolian sedimentary basins to identify sandstone-type uranium mineralisation that is amenable to in situ leach (ISL) mining.

Badrakh Energy conducted major exploration and development activities during 2019-2020 at the Zuuvch Ovoo and Dulaan Uul uranium deposits, in Dornogobi province in southeastern Mongolia. As a result, the uranium resources of the Zuuvch Ovoo deposit were increased to 93 291 tU and a technical report was submitted to the Mongolian Professional Committee of Resources in February 2020. The deposit will be mined by ISL methods using sulphuric acid. Test mining was conducted on two hexagonal cells located 470 m from each other, each of which consists of six injection wells and one production well. Fifteen groundwater monitoring wells were drilled and equipped outside and inside of each cell and at different aquifer horizons along the direction of groundwater flow. After receipt of all required authorisations from Mongolian governmental authorities, Badrakh Energy started the ISL pilot test at the North ISL cell in July 2021 and on 10 August 2021, the pilot test successfully produced its first kilogramme of uranium concentrate. ISL pilot test acidification at the south cell subsequently started in March 2022, and both North and South ISL wells continued to operate until December 2022. At the end of 2022, the Zuuvch Ovoo pilot plant had produced 7.9 tU.

As a result, key technical and economic parameters for future ISL commercial production were obtained. The pilot test results confirmed the economic and environmental feasibility of the project. The Feasibility Study was finalised and was discussed with the Mineral Resources Professional Council of Mongolia. Commercial production is planned to begin in 2030 with a nominal production capacity of 2 500 tU/yr. As of January 2025, feasibility studies for eight deposits had been completed and approved by the Mineral Resources Professional Council of Mongolia.

Mine development work including a feasibility study, an environmental study, an optimal design study of the hydraulic distribution network, a geotechnical study, a fibre optic study, a chemical reagent transportation and a storage study, were compiled in 2023-2024.

Gurvansaikhan LLC holds licences for the Kharaat, Khairkhan, Ulziit and Gurvansaikhan uranium deposits in the Middle Gobi province in south Mongolia. Major exploration activities were conducted during 1998-2012 and resources equalling 23 021 tU were accepted by the Mongolian Professional Committee of Resources. In 2022 the company restarted activities and conducted an additional 40 662 m of exploration drilling. Gurvansaikhan LLC is working on a technical report to confirm its resources according to JORC standards, based on exploration results.

Exploration and mine development expenditures

Uranium exploration expenditures in Mongolia amounted to MNT 197 million (Mongolian Tugrik) (approximately USD 71 000) in 2020, MNT 209 million (approximately USD 74 000) in 2021, and increased significantly to MNT 13 208 million (approximately USD 4.2 million) in 2022. No exploration drilling was carried out in 2020 and 2021, compared with 40 662 m reported in 2022. No exploration drilling was carried out in Mongolia in 2023-2024. Industry development expenditures carried out during 2022-2024 include Badrakh Energy pilot test works, feasibility and environmental studies.

Identified conventional resources (reasonably assured and inferred resources)

As of 1 January 2025, Mongolia’s total identified conventional recoverable resources amounted to 144 620 tU, while in situ resources comprised 192 241 tU. Recoverable conventional resources include 66 234 tU of reasonably assured resources (RAR) and 78 386 tU in the inferred category. All resources are recoverable at <USD 130/kgU, and 16 883 tU are recoverable at a cost of <USD 80/kgU by the acid ISL method.

Undiscovered conventional resources (prognosticated and speculative resources)

As of 1 January 2025, prognosticated resources (P1 in national classification) amounted to 13 300 tU. Speculative resources (P2 and P3) totalled 1 030 000 tU, which is about 290 000 tU lower than in the previous report. New estimations are based on previous and recent geological mapping and reconnaissance work.

Unconventional resources and other materials

No unconventional resources have been identified.

Uranium production

Historical review

Uranium production in Mongolia started with the operation of the Dornod open-pit mine in the Mardai-gol district in 1988 by the Russian-Mongolian JV “Erdes”. According to the original Feasibility Study, planned mining capacity was 2 300 tU/year and was based on known uranium resources of 40 279 tU of the Dornod and Gurvanbulag deposits, at an average ore grade of 0.17% U. The ores mined at the Dornod open pit were transported 484 km by rail to the Priargunsky mining and processing facility in Krasnokamensk, Russia. Erdes produced 535 tU during 1989-1995. Because of low uranium prices, political and economic changes in Mongolia, and in neighbouring areas of Russia, uranium production at Erdes was terminated in 1995.

Status of production facilities, production capability, recent and ongoing activities, and other issues

Currently, no uranium is being produced in Mongolia. However, several mines are in the planning stage of development.

Badrakh Energy has produced 2.53 tU from Dulaan Uul deposit and 7.91 tU from Zuuvch Ovoo deposit, during the industrial ISL pilot test in 2020-2023. The feasibility study of the Zuuvch Ovoo and Dulaan Uul deposits was updated based on Zuuvch Ovoo pilot test results and approved by the Mineral Resources Professional Council of Mongolia in January 2025.

The government of Mongolia signed an Investment Agreement with Orano Mining, an investor in the Mongolian-French joint venture, Badrakh Energy, on 17 January 2025.

Secondary sources of uranium

Production and/or use of mixed oxide fuels

Mongolia has not produced or used mixed oxide fuels.

Production and/or use of re-enriched tails

Mongolia currently does not have a uranium enrichment industry. Re-enriched tails are not used or produced.

Uranium production centre technical details

(as of 1 January 2025)

	Centre #1	Centre #2				Centre #3	
Name of production centre	Emeelt mines	Gurvansaihan				Badrakh energy	
Production centre classification	Prospective	Planned				Planned	
Date of first production (year)	NA	NA				2030	
Source of ore:							
Deposit name(s)	Gurvanbulag	Kharaat	Khairkhan	Gurvansaikhan	Ulziit	Dulaan uul	Zuuvch ovoo
Deposit type(s)	Volcanic	Sandstone	Sandstone	Sandstone	Sandstone	Sandstone	Sandstone
In situ resources (tU)	13 058	7 288	8 407	4 250	3 076	11 896	93 291
Grade (% U)	0.152	0.026	0.071	0.034	0.036	0.022	0.022
Mining operation:							
Type (OP/UG/ISL)	UG	ISL	ISL	ISL	ISL	ISL	ISL
Size (tonnes ore/day)	NA	NA	NA	NA	NA	NA	NA
Average mining recovery (%)	NA	NA	NA	NA	NA	79	79
Processing plan							
Acid/alkaline	Acid	Acid	Acid	Acid	Acid	Acid	Acid
Type (IX/SX)	IX	IX	IX	IX	IX	IX	IX
Size (tonnes ore/day)	NA	NA	NA	NA	NA	NA	NA
Average process recovery (%)	NA	NA	NA	NA	NA	99	99
Nominal production capacity (tU/year)	NA	NA	NA	NA	NA	500	2 500
Plans for expansion	No	No	No	No	No	No	No

Ownership structure of the uranium industry

The Nuclear Energy Law of Mongolia defines the ownership of radioactive minerals and state participation in the exploitation of radioactive minerals. Article 5 states that:

5.1: Radioactive minerals occurring in the subsoil of Mongolia shall be the property of the state.

5.2: Provided that the radioactive mineral deposit, for which exploration and reserves determination was conducted by state budget financing, and is jointly exploited with others, the state shall directly possess free of charge no less than 51% of shares of the company that will be set up jointly.

5.3: The state shall directly possess free of charge no less than 34% of shares of the company holding a special licence for exploitation of the radioactive mineral deposit, for which exploration and reserves determination were conducted without state budget involvement and was recorded in the state integrated register.

5.4: Provided the state owns shares exceeding the percentages specified in the clauses 5.2 and 5.3 of this law, the State Great Khural shall fix this share by presentation of the government in view of the size of investment made or to be made by the state.

5.5: The State Great Khural may determine otherwise upon submission by the government, taking into account the options for replacing the state ownership percentage and amount specified in Articles 5.2 and 5.3 of this law with special fees for the use of mineral resources, product sharing, changing the type of state-owned shares, and combining these, where the majority of the benefits accrue to Mongolia.

National policies relating to uranium

The Mongolian government considers the mining of uranium deposits an important national interest as it can positively influence and improve the national economy. As a result, the government has developed a special programme on uranium and is committed to implementing it.

The programme covers the following policies and guidelines:

- Exploring (geological) and mining of uranium deposits, processing and marketing of uranium ores in Mongolia. The purpose is to reduce Mongolian government investment and to encourage foreign investment.
- Developing intensive and effective co-operation with international organisations involved in the prospecting, mining and sale of uranium and other raw materials for nuclear energy.
- Developing necessary regulations, instructions and recommendations for activities related to uranium mining.
- Studying possibilities of recovering uranium from phosphate and brown coal deposits, and developing alternative extraction techniques.
- Training national specialists in the fields of radioactive minerals, nuclear energy and high technology in other countries, according to special programmes.
- Increasing the participation of national scientists and specialists in international and foreign organisations and projects, in the fields of radioactive minerals and nuclear energy.
- Training national personnel for uranium studies and production, and introducing advanced technology, instruments and tools of high precision.
- Setting up a government enterprise responsible for monitoring and co-ordinating uranium exploration and production, as well as developing and implementing government policy and strategies in the field of uranium exploration, based on mobilising efforts of national uranium specialists.

Uranium exploration and development expenditures, and drilling effort – domestic

(Mongolian tugrik millions)

	2022	2023	2024
Industry* exploration and development expenditures	13 208	9 180	13 800
Government development expenditures	0	0	0
Total expenditures	13 208	9 180	13 800
Industry* exploration drilling (m)	40 662	0	0
Subtotal exploration drilling (m)	40 662	0	0
Total drilling (m)	40 662	0	0

* Non-government.

Reasonably assured conventional resources by production method

(recoverable tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining (UG)	0	0	20 744	20 744	75
Open-pit mining (OP)	0	0	1 762	1 762	80
In situ leaching acid	0	7 572	43 728	43 728	75
Total	0	7 572	66 234	66 234	

Reasonably assured conventional resources by processing method

(recoverable tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional from UG	0	0	20 744	20 744	75
Conventional from OP	0	0	1 762	1 762	80
In situ leaching acid	0	7 572	43 728	43 728	75
Total	0	7 572	66 234	66 234	

Reasonably assured conventional resources by deposit type

(recoverable tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Sandstone	0	7 572	43 728	43 728
Volcanic-related	0	0	22 506	22 506
Total	0	7 572	66 234	66 234

Inferred conventional resources by production method
(recoverable tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining (UG)	0	0	15 582	15 582	75
Open-pit mining (OP)	0	0	5 263	5 263	80
In situ leaching acid	0	9 311	57 541	57 541	75
Total	0	9 311	78 386	78 386	

Inferred conventional resources by processing method
(recoverable tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional from UG	0	0	15 582	15 582	75
Conventional from OP	0	0	5 263	5 263	80
In situ leaching acid	0	9 311	57 541	57 541	75
Total	0	9 311	78 386	78 386	

Inferred conventional resources by deposit type
(recoverable tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Sandstone	0	9 311	57 541	57 541
Volcanic-related	0	0	20 845	20 845
Total	0	9 311	78 386	78 386

Prognosticated conventional resources
(in situ tonnes U)

Cost ranges		
<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
13 300	13 300	13 300

Speculative conventional resources
(in situ tonnes U)

Cost ranges		
<USD 130/kgU	<USD 260/kgU	Unassigned
1 030 000	1 030 000	NA

Historical uranium production by production method*

(tonnes U in concentrates)

Production method	Total through end of 2022	2023	2024	Total through end of 2024	2025 (expected)
Open-pit mining	535	0	0	535	0
Total	535	0	0	535	0

* Pilot ISL production is not assumed.

Historical uranium production by deposit type

(tonnes U in concentrates)

Deposit type	Total through end of 2022	2023	2024	Total through end of 2024	2025 (expected)
Volcanic-related	535	0	0	535	0
Total	535	0	0	535	0

Short-term production capability

(tonnes U/year)

2025				2030			
A-I	A-II	B-I	A-II	A-I	A-II	B-I	B-II
0	0	0	0	0	0	2 500	2 500

2035				2040			
A-I	A-II	B-I	B-II	A-I	A-II	B-I	B-II
0	0	2 500	2 500	NA	NA	NA	NA

Namibia [1]

Uranium exploration and mine development

Historical review

Uranium was first discovered in the Namib Desert in 1928 in the vicinity of the Rössing Mountains, but it was not until the late 1950s that the Anglo American Corporation of South Africa prospected the area through drilling and limited underground exploration. As a result of erratic uranium prices, lack of demand and limited economic prospects for uranium at that time, Anglo American abandoned its work.

With the upswing in the uranium market demand and prices, extensive uranium exploration started in Namibia in the late 1960s. Several airborne radiometric surveys were conducted and numerous anomalies were identified. In 1966, after discovering uranium occurrences, Rio Tinto acquired the rights to the low-grade Rössing deposit, located 65 km inland from the town of Swakopmund on the Atlantic coast. Trekkopje, a near-surface calcrete deposit just north of Rössing, and Langer Heinrich, another calcrete deposit situated 50 km southeast of Rössing, were also discovered during this period.

Mining commenced in 1976 at Rössing and exploration intensified as uranium prices increased sharply. However, in the early 1980s, the sharp decline in uranium prices caused rapid curtailment of exploration and mine development efforts.

Beginning in 2003, rising uranium prices once again stimulated extensive exploration activity, mainly in the Namib Desert. Based on earlier successes, two major types of deposits were targeted: the intrusive-type, associated with alaskite, as at Rössing; and the surficial calcrete-type deposits, as at Langer Heinrich.

In 2002, Paladin Energy bought the Langer Heinrich tenement. The Langer Heinrich uranium deposit is situated approximately 85 km east-northeast of the major Walvis Bay seaport. The ore occurs over 15 km in a paleochannel system, approximately 50 m deep. An exploration prospecting licence covered the western extension of the mineralised Langer Heinrich paleochannel. In 2005, this prospecting licence was converted into a mining licence. Construction at the Langer Heinrich project commenced in September 2005 and staged commissioning of the plant began in August 2006. Mining commenced in 2007, with a proposed 25-year life. However, due to sustained low uranium prices, Langer Heinrich was placed on care and maintenance in August 2018. In 2024, production was restarted (see section on recent and ongoing uranium exploration, and mine development activities).

In 2005, French state-owned Orano (at that time Areva) purchased Trekkopje from the Canadian company UraMin and began construction of an alkaline heap leach mine in 2008, as well as an associated seawater desalination plant. The Trekkopje Project, located approximately 65 km northeast of the coastal town of Swakopmund, includes the Klein Trekkopje and Trekkopje surficial uranium deposits, with 80% of the mineralisation contained in the top 15 m of strata below the surface. Hosted in calcrete sediments, the basal channels in the Trekkopje area follow the northeast trending structural grain of the underlying basement rocks. The mine was developed in a staged process, with Phase 1 "Mini" designed to validate the chemistry of

1. Report prepared by the NEA/IAEA and Namibian Uranium Institute.

the heap leach process successfully completed in 2009. Phase 2 "Midi" treated 3 million tonnes of ore to prove the commercial process before scaling up to full production. Phase 3 "Maxi" represented the full production stage of the mine, which was expected to produce about 3 000 tU per annum. However, due to the depressed uranium market, the mine was put on care and maintenance at the end of 2012.

Discovery holes for the Husab (initially known as Rössing South) uranium deposit were drilled by Extract Resources in late 2007 and chemical assay results were released in February 2008. The main part of the Husab ore body lies approximately 5 km south of the Rössing mine. Extract Resources and the current owner, Swakop Uranium Limited, completed over 800 000 m of combined reverse circulation and diamond core drilling in total, since the drilling programme began in 2006. This led to the discovery of one of the largest uranium deposits in the world, and development of the Husab Mine started in 2013. At the end of 2016, the first uranium oxide was drummed.

Bannerman Mining Resources Pty Ltd progressed the Etango project from an initial scoping study (2007) and pre-feasibility study (2009) to a definitive feasibility study in 2012. In total, over 300 000 m of exploration drilling has been completed in the Etango project area. In 2015, Bannerman commissioned a heap leach demonstration plant to demonstrate the proposed metallurgical process. Following this metallurgical test work, the flowsheet was changed from a heap leach/solvent extraction process to a heap leach/ion-exchange process, followed by nano-filtration. In 2018, Bannerman decided to develop the Etango Mine in a staged process – initially with a throughput of 22 000 tonnes of ore per day. This re-scaled Etango Mine was taken through the scoping study, pre-feasibility study and definitive feasibility study stages, between 2019 and 2022.

For the Rössing mine, since 2010, the main exploration focus has been on the southern Z20 deposit that extends across the lease boundary into the adjacent lease held by Husab. A total of 24 000 m of drilling was completed on Z20 from three phases of drilling by August 2013. Infill drilling of the eastern extension of the SJ ore body outside the current open pit was undertaken in 2015 and 2021-2022 as part of the SJ Phase 4 pushback Pre-Feasibility studies.

Reptile Mineral Resources and Exploration (Pty) Ltd (RMR) is a wholly owned Namibian registered subsidiary of the Australian public company, Deep Yellow Limited (DYL). Active in Namibia since 2006, RMR holds three exclusive prospecting licences including the Omahola, Tubas, Tumas and Aussinanis deposits. Deposits are hosted in leucogranites, also referred to as alaskites, and in surficial palaeochannel sediments. The Tumas palaeochannel system extends over more than 100 km. It contains secondary uranium mineralisation (carnotite) in fluviatile grit, calcrete and gravel sequences. The Tubas Sand project consists primarily of low-grade secondary uranium mineralisation (carnotite) in well-sorted aeolian sediments. The Aussinanis deposit forms a shallower palaeochannel system, also with carnotite-rich calcrete.

Elevate Uranium Limited is focussed primarily on identifying calcrete-hosted uranium deposits using innovative exploration techniques. The company holds several exploration licences across the Erongo region, including the Marenica, MA 7 and Koppies projects. From 2015 to 2020, the company suspended drilling activities due to depressed market conditions and focussed on metallurgical testing of the "U-pgrade™" beneficiation processes to increase the grade of mined ore, prior to leaching. Feed grade can be elevated by over 50 times to approximately 4 200 ppm U. Calcite rejection has also enabled the proposed leach circuit to be changed from an alkali leach to acid, thereby reducing expected capital expenses and operating costs.

Zhonghe is a Namibian registered company founded in 2008 by the China National Uranium Corporation (CNUC; 58%), a wholly owned subsidiary of the China National Nuclear Corporation (CNNC), and co-owned by two private companies, China Mineral Resources Investment and Development P/L Nam-China (21%) and Springbok Investment Ltd (21%). The Happy Valley project area was granted to Zhonghe Resources on 1 August 2006. Exploration work started in 2007 and JORC compliant in situ resources amounting to 40 730 tU at 0.016% U were defined. A feasibility study was undertaken from 2013 to 2018 while Zhonge Resources continued to focus on resource evaluation and economic reassessment.

Over 60 exploration licences were issued until early 2007, when a moratorium on new licences was imposed by the Namibian government pending development of new policies and legislation, primarily in response to concerns about water and energy requirements of uranium mining. In January 2017, the Namibian government lifted the 10-year moratorium on new applications for exploration licences for nuclear fuel minerals.

Recent and ongoing uranium exploration and mine development activities.

Rössing

A revision of the pricing outlook and detailed financial analysis resulted in the removal of the Z20 deposit from the 2016 JORC compliant resource declaration and reclassification to mineralised inventory. Since 2020, the SJ Phase 4 pushback has been included in the Rössing resource declarations. However, the resources contained within the Phase 2 and 3 pushbacks currently being mined, continue to demonstrate value. In February 2023, a bankable feasibility study was approved on the Phase 4 pushback, and the Phase 4 material moved into reserves. The mining licence was extended accordingly.

Exploration drilling resumed on the mining licence in 2022, to the east of the Z20 deposit at the Z17 deposit and about 12 500 m of diamond drilling was completed by the end of 2022. In 2023, exploration drilling continued on ML28, of which 23 of the holes were drilled into the Z17-Z19 anomalies, and 1 hole each was drilled into the Z23 and Z25 anomalies. In 2024, exploration drilling at the Z20 anomaly commenced, which included 323 m of reverse circulation drilling and 309 m of diamond drilling.

Langer Heinrich

A restart PFS was completed in June 2020, followed by a value study in October 2021. Restart activities commenced in July 2022 and were completed successfully in 2023. These activities included extensive refurbishment, process upgrades, and infrastructure optimisation aimed at improving operational efficiency and reliability of the processing plant.

First production restarted in the first quarter of 2024. The production ramp-up is ongoing and will continue over a four-year period, targeting a maximum annual output of 2 300 tU/yr. Operations have focussed on reclaiming stockpiled ore for the initial 18 months of production. Preparations for the resumption of mining and in-licence exploration are underway, with full-scale mining activities expected to begin in the latter half of 2025. The current life-of-mine plan remains at 17 years.

Trekkopje

While the operation is under care and maintenance, Orano has conducted research to improve uranium recovery. An optimised process was developed that enhances permeability in the heap by adding cement at the agglomeration stage and recovery of a substantial part of the reagents used is accomplished through membrane technology. In 2023, Orano conducted a pre-feasibility study for a potential reopening of the mine. In 2024, Orano started to study all options for Trekkopje development to understand the project feasibility.

The desalination plant built in association with the mine continues to supply sufficient water to meet the demand of other uranium mines and other users in the coastal area. The plant achieved an annual production of more than 15 million m^3 in 2024.

Husab

Swakop Uranium is a wholly-owned subsidiary of Taurus Minerals Ltd., which is an entity of China General Nuclear Power Group (CGN) and the China-Africa Development Fund. It holds tenure over a Mining Licence (ML 171) and two Exclusive Prospecting Licences (EPL 3439 and EPL 3138). The adjacent EPLs offer reasonable prospects for exploration and the discovery of additional uranium resources. In 2024, Swakop Uranium initiated a seven-year exploration plan aiming to discover additional uranium resources within the areas covered by the mining licence and the two EPLs, in support of the company's sustainable development strategy.

The primary exploration focus in ML 171s area is on assessing the resource potential of mineralised zones surrounding the open pits of Zone 1 and Zone 2 that are currently being mined. The future work plans for Zones 3, 4 and 5 will be determined based on the results of the 2025 resource evaluation and a preliminary study to be conducted in 2026.

Exploration activities on EPL 3138 have been directed towards the assessment of the uraniferous alaskites within the Damara metasediments and the Abbabis Metamorphic basement. Completed work includes geophysical surveys, geological mapping and modelling, drilling and resource evaluation. Drilling results have confirmed the northward continuity of uranium mineralisation at the Ida Central deposit. Future exploration activities in this EPL will focus on further delineating the resource boundaries at the Ida Central deposit.

Exploration activities on EPL 3439s area are primarily focussed on the Holland's Dome and Garnet Valley deposits, which are considered to have the highest potential for mine development within the licence area. During 2021 and 2022, drilling activities were conducted at Holland's Dome prospect area to test open-ended uranium mineralisation to the west of historic exploration. Noteworthy mineralisation was intercepted to significantly increase the resource inventory of the deposit. Further drilling at this deposit during 2023 was focussed on additional resources in the southern sector of the deposit. The company plans to increase investment in this region to support additional drilling aimed at fully assessing the resource potential and initiating independent resource certification.

In addition, in 2024, the company completed a high-resolution airborne magnetic and radiometric survey covering all licences. The survey identified multiple geophysical target areas, significantly enhancing the exploration prospects across the region. These findings indicate strong potential for additional uranium resources.

Etango

Bannerman Resources' Etango Project (a subsidary of Bannerman Energy of Australia) consists of three prospects: Anomaly A, Oshiveli and Onkelo. These prospects contain uraniferous sheeted leucogranite alaskite bodies, very similar to those at the Rössing and Husab mines. Although extensions continue to 400 m below the surface, two-thirds of the resource base is located less than 200 m below the surface. Total identified in situ uranium resources amount to about 79 810 tU, including 57 850 tU RAR. The Etango mine has all environmental approvals in place for a mine that could produce 2 770 tU/yr. Following extensive metallurgical test work at its Demonstration Plant, Bannerman Resources has decided to develop the mine at a reduced scale, with an annual production of 1 350 tU/yr to extend the mine life to 27 years (Etango XT). In December 2023, Bannerman was granted the mining licence (ML250) and started the early works construction in January 2024. The current schedule has the mine being commissioned in May 2028.

Reptile Mineral Resources and Exploration (RMR) Projects

Total identified in situ resources amount to 111 742 tU, 48 237 tU of which occur at the Omahola Project, including the Ongolo and MS7 alaskite as well as the Inca skarn deposits, and 63 505 tU are contained in the Tumas, Tubas and Aussinanis surficial calcrete deposits.

In late 2023, Deep Yellow completed the Definitive Feasibility Study for the Tumas Project. A key feature of the DFS, compared to the PFS, is the increased production capacity of the plant from 1 150 tU/yr to 1 400 tU/yr. The Environmental Impact Assessment (EIA) was submitted to the Environmental Commissioner for consideration in April 2023. The environmental approvals for the project and the 20-year Mining Licence were granted in September 2023. A final investment decision on the project development was deferred in April 2025 due to unfavourable market conditions. A staged development approach has been adopted, with engineering and early works continuing. Activities in 2024 and early 2025 were focussed on pre-development at the Tumas Project. A 42 000 m pre-mining grade control drilling programme was undertaken at the Tumas 3 deposit. The drill programme was required to support one year of mining operations, prior to commencement.

An infill drill programme was undertaken at Tumas in 2023. The objective of the programme was to expand the current Tumas resource base, with a primary focus on extending the main Tumas 3 deposit and, as such, expanding the uranium resources to the west. In total, 235 holes for 8 017 m were drilled.

RMR is also manager of the Nova JV, which is exploring two greenfield prospecting licences. In 2020, drilling delineated two prospective zones, namely Barking Gecko North and Barking Gecko South. Exploration of the Barking Gecko North prospect continued in 2021 and 2022. Thiry-seven holes confirmed prospectivity and delineated further potential. Follow-up drilling was undertaken in 2023 and 2024, including nine holes and nearly 2 000 m of drilling.

Elevate Uranium Projects

Elevate Uranium Ltd (former Marenica Energy) owns a number of Exclusive Prospecting Licences, which make them the largest uranium tenement holder in Namibia. The portfolio includes Marenica, MA7 and Koppies uranium deposits with total known resources of 49 002 tU.

Recent exploration activities were focussed on the Koppies area, with drilling confirming a continuous shallow mineralised zone across Koppies 1-4. Resource upgrades announced in October 2024 increased the total Koppies resource. The Koppies project contains 25 425 tU, including 16 771 tU in the RAR (indicated) category. During 2024-2025, Elevate Uranium completed 3 605 drillholes for 100 047 metres across its Namibian projects.

Elevate Uranium is also notable for developing its proprietary U-pgrade™ beneficiation process, designed to significantly reduce operating and capital costs for calcrete-type uranium deposits.

Happy Valley

A series of geological and geophysical surveys at the Happy Valley Project were carried out by Zhonge Resources on some anomalies in 2021-2022, followed by a diamond drilling programme started in August 2022. This project could present an opportunity for further development by Rössing Uranium Ltd.

Forsys Metals Corp.

Forsys holds a mining licence for its Valencia uranium deposit, and the neighbouring Namibplaas uranium deposit, for which it also submitted a mining licence application. The two projects together are known as the Norasa Uranium Project, for which environmental clearance is in place. In 2023, Forsys updated workflows for the 2015 Norasa Definitive Feasibility Study (DFS), launching technical trade-off studies in March, to explore practical and economic upgrades.

In 2023, Forsys also began a 4 100 m drill programme to collect fresh samples from planned pit slopes at Valencia and Namibplaas. In 2024, the company completed a total of 85 percussion drill holes, covering 7 520 m. Additionally, a 2 350 m drill programme is planned to explore potential resource extensions near the Valencia deposit. The drilling results obtained were used to create a new mineral resource estimate showing a combined total of 33 686 tU, including 17 467 tU in RAR and 16 401 tU in the inferred category.

Forsys development efforts in 2024 included metallurgical testing at Norasa, with testwork showing the project supports the use of heap leaching for uranium recovery, with 16 column leach tests revealing up to 87% uranium extraction within 30 days and sulfuric acid consumption between 17-38 kg/t.

Wings

In southeastern Namibia, Russian owned Uranium One, through its Namibian subsidiary, Headspring Investments (Pty) Ltd, conducted ground geophysical and geochemical surveys during 2016-2017, completed metallurgical test studies of core with uranium mineralisation in 2018 and began systematic intensive exploration drilling in 2019. As a result of intensive 2019-2021 drilling activities (504 core drill holes), a sandstone-type uranium deposit, Wings, was discovered with resources confirmed by a JORC compliant technical report amounting to 18 536 tU of measured and indicated resources (RAR), 22 977 tU of inferred resources and exploration potential of 30 000 tU. The total in situ resource base is 41 513 tU, equivalent to 33 210 tU of recoverable resources.

Based on 2020-2021 exploration, metallurgical and hydrogeological test results, resources are potentially amenable for development by ISL method. A PFS completed in 2021 has confirmed positive economics for the ISL mining method. This was the first time that sandstone-type mineralisation, potentially amenable for ISL recovery, has been discovered in Namibia. During 2022-2023, the company made preparations for the ISL pilot test. The pilot plant and well field construction was completed. A pilot test site, including pilot plant and chemical laboratory, was fully prepared for commissioning. Permission to begin pilot production must be issued by Namibian regulators.

In addition, in 2024 the company started research studies of radionuclide distribution in ground water horizons adjacent to the deposit, and investigations were planned to continue in 2025 and 2026. In 2025, Headspring Investments (Pty) Ltd also planned to restart exploration drilling to convert more resources from inferred to more reliable RAR categories.

Identified conventional resources (reasonably assured and inferred resources)

As of 1 January 2025, total identified in situ conventional resources in Namibia amounted to 606 565 tU (396 815 tU in RAR and 209 750 tU in the Inferred category), while recoverable known identified resources amounted to 494 525 tU, including 324 646 tU in the reasonably assured and 169 879 tU in the inferred resource categories. The average recovery factor for all mining and processing methods is 82%. Deposits in Namibia are typically large and low grade. About 80% of the recoverable identified uranium resources are classified in the <USD 130/kgU cost category. Namibia also reports 39 523 tU of recoverable resources in the <USD 80 kg/U category that belong to the Wings deposit, potentially amenable for ISL mining, and to previously stockpiled ore at the Langer Heinrich mine.

Compared with data as of 1 January 2023, there has been a decrease of 81 892 tU of in situ conventional identified resources and 56 240 tU of total recoverable known identified resources. This is the result of resource re-estimation at Husab by Swakop Uranium, at Etango by Bannerman and at Norasa by Forsys Metals. Additional resources were estimated at Koppies deposit by Elevate Resources. Decreases also account for mining depletion at the Husab and Rössing mines during 2023 and 2024.

Undiscovered conventional resources (prognosticated and speculative resources)

Undiscovered resources are estimated in areas adjacent to deposits with identified resources in Happy Valley, Etango, Tumas, Husab and Wings. As of 1 January 2025, prognosticated resources amounted to 57 000 tU and speculative resources totalled 150 700 tU, the same amount as in the previous reports.

Uranium production

Historical review

Rössing Uranium Limited was formed in 1970 to develop the Rössing deposit. Rio Tinto was the leading shareholder, initially with 51.3% of the equity of Rössing, and subsequently increasing its stake to 69%. In 2019, Rio Tinto sold its majority stake in Rössing to the Chinese state-owned company CNUC/CNNC. Mine development commenced in 1974 and initial production began in July 1976, but full design capacity of 3 816 tU/yr was not achieved because of the highly abrasive nature of the ore, an aspect not identified during the pilot plant testing stage. The production target was reached in 1979 after plant design changes were implemented. From the date of first production in July 1976 to the end of 2024, a cumulative total of 128 156 tU had been produced at Rössing.

Paladin Energy Ltd. acquired the Langer Heinrich project from Aztec Resources Ltd (formerly Acclaim Uranium NL) in August 2002. Construction of the Langer Heinrich Project commenced in September 2005 and staged commissioning of the plant began in August 2006. Initial mining commenced in 2007 and had a proposed 25-year life-of-mine, extending to 2030. The initial planned production level of 1 040 tU/yr was achieved in 2008. This was followed by the Stage 2 expansion to 1 350 tU/yr in 2010. Stage 3 expansion to 2 030 tU/yr was completed in 2012. In July 2014, Paladin Energy sold a 25% interest in the mine to CNNC Overseas Uranium Holding Limited, a wholly owned subsidiary of CNNC. A Stage 4 expansion feasibility study and environmental impact assessment were submitted to the government, but subsequently the project was put on hold. Due to sustained low uranium prices, Langer Heinrich Mine (LHM) was placed in care and maintenance in August 2018. A Restart Pre-Feasibility Study was completed in June 2020, followed by a Value Engineering Study in October 2021.

The Husab mine was developed and constructed by Swakop Uranium. In 2011, the project received an environmental clearance certificate and a mining licence. Construction of the Husab mine began in April 2013, and in December 2016, the first uranium was drummed. Throughout the construction phase, the project created over 6 000 temporary jobs, contributing to local employment and economic development. Initially, Swakop Uranium was a fully owned subsidiary of Australian public company, Extract Resources. In March 2012, the Chinese state-owned China Guangdong Nuclear Power Corporation (CGNPC) acquired Swakop Uranium. In November 2012, an agreement was finalised between Swakop Uranium and Epangelo, the Namibian state-owned mining company. Under this agreement, Epangelo obtained a 10% stake in Swakop Uranium, solidifying Namibian participation and ownership in the project.

At the Trekkopje mine, following Phase 1's 250 000 t of ore trial mining and processing operations, Phase 2's pilot tests, heap leach trials (using a sodium carbonate/bicarbonate leach process) and construction of the main production pad in 2010, a final production capacity of 2 545 tU/yr was envisaged. However, actual production was 251 tU and 186 tU in 2012 and 2013, respectively. As a direct consequence of low uranium prices, the project was placed in care and maintenance in mid-2013.

Status of production facilities, production capability, recent and ongoing activities

While historical uranium production in Namibia was between 3 000 and 4 000 tU per annum, the start-up of the Husab mine was the main reason for national production increases since 2016. In 2023, uranium production in Namibia amounted to 6 986 tU (4 510 tU was produced at Husab and 2 476 tU at Rössing), and 7 332 tU in 2024 (4 437 tU at Husab, 2 205 tU at Rössing and 690 tU at Langer Heinrich). In 2024, uranium production increased by 31% compared to 2022, which is due to the re-opening of the Langer Heinrich Mine. This historical record for Namibia is set to grow even further, as Husab is still increasing production and the Langer Heinrich Mine is ramping up. The forecast for 2025 is 8 720 tU. All uranium is produced by the open pit method. Potential re-opening of the Trekkopje Mine is under consideration and new planned Etango and Tumas mines are under development.

Rössing

Rössing Uranium is one of the largest and longest operating uranium open-pit mines in the world. In 2023, Rössing increased production by about 10% to 2 476 tU, while production declined in 2024 to 2 205 tU due to a planned one-month major maintenance shutdown.

Original mine plans foresaw a cessation of Rössing production at the end of 2026, however a feasibility study to extend the life of mine production was completed and approved in 2023, extending the life of mine to 2036. This was followed by the implementation of the approved life of mine extension projects, which commenced during 2023 and continued in 2024 with numerous technologies being tested for production scale implementation.

Langer Heinrich (LH)

From the date of first production in March 2007 to the end of 2018, a cumulative total of 16 449 tU was produced at LH mine. Due to sustained low uranium spot prices, the operations at LH mine were suspended in August 2018 and the mine was placed in care and maintenance. In June 2020, Paladin released the Mine Restart Plan, setting a pathway to transition back into reliable production.

In July 2022, a Final Investment Decision was announced, confirming the plan to restore Langer Heinrich Mine to full operational capacity. This led to the launch of the Restart Project in 2023. Langer Heinrich returned to commercial production in March 2024 and produced 690 tU in 2024. The mine implemented several plant upgrades in 2024 such as improvements to the crusher and cyclone; pre-leach surge tanks; product thickener and water recovery equipment. The operation is focussed on ramping up to a name plate production capacity of 2 300 tU/yr.

Trekkopje

The mine is expected to remain under care and maintenance unti uranium prices make it economical to restart production. Approximately 80% of the investments to develop the mine were made prior to placing the project on care and maintenance, and since then advanced processing knowledge acquired through metallurgical testing has realised further potential for efficiency improvements. In 2024, Orano began studying all options for Trekkopje to potentially become operational again.

Husab

Husab is today one of the largest operating open-pit uranium mines in the world, with a nameplate capacity of 5 100 tU/yr. Mining started in March 2014, and the processing operation started towards the end of 2016. Since then, production has steadily increased. In 2023, the production level was 4 540 tU, and in 2024 it was 4 437 tU, representing an increase from 3 357 tU in 2022, with plans for a further production ramp up. The mining fleet at Husab is designed to transport 15 million tonnes of ore per year from two open pits to the processing plant, with a total capacity of 120 million tonnes per year for both ore and waste rock transportation.

In August 2023, Swakop Uranium reported that it expects to construct a pilot heap leach plant at Husab, which will explore the economic feasibility of processing lower-grade uranium ore. Heap leach tests were concluded by the end of 2025. Further decisions will be made if economically feasible.

Uranium production centre technical details

(as of 1 January 2025)

	Centre #1	Centre #2	Centre #3	Centre #4	Centre #5	Centre #6	Centre #7
Name of production centre	Rössing	Langer Heinrich	Husab	Trekkopje	Norasa	Etango	Tumas
Production centre classification	Existing	Existing	Existing	Idled	Prospective	Planned	Planned
Date of first production (year)	1976	2007	2016	2012	NA	NA	NA
Source of ore:							
Deposit name(s)	Rössing SJ, SK,	Langer Heinrich	Husab Zones 1 and 2	Trekkopje, Klein Trekkopje	Valencia and Namibplaas	Etango	Tumas, Tubas
Deposit type(s)	Intrusive	Calcrete	Intrusive	Calcrete	Intrusive	Intrusive	Calcrete
Recoverable resources (tU)	23 316	40 705	122 451	20 000	28 788	67 842	36 370
Grade (% U)	0.030	0.038	0.054	0.012	0.011	0.020	0.030
Mining operation:							
Type (OP/UG/ISL)	OP	OP	OP	OP	OP	OP	OP
Size (tonnes ore/day)	32 178	N/A	42 000	30 800	55 000	22 000	11 500
Average mining recovery (%)	85	N/A	88	N/A	N/A	N/A	N/A
Processing plant:							
Acid/alkaline	Acid	Alkaline	Acid	Alkaline	Acid	Acid	Alkaline
Type (IX/SX)	IX/SX	IX	IX/SX	HL/IX	HL/IX/SX	IX/NF	NA
Size (tonnes ore/day)	27 397	N/A	40 000	100 000	41 100	22 000	11 500
Average process recovery (%)	85	90	80	80	85	88	80
Nominal production capacity (tU/year)	2 600	2 300	5 100	3 000	1 460	1 350	1 400
Plans for expansion (yes/no)	Yes	Yes	Yes	No	No	Yes	Yes

Uranium production centre ownership structure

Project	Rössing	Langer Heinrich	Husab	Trekkopje	Norasa	Etango	Tumas
Company	Rössing Uranium Ltd	Langer Heinrich Uranium	Swakop Uranium	Orano Mining Namibia	Forsys Metals	Bannerman Resources	Reptile Uranium Namibia
Owners	68.6% CNUC (China); 28% other interests, 3.4% Namibian government	75% Paladin Energy (Australia); 25% CNNC (China)	90% CGN Mining (China); 10% Epangelo Mining (Namibia)	100% Orano (France)	100% Forsys Metals Corp. (Canada)	100% Bannerman Energy (Australia)	100% Deep Yellow Ltd. (Australia)

Future production centres

Etango

In 2020, Bannerman Resources updated a Scoping Study and, in August 2021, the company completed a new Pre-Feasibility Study (PFS) for an 8 million tonnes of ore per annum development of its flagship Etango Project. The environmental clearance certificate for the proposed Etango Uranium Mine was renewed by the Ministry of Environment, Forestry and Tourism in 2021.

In December 2022, Bannerman Mining Resources, Namibia, released the results from the Definitive Feasibility Study completed on its Etango-8 uranium project. It confirmed technical and economic viability of a conventional open-pit mining and heap leach processing operation with a throughput of 8 million tonnes per annum, which is expected to deliver over 1 350 tU per annum over an initial operating life of 15 years. In 2023, Bannerman progressed to the Front-end Engineering & Design phase of the project. Following the approval of the mining licence in late 2023, early works construction of the mine commenced in early 2024. With rising uranium prices Bannerman has done a scoping study on the expanded Etango Mine (Etango XP) to produce 2 770 tU per year and an option to extend the mine life to 27 years with an annual production of 1 350 tU per year (Etango XT).

Tumas

The Tumas ore reserve, updated in December 2024, includes proven and probable ore reserves of 30 500 tU at 298 ppm U_3O_8 (253 ppm U), using a 100 ppm U_3O_8 (85 ppm U) cut-off grade. This substantial increase in ore reserves confirms that Tumas can support a 30-year life-of-mine at production rates assumed for the 2025 DFS (a maximum of either 4.2 Mtpa ore processed or 1 400 tU produced per annum).

In April 2025, Deep Yellow Limited provided an update regarding its progress towards a positive final investment decision for the Tumas project, following the completion of additional engineering and optimisation work, which confirmed Tumas as a robust, long-life project. Later, Deep Yellow announced the deferral in order to fully capitalise on the project's upside potential. The decision was made to provide staged approval for the project and to delay construction of the processing plant, which involves the majority of estimated capital expenditure. Early works infrastructure development and detailed engineering continue; however, full-scale project development will be delayed.

Norasa

The project has an estimated annual production capacity of about 2 000 tU over a 15-year mine life. Environmental approval for an open-pit mine was granted in June 2008 and a 25-year mining licence was granted in August 2008. A milestone was reached when the first blast for a box cut as part of the Valencia mining pit development was done on 1 August 2024.

Employment in the uranium industry

According to the Namibian Chamber of Mines annual reports, employment in the uranium industry remained relatively stable: 2 788 employees at the end of 2021, and 2 993 in 2024. These numbers include permanent, temporary and expatriate employees, and exclude employed contractors. Of the total figure for 2024, 58% are related to Swakop Uranium, 30% to Rössing Uranium and 12% to Langer Heinrich Uranium. The number of employed contractors increased from 3 066 in 2022 to 4 424 in 2024, mainly due to increases at Rössing Uranium and new contractors at the Langer Heinrich Mine, with the Husab Mine also recording moderate increases. Trekkopje continued to be under care and maintenance, and the number of permanent employees in 2024 was 17.

Environmental activities and socio-cultural issues

Namibia's "Vision 2030" outlines national development strategies aimed at long-term economic growth, social progress and environmental sustainability. Uranium mining and exploration companies actively support these government objectives. As much of the sector operates in the ecologically sensitive Namib Desert and partly in National Parks, environmental stewardship remains a central priority for the industry.

Environmental Management Framework

Namibia's Environmental Management Act, No. 7 of 2007, and Regulations, gazetted on 6 February 2012, provide the foundation for responsible environmental governance. The Act emphasises: early consideration of environmental impacts; opportunities for timely participation of interested parties through the environmental assessment process; and that the findings of assessments are considered before decisions are made.

Strategic Environmental Assessment (SEA) and Strategic Environmental Management Plan (SEMP)

Most uranium exploration and mining activities occur in the Central Namib, an area that includes parts of the Namib-Naukluft and Dorob National Parks. As uranium exploration accelerated in the mid-2000s, the need for co-ordinated environmental planning became clear. The Geological Survey of Namibia conducted a Strategic Environmental Assessment (SEA), covering water, energy, air quality, radiation, health, transport, tourism, biodiversity, heritage, economics and governance. An independent review by the International Institute for Environment and Development informed the development of the Strategic Environmental Management Plan (SEMP), implemented by the Ministry of Mines and Energy, with strong industry support.

The SEA identified opportunities, such as economic stimulation, skills development and infrastructure, as well as constraints, including water scarcity, limited technical capacity, and potential impacts on biodiversity and tourism.

The SEMP sets out several environmental quality objectives related to socioeconomic development, employment, infrastructure, water, air quality and radiation, health, tourism, ecological integrity, education, governance, heritage and future developments, closure and land use. A dedicated office administers the implementation and monitoring of the SEMP.

The Namibian Uranium Association

The Namibian Uranium Association (NUA) is the representative body of the Namibian uranium industry. It promotes policies that position uranium as a low-carbon energy source aligned with the Paris Agreement. Its membership includes all operating uranium mines, most exploration companies, and key service providers.

NUA is the leading point of contact for government, media, stakeholder and the general public, advocating for sustainable development, product stewardship, and compliance with Namibia's national legislation.

As part of its stewardship mission, NUA established the Namibian Uranium Institute (NUI), guided by independent scientists on the NUA's Scientific Committee. NUI provides a platform for NUA members to share best practices in safety, health, environmental management and radiation protection. It acts as a communication hub for the uranium industry in Namibia and promotes knowledge and capacity building in the fields of environmental management, radiation safety and health. NUI collaborates closely with government agencies and the Namibian University of Science and Technology.

Members of the NUA have undertaken corporate social responsibility projects for more than four decades, with over 20 ongoing to address themes such as economic advancement, social progression, education and training, hunger and poverty, water supply, sanitation and youth employment.

Environmental monitoring

Uranium mining operations, in co-operation with the Environmental Affairs Department of the Ministry of Environment, Forestry and Tourism, actively monitor environmental issues of concern. In addition to the environmental monitoring of the SEMP, NUA members also carry out environmental monitoring that is verified by the government. Environmental monitoring programmes that are approved under an Environmental Clearance Certificate granted by the Ministry of Environment, Forestry and Tourism, continue.

Site rehabilitation

All Namibian uranium operators adhere to the Mine Closure Framework of the Chamber of Mines of Namibia. The Framework provides guidance to the mining industry on developing relevant, practical and cost-effective closure plans, and establishes minimum requirements for members bound by the Chamber's Code of Conduct and Ethics.

Regulatory regime

Namibia has been hosting uranium exploration and mining for more than 47 years. The sector is governed by a range of comprehensive pieces of legislation, starting with the Namibian Constitution that provides for the protection of the environment and the welfare of people. Uranium mining is regulated by the Minerals (Prospecting and Mining) Act 33 of 1992. Section 2 of this Act vests all rights with respect of minerals in the state. Environmental issues are regulated by the Minister of Environment, Forestry and Tourism. The Minister of Mines and Energy may not issue a mineral licence before the applicant has obtained an environmental clearance certificate.

Furthermore, the Minerals (Prospecting and Mining) Act 33 sets the terms and conditions for granting exploration and mining licences. Section 102 of this Act prohibits the processing, import, export or possession of source material without the Minister's written authorisation. Health and safety aspects relating to the minerals industry are administered in terms of the Mines, Works and Minerals Ordinance 20 of 1968.

Namibia's Environmental Management Act underlines the importance of consultation with interested and affected parties. It promotes sustainable environmental management and use of natural resources by establishing principles for decision making and environmental impact assessment regulations.

The Atomic Energy and Radiation Protection Act (Act No.5 of 2005) was gazetted on 16 January 2012. Administered by the National Radiation Protection Authority, it provides for the regulation of all activities associated with radiation sources, radioactive or nuclear material. The primary purposes of the act are to protect people against the harmful effects of radiation, minimise environmental pollution that may be caused by radiological contamination, ensure the safety of facilities and radiation sources, and guarantee that Namibia meets its obligations within the context of international legal instruments in the sector of radiation or nuclear technologies.

Namibia is party to the Nuclear Non-Proliferation Treaty, has concluded a comprehensive safeguards agreement in force since 1998, and in 2000 signed and ratified the Additional Protocol.

Epangelo Mining

In July 2008, Epangelo Mining Company was established by the government to participate in the mining sector, and as per the provisions of the Minerals (Prospecting and Mining) Act, to acquire mining rights and equity by concluding joint ventures with existing companies. The Namibian government is the sole shareholder of Epangelo. Namibia has identified uranium as a strategic mineral and potential source of energy, expressing its desire to enhance economic development through potential local fuel cycle facilities and by considering nuclear power to augment its energy needs.

Uranium requirements

At present, Namibia has no nuclear power generating facilities. Namibia produces power locally and imports about half its electricity through the Southern African Power Pool.

National policies relating to uranium

The government has designated its uranium resources as a strategic and controlled mineral that must be treated differently from other minerals because of, among other reasons, the risk of proliferation, radiological risks and its use as fuel for generating electricity.

Given its special nature and the radiological and fissile properties of uranium, the government has developed responsive regulatory frameworks to address health, safety, research and development applicable to the nuclear fuel cycle. Because Namibia is considering the development of commercial nuclear power to promote energy security and meet its increasing energy needs without increasing greenhouse gas emissions, it has developed a Nuclear Fuel Cycle Policy to examine the potential of further value addition to the production of yellowcake.

Uranium exploration and development expenditures, and drilling effort

(NAD – Namibian dollars thousand)

	2023	2024	2025 (expected)
Industry* exploration expenditures	204 348	345 600	209 908
Industry* development expenditures**	105 369	446 433	879 792
Total expenditures	309 717	792 033	1 089 700
Industry* exploration drilling (m)	108 209	213 352	111 559
Industry* exploration holes drilled	2 672	5 871	2 861
Industry* development drilling (m)	9 634	27 713	23 619
Industry* development holes drilled	100	1 708	1 480
Total drilling (m)	117 843	241 065	135 178
Total number of holes drilled	2 772	7 579	4 341

* Non-governmental expenditures.

** Development costs include only Husab, Etango and Reptile

Reasonably assured conventional resources by production method

(recoverable tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Open-pit mining (OP)	0	6 313	266 231	309 817	80-85
In situ leaching	0	14 829	14 829	14 829	80
Total	0	21 142	281 060	324 646	82

Reasonably assured conventional resources by processing method

(recoverable tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional from OP	0	6 313	217 058	252 305	80-85
Heap leaching* from OP	0	0	49 173	57 512	80-85
In situ leaching	0	14 829	14 829	14 829	80
Total	0	21 142	281 060	324 646	82

* A subset of open-pit and underground mining, since it is used in conjunction with them.

Reasonably assured conventional resources by deposit type

(recoverable tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Intrusive	0	0	192 239	214 070
Surficial	0	6 313	73 992	95 747
Sandstone	0	14 829	14 829	14 829
Total	0	21 142	281 060	324 646

Inferred conventional resources by production method

(recoverable tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Open-pit mining (OP)	0	0	93 338	151 498	80-85
In situ leaching	0	18 382	18 382	18 382	80
Total	0	18 382	111 720	169 880	81

Inferred conventional resources by processing method

(recoverable tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional from OP	0	0	74 669	121 134	80-85
Heap leaching* from OP	0	0	18 669	30 364	80-85
In situ leaching	0	18 382	18 382	18 382	80
Total	0	18 382	111 720	169 880	81

* A subset of open-pit and underground mining, since it is used in conjunction with them.

Inferred conventional resources by deposit type

(recoverable tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Intrusive	0	0	56 960	96 500
Surficial	0	0	36 378	54 998
Sandstone	0	18 382	18 382	18 382
Total	0	18 382	111 720	169 880

Prognosticated conventional resources

(in situ tonnes U)

Cost ranges		
<USD80/kgU	<USD 130/kgU	<USD 260/kgU
0	0	57 000

Speculative conventional resources

(in situ tonnes U)

Cost ranges		
<USD 130/kgU	<USD 260/kgU	Unassigned
0	0	150 700

Historical uranium production by production method

(tonnes U in concentrates)

Production method	Total through end of 2022	2023	2024	Total through end of 2024	2025 (expected)
Open-pit mining*	158 999	6 986	7 332	173 317	8 720
Total	158 999	6 986	7 332	173 317	8 720

* Pre-2018 totals may include uranium recovered by heap and in-place leaching.

Historical uranium production by processing method

(tonnes U in concentrates)

Processing method	Total through end of 2022	2023	2024	Total through end of 2024	2025 (expected)
Conventional	158 562	6 986	7 332	172 880	8 720
Heap leaching	437	0	0	437	0
Total	158 999	6 986	7 332	173 317	8 720

Historical uranium production by deposit type

(tonnes U in concentrate)

Deposit type	Total through end of 2022	2023	2024	Total through end of 2024	2025 (expected)
Intrusive	142 550	6 986	6 642	156 178	7 270
Surficial	16 449	0	690	17 139	1 450
Total	158 999	6 986	7 332	173 317	8 720

Ownership of uranium production in 2024

Domestic				Foreign				Totals	
Government		Private		Government		Private			
(tU)	(%)	(tU)	(%)	(tU)	(%)	(tU)	(%)	(tU)	(%)
519	7	0	0	6 241	85	573	8	7 332	100

Uranium industry employment at existing production centres

(Person-years)[1]

	2022	2023	2024
Employment directly related to uranium production	2 716	2 843	2 993
Contractors	3 066	3 574	4 424

1. Includes permanent, temporary and expatriate employees and excludes employed contractors.

Short-term production capability

(tonnes U/yr.)

2025				2030			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
0	0	8 900	8 900	0	0	9 700	12 450

2035				2040			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
0	0	7 400	10 150	0	0	6 300	9 050

Niger *

Uranium exploration and mine development

Historical review

Uranium exploration began in 1956 in the Arlit area of Niger, within the Tim Mersoï sedimentary basin, and uranium was first discovered in sandstone at Azelik, in 1957, by the French Bureau de Recherches Géologiques et Minières (BRGM). The French Atomic Energy Commission initiated further studies of the sandstone, which were taken over by the Compagnie Générale des Matières Nucléaires (COGEMA) and resulted in the discoveries of Abokurum (1959), Madaouela (1963), Arlette, Ariege, Artois and Taza (1965), Imouraren (1966) and Akouta (1967).

The Société des Mines de l'Aïr (Somaïr) was created in 1968 and started production from the Arlette deposit in 1971 by shallow (60 m depth) open-pit mining. From 1971 to 1988, acid heap leaching was used at Arlit, producing 200-600 tU/yr, for a total of 5 900 tU over this 17-year period. The uranium recovery rate achieved was low (50% or less) and from 1988 to 2009, more than 10 Mt of low-grade ore (0.08% U average grade) had been stockpiled. In 2009, after conducting tests over several years, Somaïr restarted heap leaching using an improved process to achieve recovery rates above 85%. Since the start of operations in 1971, about 70 000 tU were produced at the Somaïr mine. In 2017, due to tough uranium market conditions, Somaïr entered a plan to reduce annual production to 1 700 tU.

The Compagnie Minière d'Akouta (Cominak) was set up in 1974, and started production from the Akouta and Akola deposits, near the town of Akokan. This was an underground operation at a depth of about 250 m. Production subsequently switched to the deposit of Ebba/Afasto, south of Akouta and Akola. Since the start of operations in 1978, more than 70 000 tU were produced at Cominak mine.

In 2004, COGEMA and the government of Niger signed an agreement to undertake a major exploration programme. In subsequent years, both Somaïr and Cominak were involved in exploration solely for the purpose of better evaluating previously discovered deposits. Somaïr delineated the Taza Nord deposit, while Cominak evaluated a mineralised area southeast of the Akola deposit.

Development of the large Imouraren deposit, about 80 km south of Arlit, was confirmed in January 2008. In 2009, Areva SA (now Orano SA, as of January 2018) was awarded a mining licence and a joint venture agreement was signed to develop Imouraren, but it did not proceed due to unfavourable market conditions.

In 2006, the China National Nuclear Corporation (CNNC) signed an agreement to develop the Azelik-Abokurum deposit and a new company, Société des Mines d'Azelik (Somina), was created in 2007 for this purpose. About 670 tU were produced up to 2014, when the mine was put in care and maintenance.

All uranium deposits in Niger are located within the Tim Mersoï Basin, a sub-basin of the Illemmenden Basin. The Tim Mersoï Basin is close to the main Arlit-In Azaoua fault. Uranium is mined close to the twin mining towns of Arlit and Akokan, 900 km northeast of the capital, Niamey (more than 1 200 km by road), near the southern border of the Sahara Desert and the

* Report prepared by the NEA/IAEA, based on company reports and government data.

western range of the Aïr Mountains. The concentrates are trucked to ports in Benin and the majority are exported to the Malvési conversion facility in France.

Uranium exploration in Niger was revitalised in 2007 as the price of uranium increased. Six new exploration permits were granted that year and, by 2011, uranium exploration activities were being carried out on 160 concessions by foreign companies. From 2001 to 2016, 356 uranium exploration permits were registered. However, since 2011, there have been increasing geopolitical tensions in the region, resulting in foreign companies like Paladin and URU Metals ceasing exploration activities in Niger.

Following a 2006 agreement in which Areva agreed to increase royalty payments to the government by 50%, development of the Imouraren deposit, about 80 km south of Arlit and 160 km north of Agadez, was announced in January 2008. In January 2009, Areva was awarded a mining licence. The Imouraren SA mining company was established, with Areva NC Expansion (86.5% Areva, 13.5% KEPCO) holding a 66.65% interest and Sopamin of Niger holding the remaining 33.35%. Production was expected to be 5 000 tU/yr for 35 years. The deposit covers 8 km by 2.5 km. Orano reported 213 722 tU of probable reserves at 0.072% U plus 62 584 tU of indicated and 2 879 tU of inferred resources. Average depth is 110 m and maximum thickness 60 m. At full production, the project's heap leaching facility was planned to process 20 000 tonnes of ore per day with an expected 85% rate of recovery. Excavation of the first pit started in mid-2012. In May 2014, as uranium prices were not sufficient for profitable mining of the deposit, the Nigerien government and Areva agreed to suspend development and set up a joint strategic committee to determine when mining should start.

In 2008, GoviEx Uranium held two exploration properties of 2 300 km^2: one near the Arlit mine, including the Madaouela deposit, as well as 2 000 km^2 near Agadez. In August 2008, Cameco bought an 11% share in the company for USD 28 million, with an option to increase its share to 48%. The government of Niger had the right to hold a 10% carried interest and the option to purchase a further 30% share when the Nigerien mining company is incorporated. The GoviEx drilling programme commenced in August 2008. The work programme was based on three objectives: i) resource delineation drilling of the Marianne and Marilyn deposits; ii) exploration and resource definition drilling on the Madaouela South deposit area; and iii) exploratory drilling between the known deposits. As of February 2010, a project-wide total of 584 000 m had been drilled by GoviEx.

Global Atomic Fuels Corp. (GAFC), a private Canadian company, has six exploration permits (728.8 km^2) located in the north of Agadez, four at Tin Negouran (the "TN permits") and two at Adrar Emoles (the "AE permits"). The Adrar Emoles permit hosts the Dasa deposit, a sandstone basal-channel type deposit. From 2010 to 2014, GAFC drilled 969 holes (867 rotary drill holes and 102 diamond drill holes), for a total of >120 000 m and in January 2014 released an initial inferred resource estimate, which totalled 43 850 tU grading 0.054% U, using an 0.0085% U cut-off. In June 2014, GAFC announced internal resource estimates ranging from 64 600 tU at 0.049% U (0.0085% U cut-off), to 29 600 tU grading 0.29% U (0.127% U cut-off). The base case appeared to be 36 500 tU grading at 0.222% U (0.085% U cut-off).

URU Metals Limited reported a South African Mineral Resource Committee (SAMREC) compliant inferred resource of 1 654 tU on the In Gall deposit and in 2011 continued to drill the Aboye, Akenzigui and Fagochia targets within their Irhazer and In Gall permits. Project commitments elsewhere caused URU Metals to take steps to terminate activities in Niger by 2014.

In December 2010, Paladin completed the takeover of NGM Resources Ltd, the owner of the local company Indo Energy Ltd that held concessions in the Agadez region. NGM Resources had announced an inferred mineral resource of 4 320 tU. In early 2011, Paladin carried out a drilling programme that further defined targets for follow-up and information from the drilling was used to plan a 15 000 m drilling campaign. However, this was put on hold because of security concerns. All fieldwork has ceased, and *force majeure* was requested from the government authorities for an indefinite suspension of further expenditures.

In 2011, GazPromBank Niger Minerals SARL, a Russian company, was granted two uranium licences (Toulouk) located in the Tim Mersoï Basin. In March 2017, the company submitted a pre-feasibility study through which it declared JORC compliant inferred resources of sandstone-type tabular mineralisation with 29 630 tU at a grade of 0.016%, a roll-front type deposit containing 17 000 tU with grades varying from 0.04% to 0.06% and a surficial sandstone-type deposit containing 8 237 tU at a grade of 0.025% U.

On 20 September 2013, Pan African Minerals Ltd was granted four uranium licences (Ouricha 1 and 2 and Tegmert 1 and 2) located in the Agadez area. Pan African Minerals planned to invest at least USD 20 million in exploration activities during the next three years.

In March 2017, GoviEx began a drilling programme focussed on expanding shallow near-surface uranium mineralisation associated with the Miriam deposit. The 4 000 m drilling programme was conducted on a 100 m grid at Madaouela to an average depth of approximately 100 m (40 drill holes). However, the drilling did not result in additional resources. On 15 November 2017, GoviEx was granted an exploration permit for Agaliouk, which is adjacent to the Madaouela deposit. The Agaliouk exploration permit added 4 488 tU of mineral resources in the measured and indicated categories and 3 596 tU in the inferred category.

GoviEx developed a NI 43-101 compliant integrated development plan for five deposits (Marianne, Marilyn, Miriam, Madaouela South North East [MSNE] and Maryvonne). The plan was based on detailed pre-feasibility studies that considered metallurgical testing and processing options, mine design, infrastructure, rock mechanics, tailings and heap leach, and hydrogeological and environmental impacts. As of November 2017, NI 43-101 compliant resources at Madaouela totalled 42 603 tU of measured and indicated resources and 10 647 tU of inferred resources. An open-pit mine on at least part of the deposit, followed by underground room and pillar mining with conventional processing, was expected to produce 1 030 tU/yr over 21 years, with potential for expanding the resource. Production was expected to begin by 2022. The Environmental and Social Impact Assessment for the project was filed with the Nigerien government in March 2015 and a mining licence was obtained in January 2016.

In 2017-2018, Global Atomic Corporation (GAC) carried out a drilling programme (a total of 59 holes amounting to 26 479 m) targeting various areas of the Dasa project. This delineated higher-grade mineralisation within 300 m of the surface. The drilling was focussed on areas of faulting associated with a graben structure and results improved understanding of the distribution of mineralisation within the deposit and confidence in the geological model. This resulted in an upgraded classification of resources from inferred to indicated.

In 2018, GoviEx reviewed the ore process design of the Madaouela project and determined that the inclusion of membrane separation in the process design could potentially reduce operating and capital costs, to improve project economics. On 19 September 2018, GoviEx announced the appointment of SRK Consulting (UK) Ltd and SGS Bateman (Pty) Ltd as the consultants to complete a feasibility study for the Madaouela project.

In September 2019, Niger approved the revision to the shape of the Madaouela mining permit to include 1 550 tU in the measured and indicated categories associated with the Miriam uranium deposit as well as 6 880 tU in the measured and indicated categories associated with the Madaouela South North East deposit, both previously situated within the Agaliouk exploration permit.

The Dasa project mineral resources were first estimated and reported by CSA Global in April 2017, then updated in June 2018 and June 2019. Mineral resources were reported in two parts; those with potential for extraction by open pit, and the deeper, higher-grade material outside of the open pit that may be amenable to underground mining. The open-pit mineral resources are the parts of the deposit above a cut-off of 320 ppm equivalent-U_3O_8 (eU_3O_8). Higher-grade material above a cut-off grade of 1 200 ppm eU_3O_8 outside of the optimised pit shell was considered for underground mining. Some areas could also be considered for ISL.

Dasa mineral resources as of 1 June 2019

(NI 43-101 compliant)

Category	Ore (Mt)	Grade (% eU)	Uranium (t)
Indicated OP	25.59	0.145	37 118
Indicated UG	0.71	0.275	1 962
Total indicated	26.30	0.148	39 080
Inferred OP	18.93	0.115	21 771
Inferred UG	3.38	0.352	11 924
Total inferred	22.31	0.151	33 695

Recent and ongoing uranium exploration, and mine development activities

Dasa project

In May 2020, GAC completed a preliminary economic assessment (PEA) using a base case uranium price of USD 35/lb (USD 91/kgU) to mine the flank zone of the Dasa deposit. GAC planned to use conventional underground mining and proven processing technology that has been used at existing uranium mines in Niger (COMINAK), targeting an initial production of 44 Mlb U_3O_8 (16 900 tU) with an average processed grade of 0.46 %U. The PEA cash costs amounted to USD 16.72/lb U_3O_8 (USD 43.47/kgU), including corporate and all other off-site costs, and an all-in sustaining cost of USD 18.39/lb U_3O_8 (USD 47.81/kgU).

An environmental impact statement (EIS) was completed and filed with the Niger government in July 2020. The Dasa project site hydrogeology drilling and water flow test work was completed and a tender for final geotechnical diamond drilling for the feasibility study was issued. Public hearings regarding the EIS were organised, one in the Dasa project area and one in the capital city of Niamey.

In August 2020, pilot plant tests were initiated at the Ortech process research facility in Canada to confirm and optimise the processing plant flow sheet. The tests demonstrated the viability of the uranium recovery process detailed in the May 2020 PEA.

On 25 September 2020, GAC announced that it had applied for a mining permit for the Dasa project. In December 2020, a presidential decree granting the mining permit was approved by the Council of Ministers for the project. GAC also received three-year permit extensions for each of its six exploration properties in Niger. These include the Adrar Emoles 3 permit, hosting the Dasa and Dajy deposits (6 540 tU), the Adrar Emoles 4 permit, hosting the Isakanan deposit (13 080 tU) and the Tin Negouran 1, 2, 3 and 4 permits, hosting the Tin Negouran deposit (3 850 tU).

In September 2021, GAC started a 15 000 m drilling programme of both in-fill and step-out drilling to increase Phase 1 resources and upgrade Phase 2 resources. Based on the positive results, the programme was extended in 2022 by a further 1 000 m.

A feasibility study (FS) focussed solely on Phase 1, primarily comprised of the Flank zone (less than 20% of the Dasa deposit total mineralisation), was completed in November 2021. The study, representing the initial 12 years and production of 17 460 tU, confirmed that the project is economically compelling at a price of USD 35/lb U_3O_8 (USD 91/kgU), and formed the basis for the Board of Directors' decision to proceed with production at the Dasa project.

Revised resource estimates based on the 2021-2022 drill campaign and prepared in accordance with CIM NI 43-101 Standards for Mineral Resources and Mineral Reserves were reported on 23 May 2023.

Mineral Resources for the DASA deposit were estimated assuming that the deposit would be exploited by underground mining within the central part of the deposit only and above the cut-off grade of 1 480 ppm eU_3O_8 (1 255 ppm eU). The Mineral Resource report differs from the previous resource estimate completed in 2019 as the previous estimate was reported assuming combining open-pit and underground mining methods, with corresponding reporting cut-offs of 270 and 1 020 ppm eU.

Dasa mineral resources as of 12 May 2023*

Category	Ore (Mt)	Grade (% eU)	Uranium (t)
Indicated UG	10.09	0.417	42 040
Inferred UG	4.45	0.445	19 770

* Mineral resources are based on CIM Definitions. A cut-off grade of 1 480 ppm U_3O_8 (1 255 ppm U) and a bulk density of 2.36 t/m^3 have been applied. GAC intends to update the Dasa mine plan and feasibility study by the end of 2023, using the results of the new resources estimate, actual mining costs and capital costs for the processing plant.

In the framework of the feasibility study released on 28 February 2024, mineral reserves for the Dasa Uranium Project have been estimated based on the 2023 mineral resource estimate. The mining method for the Dasa ore body is a transverse Long Hole Open Stoping method with a cemented hydraulic fill. The recommended plant recovery model allocates an overall recovery of 94.15% for the processed uranium ore. Including sustaining capital and royalty costs, the all-in sustaining cost is USD 35.70/lb (USD 92.8 / kgU).

Dasa mineral reserve estimate as of 28 February 2024

	Ore (Mt)	Grade (%U)	U (tU)
Probable Mineral reserves	8.05	0.349	28 090

In addition to Dasa, two other deposits are located on the Adrar Emoles permits, Dajy and Isakanan. The Dajy deposit is located along the major northeast-southwest trending Azouza Fault that hosts the Azelik and Dasa deposits, some 30 km southeast of Imouraren. Whereas Dasa can be traced to the surface, Dajy occurs at depth. Dajy uranium mineralisation is hosted in three sandstone units over a 3.5 km long and 400 m wide area. The Dajy deposit contains 6 540 tU grading 0.058 U (inferred resources). The Isakanan deposit, located 15 km south of the Dasa and Dajy deposits, hosts 13 080 tU grading 0.076% U (inferred resources). The Tin Negouran permits host the Tagadamat deposit, where mineralisation occurs within surface paleochannels along a 3-km strike, with potential for open-pit mining and heap leach processing. The Tagadamat deposit hosts 3 850 tU grading 0.015% U (inferred resources). An environmental baseline study was completed in 2009, but the project was put on hold.

Madaouela project

In 2020, GoviEx decided to complete an updated preliminary feasibility study and announced the results in February 2021. Open-pit mining was planned to be based on standard truck and shovel operations for the Miriam deposit, at a planned rate of 1 Mt per year of ore feed to the process plant. Mining operating and capital costs were updated with a high degree of confidence as they were based on the current supplier quotes to define owner-operator operating costs of USD 2.30/tonne mined. The Marianne-Marilyn and MNSE-Maryvonne deposits would be mined by underground methods. Ore mining was designed to be undertaken at a rate of approximately 1.4 Mt per year with run-of-mine (ROM) ore to be sorted by X-ray fluorescence to remove waste dilution. The sorted ore would be trucked to the processing plant at a rate of 1.0 Mt per year.

On 18 February 2021, GoviEx released the results of a mineral reserves estimate. The estimate is based on the mineral resources classified as measured and indicated (as of 2 March 2016), and incorporates technical and economic studies that justify economic extraction. All mineral reserves are classified as probable in accordance with the CIM NI 43-101 code.

Open-pit mineral reserves are reported within a designed pit shell at a cut-off grade of 0.03% eU. Cut-off grades are based on a price of USD 50 /lb U_3O_8 (USD 130/kgU) and uranium recovery of 93%, without considering revenues from other metals. Underground mineral reserves for Marianne-Marilyn and MSNE-Maryvonne are reported at a cut-off grade of 0.06% eU. Cut-off grades are based on a price of USD 50 /lb U_3O_8 (USD 130/kgU) and uranium recoveries of 89.3%, without considering revenues from other metals. A 20-year project life is forecast, producing an estimated total of 19 100 tU, averaging 950 tU per annum. For the first four years of operation, the expected cash operating costs, excluding royalties and including credits for molybdenum, is USD 47.6 per kgU, with a life of mine cost of USD 57.7 per kgU.

In 2021, GoviEx carried out a diamond drilling programme over the Miriam and Marianne deposits, in order to obtain samples for chemical assay to enable the modelling of molybdenum resources, as well as to confirm eU grades derived from downhole radiometric surveys. In addition to the diamond drilling programme, 6 holes were completed for geotechnical purposes within the proposed Miriam open-pit area, 14 short diamond holes were also completed for the civil engineering of the process plant area, and a further 5 mud rotary holes were drilled over the planned process plant area for sterilisation purposes. No significant mineralisation was found in the sterilisation holes. Total 2021 drilling amounted to 15 906 m.

On 1 July 2022, GoviEx released the results of a new uranium and molybdenum NI 43-101 compliant mineral resources estimate. For the open-pit resources, volumes were defined by the optimised pit shell above an eU cut-off of 0.22 kgU/t (0.022%U). The underground resources were constrained within an optimised underground mining shape constructed assuming economic extraction at a uranium price of USD 70/lb U_3O_8 (USD 182kg/U) and a cut-off of 0.40kgU/t (0.04%U). Molybdenum resources, at the Marianne/Marilyn and Miriam deposits, were estimated within the same volume as for uranium resources.

Madaouela uranium resources as of 1 July 2022

Deposit	Classification	Ore (Mt)	Grade (%eU)	eU (t)
Marianne/Marilyn	Measured	3.00	0.150	4 458
	Indicated	14.00	0.119	16 728
	Inferred	3.10	0.096	2 949
Miriam	Measured	10.70	0.067	7 110
	Indicated	0.50	0.046	238
MSNE	Indicated	5.05	0.137	6 878
	Inferred	0.10	0.114	111
Maryvonne	Indicated	1.23	0.152	1 861
	Inferred	0.42	0.141	596
MSCE	Inferred	1.16	0.115	1 332
MSEE	Inferred	1.95	0.131	2 547
	Total Measured	**13.70**	**0.085**	**11 568**
	Total Indicated	**20.78**	**0.124**	**25 705**
	Total Inferred	**6.73**	**0.112**	**7 535**

The mineral reserves for the Madaouela project consist of open-pit mineral reserves at Miriam, and underground mineral reserves at M&M, MSNE and Maryvonne.

Uranium reserves for Miriam Open-Pit Deposit as of 1 July 2022

Deposit	Classification	Ore (kt)	Grade (%U)	U (t)
Miriam	Proven	5 344	0.088	4 696
	Probable	55	0.040	22
	Total	**5 399**	**0.087**	**4 718**

Uranium reserves for the M&M, MSNE, Maryvonne Underground Deposits as of 1 July 2022

Deposit	Classification	Ore (kt)	Grade (%U)	U (t)
M&M	Proven Probable	3 149 10 602	0.106 0.081	3 353 8 629
MSNE + Maryvonne	Proven Probable	- 6 652	- 0.079	- 5 273
	Total Proven	**3 149**	**0.106**	**3 353**
	Total Probable	**17 254**	**0.081**	**13 902**
	Total	**20 403**	**0.085**	**17 255**

In November 2022, GoviEx released a feasibility study for the Miriam open-pit project, process plant and associated infrastructure. Additional work and mine modelling were carried out on the two underground mines, updating previous pre-feasibility studies.

The Miriam open-pit operation would be a conventional drill, blast, truck and shovel operation. Pit optimisation was undertaken based on a USD 55/lb U_3O_8 price (USD 143/kgU). The pit design was divided into six stages resulting in 5.4 Mt of ROM ore at 0.87 kgU/t (0.087% U) and 123 ppm molybdenum with 50 Mt of waste, for a strip ratio of 9.3. The inventory is based on a cut-off grade of 0.28 kgU/t (0.028% U) and includes 2% dilution and 0% mining loss.

The M&M and MSNE-Maryvonne deposits were planned to be mined as two independent underground room and pillar operations. M&M is to be mined first following completion of the Miriam open-pit operation. The project also includes a series of other deposits, not included in the 2022 FS, anticipated to be mined by either open-pit or underground method.

In 2021, exploration and evaluation expenditures amounted to USD 5 076 000, USD 3 527 000 in 2022, USD 2 143 000 in 2023 and USD 1 589 000 in 2024.

Beginning in 2024, GoviEx commenced a due diligence study to evaluate environmental and social risks, and ensure compliance with regulations and international standards to meet lender requirements for project financing.

On 4 July 2024, GoviEx Uranium Inc. was informed by the government of the Republic of Niger, by way of a letter from the Minister of Mines, that it no longer had rights over the perimeter of the Madaouela mining permit, which was now in the public domain. However, on 18 February 2025, GoviEx Uranium Inc. announced that it has signed – with the Republic of Niger, represented by the Minister of Mines – a letter of intent agreeing to a structured roadmap that details a mutually acceptable plan to negotiate a resolution to the ongoing dispute regarding the Madaouela Uranium Project.

Cominak, Somair and Arlit

In 2021-2022, Orano continued exploration and development activities in the Somaïr mines perimeters and in the Arlit concession. As a result of an increase in the level of resources and reserves and the optimisation of its production costs, Somaïr now has more than ten years of production viability.

On 31 March 2021, the Akouta mine in Niger operated by Cominak ceased production after more than 40 years of operation and 75 000 tU extracted. Remediation of the site began immediately after production ceased and is expected to last about ten years, followed by a period of environmental monitoring of at least 5 years.

Somar mineral reserves (in situ) reported by Orano as of 31 December 2024*

Category	Ore (kT)	Grade (%U)	Uranium (tU)
Proven	53	0.08	43
Probable	37 039	0.11	40 065
Total	37 092	0.11	40 108

* Does not include mineral resources. Recovery factor for Somaïr 86.3%.

On 19 June 2025, the government of Niger announced the nationalisation of Somaïr.

Somaïr in situ mineral resources reported by Orano as of 31 December 2024*

Category	Ore (kT)	Grade (%U)	Uranium (tU)
Indicated	35 155	0.09	30 609
Inferred	25 132	0.11	28 757
Total	60 287	0.10	59 366

* Does not include mineral reserves. Recovery factor for Somaïr 86.3%.

Imouraren

In 2022, as part of optimisation studies for the Imouraren open-pit mining project, a mineral resource update was carried out with the use of a deterministic ore envelope model that is more restrictive and conservative than the probabilistic models used previously, in order to improve the robustness of the project. The work has led to a decrease in mineable mineral resources and economic reserves recognised in Orano's specifications, accompanied by an increase in the average grade of the ore and an improvement in its classification. Geological studies and work to determine the technical and environmental feasibility of mining using the ISR (In Situ Recovery) method were initiated in 2022 and continued in 2023, with the aim of minimising the environmental impact of the operation and improving the economics of the deposit.

On 20 June 2024, the company Imouraren SA was notified by the Ministry of Mines of Niger of the withdrawal of its permit to mine the Imouraren deposit.

Imouraren in situ mineral reserves (Orano estimate as of 31 December 2023)*

Classification	Ore (kT)	Grade (%U)	Uranium (tU)
Proven	36 682	0.09	34 494
Probable	174 868	0.08	136 932
Total	211 550	0.08	171 426

* Does not include mineral resources. Recovery factor: Imouraren 85%.

Imouraren in situ mineral resources (Orano estimate as of 31 December 2023)*

Classification	Ore (kT)	Grade (%U)	Uranium (tU)
Indicated	32 512	0.07	22 368
Inferred	9 926	0.07	6 475
Total	42 438	0.07	28 843

* Does not include mineral reserves. Recovery factor: Imouraren 85%.

Takardeit project

The Takardeit project is located about 40 km northwest of the city of Agadez.

First exploration activities in the Takardeit area were completed in 1972-1973 by COGEMA and ONAREM (Office National des resources Minières, now SOPAMIN).

In 2009-2010, NGM Resources Ltd completed 241 drill holes (9 464 m) over an area defined by geophysical studies. Inferred resources were estimated to amount to 23 Mt of ore at an average grade of 210 ppm eU_3O_8, resulting in 11 Mlbs U_3O_8 (4 230 tU).

The Takardeit project was acquired in 2011 by Paladin Energy Ltd, then by ENRG Elements in 2021. ENRG Elements acquired historical information including geological and geophysical data, surveys, drill logs and assays results.

In 2022, ENRG Elements completed an exploration programme including 5 340 m of rotary mud drilling and 160 m of diamond core drilling, in conjunction with a surface sampling programme. The drilling programme confirmed the mineralisation from surface to about 40 m depth and extending beyond the previous mineral resource estimate area.

In March 2023, ENRG Elements released the results of a new mineral resource estimate, completed according to the JORC 2012 standards. At a cut-off of 175 ppm, inferred resources amounted to 31.1 Mt of ore at an average grade of 315 ppm eU_3O_8, resulting in 21.5 Mlbs U_3O_8 (8 270 tU).

On 24 April 2024, ENRG reported positive results from the ground survey and trenching programme across the Takardeit area. The trenching programme consisted of five trenches at three sites for a total length of 157 m, ranging in depth from 0.9 to 2.5 m. It returned high uranium assay results, and validated the geology and mineralisation distribution of the area.

Uranium resources

Identified conventional resources (reasonably assured and inferred resources)

The total recoverable identified conventional resources for Niger, as of 1 January 2025, amounted to 462 791 tU (574 789 tU in situ), compared to 447 665 tU as of the end of 2022. Recoverable reasonably assured resources (RAR) amounted to 331 639 tU; inferred recoverable resources total 131 152 tU. The increase of total recoverable resources by 15 126 tU is associated with an increase of Somaïr resources (update of the resources estimates) and an increase of the process recovery factor at Dasa, following additional test work in the framework of the feasibility study.

In the <USD 130/kgU cost category, recoverable RAR amount to 289 606 tU (87% of total RAR), and inferred recoverable resources amount to 61 477 tU (47% of total inferred resources).

All uranium deposits in Niger are sandstone-hosted, with average grades of 0.02 to 0.45% U, and 72% of total identified resources are in the RAR category, with 79% of these being amenable to open-pit mining.

Undiscovered conventional resources (prognosticated and speculative resources)

Total speculative and prognosticated resources in Niger, as of 1 January 2025, amounted to 64 900 tU (unchanged since 2017).

Uranium production

Historical review

Uranium has been produced from sandstone deposits in Niger since 1971 by Somaïr at the Arlit mine, since 1978 by Cominak at the Akouta mine (Akouta, Akola and Ebba deposits) and since 2010 by Somina at the Azelik mine.

The Société des Mines d'Azelik SA (Somina) was established in 2007 to mine the Azelik/ Teguidda deposits. Azelik was developed by the China National Nuclear Corporation (CNNC) and came into production at the end of 2010, with the aim of ramping up to 700 tU/yr. It is an open-pit and underground operation using alkaline leach. In August 2014, CNNC announced that Azelik had experienced prolonged project delays, overruns in its construction budget, and low production. In February 2015, CNNC announced that the mine would be closed and put in care and maintenance because of "tight cash flow".

Somaïr and Cominak were licensed to the end of 2013, and in mid-December 2013, both were shut down for maintenance, pending resolution of negotiations on licence renewals. The mines resumed operation at the end of January 2014, under the terms of a government decree. In May 2014, the government and Areva signed a new five-year agreement for the two mines based on the 2006 mining law and expressed what both sides said was a balanced partnership.

In 2015, production recorded for Niger amounted to 4 116 tU, then decreased to 3 478 tU in 2016, 3 484 tU in 2017 and 2 878 tU in 2018, but slightly increased to 2 982 in 2019 and 2 991 tU in 2020.

Status of production facilities, production capability, recent and ongoing activities, and other issues

Arlit and Akouta mines

Production in 2021 amounted to 2 248 tU, 1 996 tU of which was produced by Somaïr at the Arlit open-pit mine and 252 tU was produced by Cominak at the Akouta underground mine. Production in 2022 amounted to 2 020 tU, all from the Arlit mine.

In October 2022, a new heap leach area was commissioned at Somaïr. Heap leach allows for the processing of low-grade ore, helping to extend the life of the mine. It was expected to account for nearly a third of Somaïr's annual capacity (500 to 700 tU/yr).

On 26 July 2023, a coup d'État occurred in the country. In response, the ECOWAS (Economic Community of West African States) introduced an embargo leading to the closure of the main supply corridor to mining sites via Benin. In this context, Somaïr gradually adjusted the organisation of work by anticipating maintenance activities at its ore processing facilities and maintaining ore extraction activities at the mine for as long as possible. In September 2023, due to political events that resulted in disruption of supplies of chemical products, Somaïr halted yellowcake production at the Arlit mine and brought forward plant maintenance initially planned for early 2024. Only mining operations continued.

In 2023 and 2024, production by Somaïr at the Arlit mine was 1 130 tU and 959 tU, respectively.

On 12 November 2024, Orano suspended expenses related to production activities. On 19 June 2025, the government of Niger announced the nationalisation of Somaïr. Given the current situation, Orano did not plan any production for 2025.

On 31 March 2021, the Akouta mine in Niger operated by Cominak ceased production after more than 40 years of operation and the extraction of 75 000 tU.

Dasa project

On 25 September 2020, GAC submitted a mining permit application for the Dasa project and, in December 2020, a presidential decree granting the mining permit was approved by the Council of Ministers. GAC also received three-year permit extensions for each of its six exploration properties in Niger.

Construction of the surface infrastructure started in 2022. Underground development of the mine started in November 2022 and in 2024 had reached the ore zone, with development ore being hauled to surface. As of November 2024, 950 tonnes of medium-grade ore, 6 850 tonnes of low-grade ore, and 10 200 tonnes of mineralised waste had been brought to the surface.

In 2024, GAC began extensive earthworks to prepare the site for construction of the Dasa processing plant, as well as for expansion of the Dajy Camp to house employees and construction crews. Earthworks for the acid plant were completed at the end of 2024.

Dasa is fully permitted for production, with the company projecting that first uranium delivery to utilities will commence in 2026. Mine development "waste" brought to the surface include medium-grade (3 000 to 5 000 ppm U), low-grade (1 300 to 3 000 ppm U) and mineralised waste (240 to 1 300 ppm U), all of which can be processed during the commissioning of the plant.

Madaouela project

On 19 July 2019, GoviEx announced that it had finalised agreements with Niger stipulating commercial terms to progress the Madaouela project. Under the terms of these agreements, a Nigerien operating company named Compagnie Minière Madaouela SA ("COMIMA") was incorporated by GoviEx, into which the Madaouela mining permit was transferred. GoviEx and the government of Niger own 80% and 20% shares in COMIMA, respectively.

In 2023, the Madaouela project advanced with groundwork, including building an access road, site clearing, terracing and civil engineering construction. Work on the project stopped in July 2024 when Niger's Ministry of Mines informed GoviEx that its mining rights for Madaouela had been revoked. In January 2025, GoviEx initiated arbitration proceedings. In February 2025 GoviEx and the Republic of Niger (represented by the Minister of Mines) agreed to a process of negotiations and, as part of the process, GoviEx has temporarily suspended the ongoing arbitration proceedings. The Madaouela project represents a significant potential investment in the Nigerien economy, with anticipated initial capital expenditures of USD 343 million and employment opportunities of up to 800 jobs over its 20-year mine life.

Azelik project

In 2023-2024, China National Uranium Corporation carried out studies towards the restart of production at Azelik. Somina is projected to produce 100 tU in 2026, 200 tU in 2027, then 300 tU starting from 2028.

Uranium production centre technical details

(as of 1 January 2025)

	Centre #1		Centre #2	Centre #3	Centre #4	Centre #5
Name of production centre	Arlit (Somaïr)		Azelik (Somina)	Imouraren	Madaouela (Comima)	Dasa (Somida)
Production centre classification	Existing		Idled	Planned	Planned	Committed
Date of first production	1971	2009	2010	NA	NA	2025
Deposit name(s)	Tamou, Artois, Tamgak	Low-grade stockpiles	Azelik, Teguidda, Abolorum	Imouraren	Miriam, Marianne, Marilyn, MSNE, Maryvonne	Dasa (Phase 1)
Deposit type(s)	Sandstone	Sandstone	Sandstone	Sandstone	Sandstone	Sandstone
Recoverable resources (tU)	40 108	NA	9 684	145 636	11 539	28 090
Grade (%U)	0.11	0.08	0.142	0.08	0.085	0.349
Type (OP/UG/HL)	OP	OP/HL	OP/UG	OP/HL	OP/UG	UG
Size (tonnes ore/day)		1 800 kt/yr				
Acid/Alkaline	Acid	Acid	Alkaline	Acid	Acid	Acid
Type (IX/SX)	SX	SX		SX	SX	SX
Average process recovery (%)	86	Up to 85	85	85	82	95
Nominal production capacity (tU/year)	2 000	700	300	NA	950	1 400
Other remarks			Restart of production in 2026			First production in 2026

Ownership structure of the uranium industry as of 1 January 2023

Uranium industry operations in Niger are each structured with a specific operating company established for the operation, which is jointly owned by a foreign uranium company (and any joint venture partners) and the State of Niger, through the state-owned company Sopamin (Société du Patrimoine des Mines du Niger).

On 12 August 2012, the government of Niger and Global Atomic Corporation signed an agreement for the creation of the Société des Mines de DASA (SOMIDA S.A.). This new company with a share capital of two billion CFA francs is 80% owned by Global Atomic and 20% by the State of Niger.

The ownership structure of Niger's six major uranium exploration and production companies is set out in the table below:

Somaïr	Cominak	Somina	Imouraren	Comima	Somida
36.6% Sopamin (Niger)	31% Sopamin (Niger)	33% Sopamin (Niger)	33.35% Sopamin (Niger)	20% Sopamin (Niger)	20% Sopamin (Niger)
63.4% Orano (France)	69% Orano (France)	37.2% CNUC (China)	66.65% Orano (France)	80% GoviEx (Canada)	80 % Global Atomic Corp (Canada)
		24.8% ZXJOY invest (China)			
		5% Trend Field Holdings SA (Hong Kong [China])			

Cominak is 69% owned by Orano Mining following the February 2021 acquisition of the 25% previously owned by the Japanese company OURD (Overseas Uranium Resources Development) and the December 2022 acquisition of the 10% previously owned by the Spanish company, ENUSA (Enusa Industrias Avanzadas SA). OURD contributed 25% to the decommissioning and transition estimate when Orano bought out its share. The other remaining shareholder is SOPAMIN (Niger), with a 31% ownership share of Cominak.

In July 2024, Niger's Ministry of Mines informed GoviEx that its mining rights for Madaouela had been revoked. On 20 June 2024, the company Imouraren SA was notified by the Ministry of Mines of Niger of the withdrawal of its permit to mine the Imouraren deposit. On 19 June 2025, the government of Niger announced the nationalisation of Somaïr.

Employment in the uranium industry

As of 1 January 2025, Somaïr employed 721 people and an equivalent number of subcontractors. It is reported that 99% of the workers are Nigerien.

At Cominak, following the closure of mining activities, part of the workforce has been kept on for remediation of the site. A plan has been rolled out dedicated to supporting employees and subcontractors affected by the closure, exceeding the requirements of the existing legal system. At the end of 2022, 87% of Cominak employees had a validated outplacement solution.

Development of new mines at Dasa and Madouela could again increase Niger uranium industry employment in the future. At Dasa, the initial two years of underground development will be undertaken by a mining contractor. More than 600 jobs are expected to be added during the peak construction phase. After the initial two years of mine development, Global Atomic Corp plans to assume operational control of the mine.

At Madaouela, it is estimated that around 800 skilled and semi-skilled jobs will be created during the life of operations, with substantially more temporary positions during construction.

Future production centres

There are three significant potential future production centres in Niger that could add substantial uranium supply. As updated in previous sections, Orano's Imouraren project, GoviEx's Madaouela project, and GAC's Dasa project were each advancing either in the development or study phase prior to the 26 July 2023 coup d' État and subsequent events. With the government revoking mining rights for Imouraren and Madaouela in June and July 2024, and nationalising Somaïr in June 2025, it is not possible to forecast when and if the Imouraren and Madaouela projects will resume, and when production might start. Only Dasa has continued to advance generally as planned with commercial uranium production expected to begin in 2026, ramping up to targeted annual capacity of 1 400 tU/yr.

Environmental activities and socio-cultural issues

Both mining operations at Somaïr and Cominak have maintained their ISO 14001 certification for environmental management for many years (certification is renewed every three years). Orano maintains that environmental issues, including water preservation, is fundamentally important to their operations. The mandate of the AMAN project, established in 2004, is to study the existing aquifers in the Arlit and Akokan areas, to ensure an adequate supply of potable and industrial water is available and not being compromised. Ways to conserve and reduce water consumption have been implemented, and over the past 15 years, the annual consumption of water at the mines has been reduced by 35%, despite uranium production doubling at Somaïr over that time.

In April 2010, Areva (now Orano) and local authorities signed a series of protocols and procedures to implement multipartite radiological control of materials and equipment in the streets of Arlit and Akokan, including more stringent monitoring of used materials being taken from the industrial sites.

Somaïr and Cominak manage two hospitals in Arlit and Akokan, with technical support centres. First created to provide medical care for the miners and their families, the centres are now largely open to the public free of charge. Imouraren also recently opened a medical centre that treats local residents for free.

As the country's largest private employer, Orano contributed significantly to the improvement of living conditions in local communities. In 2010, Orano (then Areva) initiated a social policy and committed EUR 6 million per year (about USD 6.5 million) for the next five years for implementation. Mining activity resulted in the construction of housing and a modern network of water distribution, as well as contributing to the funding of public services and the construction of educational facilities (schools, libraries, lunchrooms, etc.).

In 2018, Orano invested EUR 2 million (about USD 2.2 million) in the Irhazer project to develop irrigation systems and agricultural activities in desert areas in the Agadez region. The objective of the project was to contribute to sustainable food safety to reduce poverty.

As part of Orano's commitment to reduce its CO_2 emissions, Somaïr decided in 2022 to build an 8 MW solar power plant, expandable to 10 MW. It was scheduled to be commissioned by the end of 2024.

Studies for the remediation of the Cominak site began in 2002, with the collection of environmental data to inform the closure planning process. The remediation plans were regularly updated over the subsequent years to include the results of additional data and technical studies, to fully inform the possible closure options.

A remediation plan that includes technical, social and community components was defined in the Detailed Basic Design study to meet three major challenges:

- Technical: ensure lasting stability in terms of public health and safety, reduce as low as reasonably achievable (ALARA principles) the residual impacts as well as the surface area of land subject to use restrictions after the remediation.
- Employees: minimise the social impact of the closure of production activities and ensure fair and equitable treatment of all employees.
- Community: take into consideration and minimise the impacts of the closure on the community, by ensuring a sustainable transition, adapted to the needs of the local populations and in keeping with the company's scope of responsibility.

Remediation work of the Cominak site is proceeding according to the planned schedule, with the deconstruction of the plant and part of the buildings in the industrial zone, the continuation of the reprofiling and capping tests of the tailings zone, as well as the permanent closure of the accesses to the underground mine.

At Dasa, according to the Environmental and Social Impact Assessment, the project involves the mining of uranium in an area (7 km around the project) which is sparsely inhabited, with no permanent villages. Livestock grazing occurs to a limited extent within the area. The extended (15 km) area of influence includes two permanent villages located on the Agadez-Arlit road, and more extensive livelihood activities. In parallel with the feasibility study, GAFC commissioned a local environmental consultancy group to undertake an Environmental and Social Impact Assessment (ESIA) of the proposed Project, in compliance with Nigerien legislation.

Uranium requirements

There are currently no uranium requirements in Niger. However, it has been reported that Niger has started consultations with the International Atomic Energy Agency and is considering the installation of two civilian nuclear reactors to meet domestic energy requirements and assist in national economic development.

Uranium policies, uranium stocks and uranium prices

National policies relating to uranium

In September 2024, the Council of Ministers approved the creation of two new state-owned companies, namely the Mazoumawa National Gold Company (MNGC) and the Timersoi National Uranium Company (TNUC), which will be responsible for the exploitation of the country's gold and uranium resources, respectively. The main objective of this initiative is to enable Niger to maximise the economic benefits of its mineral resources, by reducing dependence on foreign companies, and promoting more autonomous and sustainable management of national wealth.

The creation of the Timersoi National Uranium Company demonstrates Niger's ambition to take control of uranium production, a strategic mining resource. The government of Niger thus affirms its intention to redefine the terms of the exploitation of the country's uranium resources. The precise impact of this new entity on the operations of foreign companies remains to be determined.

Uranium prices

The price of uranium sold to joint venture partners (prix Niger) is proposed by mining companies to the Ministry of Mines, which ultimately decides on its level and duration of validity – usually equivalent to one year. This price is officially published in the *National Gazette* (*Journal Officiel de la République du Niger*) and posted on its website. In cases where the price determination is made during the year, it is retroactively applied to deliveries already made.

Reasonably assured conventional resources by production method

(recoverable tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining (UG)	0	0	51 190	70 564	86
Open-pit mining (OP)	0	34 611	238 416	2 61 075	84
Total	0	34 611	289 606	331 639	85

Reasonably assured conventional resources by processing method

(recoverable tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional from UG	0	0	51 190	70 564	86
Conventional from OP	0	34 611	92 780	96 427	83
Heap leaching from OP	0	0	145 636	164 648	85
Total	0	34 611	289 606	331 639	85

Reasonably assured conventional resources by deposit type

(recoverable tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Sandstone	0	34 611	289 606	331 639
Total	0	34 611	289 606	331 639

Inferred conventional resources by production method

(recoverable tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining (UG)	0	0	14 828	22 658	76
Open-pit mining (OP)	0	0	46 649	46 649	82
Unspecified	0	0	0	61 845	75
Total	0	0	61 477	131 152	78

Inferred conventional resources by processing method

(recoverable tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional from UG	0	0	14 828	22 658	76
Conventional from OP	0	0	41 145	41 145	82
Heap leaching from OP	0	0	5 504	5 504	85
Unspecified	0	0	0	61 845	75
Total	0	0			78

Inferred conventional resources by deposit type

(recoverable tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Sandstone	0	0	61 477	131 152
Total	0	0	61 477	131 152

Prognosticated conventional resources

(in situ tonnes U)

Cost ranges		
<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
0	13 600	13 600

Speculative conventional resources

(in situ tonnes U)

Cost ranges		
<USD 130/kgU	<USD 260/kgU	Unassigned
0	51 300	0

Historical uranium production by production method

(tonnes U in concentrates)

Production method	Total through end of 2022	2023	2024	Total through end of 2024	2025 (expected)
Open-pit mining*	80 587	1 130	959	82 676	0
Underground mining*	75 793	0	0	75 793	0
Total	156 380	1 130	959	158 469	0

* Pre-2018 totals include uranium recovered by heap and in-place leaching.

Historical uranium production by processing method

(tonnes U in concentrates)

Processing method	Total through end of 2022	2023	2024	Total through end of 2024	2025 (expected)
Conventional	NA	NA	NA	NA	NA
Heap leaching*	NA	NA	NA	NA	NA
Total	156 380	1 130	959	158 469	0

* A subset of open-pit and underground mining, since it is used in conjunction with them.

Historical uranium production by deposit type

(tonnes U in concentrates)

Deposit type	Total through end of 2022	2023	2024	Total through end of 2024	2025(expected)
Sandstone	156 380	1 130	959	158 469	0
Total	156 380	1 130	959	158 469	0

Ownership of uranium production in 2024

Domestic				Foreign				Totals	
Government		Private		Government		Private			
(tU)	(%)	(tU)	(%)	(tU)	(%)	(tU)	(%)	(tU)	(%)
351	36.6	0	0	608	63.4	0	0	959	100

Uranium industry employment at existing production centres

(person-years)

	2022	2023	2024
Total employment related to existing production centres	NA	NA	NA
Employment directly related to uranium production	NA	NA	NA

Mid-term production projections (tonnes U/year)

2025	2030	2035	2040	2045	2050
0	4 000	6 000	6 000	NA	NA

Mid-term production capability

(tonnes U/year)

2025				2030			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
2 000	2 000	2 000	2 000	2 000	2 000	4 000	5 500

2035				2040			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
2 000	2 000	4 000	8 000	2 000	2 000	4 000	8 000

Paraguay

Uranium exploration and mine development

Historical review

Exploration for uranium in southeastern Paraguay was started in 1976 by the Anschutz Corporation (Anschutz) of Denver, Colorado, after signing of the Concession Agreement between the Government of Paraguay and Anschutz in December 1975. This agreement allowed Anschutz to explore for “all minerals, excluding oil, gas and construction materials”.

Previously, intermittent exploration had been carried out by international oil companies, with insignificant results. The region is known for its limited mining activities and production of high-grade iron ore, mineral pigments, clays, limestone, sandstone, sand and gravel by indigenous people.

In early 1976, several reports by Anschutz consultants covered the geology of eastern Paraguay based on reconnaissance field trips made through the southern Precambrian area, the sedimentary section from north to south and the alkalic intrusions in the north-central part of a large concession. From field examinations of various rock types and airborne radiometric data, it was concluded that the Anschutz Concession contained areas with good potential for uranium mineralisation. The regional correlation of stratigraphic horizons favourable for uranium mineralisation was shown in that report.

The initial uranium exploration by Anschutz in 1976 included an exclusive exploration concession covering some 162 700 km^2, virtually the whole eastern half of Paraguay. This included geological mapping, water sampling, soil sampling and a broad reconnaissance track etch program, with stations spaced 10 km apart. The station spacing for the track etch survey was subsequently reduced to 5 km in the southern part of the concession. The reconnaissance program outlined large anomalous zones, and Anschutz concluded that the concession in Paraguay constituted a new uranium province in an area underlain by granitic rocks and sandstones.

The initial reconnaissance program by Anschutz was followed by a program of airborne radiometric and magnetic surveys, a detailed track etch survey, with station spacing of 100 m to 200 m, geochemical stream sediment and soil sampling, and diamond drilling and rotary drilling over selected target areas. In total, some 75 000 m of drilling was completed from 1976 to 1983. Flight line spacing for the airborne radiometric survey was 5 km, with a clearance of 100 m above the surface.

Anschutz carried out exploration on behalf of a Joint Venture with Korea Electric Power Corporation (Kepco) and Taiwan Power Company (Taiwan Power). Exploration works intersected uranium mineralisation in drill holes ranging from 0.017% eU (equivalent U) to 0.17% eU associated with layers of sub-horizontal sandstones, and higher-grade intersections ranging from 0.1% eU over 10.2 m to 0.3% eU over 0.3 m in sandstones and siltstones. Work was suspended in 1983 due to low uranium prices.

Since 2011-2012, the companies that have been working on uranium projects in Paraguay are Uranium Energy Corporation (UEC), through its Paraguayan subsidiaries Transandes Paraguay S.A. and Piedra Rica Mining S.A., and UrAmerica Limited (UrAmerica), through joint ventures with Ita Pora Mining S.A. and Minera Mbujapeju S.A. However, UrAmerica is no longer working on uranium projects in Paraguay.

In September 2015, UEC requested a two-year suspension of activities due to low uranium prices. Because of this and other administrative issues, there was no exploration activity until 2019.

Historic exploration expenditures by the Anschutz/Taiwan Power/Korea Electric Power joint venture and by Cue Resources, plus more recent exploration by UEC, totalled approximately USD 50 million.

As a result of this work, all known uranium occurrences in the country are found in the eastern part of the country, and most are situated in the sandstones in the western flank of the Parana Basin. The age of most major sandstone uranium deposits ranges from Paleozoic to Mesozoic.

In southeastern Paraguay there is one uranium deposit close to the town of Yuty, and drilling indicates elongated, uranium bearing roll fronts. At least one other area with good potential for becoming a new uranium district is presently under investigation to the east and north of the city of Coronel Oviedo. Additional uranium potential in eastern Paraguay is also likely to exist in Upper Permian sandstone near the town of Curuguaty and within Silurian sandstone sequences east of the village of Eusebio Ayala.

Recent and ongoing uranium exploration and mining development activities

In the 2019-2021 period, exploration activities focussed on the Coronel Oviedo area. Several radon emmanometry surveys and drilling explorations totalling approximately 1 000 m were carried out. Total expenditures for the period were estimated at USD 750 000. No activities have been reported in the 2022-2025 period.

Uranium resources

Identified conventional resources (reasonably assured and inferred resources)

In 2011, about 4 290 in situ tU of Canadian Securities Administrators (CSA) National Instrument 43-101 identified conventional resources have been reported from the Yuty Project by UEC, comprised of reasonably assured resources of 3 430 tU, at a grade of 0.044% U, and inferred resources of 860 tU at a grade of 0.04% U. In 2022, as a United States domestic and domiciled company, UEC reported all mineral resources in accordance with Item 1302 of Regulation S-K ("S-K 1300").

The resource estimate is based on the development of a three-dimensional geologic and resource model, using mainly the results of 256 drill holes, totalling 31 000 metres of core and rotary drilling carried out between 2007 and 2011. Additionally, some 75 000 metres of drilling had been completed from 1976 to 1983.

Pumping testing indicates that the uranium bearing unit has aquifer characteristics that would support operational rates for ISL mining and that the aquifer properties determined from the test fall within the range of values determined at other uranium ISL projects located in the U. S. Metallurgical test work indicates that a satisfactory rate of extraction can be obtained using a sulphuric acid lixiviant.

Adjacent to Yuty, the Parana Basin Project (previously owned by UrAmerica) covers an extensive area of uranium mineralisation potential with several detected uranium anomalies and an inferred resource of 770 tU. This estimate is based on extensive regional exploration work and reconnaissance scale drilling by an earlier owner of the project, Wildhorse Explorations S.A., the Paraguayan branch of Wildhorse Energy Ltd.

Updated in situ uranium identified resources for the country total 5 060 tU at the production cost category <USD 130/kg.

Undiscovered conventional resources (prognosticated and speculative)

UEC has reported an NI 43-101 exploration target at Coronel Oviedo, ranging from 8 900 to 21 500 tU at grades between 0.034 and 0.044% U, which can be categorised as prognosticated resources.

Estimates are based on a 10 000 metre drilling programme completed by UEC in 2012. A total of 35 holes were drilled, averaging 290 metres in depth.

Aquifer testing to date indicates that the uranium bearing unit has aquifer characteristics that would support operational rates for ISL mining and that the aquifer properties determined from the test fall within the range of values determined at other uranium ISL projects located in Wyoming, Texas and Nebraska. Determination of amenability to acid and alkaline leaching is still pending.

Uranium production

There has been no past production of uranium.

Uranium exploration and development expenditures and drilling effort – domestic

(USD)

	2022	2023	2024	2025 (expected)
Private* exploration expenditures	0	0	0	0
Total expenditures	0	0	0	0
Private* exploration drilling (m)	0	0	0	0
Total drilling (m)	0	0	0	0

* Non-government

Reasonably assured conventional resources by production method

(in situ tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)*
In-situ leaching acid	0	0	3 430	3 430	86
Total	0	0	3 430	3 430	86

* Based on column leaching test (NI 43-101 report).

Reasonably assured conventional resources by processing method

(in situ tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)*
In-situ leaching acid	0	0	3 430	3 430	86
Total	0	0	3 430	3 430	86

* Based on column leaching test (NI 43-101 report).

Reasonably assured conventional resources by deposit type

(in situ tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Sandstone	0	0	3 430	3 430
Total	0	0	3 430	3 430

Inferred conventional resources by production method

(in situ tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)*
In-situ leaching acid	0	0	1 630	1 630	86
Total	0	0	1 630	1 630	86

*Based on column leaching test (NI 43-101 report).

Inferred conventional resources by processing method

(in situ tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)*
In-situ leaching acid	0	0	1 630	1 630	86
Total	0	0	1 630	1 630	86

* Based on column leaching test (NI 43-101 report).

Inferred conventional resources by deposit type

(in situ tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Sandstone	0	0	1 630	1 630
Total	0	0	1 630	1 630

Prognosticated conventional resources

(in situ tonnes U)

<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
0	8 900-21 500	8 900-21 500

Peru

Uranium exploration and mining development

Historical review

Historically, radiometric prospecting revealed over 40 uraniferous areas; the most important of which are Chapi, Chilcuno-VI, Pinocho, Cerro Concharrumio and Cerro Calvario, which are hosted almost entirely in the Macusani district, located in southeastern Peru (Department of Puno). Uraniferous mineralisation occurs mainly within the Upper Miocene-Pliocene Macusani Formation, composed of peraluminous rhyolites enriched in alkalis (Li, Rb, Cs), lithophile metals (Sn, W, Nb, Ta, Be) and volatile elements (F, B, P). The Macusani uranium deposit has been assigned to the IAEA geological type of "volcanic-related" deposits, and its mineralisation is primarily represented by meta-autunite and subordinate weeksite, precipitated from meteoric waters under low-temperature conditions, without evidence of U^{4+} phases. It occurs in stockworks and fracture-controlled zones within structural lineaments, with grades ranging from 0.03% to 0.75% U (average 0.1%).

Since 2003, private companies have restarted exploration in both the Macusani district, and the Santa Lucia-Rio Blanco and Pampacolca areas (250 km from Macusani near Arequipa, in the south of Peru), which are also located in a Tertiary volcanic environment.

Between 2010 and 2013, resource estimates by the Mineral Corporation for different complexes of the Macusani district were reported. In 2015, Plateau Uranium Inc. reported an NI 43-101 compliant resource estimate for the Kihitian, Isivilla and Corani uranium complexes in the Puno district.

In 2016, an NI 43-101 preliminary economic assessment (PEA) of the Macusani project was prepared for Plateau Energy Metals (formerly Plateau Uranium Inc.).

In 2018, NI 43-101 measured, indicated and inferred uranium resources contained in the properties controlled by Plateau Uranium Inc. in the Macusani district, were reported.

Recent and ongoing uranium exploration, and mining development activities

The Macusani district continues to be the focus of uranium exploration activities in Peru. Uraniferous mineralisation in Macusani is hosted by young rhyolites of Upper Miocene age (8-6 Ma), where there are more than 70 radiometric anomalies depicted to date on the Macusani plateau, of which around 20 have been drilled.

In 2021, American Lithium Corp. acquired Plateau Energy Metals and its projects in the Macusani district that total about 93 000 hectares. Additionally, American Lithium acquired mining concessions that cover another 14 243 hectares in Puno. In addition to the uranium deposits from this acquisition, American Lithium subsequently discovered three new anomalies with grab samples that returned an average uranium content of 18 270 ppm U (1.8% U).

Also in 2021, the Canadian company Sulliden Mining Capital Inc., acquired 22 600 hectares of concessions in Puno, a region that hosts interesting uranium deposits.

Based on positive results from prospecting, mapping and sampling, American Lithium announced updated drilling plans (12 000 m; 70 holes) for the Macusani project to expand existing uranium resources and identify new deposits. The permitting process has been initiated, including development of an environmental impact assessment and community access agreements. Drilling is expected to start once an exploration permit is granted.

Azincourt Energy Corp. (Canada) reported interest in intensifying exploration activities at the Escalera Group uranium-lithium project located on the Picotani Plateau in southeastern Peru. The Escalera Group consists of three concessions (Lituania, Condorlit and Escalera) acquired by the company in 2020, covering a combined area of 7 400 hectares of prospective exploration targets for volcanic-hosted supergene/surficial uranium and lithium. Surface rock samples obtained in 2017-2018 from the Escalera project returned values of up to 3 560 ppm U (0.36% U) and 153 ppm Li, while historical samples have yielded values up to 6 812 ppm U (0.68% U).

Fission 3.0 Corp. (Canada) holds the rights to nine claim blocks encompassing 5 100 ha, and surface rights over some of the areas with known uranium mineralisation. In 2016, the potential of these properties was demonstrated by a drilling programme that resulted in 13 of 16 holes striking mineralisation, with high-grade uranium values of up to 12 151 ppm U (1.2% U) over 0.5 m only 16 m from surface, and lithium of up to 533 ppm over 0.5 m.

In 2024, Macusani Yellowcake S.A.C, a subsidiary of American Lithium Corp., announced plans to explore the Isibilla project in Puno. Macusani has been the most important uranium district, with uranium mineralisation found in acid volcanic Mio-Pliocene rocks in the Department of Puno in southeastern Peru.

Uranium resources

Identified conventional resources (reasonably assured and inferred resources)

According to the NI 43-101 report originally prepared for Plateau Energy Metals, the identified in situ conventional resources of the Macusani district total approximately 47 710 tU, comprised of 19 970 tU reasonably assured resources and 27 740 tU inferred resources. Since 2021, the Macusani project has been under the control of Macusani Yellowcake S.A.C. (subsidiary of American Lithium Corp.).

Identified conventional resources of Macusani district

(in situ tonnes U)

Prospect	RAR	IR	Total
Corachapi	1 930	730	2 660
Chilcuno	7 610	9 120	16 730
Quebrada Blanca	1 540	3 620	5 160
Tantamaco	1 410	6 150	7 560
Isivilla	1 350	2 180	3 530
Colibri II-III	5 650	1 580	7 230
Nuevo Corani	480	680	1 160
Tuturumani	0	480	480
Calvario I-Real	0	550	550
Puncopata	0	1 280	1 280
Tupurumani	0	1 370	1 370
Total	19 970	27 740	47 710

Undiscovered conventional resources (prognosticated and speculative resources)

Prognosticated conventional resources account for approximately 19 780 tU and occur in the following sectors of Macusani: Kihitian (10 440 tU), Tupurumani (5 600 tU), Corachapi (1 910 tU), Isivilla (1 330 tU) and Corani (500 tU).

In addition, there are some 45 360 tU of speculative resources, according to the information by private companies involved in uranium exploration projects in the Macusani district, notably American Lithium and Fission 3.0.

Unconventional resources and other materials

Unconventional/low-grade resources account for a minimum of 41 600 tU, which include phosphates, granites and hydrothermal deposits. Only uranium resources related to phosphate have been estimated with a moderate degree of confidence.

Unconventional/low-grade resources

(in situ tonnes U)

Permo-triasic granites*	20 000 tU
Bayóvar phosphates**	16 000 tU
Thirty-nine locations***	5 600 tU
Total	41 600 tU

* Granites with radioactive anomalies and uranium occurrences located in the departments of Junín and Pasco, average 50-80 ppm U (0.005-0.008% U).

** Currently, only exploited rock phosphate concentrate; the evaluated content of which is 46 ppm U (0.005%U).

*** Others in the rest of the country, uranium deposits associated with hydrothermal deposits (Cu Pb-Ni-W).

In 2010, the Vale company (formerly Vale do Rio Doce) of Brazil started exploitation of the Bayóvar phosphate deposit through its local subsidiary, Miski Mayo SRL. Before the start of the operation, the company planned for the possibility of uranium recovery during phosphate production, but these plans have not yet been implemented.

Uranium policies, uranium stocks and uranium prices

National policies relating to uranium

Mining activities, formerly conducted by the government, entered a privatisation process in 1992, with the application of the Mining Investment Promotion Law. This legislation aims to provide stability and a guaranteed framework for long-term investments in mining, including uranium. In recent years, the reactivation of interest in uranium exploration has resulted in several foreign private companies conducting exploration and evaluation programmes.

The Peruvian state, by promoting investment in uranium mining, plans to evaluate the potential for uranium in the entire country.

The Law 28 028 regulates the use of ionising radiation sources (2003), while the nuclear regulatory body is the Peruvian Nuclear Energy Institute (IPEN).

Complementary regulations issued by IPEN are:

- Regulation of Radiological Safety (1997), based on IAEA International Basic Safety Standard No. 115;
- Regulation of Physical Protection for Nuclear Facilities and Materials (2002);
- Regulation of Law 28 028 (2008), which refers to the authorisations for different nuclear and radiological practices.

Peru does not yet have any specific regulations for uranium mining, but IPEN is working with the support of the IAEA on the development of a regulatory framework for this purpose. Under this initiative, mandatory technical standards and regulatory guides to inform applicants are being prepared.

Reasonably assured conventional resources by production method

(in situ tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Open-pit mining (OP)	0	19 970	19 970	19 970
Total	0	19 970	19 970	19 970

Reasonably assured conventional resources by processing method

(in situ tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Heap leaching* from OP	0	19 970	19 970	19 970
Total	0	19 970	19 970	19 970

* A subset of open-pit and underground mining, since it is used in conjunction with them.

Reasonably assured conventional resources by deposit type

(in situ tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Volcanic-related	0	19 970	19 970	19 970
Total	0	19 970	19 970	19 970

Inferred conventional resources by production method

(in situ tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Open-pit mining (OP)	0	27 740	27 740	27 740
Total	0	27 740	27 740	27 740

Inferred conventional resources by processing method

(in situ tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Heap leaching* from OP	0	27 740	27 740	27 740
Total	0	27 740	27 740	27 740

* A subset of open-pit and underground mining, since it is used in conjunction with them.

Inferred conventional resources by deposit type

(in situ tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Volcanic-related	0	27 740	27 740	27 740
Total	0	27 740	27 740	27 740

Prognosticated conventional resources

(in situ tonnes U)

Cost ranges		
<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
6 610	19 780	19 780

Speculative conventional resources

(in situ tonnes U)

Cost ranges		
<USD 130/kgU	<USD 260/kgU	Unassigned
45 360	45 360	0

Poland

Uranium exploration and mine development

Historical review

Prospecting for uranium in Poland began in 1948. An industrial plant in Kowary (Lower-Silesian Voivodeship) was established for the exploitation and processing of uranium from local deposits.

Research beginning in 1956 by the Polish Geological Institute involved the exploration of Carboniferous formations of the Upper Silesian Coal Basin, phosphorite formations and research in boreholes in the Polish Lowlands. As a result of this research, signs of uranium mineralisation were discovered in lower Ordovician formations of the Podlasie Depression (the "Rajsk" deposit), and in Triassic formations of the Perybaltic Syneclize and the Sudetes (Okrzeszyn, Grzmiąca, Wambierzyce).

In the Ladek and Snieznik Klodzki metamorphic formations, small occurrences of uranium mineralisation were discovered, including the Kopaliny-Kletno deposit. Approximately 20 tU was extracted from the Kopaliny-Kletno deposit.

In 2014, Poland completed geological and technological analyses and modelling of a process for uranium extraction from low-grade Ordovician Dictyonema shale (black shale-type). Analysis has shown that the costs of obtaining raw material required to produce 1 kg of uranium would be several times higher than the uranium market price at that time. In addition, resources of uranium in waste heaps from prospecting and extractive operations in the Sudety Mountains in the years 1948-1967 are estimated at 10 to 30 tU. Since 2015, geological exploration of uranium ore has not been conducted in Poland.

Recent and ongoing uranium exploration, and mine development activities

There have been no uranium deposits documented and no recent uranium exploration in Poland. However, there are some prospective indications of uranium and small occurrences favourable for uranium deposit discovery that could potentially be economically exploited.

Uranium resources

Identified conventional resources (reasonably assured and inferred resources)

Reinterpretation of historical geological data in 2009-2010 showed that Poland has no identified conventional uranium resources that could be classified according to Red Book standards. Modelling of uranium extraction by underground mining from the Rajsk deposit related to the low-grade Ordovician Dictyonema shales (black shale-type), showed that the cost of obtaining raw material to produce 1 kg of uranium would be above USD 260 kgU. A comparison of these costs with market prices from the last 30 years implies that the extraction of uranium from these rocks will remain uneconomic for the foreseeable future. The data presented in the table below summarises information from historic geological documentation that does not fulfil current requirements for resource reporting and the potential for mining under current economic conditions.

Historical identified conventional resources*

(in situ tonnes U)

Region	Resources (tU)	Uranium content (% U)
Rajsk deposit (Podlasie Depression)	5 320	0.025
Okrzeszyn (Sudetes)	938	0.05-0.11
Grzmiąca (Sudetes)	792	0.05
Wambierzyce (Sudetes)	218	0.0236

* Note: These data represent historical geological resources that were reinterpreted in 2009-2010 and are subeconomic under present-day market conditions.

Undiscovered conventional resources (prognosticated and speculative resources)

Historical research also led to the identification of 20 000 tU of speculative resources in Perybaltic Syneclise. However, as with the identification of uranium occurrences noted above, the speculative resource estimate requires modern methods to confirm results.

Unconventional resources and other materials

Polish copper ore contains uranium, though in small quantities. Uranium resources in these ores are estimated at 144 thousand tonnes. The uranium content is about 60 ppm with a copper content of 2%. The main uranium deposits in Polish copper ore are located in the Sieroszowice-Lubin Basin. The total copper ore resources in Poland are 2 400 million tonnes, of which 48 million tonnes are copper, and 144 thousand tonnes are uranium.

Uranium production

Historical review

In 1948, a government-operated industrial plant was established in Kowary (Lower Silesia) to process ore mined from local uranium deposits. Exploitation of vein deposits in the Karkonosze-Izera Block, and metamorphic deposits in the Ladek and Snieznik Klodzki Blocks continued until 1967. Total production amounted to 541.8 tU from deposits as presented in the table below.

Exploitation of vein deposits in the Karkonosze-Izera Block (Wolnosc, Miedzianka, Podgorze, Rubezal, Mniszkow, Wiktoria, Majewo, Wolowa Gora, Radoniów and Wojcieszyce), and of metamorphic deposits in the Ladek and Snieznik Klodzki Blocks (where some small uranium occurrences and the Kopaliny-Kletno deposit were discovered) took place until 1967, at which time the deposits were almost completely depleted. In the Ladek and Snieznik Klodzki metamorphic rocks, a few occurrences of uranium mineralisation and the "Kopaliny-Kletno" deposit were discovered, from which approximately 20 tU was extracted.

During this period, all uranium produced was exported to the former Soviet Union. It is estimated that between 1948 and 1967, approximately 650 tU was mined in the Sudetes (southwest Poland). Chemical treatment of low-grade ores started in Kowary in 1969 and continued until 1972, producing a significant volume of waste that was left in a tailings pond.

Historical uranium production from selected deposits

(tonnes U)

Deposit name*	Initial resources**	Produced***
Wolnosc	94.0	94.0
Miedzianka	14.7	14.7
Podgorze	280.0	199.0
Rubezal	0.5	0.5
Mniszkow	4.5	4.5
Wiktoria	0.3	0.3
Wolowa Gora	2.5	2.5
Radoniów	345.0	214.0
Wojcieszyce	14.4	12.3
Total	755.9	541.8

* These are a subset of vein deposits from a larger group of deposits listed below.

** Resources not specified as either recoverable or in situ.

*** Production not specified but assumed to be from concentrates.

Status of production capability, and recent and ongoing activities

As of 1 January 2025, no licences for uranium production have been granted in Poland.

Secondary sources of uranium

There is no production of or demand for mixed-oxide fuel, re-enriched tails and reprocessed uranium in Poland.

Environmental activities and socio-cultural issues

All exploitation activities associated with uranium mining and processing in Poland were performed between 1948 and 1976. Although the companies associated with this activity no longer exist, there remains a need to remediate the environment in the area around the sites where the mines operated. The Geological and Mining Law stipulates that the State Treasury is accountable for liabilities from all past uranium production activities in Poland. Therefore, the government is responsible for funding the remediation, using either the national or the district Environmental Protection Fund.

The regional authorities of the voivodship (local administration area) and its special inspectorates, or officers, are responsible for different aspects of the remediation. The local authorities approve remediation plans, and supervise their execution and impact. The inspectorates of the Environmental Protection of a particular voivodship are responsible, in general, for environmental monitoring. Radiological monitoring is considered a part of this overall monitoring effort, and it is performed under the responsibility of the President of the National Atomic Energy Agency.

Since 1996, Poland has taken part in the PHARE Multi-country Environmental Sector Programme on "Remediation Concepts for the Uranium Mining Operations in Central and Eastern European Countries" (CEEC). In the framework of this programme, an inventory and a common database for the CEEC have been created. According to this inventory, the situation in Poland is characterised by a large number of small-scale liabilities from uranium exploration, localised over several places in the country and generally causing minor environmental impacts.

Only a limited number of issues related to mining and milling are considered to be causing serious impacts, with the most important being the tailings pond in Kowary. The 1.3 ha hydrological construction is closed on three sides by a dam that has been modified a number of times in the past. The dam itself is 300 m long (the sum of three sides) and has a maximum height of 12 m. As a result of uranium processing activities, the tailings pond has been filled with about 250 000 tonnes of fine-grained gneisses and schists, with average uranium content of 30 ppm (0.003% U). In the early 1970s, the Wroclaw University of Technology (WUT) received, by governmental decision, the ownership of both the area and the facilities of the former uranium mining company. Subsequently, a company owned by the WUT has continued to use the existing chemical plant for various experimental processes on rare earth metals, chemical production and galvanic processes. As a result, about 300 tonnes of remnants of rare earth metal processing and 5 000 m^3 of post-galvanic fluids, with up to 30 tonnes of solids with a high content of aluminium, nickel, zinc and sodium sulphates, have been deposited in the pond.

The remediation programme of the tailings pond was prepared in 1997 by the WUT and successfully carried out under the PHARE programme until 2003. The specific objectives of this programme were related to the construction of drainage systems, the design and construction of the tailings pond cover, and the final site reclamation.

Three abandoned uranium mines in the Sudetes Mountains of southwest Poland have been successfully adapted for use as tourist attractions and for educational purposes.

The National Atomic Energy Agency conducts regular monitoring of radiation. The monitoring covers the area degraded by extraction and processing of uranium ore in the Lower Silesia region. The monitoring programme consists of the following measurements:

- Total alpha and beta radioactivity in surface waters and groundwater.

  The water is sampled from the natural outflow of the former uranium mine workings, including surface watercourses and reservoirs, dug wells and natural springs discharge (a total of 30 sampling points).

- Total alpha and beta radioactivity in drinking water.

  The water is sampled from the surface and underground public drinking water intakes (a total of 37 sampling points).

- The level of gamma radiation on the surface.

  The measurements of gamma dose rates around former mine workings: drifts, shafts, dumps, and in their immediate surroundings (a total of 62 objects).

- Radon concentration in the atmosphere.

  The instantaneous radon Rn-222 concentration measurements (radon emanation) in the atmosphere in the open mine workings, such as shafts and tunnels (a total of 22 objects).

- Radon concentration in water.

  The water is sampled from public drinking water intakes, natural outflow from former mine workings, springs and dug wells (a total of 58 objects).

Uranium policies, uranium stocks and uranium prices

National policies relating to uranium

In 2014, the Polish government introduced nuclear energy into the energy mix and the Council of Ministers adopted the Polish Nuclear Energy Programme. One of the topics covered is the potential mining of domestic uranium resources.

In 2020, the Council of Ministers approved an update of the Polish Nuclear Energy Programme. It reaffirmed the strategic plan of introducing the first nuclear power reactor with a capacity of 1.2 GWe by 2036 and two subsequent blocks every two years, and from year 2040, three new units every year. As a result, it is expected that six reactors with a combined capacity of 6-9 GWe will be built in Poland. In terms of the institutional framework, there has been a substantial change as the Ministry of Energy was dissolved and its policymaking competences have been transferred to the newly created Ministry of Climate, which is now in charge of both energy and climate protection policies.

In 2022, the Polish government selected Westinghouse as a technology supplier for the construction of the first nuclear power plant in Poland.

Historical uranium production by production method

(tonnes U in concentrates)

Production method	Total through end of 2022	2023	2024	Total through end of 2024	2025 (preliminary)
Underground mining	650	0	0	650	0
Total	650	0	0	650	0

Historical uranium production by deposit type

(tonnes U in concentrates)

Deposit type	Total through end of 2022	2023	2024	Total through end of 2024	2025 (preliminary)
Granite-related	435	0	0	435	0
Metamorphite	215	0	0	215	0
Total	650	0	0	650	0

Installed nuclear generating capacity to 2050

(MWe net)

2023	2024	2025		2030		2035		2040		2045		2050	
		Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
0	0	0	0	0	0	1 200	1 200	3 600	5 000	9 000	12 000	9 000	15 000

Annual reactor-related uranium requirements to 2050 (excluding MOX)

(tonnes U)

2023	2024	2025		2030		2035		2040		2045		2050	
		Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
0	0	0	0	0	0	192	192	576	800	1 440	1 920	1 440	2 400

Portugal

Uranium exploration and mine development

Historical review

There has been no exploration and exploitation of uranium in Portugal since 2001. Unexploited uranium resources exist in the southern part of the country, in the Nisa ore deposit, and in the north Horta da Vilariça area. Existing uranium mines have been closed and rehabilitated. In 2001, the Portuguese government issued the decree-law nº 198A/2001, which granted the state-owned mining company, Empresa de Desenvolvimento Mineiro, S.A. (EDM), the concession for environmental rehabilitation of all abandoned and legacy mines (uranium and polymetallic). Since then, activities undertaken by EDM have prioritised safety, and the environmental rehabilitation and remediation of legacy uranium mining sites. Since then, 92% of all existing uranium mines have been rehabilitated.

Recent and ongoing uranium exploration and mine development activities

There has been no activity in the country or elsewhere.

Uranium resources

Identified conventional resources (reasonably assured and inferred resources)

Portugal hosts an estimated 4 500 tU of reasonably assured resources at a production cost of <USD 80/kgU and 6 000 tU of reasonably assured resources in situ, at a production cost of <USD 130/kgU. Additionally, 1 000 tU are reported as in situ inferred resources at a production cost of <USD 130/kgU. No processing or mining loss recovery factors have been applied to the resource categories.

Undiscovered conventional resources (prognosticated and speculative resources)

Undiscovered conventional resources are estimated to include 1 500 tU of prognosticated resources. Speculative resources are not reported because only one outdated appraisal is available.

Uranium production

Historical review

Portugal's granite-related uranium deposits, located in the north-central area of the country, had been exploited from the beginning of the 20th century to 2001. Most of the uranium concentrates produced were exported.

From 1950 to 1951, a uranium mill facility processing 50 000 t/yr was built at Urgeiriça. Underground extraction continued until 1973, followed by in-situ leaching from 1970 to 1991. The mine reached a depth of about 580 m and 1 600 m in length.

Between 1951 and 1962, Companhia Portuguesa de Radio (CPR) produced a total of 1 123 tU from 22 concessions, of which 1 058 tU were milled at the Urgeiriça plant and 65 tU at other mines by heap leaching. A low-grade concentrate was obtained by precipitation using magnesium oxide.

During the period 1962-1977, Junta de Energia Nuclear (JEN) took over the mining and milling activities from CPR, introducing organic solvent extraction in 1967 and expanding ore treatment capacity to 100 000 t/yr to produce a rich ammonium uranate concentrate. In July 1985, a new capacity expansion to 200 000 t/yr was implemented. In total, 825 tU was produced under JEN management from the Urgeiriça plant and the pilot plant at Senhora das Fontes. Between 1977 and 2001, Empresa Nacional de Uranio, SA (ENU) produced 1 772 tU.

Of the total historical concentrate production, 25% came from the Urgeiriça mine. The Urgeiriça mill stopped conventional ore processing in 1999 and was decommissioned in March 2001. In the interim period, only charged ion-exchange resins from heap and in-place leaching plants, located in the Bica and Quinta do Bispo mines, were processed at the Urgeiriça plant for yellowcake production. Nationally, 57 ore bodies have been mined, 29 by underground methods, 24 by open-pit, and 4 by mixed underground/open-pit methods. In 18 of these mines, local ore treatment was used, but only at Urgeiriça were uranium concentrates produced at an industrial scale. Two pilot treatment plants (Forte Velho and Senhora das Fontes) produced limited amounts of concentrates (sodium uranate).

Ownership of the Urgeiriça mill plant evolved over its operational history. After CPR concluded the agreement with the Portuguese government in 1962, JEN took over until 1977 when ENU, a publicly owned enterprise, acquired exclusive rights to uranium concentrate production and sales. In 1978, JEN exploration teams joined the Direcçao-Geral de Geologia e Minas. In 1992, ENU was integrated into the Portuguese state-owned mining company EDM. In March 2001, EDM decided to liquidate ENU by the end of 2004.

Status of production facilities, production capability, recent and ongoing activities, and other issues

Rehabilitation and remediation (environment and safety) are the only activities currently being developed by EDM.

Future production centres

No future production centres are planned.

Environmental activities and socio-cultural issues

EDM was granted the exclusive concession contract by the Portuguese government to deal with mining legacy sites, including remediation work at 62 uranium legacy sites. This work on legacy uranium and radium mine sites required expenditures of more than EUR 100 million (approximately USD 103.5 million) until 2024. As of 2024, from the 62 identified uranium mining and milling sites, 52 have been remediated, including Urgeiriça, Bica, Cunha Baixa, Rosmaneira, Mondego Sul, Vale da Abrutiga, Barroco, Freixiosa, Prado Velho, Castelejo, Mortórios, Ribeira do Bôco, Canto do Lagar, Picoto, A-do-Cavalo, Reboleiro, Ferreiros, Lenteiros, Barrôco do Ouro and Quinta do Bispo (1st phase).

Uranium requirements

Portugal has no uranium requirements.

Uranium policies, uranium stocks and uranium prices

National policies relating to uranium

The Ministerial Council Resolution No. 107/2019 approved the Roadmap for Carbon Neutrality 2050 (RNC 2050), adopting the commitment to achieve carbon neutrality in Portugal by 2050. Nuclear energy is not considered in Portugal's energy mix. A new energy strategy, PNEC 2030 (Climate and Energy National Plan), reaffirms the importance of renewable sources (mainly wind and hydropower) and increased efficiency as a means of reducing external energy dependence, as well as its associated impact on trade balance and meeting commitments made with respect to the Kyoto Protocols.

Uranium stocks

There have been no changes of stocks since the 2007 edition of the Red Book.

Reasonably assured conventional resources by production method

(in situ tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	<USD 390/kgU	Recovery factor (%)
Underground mining (UG)	0	0	500	500	500	80
Open-pit mining (OP)	0	4 500	5 500	5 500	5 500	75
Total	0	4 500	6 000	6 000	6 000	

Reasonably assured conventional resources by processing method

(in situ tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	<USD 390/kgU	Recovery factor (%)
Conventional from UG	0	0	500	500	500	80
Conventional from OP	0	4 500	5 500	5 500	5 500	75
Total	0	4 500	6 000	6 000	6 000	

Reasonably assured conventional resources by deposit type

(in situ tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	<USD 390/kgU
Granite-related	0	4 500	6 000	6 000	6 000
Total	0	4 500	6 000	6 000	6 000

Inferred conventional resources by production method
(in situ tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	<USD 390/kgU	Recovery factor (%)
Open-pit mining (OP)	0	0	1 000	1 000	1 000	75
Total	0	0	1 000	1 000	1 000	

Inferred conventional resources by processing method
(in situ tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	<USD 390/kgU	Recovery factor (%)
Conventional from OP	0	0	1 000	1 000	1 000	75
Total	0	0	1 000	1 000	1 000	

Inferred conventional resources by deposit type
(in situ tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	<USD 390/kgU
Granite-related	0	0	1 000	1 000	1 000
Total	0	0	1 000	1 000	1 000

Prognosticated conventional resources
(in situ tonnes U)

Cost ranges			
<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	<USD 390/kgU
1 000	1 500	1 500	1 500

Historical uranium production by production method
(tonnes U in concentrate)

Production method	Total through end of 2022	2023	2024	Total through end of 2024	2025 (expected)
Open-pit mining*	1 810	0	0	1 810	0
Underground mining*	1 326	0	0	1 326	0
Unspecified	584	0	0	584	0
Total	3 720	0	0	3 720	0

* Pre-2020 totals may include uranium recovered by heap and in-place leaching.

Historical uranium production by processing method

(tonnes U in concentrate)

Processing method	Total through end of 2022	2023	2024	Total through end of 2024	2025 (expected)
Conventional	3 136	0	0	3 136	0
In-place leaching*	250	0	0	250	0
Heap leaching**	321	0	0	321	0
Other methods***	13	0	0	13	0
Total	3 720	0	0	3 720	0

* Also known as stope leaching or block leaching.

** A subset of open-pit and underground mining, since it is used in conjunction with them.

*** Includes mine water treatment and environmental restoration.

Historical uranium production by deposit type

(tonnes U in concentrate)

Deposit type	Total through end of 2022	2023	2024	Total through end of 2024	2025 (expected)
Granite-related	3 720	0	0	3 720	0
Total	3 720	0	0	3 720	0

Total uranium stocks

(tonnes natural U-equivalent)

Holder	Natural uranium stocks in concentrate	Enriched uranium stocks	Depleted uranium stocks	Reprocessed uranium stocks	Total
Government	168	0	0	0	168
Producer	0	0	0	0	0
Utility	0	0	0	0	0
Total	168	0	0	0	168

Romania

Uranium exploration and mine development

Historical review

In Romania, uranium mining activity has been carried out in five regions where uranium accumulations have been identified, namely the Ciudanovița-Dobrei-Natra-Lișava mineralised structure, the Băița Plai mineralised structure, the Avram-Iancu mineralised structure, the Crucea-Botusana mineralised structure and the Tulgheș-Grințieș mineralised structure.

Exploitation of the Ciudanovița-Dobrei-Natra-Lișava mineralised structure began in 1952. The ore is represented by fine uranium oxides disseminated in a mass of polymerised bitumens known in the area as anthraxolites, and the host rock is represented by fine-grained grey and red siltstones, grey micaceous sandstones, siltstones and grey sandstones, dolomitic sandstones and red siltstones.

The Băița-Plai and Avram-Iancu mineralised structures were discovered in 1950, and in 1952 geological research began for the delineation of the radioactive mineralisation and the extraction of uranium ore. The uranium in these deposits is associated with magnesian and chalcomagnesian skarns, which occur at the limit of dolomites with the corneenes at the base, forming tabular bodies, or, in fault and fissure areas, near the dykes of andesites and laramic basalts, forming metasomatic columns of the dolomitic paleosome.

During the 1965-1983 period, geological, mineralogical and petrographic research was carried out on the Crucea-Botusana mineralised structure, and in 1983, exploitation of the Crucea-Botusana deposit began. Currently, exploitation activity is stopped and conservation works for closure and ecologisation is ongoing.

Near the Crucea-Botusana deposit, geological, mineralogical and petrographic research works have been carried out in parallel at the Tulgheș-Grințieș mineralised structure. At present, the exploitation activity at this deposit is suspended to re-evaluate the reserve in preparation for exploitation. The uranium mineralisation is represented by pitchblende (the only identified mineral), intimately associated with organic matter (bitumen), included in carbonates (breccia) in rock and clay fragments. It is concentrated in the form of lenses, veins, nests and fine impregnations, grouped and located on approximately parallel tectonic zones.

From the research carried out, it was concluded that the uranium mineralisation belonging to the Alpine Uranium Province of the Eastern Carpathians. The Crucea-Botusana type structure, is hydrothermal.

Due to the need to process uranium ore in Romania, the Feldioara hydrometallurgical uranium ore preparation plant was put into operation in 1978, and the associated technical uranium concentrate refining plant was put into operation in 1986. Within the hydrometallurgical plant, the raw uranium ore was processed to the technical uranium concentrate (DUNa) phase. Within the refining plant, the technical uranium concentrate (DUNa) was then processed to uranium octoxide (U_3O_8) and uranium oxide (UO_2) phases. Sinterable uranium dioxide (UO_2) powder is the raw material for the manufacture of fuel elements used in the Cernavoda Nuclear Power Plant.

Recent and ongoing uranium exploration, and mine development activities

Currently, mining activity is carried out as follows:

- Conservation, closure and ecologisation works at the Băița Plai, Avram-Iancu, Ciudanovița-Dobrei-Natra-Lișava and Crucea-Botusana (previously mined deposits).
- Planned commissioning of the Tulgheș-Grințieș mine, which is currently suspended pending re-evaluation of mineral reserves.

No uranium exploration and mine development expenditures have been reported for the 2023-2024 period.

Uranium resources

As of 1 January 2025, no new information has been reported

The latest resource figures (recoverable resources) were provided in the 2001 Red Book. Reasonably assured resources amounted to 4 547 tU in the cost range <USD 130/kgU, and EAR-I (inferred resources) amounted to 4 686 tU. There were no estimates for other cost ranges.

In the 2001 Red Book, estimates for EAR-II (now prognosticated resources) were given as 3 344 tU and those for speculative resources as 3 000 tU in the cost range <USD 130/kgU.

Uranium production

Historical review

In the 1950s, the Ciudanovița-Dobrei-Natra-Lișava, Băița-Plai and Avram-Iancu deposits were identified and put into exploitation, and later the Crucea-Botusana and Tulgheș-Grințieș uranium deposits were outlined.

The level of annual production achieved in the 1950s and the first half of the 1960s was not subsequently reached, due to the Băița-Plai deposit being largely mined out.

Uranium production in Romania ended in 2015. Total historical production is estimated to amount to 18 974 tU, with 1 250 tU estimated to have been produced from 2001 to 2015.

Status of production facilities, production capability, recent and ongoing activities, and other issues

Currently, all mining facilities are under conservation or in the process of being decommissioned.

In 2024, production associated with mine water treatment amounted to 0.726 tU.

In 2024, Romania announced plans to restart uranium mining in 2028, with development of the Tulgheş-Grinţieş mine.

Secondary sources of uranium

Production and/or use of mixed-oxide fuels:

None.

Production and/or use of re-enriched tails:

None.

Production and/or use of reprocessed uranium:

None.

Regulatory regime

There are legal requirements regarding mine decommissioning plans and how to establish financial guarantees to cover decommissioning costs, if the company carrying out the mining activity does not exist at the time of decommissioning – Mining Law no. 85/2003.

Uranium requirements, and supply and procurement strategy

Uranium requirements

Currently, two CANDU 6 nuclear reactor units are operational in Romania.

The annual technological consumption required for the two CANDU 6 reactors is 210 tonnes of uranium in the form of sinterable uranium dioxide powder.

This annual technological consumption requirement is ensured under a framework agreement (2023-2026) concluded with the companies CAMECO and KAZATOMPROM.

Supply and procurement strategy:

The supply strategy to cover the domestic technological consumption needs provides that, starting with 2028, part of it will be covered from domestic uranium production from the Tulgheș-Grinties mine.

Uranium policies, uranium stocks and uranium prices

National policies relating to uranium:

N/A.

Uranium stocks:

N/A.

Uranium prices:

N/A.

Conventional reasonably assured resources by production method

(recoverable tonnes U)*

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining (UG)	0	0	3 297	3 297	NA
Total	0	0	3 297	3 297	NA

* Resources reported in 2001, less production from 2001 to 2015. Highest Red Book cost category in 2001 was <USD 130/kgU.

Conventional reasonably assured resources by processing method

(recoverable tonnes U)*

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional from UG	0	0	3 297	3 297	NA
Total	0	0	3 297	3 297	NA

* Resources reported in 2001, less production from 2001 to 2015. Highest Red Book cost category in 2001 was <USD 130/kgU.

Conventional reasonably assured resources by deposit type

(recoverable tonnes U)*

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Metamorphite	0	0	3 297	3 297
Total	0	0	3 297	3 297

* Resources reported in 2001, less production from 2001 to 2015. Highest Red Book cost category in 2001 was <USD 130/kgU.

Conventional Inferred Resources by production method

(recoverable tonnes U)*

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining (UG)	0	0	4 686	4 686	NA
Total	0	0	4 686	4 686	NA

* Resources reported in 2001. Highest Red Book cost category in 2001 was <USD 130/kgU.

Conventional inferred resources by processing method

(recoverable tonnes U)*

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional from UG	0	0	4 686	4 686	NA
Total	0	0	4 686	4 686	NA

* Resources reported in 2001. Highest Red Book cost category in 2001 was <USD 130/kgU.

Conventional inferred resources by deposit type

(recoverable tonnes U)*

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Metamorphite	0	0	4 686	4 686
Total	0	0	4 686	4 686

* Resources reported in 2001. Highest Red Book cost category in 2001 was <USD 130/kgU.

Conventional in situ prognosticated resources

(tonnes U)*

Cost ranges		
<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
0	3 344	3 344

* Resources reported in 2001. Highest Red Book cost category in 2001 was <USD 130/kgU.

Conventional in situ speculative resources

(tonnes U)*

Cost ranges		
<USD 130/kgU	<USD 260/kgU	Unassigned
3 000	3 000	0

* Resources reported in 2001. Highest Red Book cost category in 2001 was <USD 130/kgU.

Historical uranium production by production method

(tonnes U in concentrates)

Production method	Total through end of 2022	2023	2024	Total through end of 2024	2025 (preliminary)
Open pit mining	NA	0	0	NA	0
Underground mining*	NA	0	0.726	NA	NA
Total	18 974	0	0.726	18 975	NA

* Uranium recovered from mine water treatment.

Historical uranium production by processing method

(tonnes U in concentrates)

Processing method	Total through end of 2022	2023	2024	Total through end of 2024	2025 (preliminary)
Conventional	NA	0	0	NA	0
Other or unspecified methods*	NA	0	0.726	0.726	NA
Total	18 974	0	0.726	18 975	NA

* Uranium recovered from mine water treatment.

Historical uranium production by deposit type
(tonnes U in concentrates)

Deposit type	Total through end of 2022	2023	2024	Total through end of 2024	2025 (preliminary)
Metamorphite*	NA	0	0.7	NA	NA
Sandstone	NA	0	0	NA	0
Total	18 974	0	0.7	18 975	NA

* Includes uranium recovered from mine water treatment.

Ownership of uranium production in 2024

Domestic				Foreign				Totals	
Government		Private		Government		Private			
(tU)	(%)	(tU)	(%)	(tU)	(%)	(tU)	(%)	(tU)	(%)
0.7	100	0	0	0	0	0	0	0.7	100

Uranium industry employment at existing production centres
(person-years)

	2022	2023	2024	2025 (preliminary)
Total employment related to existing production centres	NA	NA	NA	NA
Employment directly related to uranium production	NA	NA	NA	NA

Mid-term production projection
(tonnes U/year)

2025	2030	2035	2040	2045	2050
NA	NA	NA	NA	NA	NA

Mid-term production capability
(tonnes U/year)

2025				2030			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
NA	NA	NA	NA	NA	NA	NA	NA

2035				2040			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
NA	NA	NA	NA	NA	NA	NA	NA

2045				2050			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
NA	NA	NA	NA	NA	NA	NA	NA

Uranium production centre technical details

(as of 1 January 2025)

	Centre #1
Name of production centre	Tulgheş Grinties
Production centre classification (existing, in care and maintenance, placed in stand-by, idled, committed or planned)	planned
Date of first production (year)	2028
Source of ore	
Deposit name(s) or district name	Tulgheş Grinties
Deposit type(s)	Metamorphite
Recoverable resources (tU)	NA
Grade (% U)	NA
Mining operation	
Type (OP/UG/ISL)	UG
Size (tonnes ore/day)	NA
Average mining recovery (%)	NA
Processing plant	
Acid/alkaline	Acid
Type (IX/SX)	IX
Size (tonnes ore/day)	NA
Average process recovery (%)	NA
Nominal production capacity (tU/year)	NA
Plans for expansion (yes/no)	Yes
Other remarks	No

Net nuclear electricity generation

(TWh net)

	2023	2024
Nuclear electricity generated (TWh net)	10.29	10.02

Installed nuclear generating capacity to 2050

(MWe net)

2023	2024	2025		2030		2035		2040		2045		2050	
		Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
1.300	1.300	1.300	1.300	1.974	2.413	2.648	3.087	2.648	3.087	2.648	3.087	2.648	3.087

Annual reactor-related uranium requirements to 2050 (excluding MOX)

(tonnes U)

2023	2024	2025		2030		2035		2040		2045		2050	
		Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
210	210	210	210	320	390	430	500	430	500	430	500	430	500

Russia

Uranium exploration and mine development

Historical review

Since the beginning of uranium exploration in Russia in 1944, more than 100 uranium deposits have been discovered in 14 districts. The most significant deposits are located in four uranium-bearing districts:

- the Streltsovsk district, which includes 19 volcanic, caldera-related deposits where underground mining of some deposits is ongoing or under development;
- the Trans-Ural and Vitim districts, where basal-channel sandstone-type deposits are being developed for uranium production by in situ leaching (ISL);
- the Elkon district, which contains large metasomatite-type deposits prospective for future mining.

Recent and ongoing uranium exploration activities

There are two types of uranium exploration activities in Russia. One involves early-stage prospecting aimed at new deposit discovery and preliminary evaluation, and the second involves additional, more detailed exploration of earlier discovered deposits, to improve resource estimates and delineate new resources.

Uranium prospecting

Uranium prospecting is financed by the federal budget of Russia through the Federal Agency for Mineral Resources (Rosnedra). In 2023-2024, the work was carried out mainly in the Siberian Federal District (Irkutsk Region) and in the Far Eastern Federal District (Republic of Buryatia and Trans-Baikal Region). The work was focussed on identifying large deposits and occurrences suitable for development by ISL and conventional mining methods.

In 2023, exploration expenditures amounted to 242 million rubles. 141 million rubles were spent to conduct greenfield exploration within the Tuyukan area of the Tonod district (Irkutsk region) and 101 million rubles were spent on exploration focussed on sandstone-type deposit discovery at the Baitakh area within the Vitim district (Republic of Buryatia).

In 2024, the geological prospecting expenses amounted to 566 million rubles. Activities were targeted on sandstone basal channel deposits discovery for future ISL mining within three prospective areas. To continue exploration at the Baitakh area, 174 million rubles were spent; for the Dulesma ore promising area in the Republic of Buryatia, 222 million rubles were spent; and within the Bada area (Trans-Baikal Region), 170 million rubles were spent.

Significant increases of uranium exploration expenditures to about 1 198 million rubles is planned for 2025. Exploration will continue within the Baitakh and Bada areas and will start in eight new areas.

Exploration of existing deposits

Exploration of identified deposits is carried out by the subsidiary uranium mining enterprises of the JSC Rosatom Minerals (former Atomredmetzoloto or ARMZ), which is a part of the Russian State Atomic Energy Corporation, Rosatom.

During 2023-2024, JSC Dalur continued exploration at the Dobrovolnoye deposit in Kurgan district. Its completion is planned for 2027.

In 2024, JSC Khiagda continued exploration at the ore body #X2 of the Khiagda deposit with plans to get a licence for the Tetrakh deposit, with estimated in situ resources of 6 429 tU and to start exploration.

In 2023-2024, the Priargunsky production centre continued limited exploration focussed on identifying uranium resources on the flanks of the deposits by drilling boreholes from underground mine workings.

In 2023, total exploration investments amounted to 33.4 million rubles and in 2024 they amounted to 36.4 million rubles.

Uranium exploration abroad

From 2022 to 2024, through Uranium One Group, owned by the State Atomic Energy Corporation, Rosatom, Russia continued exploration for uranium in joint ventures in Kazakhstan, exploration at the Wings deposit in Namibia and at the Mkuju River deposit in Tanzania, to prepare it for development.

In Kazakhstan, all five uranium mines jointly owned by the Uranium One Group are in commercial operation. During 2021-2023 exploration programmes were carried out at the Kharasan mine (Uranium One Group sold its 30% share in the Kharasan mine in January 2025) and at the Budenovskoe #6,7 mine to convert resources into more reliable categories.

In Tanzania, Mantra Tanzania Ltd completed major exploration of the Mkuju River deposit in 2016. Total identified in situ resources amounted to 58 489 tU, of which 47 927 tU were classified as Measures & Indicated (RAR). During 2017-2019, further development was suspended due to unfavourable uranium market conditions. In 2020, a decision was made to build a pilot processing plant during 2021-2023 and to proceed with pilot open-pit mining during 2023-2025. In 2022, the company received all approvals for construction works. In 2023, it completed construction of production facilities and installed the equipment of the pilot processing complex. In 2025, Mantra Tanzania Ltd obtained all required approvals from Tanzanian regulators and launched pilot operations in late July 2025.

In 2024, Mantra Tanzania Ltd issued an updated Definitive Feasibility Study for the main mining complex construction, with annual capacity up to 3 000 tU. Preparatory works started in 2025 and start of construction is planned for 2026. In 2025, the company also planned to restart exploration for resource base expansion and hydrological research works focussed on extraction of a part of resources by the ISL method.

In Namibia, Uranium One Group, through its subsidiary Headspring Investments (Pty) Ltd, completed an intensive drilling exploration programme in 2021. As a result, JORC compliant resources of the sandstone-type uranium deposit, Wings, increased to 18 536 tU of RAR (Measured and Indicated) and 22 977 tU of inferred resources. Additional exploration potential was estimated to be 30 000 tU. A pre-feasibility study completed in 2021 has confirmed positive economics for the ISL mining method. The Wings deposit is the first deposit in Namibia which is potentially amenable for development by ISL. In 2022-2023, the company planned to start with an on-site ISL pilot test. A pilot test site, including pilot plant and chemical laboratory, was constructed and fully prepared for commissioning. The test will start after regulatory approval is issued. In addition, in 2024 the company started research studies of radionuclides distribution in ground water horizons adjacent to the deposit, and investigations were planned to continue in 2025 and 2026. In 2025, Headspring Investments (Pty) Ltd planned to restart exploration drilling to convert more resources from inferred to more reliable RAR categories.

Recent mine development activities

During 2023-2024, the JSC Dalur (Kurgan Region) continued with preparation for pilot ISL uranium mining at the Dobrovolnoye deposit. Pilot plant facilities construction was completed in 2025 and actual pilot mining started in 2025.

In 2023-2024, JSC Khiagda (Republic of Buryatia) continued development at the Kolichikan, Dybryn and Namaru deposits, with aggregated in situ resources of about 19 300 tU. Dybryn was planned for commercial mining in 2025 and Namaru in 2026.

During 2023-2024, the Priargunsky production centre continued construction of the surface complex and infrastructure elements of new mine No. 6, with a design capacity of 2 300 tU/yr. It will support the development of the Argunskoye and Zherlovoye deposits, with total identified resources of about 40 900 tU. Mining start is planned for 2029. In 2025, Priargunsky obtained a mining licence for a standby Shirondukui deposit, with known resources of 8 000 tU and plans to start its development in 2027.

The development of deposits in the Elkon uranium region was suspended due to unfavourable market conditions. In 2020, pilot mining started for gold resources extraction from the upper oxidised part of the Severnoye gold-uranium deposit of the Elkonsky district. Constructed infrastructure may be used in the future for the development of uranium deposits with aggregated known in situ resources of 357 150 tU.

Uranium resources

Identified resources (reasonably assured and inferred resources)

As of 1 January 2025, total recoverable uranium resources in Russia (RAR + inferred resources) amounted to 650 387 tU, while in situ known resources comprised 832 503 tU. Compared with the data as of 1 January 2023, this is a small decrease of 2 148 tU in recoverable resources. Depletion of the resources by mining in 2023 and 2024 by 4 541 tU was partly compensated by resources increase at the Khiagda deposit (operated by the same mine) and at the Severnoye deposit (Elkon district). More than 70% of total resources are from existing and prospective uranium mines.

Total recoverable RAR amounted to 243 187 tU (in situ 315 815 tU), of which 81% are recoverable at a cost of <USD 130/kgU and 7% at <USD 80/kgU. With respect to RAR, 69% belong to volcanic-related and metasomatic geologic types, and are planned for development by conventional underground mining methods. The majority in this group relates to metasomatic-type uranium deposits in the Elkon region. All resources in the cost category of <USD 80/kgU relate to the sandstone-type deposits that are planned to be developed by ISL.

Inferred recoverable uranium resources in Russia amounted to 407 200 tU (in situ 516 688 tU), of which less than 4% can be recovered at less than USD 80/kg. More than 70% of inferred resources are planned for future development by underground mining from metasomatic and volcanic-type deposits.

Undiscovered conventional resources (prognosticated and speculative resources)

In the Russian classification system, prognosticated resources relate to the P1 category and speculative resources relate to the P2 category. As of 1 January 2025, prognosticated (P1) resources in Russia amounted to 163 990 tU, of which 115 280 tU are in the cost category of <USD 130/kgU. Speculative (P2) resources amounted to 528 700 tU, of which 151 110 tU are categorised as <USD 130/kgU. The majority of the undiscovered uranium resources are located in the Trans-Baikal Region (106 510 tU), in the Irkutsk Region (167 800 tU) and in the Republic of Buryatia - Vitim uranium region (225 500 tU).

Compared with the data as of 1 January 2023, there are no changes in prognosticated resources and there is a 23 000 tU decrease in speculative resources explained by resources re-evaluation at known areas.

Undiscovered resources categorised at <USD 130/kgU are dominated by sandstone-type deposits, and in the cost category of <USD 260/kgU, volcanic-related and unconformity-type deposits prevail. The main sandstone-type resources are concentrated in the Republic of Buryatia (the Vitim and South Vitim uranium regions), where prognosticated (P1) resources amount to 85 300 tU and speculative (P2) resources amount to 103 010 tU. Additional prognosticated (P1) resources (20 000 tU) associated with fishbone detritus (phosphate deposit type) are located in the Ergeninsky uranium region in the Republic of Kalmykia. Resources related to unconformity and volcanic-type mineralisation prevail in the Trans-Baikal Region and the Irkutsk region, categorised at <USD 260/kgU.

Uranium production

Historical review

As of 1 January 2025, cumulative uranium production in Russia amounted to 187 073 tU. Total production at the Priargunsky production centre amounted to 162 600 tU, making it the world's largest enterprise for aggregate production of uranium.

Status of productive capabilities

Uranium mining in Russia is carried out by three enterprises that are part of the uranium mining company, Rosatom Minerals (former ARMZ or JSC Atomredmetzoloto). The annual uranium production in Russia in 2024 amounted to 2 738 tU, of which 1 047 tU were obtained by traditional underground mining and 1 691 tU by ISL.

The PJSC Priargunsky Industrial Mining and Chemical Union (PIMCU) remains the main uranium mining centre in Russia. The resource base for the enterprise includes the volcanic-type uranium deposits of the Streltsovsk uranium ore region, with recoverable resources of 71 800 tU as of 1 January 2025.

Uranium mining at the Priargunsky Mining Centre was carried out at two underground mines (mine No. 1 and mine No. 8) and mined ore was processed either at a hydrometallurgical plant or at a heap leach site. Of the 1 047 tU mined in 2024 by the underground method, 978 tU were produced at the hydrometallurgical plant and 69 tU were processed by heap leaching. During 2023-2024, construction of the mine No. 6 surface complex, and infrastructure elements continued (design capacity of 2 300 tU/yr) for the Argunskoye and Zherlovoye deposits, with mining planned to start from 2029.

JSC Dalur, in the Kurgan Region of Russia, carries out the development of the Dalmatovskoye, Khokhlovskoye and Dobrovolnoye deposits by ISL, to maintain a production capacity of 600 tU/yr. As of 1 January 2025, recoverable resources of the three deposits amounted to 7 900 tU. Uranium production in 2024 amounted to 588 tU. In 2024, Dalur commenced pilot plant construction at the Dobrovolnoye deposit and started its pilot mining in 2025.

JSC Khiagda carries out ISL uranium mining of deposits at the Khiagda ore field in the Republic of Buryatia with recoverable resources of 21 600 tU. In 2024, 1 103 tU were produced. Commercial mining is ongoing at the Khiagda, Vershinnoye, Kolichikan and Istochnoye deposits. Mining at the Dybryn deposit was planned to start in 2025 and at Namaru deposit, in 2026.

Uranium production centre technical details

(as of 1 January 2023)

	Centre #1	Centre #2	Centre #3	Centre #4
Name of production centre	Priargunsky Mining Center (Priargunsky)	Dalur	Khiagda	Elkon Mining and Metallurgical Complex (Elkon)
Production centre classification	Existing	Existing	Existing	Prospective
Date of first production	1968	2004	2010	After 2035
Source of ore:				
Deposit name(s)	Antei, Streltsovskoe and others	Dalmatovskoe, Khokhlovskoe, Dobrovolnoye	Khiagda, Vershinnoe and others	Yuzhnoe, Severnoe
Deposit type(s)	Volcanic	Sandstone basal channel	Sandstone basal channel	Metasomatic
Recoverable resources (tU)	71 800	7 900	21 600	303 000
Grade (% U)	0.16	0.04	0.05	0.15
Mining operation:				
Type (OP/UG/ISL)	UG, HL	ISL	ISL	UG
Size (tonnes ore/day)	3 300	NA	NA	5 500
Average mining recovery (%)	95	75	75	85
Processing plant:				
Acid/alkaline	Acid	Acid	Acid	Acid
Type (IX/SX)	IX	IX	IX	IX
Size (tonnes ore/day)	4 700	No data	No data	No data
Average process recovery (%)	95	98	98	95
Nominal production capacity (tU/year)	1 200	600	1 300	5 000
Plans for expansion	Mine #6	Dobrovolnoye dep.	Yes	No

Future production centres

Since 2017, the development of deposits in the Elkon uranium ore region has been suspended due to unfavourable market conditions. Development of deposits in the Trans-Baikal uranium ore region will be considered after 2035.

Employment in the uranium industry

In 2024, the number of employees working in the uranium industry amounted to 7 106, of which 5 917 were Priargunsky (PIMCU) employees, 491 were Dalur employees and 698 were Khiagda employees. Considering that a portion of PIMCU personnel is involved in general-purpose auxiliary and service facilities, the number of employees directly related to its uranium production amounted to 3 570.

Uranium requirements

As of 1 January 2025, there were 10 nuclear power plants in Russia, comprised of 34 units, plus one floating nuclear power plant, with a total installed capacity of 28.6 GWe. During 2024, Russian nuclear power plants generated 215.5 TWhr of electricity, which amounted to 18.2% of the electricity produced in the country. In late January 2024, Unit #2 of Kurskaya Nuclear Power Plant was stopped and switched to the non-generation mode.

The current annual consumption of Russian nuclear power plants amounts to a uranium equivalent of about 4 000 tU. Uranium fuel requirements are supplied by uranium produced in Kazakhstan and Russia, from uranium stockpiles and secondary sources.

The general strategy for electric power facilities construction in Russia, approved by the Russian Federation Government on 30 December 2024, foresees achieving a share of nuclear energy up to 25% in total electricity production by 2045. The capacity of new nuclear power plants commissioned by 2042 will amount to 29.3 GW. Taking into account planned replacement of retiring RBMK reactors with more efficient VVER, fast breeder and fast neutron reactors, the demand for uranium by 2045 will increase slightly. This scenario assumes nuclear energy development based on new nuclear power generation technologies and takes into account the UN Sustainable Development Goals on the global climate agenda and global energy security.

Uranium exploration and development expenditures, and drilling effort – Government domestic

(RUB millions)

	2022	2023	2024	2025 (expected)
Rosatom* exploration expenditures	40	33	34	266
Rosnedra** exploration expenditures	97	242	566	1 198
Rosatom development expenditures	445	1 447	2 391	1 919
Rosnedra development expenditures	0	0	0	0
Total Government expenditures	582	1 722	2 991	3 383
Rosatom exploration drilling (m)	20 600	4 900	3 600	13 600
Rosatom exploration holes drilled	59	13	15	51
Rosnedra exploration drilling (m)	2 644	4 757	9 431	18 204
Rosnedra exploration holes drilled	17	33	77	128
Rosatom development drilling (m)	NA	NA	NA	NA
Rosatom development holes drilled	NA	NA	NA	NA
Rosnedra development drilling (m)	0	0	0	0
Rosnedra development holes drilled	0	0	0	0
Subtotal exploration drilling (m)	23 244	9 657	13 031	31 804
Subtotal exploration holes	76	46	92	179
Subtotal development drilling (m)	NA	NA	NA	NA
Subtotal development holes	NA	NA	NA	NA
Total Government drilling (m)	23 244	9 657	13 031	31 804
Total number of Government holes drilled	76	46	92	179

* Russian State Corporation Rosatom. In previous editions, these expenditures were attributed to industry.

** Rosnedra is the Federal Agency for Mineral Resources.

Uranium exploration and development expenditures (non-domestic)

(USD millions)

	2022	2023	2024	2025 (expected)
Industry exploration expenditures	0	0	0	0
Government* exploration expenditures	0.8	1.7	0.5	5.4
Industry development expenditures	0	0	0	0
Government* development expenditures	16.4	20.2	5.7	31.2
Total expenditures	17.2	21.9	6.2	36.6

* Expenditures in Kazakhstan accounted proportionally to Russian shares in JVs with NAC Kazatomprom.

Reasonably assured conventional resources by production method

(recoverable tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining (UG)	0	0	167 333	167 333	80-90
In situ leaching acid	0	15 978	15 978	15 978	75
Co-product and by-product	0	0	0	45 424	65
Unspecified	0	0	14 452	14 452	75
Total	0	15 978	197 763	243 187	77

Reasonably assured conventional resources by processing method

(recoverable tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional from UG	0	0	150 221	150 221	80-90
In situ leaching acid	0	15 978	15 978	15 978	75
In-place leaching*	0	0	516	516	70
Heap leaching** from UG	0	0	16 596	16 596	70
Unspecified	0	0	14 452	59 876	65-75
Total	0	15 978	197 763	243 187	77

* Also known as stope leaching or block leaching. ** A subset of open-pit and underground mining, since it is used in conjunction with them.

Reasonably assured conventional resources by deposit type

(recoverable tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Sandstone	0	15 978	15 978	15 978
Granite-related	0	0	1 550	1 550
Intrusive	0	0	0	45 424
Volcanic-related	0	0	67 518	67 518
Metasomatite	0	0	103 398	103 398
Phosphate*	0	0	9 319	9 319
Total	0	15 978	197 763	243 187

* Considered conventional resources because uranium is the main commodity of interest.

Inferred conventional resources by production method

(recoverable tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining (UG)	0	0	250 944	304 467	75-85
Open-pit mining (OP)	0	0	0	1 604	70
In situ leaching acid	0	13 892	13 892	22 262	75
Co-product and by-product	0	0	0	35 217	65
Unspecified	0	0	9 087	43 651	75
Total	0	13 892	273 923	407 200	79

Inferred conventional resources by processing method

(recoverable tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional from UG	0	0	242 464	293 312	75-85
In situ leaching acid	0	13 892	13 892	22 262	75
In-place leaching*	0	0	2 068	4 565	70
Heap leaching** from UG	0	0	6 412	6 590	70
Heap leaching** from OP	0	0	0	1 604	70
Unspecified	0	0	9 087	78 867	65-75
Total	0	13 892	273 923	407 200	79

* Also known as stope leaching or block leaching. ** A subset of open-pit and underground mining, since it is used in conjunction with them.

Inferred conventional resources by deposit type

(recoverable tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Sandstone	0	13 892	13 892	50 741
Granite-related	0	0	2 686	5 689
Intrusive	0	0	0	34 701
Volcanic-related	0	0	28 966	42 613
Metasomatite	0	0	221 252	260 749
Phosphate*	0	0	7 127	12 707
Total	0	13 892	273 923	407 200

* Considered conventional resources because uranium is the main commodity of interest.

Prognosticated conventional resources

(in situ tonnes U)

Cost Ranges		
<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
0	115 280	163 990

Speculative conventional resources

(in situ tonnes U)

Cost Ranges		
<USD 130/kgU	<USD 260/kgU	Unassigned
157 110	528 700	0

Historical uranium production by mining method

(tonnes U concentrate)

Production method	Total through end of 2022	2023	2024	Total through end of 2024	2025 (expected)
Open-pit mining	38 655	0	0	38 655	0
Underground mining	121 824	1 055	1 047	123 926	940
In situ leaching	21 146	1 655	1 691	24 492	1 680
Total	181 625	2 710	2 738	187 073	2 620

Historical uranium production by processing method

(tonnes U concentrate)

Processing method	Total through end of 2022	2023	2024	Total through end of 2024	2025 (expected)
Conventional	155 458	987	978	157 423	845
In-place leaching*	241	0	0	241	0
Heap leaching**	4 780	68	69	4 917	95
In situ leaching	21 146	1 655	1 691	24 492	1 680
Total	181 625	2 710	2 738	187 073	2 620

* Also known as stope leaching or block leaching.

** A subset of open-pit and underground mining, since it is used in conjunction with them.

Historical uranium production by deposit type

(tonnes U in concentrate)

Deposit type	Total through end of 2022	2023	2024	Total through end of 2024	2025 (expected)
Sandstone	21 146	1 655	1 691	24 492	1 680
Volcanic and caldera-related	160 479	1 055	1 047	162 581	940
Total	181 625	2 710	2 738	187 073	2 620

Ownership of uranium production in 2024

Domestic				Foreign				Totals	
Government		Private		Government		Private			
(tU)	(%)	(tU)	(%)	(tU)	(%)	(tU)	(%)	(tU)	(%)
2 738	100%	0	0	0	0	0	0	2 738	100%

Uranium industry employment at existing production centres

(person-years)

	2022	2023	2024	2025 (expected)
Total employment related to existing production centres	6 099	7 148	7 106	7 617
Employment directly related to uranium production	4 668	4 749	4 740	5 119

Mid-term production projection (tonnes U/year)

2025	2030	2035	2040	2045	2050
2 620	3 700	3 900	2 800	NA	NA

Mid-term production capability projections*

(tonnes U/year)

2025				2030			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
1 700	1 700	1 700	2 700	1 700	1 700	1 700	3 700

2035				2040			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
1 600	1 600	1 600	3 900	1 500	1 500	1 500	2 800

* B-II projections also include production from resources >USD 130/ kgU.

Net nuclear electricity generation

(TWh net)

	2023	2024
Nuclear electricity generated (TWh net)	217.4	215.5

Installed nuclear generating capacity to 2050

(GWe net)

2023	2024	2025		2030	
		Low	High	Low	High
29.6	28.6	28.6	29.8	30.5	30.5

2035		2040		2045		2050	
Low	High	Low	High	Low	High	Low	High
36.0	36.0	42.5	42.5	51.6	51.6	NA	NA

Annual reactor-related uranium requirements to 2050 (excluding MOX)

(tonnes U)*

2023	2024	2025		2030	
		Low	High	Low	High
4 000	4 000	4 000	4 200	4 400	4 400

2035		2040		2045		2050	
Low	High	Low	High	Low	High	Low	High
5 200	5 300	4 100	4 700	3 700	4 300	NA	NA

* Assumed enrichment tails assay of 0.18%.

Saudi Arabia

Uranium exploration and mine development

Historical review

Historical uranium exploration programmes were completed in Saudi Arabia from the 1960s to the 1990s by contracted foreign organisations including the United States Geological Survey (USGS) and Lockwood, leading to the identification of airborne radiometric anomalies. The USGS also studied the uranium potential of the Ghurayyah deposit that was known for its rare earth elements (REE), Nb, Ta and Zr contents. Minatome completed a multi-year uranium exploration programme (1979-1984), including the follow-up of airborne radiometric anomalies and the evaluation and drill testing of U and Th prospects.

The mining and metals processing sector in Saudi Arabia is expected to grow as the country pursues its Vision 2030 goal of having the mining sector be a third pillar of the economy. The country is going through a large industrial and economic diversification that will grow resource-heavy manufacturing sectors, such as industrial machinery, electrical equipment and the automotive industry, leading to an increase in demand for metal and mineral products.

Saudi Arabia hosts the annual Future Minerals Forum on the future of exploration, mining and processing. Saudi Arabia has introduced reforms to mining sector legislation that encourage private sector participation in the industry.

Recent and ongoing uranium exploration, and mine development activities

Saudi Arabia has initiated a strategic exploration programme for mineral resources, including uranium. Several government entities were aligned and co-operate with well-known international institutions. From March 2017 to March 2019, the first phase of uranium and thorium exploration was conducted, including the evaluation of nine designated areas, with 36 subareas, covering a total of 27 000 km^2 across Saudi Arabia. Exploration targets comprised intrusive, volcanic, phosphate, surficial (calcrete) and sandstone deposit types.

The project's aim was to carry out general exploration and geological assessment, including the estimation of inferred resources for uranium at promising sites, according to the JORC standard. Geological, geochemical and geophysical surveys, as well as trenches, were completed over the 36 subareas. Within nine selected areas, seven subareas were tested by drilling, with a total amount of 70 763 m drilled in 1 467 holes.

The Ghurayyah, Jabal Sayid and Thaniyat Turayf subareas were selected for detailed exploration and the estimation of inferred resources. Exploration activities and office-based evaluation of information continued from 2021 onwards, and exploration programmes were implemented to follow up on the results of the 2017-2019 work. The first phase was carried out with modern exploration techniques and brought the database up to updated levels. The second phase continued testing many subareas, both within the Arabian Shield and in the cover rocks (eastern part of the Arabian Shield). In the 2021-2024 period, a total of 117 857 metres had been drilled in 486 holes.

The next phase of exploration will include the continued exploration of uranium in other prospects and the development of reasonably assured resources at select deposits.

The current and future prospects for uranium exploration in the sedimentary cover of Saudi Arabia are based on experience gained from past activities in uranium exploration, in which uranium occurrences and provinces were determined by geological analogy to worldwide uranium deposits and occurrences.

In 2020, sandstone uranium deposits accounted for over 60% of annual global production, largely through in-situ leach (ISL) mining (Australia, China, Kazakhstan, Niger and the United States). Therefore, Saudi Arabia's current exploration targets include:

- Sandstone uranium deposits in sedimentary basins in the Tabuk area of northern Saudi Arabia in a terrain similar to that hosting Wyoming sandstone-type uranium deposits in the United States;
- Large sandstone uranium deposits associated with hydrocarbon reservoirs in Saudi Arabia similar to sandstone-type deposits in Kazakhstan;
- Six sites selected for regional exploration for the sandstone-type uranium deposits associated with shallow marine to deltaic sedimentary facies, high background uranium content and the presence of lignite in the sedimentary depositional environments. These sites include areas where shallow marine and deltaic facies are prevailing;

In the near future, a new Proposal of Exploration and Evaluation for sandstone-type uranium resources in the sedimentary basins in the Kingdom of Saudi Arabia will be implemented. The key objective of this project is to take the Mesozoic and Cenozoic formations in the slope area between the Arabian Shield and the eastern oil and gas basin as the priority work area to look for sandstone uranium deposits, which covers an area of more than 370 000 km^2. The project would adopt advanced sandstone uranium mineralisation theory and exploration techniques to implement the regional geological survey and the reconnaissance targeting survey.

Saudi Arabia uranium exploration expenditures and drilling activities

(USD)

	2017-2020*	2021-2022**	2023-2024***
Government exploration expenditures (USD)	37 000 000	19 778 580	31 078 420
Total expenditures (USD)	37 000 000	19 778 580	31 078 420
Government exploration drilling (metres)	70 763	77 374	40 483
Government exploration holes drilled	1 467	290	196
Government trenches (number)	967	11	7
Total drilling (metres)	70 763	77 374	40 483
Total number of holes drilled	1 467	290	196

* Exploration activities were carried out in the field from March 2017 to March 2019.

** Exploration activities and office-based evaluation of information continued from 2021 onwards.

*** Exploration activities and office-based evaluation of information continued from 2023 onwards.

Uranium resources

Identified unconventional resources (reasonably assured resources and inferred resources)

The following uranium resources are considered unconventional resources according to the Red Book classification scheme (see Appendix 3) because they are associated with (occur in) unconventional deposit types, which typically have very low grades of uranium, and therefore do not have an established history of production where uranium is a primary product, co-product or an important by-product. In some instances, however, where uranium grades are unusually high for the unconventional deposit type, the specific uranium deposit and its uranium resources may be considered conventional if the deposit is actively being mined for uranium.

Ghurayyah Deposit (intrusive type: plutonic, peralkaline granite complex subtype – U, Nb, Zr, REE, Ta + Th)

The Ghurayyah deposit is located in the northwestern part of the Arabian Shield, in Saudi Arabia. This polymetallic deposit is hosted in a sub-circular granite complex with an outcrop area of 0.27 km^2. Based on geological and geophysical surveys and the drill core results, the granite's size was increased to 0.89 km^2 in area. It is distributed along a northwest trending regional fault and extends approximately 1 100 m along strike, with a maximum width of 1 100 m. The maximum uranium mineralisation depth is up to 500 m, and an audio-magnetotelluric survey showed that the depth of the granite could reach more than 1 000 m. The uranium-bearing minerals in the deposit are accessory minerals, including uranothorite, which occur as fine-grained disseminations, as well as along micro-fractures in the granitic rocks. In addition, Th-U-Nb-Ta and REE-bearing minerals are recorded, including thorite, columbite-tantalite, fergusonite, pyrochlore, zircon, cassiterite, xenotime, bastnaesite and monazite. They are the major economically interesting minerals, which are mainly hosted within the matrix of the granite. Therefore, the Ghurayyah deposit is a granite intrusion with polymetallic mineralisation, including uranium, thorium, niobium, tantalum, zirconium, hafnium, tin and REEs, of which U is considered to be a co-product of the Ta and Nb.

- Ghurayyah Deposit mineral resource estimation (2023)

The Ghurayyah deposit is a large polymetallic deposit containing measured, indicated and inferred in situ resources of 531 million tonnes of ore, grading 109 ppm U (128.5 ppm U_3O_8), and 299 ppm Th (340 ppm ThO_2). The resource estimates were completed based on the uranium mineralisation modelling. The resource remains open at depth and on the periphery of the deposit. During the exploration programme, 164 drill holes totalling 35 447 m were completed at the Ghurayyah deposit. The chemical assay results from a total of 31 727 samples, including 9 319 quality control samples, were used for the resource estimation.

Summary of in situ unconventional mineral resources for the Ghurayyah deposit, December 2023

(at a cut-off grade of 100 ppm U)

Classification	Tonnage	Grade (ppm)	
	(Mt)	U_3O_8	ThO_2
Measured	50	124	399
Indicated	105	125	370
Inferred	376	130	324
Total	531	128	340

In the Ghurayyah deposit, the measured, indicated and inferred in situ uranium resources are 5 258 tU, 11 130 tU and 41 450 tU, respectively.

Jabal Sayid prospect (intrusive type: plutonic, peralkaline granite complex subtype – U, Nb, Zr, REE, Ta + Th)

The Jabal Sayid U-Th prospect is in the central Arabian Shield, about 320 km northeast of Jeddah and 150 km southeast of Medina, covering an area of 588 km^2. The prospect is characterised by a large, exposed, pegmatite-aplite mineralisation zone extending nearly 2 km in an east-northeast to west-southwest direction, with varying widths of more than 50 m in the centre to 5-10 m in both the easternmost and westernmost sections. The outcropping mineralisation zone is consistent with the high eU (>300 ppm) and high eTh (>1 000 ppm) radiometric anomalies revealed by ground gamma-ray spectrometric surveys, indicating a promising U-Th mineralisation potential. The mineralisation potential is supported by radon anomalies in the

Quaternary cover area to the north of the main mineralisation zone. Besides U and Th, the pegmatite-aplite is also enriched in REE and transition metals such as Nb, Ta and Zr.

The major U-, Th-, REE-, and rare metal- (Nb, Ta, Zr) bearing minerals include thorite, uranothorite, pyrochlore, xenotime, monazite, bastnaesite, parisite-(Ce), samarskite, synchysite (Y), fergusonite (Y) and zircon.

The geology and grade continuity of the outcropped mineralisation zone was well established by systematic trenching (8 trenches), surface channel sampling (11 channels) and drilling (50 m x 50 m spacing). The drilling results indicated that the mineralisation remains open to both depth and along strike to the west, with a maximum extension along the dip direction of approximately 700 m, and 400 m in the central and western parts of the mineralised zone, respectively.

- Jabal Sayid prospect mineral resource estimation

The uranium and thorium mineral resources in the Jabal Sayid U-Th prospect were estimated using the kriging method. Total in situ resources are 114 million tonnes of ore grading 242 ppm U (285 ppm U_3O_8) and 944 ppm Th (1 074 ppm ThO_2), reported at a cut-off grade of 100 ppm U. Measured, indicated and inferred in situ uranium resources are 19 708 tU (23 240 t U_3O_8), 6 106 tU (7 200 tU_3O_8) and 1 781 tU (2 000 tU_3O_8), respectively. During the exploration programme, 96 drill holes totalling 30 751 m were completed at the Jabal Sayid U-Th prospect. The chemical assay results from a total of 81 078 samples, including 22 000 quality control samples, were used for the resource estimation. Two domains were delineated and estimated.

Summary of in situ unconventional resources for the Jabal Sayid U-Th prospect, May 2024

(at a cut-off grade of 100 ppm U)

Classification	Tonnage	Grade (ppm)	
	(Mt)	U_3O_8	ThO_2
Measured	83	280	1 030
Indicated	24	300	1 160
Inferred	7	300	1 300
Total	114	285	1 074

Notes:

1. Mineral resources have been estimated in accordance with the JORC Code 2012.

2. No deductions for mining or metallurgical losses have been factored at this stage.

Thaniyat Turayf prospect (phosphate type)

The phosphorite deposits within the sediments of the Sirhan-Turayf shelf in northern Saudi Arabia form part of the large North African Middle East Tethyan phosphate province, which stretches from Morocco to Iraq. The Thaniyat phosphorite member at the base of the Jalamid Formation of the late Cretaceous (Campanian) to Palaeocene age, was deposited in a shallow marine shelf to intertidal zone. The uraniferous phosphorite layer extends continuously within a target area of about 70 km^2 and has an average thickness of 1.8 m, with an average density of 2.0 g/cm^3. The inferred in situ resources are estimated at 14 551 tU.

Inferred unconventional mineral resources in the Thaniyat prospect

(at cut-off grade of 50 ppm U)

Category	Tonnage (Mt)	Average grade		Uranium resources		Phosphate resources
		U_3O_8 (ppm)	P_2O_5 (%)	tU	tU_3O_8	tP_2O_5
Inferred	178	96	19.8	14 551	17 170	35 201 000

Total identified unconventional resources

As of 1 January 2025, Saudi Arabia's total identified unconventional resources (in situ) amount to 99 984 tU, an increase of 23 979 tU, compared to 1 January 2023.

Undiscovered unconventional resources (prognosticated and speculative resources)

Prognosticated and speculative undiscovered unconventional resources have not been identified.

Uranium production

Historical review

No uranium has been produced in Saudi Arabia.

Status of production facilities, production capability, recent and ongoing activities, and other issues

Although no uranium has been produced in Saudi Arabia, numerous preliminary studies and economic assessments have been initiated to evaluate uranium production from the Ghurrayyah and Jabal Sayid deposits, and the uranium-bearing phosphorite deposits in the northern part of Saudi Arabia.

Secondary sources of uranium

Production and/or use of mixed oxide fuels

Saudi Arabia has not produced or used mixed oxide fuels.

Production and/or use of re-enriched tails

Saudi Arabia does not have a uranium enrichment facility. Re-enriched tails have not been produced or used.

Production and/or use of reprocessed uranium

There is no production or use of reprocessed uranium.

Regulatory regime

The Nuclear and Radiological Regulatory Commission (NRRC) and the Ministry of Environment, Water and Agriculture (MEWA) are mandated to regulate uranium mining activities in Saudi Arabia – each within its respective mandate. The NRRC is responsible for radiological aspects, while MEWA oversees non-radiological aspects. Both the NRRC and MEWA are public, legal entities with financial and administrative autonomy.

Environmental activities related to uranium mining and milling – covering both radiological and non-radiological aspects – are guided by national policies, strategies and laws. These include the National Policy for the Atomic Energy Program, the National Policy for Radioactive Waste Management, the National Policy on Occupational Safety and Health andthe National Environment Strategy, as well as applicable nuclear and environmental laws. Together, these frameworks ensure environmental compliance across all sectors in Saudi Arabia, and support the overarching goal of protecting human health and preserving the environment.

The NRRC is mandated to regulate and control nuclear and radiological activities, practices and facilities involving the peaceful use of nuclear energy and ionising radiation; to ensure the protection of humans and the environment from actual or potential exposure to radiation, including natural radiation; and to fulfil Saudi Arabia's international obligations. In line with this mandate, the NRRC has issued a comprehensive set of technical regulations covering the nuclear and radiological aspects of uranium mining and milling. These regulations address, among other areas: radiation protection; notification and authorisation of facilities and activities involving radiation sources; leadership and management for safety; construction and commissioning of nuclear facilities; nuclear material accountancy and control; safe transport of radioactive material; radioactive waste management; security of radioactive material; authorisation and regulatory control of nuclear-related items; nuclear security; emergency preparedness and response for nuclear facilities; and the decommissioning of nuclear facilities.

Moreover, the NRRC has issued a specific regulation, *NRRC-R-01-SR06: Uranium Exploration, Mining, and Milling,* which establishes regulatory requirements for safety, security and safeguards in uranium exploration, mining and milling activities. This specific regulation's objective is to ensure the protection of workers, the public and the environment from the harmful effects of radiation associated with these activities and facilities.

Finally, the NRRC has also established a structured licensing process for uranium mining and milling activities. This process includes a pre-engagement phase and a communication protocol with prospective licensees, to ensure regulatory compliance at all stages.

Uranium requirements, and supply and procurement strategy

Uranium requirements

Saudi Arabia has announced Vision 2030, which includes a large number of economic and social development goals, and launched several economic initiatives and programmes aiming at shifting away from a single income source – hydrocarbons – towards economic diversification with multiple sources. The mining sector is one of these sources of income in which Saudi Arabia aims to increase investment. The results of exploration activities show the abundance of several promising minerals in Saudi Arabia, including uranium. Therefore, Saudi Arabia intends to exploit uranium resources commercially and in accordance with its international commitments. In addition, Saudi Arabia is preparing to introduce its first nuclear power plant. This plant is expected to come into operation in the mid-2030s, which will introduce a local demand for uranium in the next decade, to fuel it.

Supply and procurement strategy

The supply and procurement strategy for uranium has not yet been finalised.

Reasonably assured unconventional resources by deposit type

(in situ tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Intrusive	0	0	0	42 202
Total	0	0	0	42 202

Inferred unconventional resources by deposit type

(in situ tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Intrusive	0	0	0	43 231
Phosphate	0	0	0	14 551
Total	0	0	0	57 782

Senegal

Historical review

There are two important phases of past uranium exploration in Senegal: 1) 1957 to 1965, when a general inventory of the uranium potential of Africa was undertaken, at which time the large deposits in Niger and Gabon were discovered; and 2) 1974 to 2016, which is characterised by specific surveys focussed on the Birimian Superior Precambrian sediments, and secondary and tertiary basins with phosphate deposits. The collapse of uranium prices in the 1980s raised questions about the value of these focussed surveys and the viability of uranium mineralisation in areas far inland and with no infrastructure – areas that could have been eliminated from further exploration because of the limited chances of finding uranium concentrations large and rich enough to be economic.

1957-1966

The first work undertaken in Senegal by the French Atomic Energy Commission (CEA) from 1957 to 1961 was part of a systematic aerial survey of West Africa, covering Senegal, Mali, Upper Volta (today Burkina Faso) and Niger. It was during these survey flights in 1960 that an aerial radiometric anomaly, Saraya, was identified at Kédougou (Southeast Senegal). Fourteen trenches were dug and geochemical samples taken, which resulted in the identification of two types of anomalies: one in a fracture striking North 130° with yellow mineralisation, and the other in a light-coloured syenite with calcite. Around the same time, ground verification of other airborne anomalies was undertaken, mainly by geochemical sampling and small research wells. Some geochemical anomalies were detected (the Dalafinn site, for example), which were usually associated with laterites. In 1961, the CEA made the decision to suspend the study of anomalies at Kédougou and nothing was undertaken in this area until work resumed in 1974.

In 1966, as part of a joint study between Mauritania and Senegal, the CEA undertook a systematic radiometric study of the continental sedimentary basin of the Ferlo (northern Senegal) and along the bank of the Senegal River. This work, however, yielded no interesting results.

1974-2016

On 29 May 1974, the Minister of Development of Senegal sent a letter to the General Administrator of the CEA, which later became the Compagnie Générale des Matières Nucléaires (COGEMA), requesting a resumption of uranium research. After a positive response, a research permit within East Senegal of 38 600 km² was awarded on 27 November 1974. From 1975 to 1976, studies focussed on a series of Cambrian and Precambrian Superior lithologies in the remaining area of the permit. From 1979 to 1984, magnetometry and electromagnetism surveys on the Saraya granite identified uranium mineralisation in conjunction with episyenites, representing a geological in situ resource estimated at about 1 500 tU at an average grade of 0.2%.

COGEMA extensively explored uranium in eastern Senegal during the period 1975-1985 (about 400 vertical and oblique drill holes). The drastic drop in the price of uranium, in the context of rather mixed results, led to the discontinuation of the exploration programme. In 1975, the Total Mining Company of Senegal led exploration studies on uranium anomalies associated with phosphates in secondary and tertiary basins of Cape Verde. The results were not encouraging.

In 2007, due to uranium price increases, exploration was revived and, as a result, the East Saraya licence was purchased by Areva (ex COGEMA) from the junior South African company UraMin. The Saraya western perimeter was awarded to Kansala Resources on 22 March 2007. The exploration licence was renewed again in 2013, for a period of three years. The results of the work showed that the structural setting of the Saraya granitic complex can be considered favourable for alaskite-type uranium mineralisation.

Historical exploration has not identified any uranium resources of economic interest but has nevertheless contributed greatly to understanding the geology of Senegal, particularly in eastern Senegal, on the upper Precambrian basin, including equivalents that exist throughout West Africa (i.e. the uranium belt of Zaire) prospected in the past by CEA-COGEMA (currently ORANO). The research carried out in Senegal, as well as in Guinea and Mali, helped to establish a detailed map and improved understanding of the geological history of the country.

Recent and ongoing uranium exploration and mining development

Currently, the Saraya project is owned by Haranga Resources Ltd. Upon acquisition of the project, Haranga launched confirmatory drilling programmes to test the validity of historical results, which prompted the company, in 2022, to announce an exploration target for the project area of 4 to 35 Mlbs U_3O_8 at an average grade of 0.055% U_3O_8.

In March 2023, Haranga reported results of a drill programme, consisting of 34 RC holes completed for 4 289 m. The drill programme reportedly validated the geological model used to estimate the recently published exploration target, validated the historical drill data and identified extensions to known uranium mineralisation. The uranium mineralisation at Saraya is shear hosted in an NNE structural corridor affected by sodic metasomatism and episyenitisation within the felsic granitic batholith of Saraya. Mineralisation is almost exclusively constrained in the episyenites.

Exploration expenditures in 2023 and 2024 amounted to 768 277 Australian dollars (AUD) and 1 172 297 AUD, respectively.

In 2025, Haranga planned to conduct a termite mound sampling campaign across the Saraya permit, targeting up to 20 000 samples, a new RC drill program targeting Saraya’s extensions, and metallurgical studies to assess ore processing options.

Uranium resources

Identified conventional resources (reasonably assured and inferred resources)

In August 2024, Haranga Resources reported a maiden mineral resource estimate of 17.6 Mlbs U_3O_8 (6 770 tU) at 0.055% U_3O_8 (0.047 %U) at Saraya (JORC Code compliant resources), 2 576 U of which were classified as indicated and 4 194 tU as inferred. The maiden Saraya mineral resource estimate was based on a database containing data from 519 historical drillholes, together with data from Haranga’s 2022-2023 drill campaign (22 diamond drill holes and 29 RC holes).

80% of the resources are located within 140 m from the surface, amenable to open-pit operations.

Undiscovered conventional resources (prognosticated and speculative resources)

No undiscovered resources are currently reported. Senegal previously reported prognosticated conventional resources of 1 500 tU (Red Book 2018), subsequently classified as inferred resources (Red Book 2020 and 2022) after an IAEA Uranium Group Secretariat review, and now reports an increase in the maiden Saraya mineral resource estimate reported in 2023, discussed above.

Unconventional resources and other materials

Senegal does not report unconventional resources.

Reasonably assured conventional resources by deposit type

(in situ tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Granite-related	0	0	0	2 576
Total	0	0	0	2 576

Inferred conventional resources by deposit type

(in situ tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Granite-related	0	0	0	4 194
Total	0	0	0	4 194

Slovak Republic

Uranium exploration and mine development

Historical review

Since 1947, uranium exploration (surface radiometric prospecting) has been performed in different areas of the Slovak Republic (part of the former Czechoslovakia), identifying six regions of uranium mineralisation. Based on the results of this early work, it was concluded that the Slovak Republic had few uranium resources of economic interest.

Between 1985 and 1990, state exploration activities in the eastern part of the Slovak Ore Mountains led to the estimation of resources of economic interest at the Košice deposit, but the deposit was not mined. Uranium mining was terminated in 1989-1990, and an attenuation programme for exploration and mining was instituted between 1990 and 2003, bringing state-funded exploration activities to an end. No uranium exploration occurred between 1990 and 2005.

Ludovika Energy Ltd (a subsidiary of European Uranium Resources) continued exploration in two prospecting areas in the east of the Slovak Republic. The most promising exploration licence concerns uranium mineralisation in Kuriskova, near Košice, which is located within the Jahodná pri Košiciach recreational area. In January 2012, European Uranium Resources announced the results of a preliminary feasibility study (PFS), prepared by Tetra Tech Inc., for an underground mine and a processing facility that would utilise conventional alkaline (non-acid) processing. The PFS included an initial rate of return of 30.8%, a 1.9-year payback, a net present value of USD 277 million at an 8% discount rate (pre-tax, base case assuming prices of USD 68/lb U_3O_8 and USD 15/lb Mo). Indicated resources total 28.5 Mlb U_3O_8 (10 960 tU) and inferred resources amount to 12.7 Mlb U_3O_8 (4 885 tU), using a cut-off of 0.05% U. Operating costs covering the life of the mine were estimated at USD 22.98/lb U_3O_8 (USD 59.75/kgU), assuming a net molybdenum credit of about USD 1.27/lb U_3O_8 (USD 3.30/kgU).

In 2014, various private entities attempted to continue the Kuriskova and Novoveská Huta uranium projects. These efforts were unsuccessful and exploration licences expired in 2015. Further discussions led to the Ministry of Environment rejecting Ludovika Energy's application to identify a new exploration area for rare earth elements in the Jahodná-Kurišková area, in late 2016.

In 2011, Crown Energy Ltd (a subsidiary of GB Energy) drilled five exploration holes (totalling 204 m). During 2012, GB Energy completed exploration programmes over the Kluknava and Vitaz-II exploration areas. In June 2012, following an extensive review of archival material, Crown Energy Ltd uncovered data from a 1960s drilling programme in the vicinity of the Kluknava and Vitaz-II licence areas. Given the volume of data generated from this historic activity, GB Energy deferred new exploration work until the data could be fully analysed. Detailed results of the 1960s programme were expected to be published in 2014. However, no new information on prospection activities appeared publicly and exploration licences expired in 2014.

The activity and exploration results of Beckov Minerals Ltd in the Horka nad Vahom-Kalnica area were not published.

Recent and ongoing uranium exploration, and mine development activities

Since 2015, there have been several protests and lawsuits over the allocation of exploration areas, as well as political discussions about banning uranium mining and exploration in the country, and no new uranium exploration licences have been issued in the Slovak Republic.

Uranium resources

Identified conventional resources (reasonably assured and inferred resources)

No new identified conventional resources have been assessed since 2012, when a pre-feasibility study was finalised and a reserves calculation report for Košice I (Kuriskova area) was approved by the Commission for Reserves Classification (Ministry of Environment of the Slovak Republic). As of 2023, total identified resources (reasonably assured and inferred categories) in the two registered uranium deposits amounted to 19 319 tU.

Deposit	Organisation	Ore resources (t)	U resources (tU)
Košice I	Ludovika Energy Ltd	5 427 000	15 830
Novoveská Huta	Ludovika Energy Ltd	3 876 000	3 489

Undiscovered conventional resources (prognosticated and speculative resources)

Prognosticated resources are estimated to occur in areas surrounding identified deposits and a new estimate of prognosticated resources for the Košice deposit was developed. No other changes have been made since Red Book 2022.

Deposit	Estimated grade (%)	Ore resources (t)	U resources (tU)
Košice I	0.2% U	1 845 432	3 691
Novoveská Huta	0.06% U	12 040 000	7 224

Uranium production

Historical review

During the first period of uranium exploration (1954-1957), a small amount (1.4 tU) was mined in the Novoveská Huta – Hnilcik region. From 1961 to 1990, a total of 210 tU was mined, mainly from Novoveská Huta as a by-product of copper mining, but also from the Muran, Kravany, Svabovce and Vikartovce deposits.

There is currently no uranium production in the Slovak Republic, and none is expected in the future.

Secondary sources of uranium

There is no production and no use of secondary sources of uranium in the Slovak Republic.

Environmental activities

Environmental activities have covered monitoring in the historical mining area of the Novoveská Huta deposit. Monitoring has included chemical analyses of mine water outflow, as well as geochemical and geological engineering evaluations of the condition of tailings and waste rock piles.

Partial monitoring of such factors has been part of a national environmental monitoring network focussed on natural or anthropogenic geological hazards (as indicated by the acronym ČMS GF). Selected mining sites have been monitored, including the above-mentioned area.

Waste rock management must be performed according to Directive 2006/21/EC of the European Parliament and of the Council of 15 March 2006 on the management of waste from extractive industries and amending Directive 2004/35/EC. In the Slovak Republic, the related legislation is NR SR (National Council of the Slovak Republic) Act No. 514/2008 Col. on the management of waste from extractive industries and the Decree of the MŽP SR (Ministry of the Environment of the Slovak Republic) No. 255/2010 Col., which executes the act on the management of waste from extractive industries.

Uranium requirements

As of 1 January 2025, the Slovak Republic had two nuclear power plant sites (Bohunice and Mochovce), with a total of five pressurised water reactors of the VVER-440 type in operation. Two reactors were in operation at the Bohunice site, while three were at the Mochovce site. As of 1 January 2025, total installed capacity amounted to 2 302 Mwe net, with uranium requirements of 367 tU for the year 2025.

In 2009, the construction of two reactors at the Mochovce site (units 3 and 4) began. On 31 January 2023, Mochovce 3 was connected to the grid. Mochovce 4 was expected to be commissioned in 2025.

Uranium policies, uranium stocks and uranium prices

National policies relating to uranium

Energy Policy of the Slovak Republic (Resolution of the Government of the Slovak Republic No. 29/2006)

One of the priorities set to meet energy policy objectives is to utilise domestic primary energy sources for electricity and heat production in an economically effective way.

Energy Security Strategy of the Slovak Republic (Resolution of the Government of the Slovak Republic No. 732/2008)

The objective of the Energy Security Strategy is to achieve a competitive, secure, reliable and efficient supply of all forms of energy at reasonable costs, that protects consumers and the environment, and promotes sustainable development, security of supply and technical safety.

The high share of nuclear energy in the energy mix of the Slovak Republic relies on dependable sources of a sufficient number of fuel elements, which in Europe are offered only by France and Russia. It is possible that in the future these fuel element producers could require from customers a counter-value in the form of uranium as a form of payment. If this occurs, it will be necessary to create the appropriate legislative conditions for the extraction of uranium by amending the relevant laws and strategic documents, including the Raw Materials Policy, since domestic deposits of uranium ore are located near Košice and Spisska Nova Ves – Novoveská Huta.

Legislative and economic support for the efficient and rational use of domestic uranium resources is needed to considerably reduce the dependency on imported energy sources, whose market prices have risen sharply in recent years. Increased uranium prices and higher nuclear fuel costs can privilege those states that will be able to supply their own uranium and require its further processing to produce nuclear fuel.

The possibility of extracting uranium in the Slovak Republic is also to be assessed from the perspective of maximum environmental protection. Mining projects must be harmonised with the development of documentation by concerned municipalities and regional governments in conformity with the applicable legislation.

To meet the Energy Security Strategy targets, it is necessary to assess the feasibility of uranium extraction in the Slovak Republic. It is important to support the use of domestic energy sources rationally and effectively, with the aim of decreasing dependency on imports.

Assessing the viability of uranium mining in the Slovak Republic was one of the priorities of the country's 2008 Energy Security Strategy. However, in May 2014, the government resolved to ban uranium mining in the country unless it was approved by a referendum of local inhabitants. The Slovak Environment Ministry proposed the amendment to the law, which came into effect in June 2015.

European Uranium signs a Memorandum of Understanding with the Slovak Ministry of Economy

In December 2012, European Uranium Resources Ltd (EUU) reported that it had signed a Memorandum of Understanding with the Ministry of Economy of the Slovak Republic. The memorandum defines the parameters by which EUU and the ministry would co-operate in advancing the Košice uranium deposit – on which EUU holds the exploration licence – through ongoing feasibility and environmental studies. A PFS completed by Tetra Tech, Inc. indicates that the Košice uranium deposit can be developed as an economically feasible underground mine, using the best available technologies with minimal environmental impact.

After the affected municipalities and civic associations voiced disagreement, all the mentioned activities were stopped.

Uranium stocks

The Slovak Republic does not maintain an inventory of natural or reprocessed uranium.

Slovenské Elektrárne has a small stock of enriched uranium in the form of complete fuel assemblies. The exact amount is not available.

Uranium exploration and development expenditures, and drilling effort – domestic

(EUR million)

	2022	2023	2024	2025 (preliminary)
Industry* exploration expenditures	NA	NA	NA	NA
Government exploration expenditures	0	0	0	0
Industry* development expenditures	NA	NA	NA	NA
Government development expenditures	0	0	0	0

* Expenditures made by private companies. Government expenditures refer to those corresponding to majority government funding.

Reasonably assured conventional resources by production method

(in situ tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining (UG)	0	10 950*	10 950*	10 950*	80
Total	0	10 950	10 950	10 950	

* Indicated resources (pre-feasibility study).

Reasonably assured conventional resources by processing method

(in situ tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional from UG	0	10 950*	10 950*	10 950*	80
Total	0	10 950	10 950	10 950	

* Indicated resources (pre-feasibility study).

Reasonably assured conventional resources by deposit type

(in situ tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Volcanic-related	0	10 950*	10 950*	10 950*
Total	0	10 950	10 950	10 950

* Indicated resources (pre-feasibility study).

Inferred conventional resources by production method

(in situ tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining (UG)	0	4 881*	8 369*	8 369*	80
Total	0	4 881	8 369	8 369	

* Inferred resources (pre-feasibility study).

Inferred conventional resources by processing method

(in situ tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional from UG	0	4 881*	8 369*	8 369*	80
Total	0	4 881	8 369	8 369	

* Inferred resources (pre-feasibility study).

Inferred conventional resources by deposit type

(in situ tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Volcanic-related	0	4 881*	8 369*	8 369*
Total	0	4 881	8 369	8 369

* Inferred resources (pre-feasibility study).

Conventional prognosticated resources

(in situ tonnes U)

Cost ranges		
<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
0	3 691	10 915

Note: Category shift concerning new reserves calculation and estimated ore quality.

Historical uranium production by production method

(tonnes U in concentrates)

Production method	Total through end of 2022	2023	2024	Total through end of 2024	2025 (expected)
Open-pit mining*	50**	0	0	50	0
Underground mining*	161**	0	0	161	0
Total	211	0	0	211	0

* Pre-2020 totals may include uranium recovered by heap and in-place leaching.

** Estimate.

Historical uranium production by processing method

(tonnes U in concentrates)

Processing method	Total through end of 2022	2023	2024	Total through end of 2024	2025 (expected)
Conventional	211	0	0	211	0
Total	211	0	0	211	0

Historical uranium production by deposit type

(tonnes U in concentrates)

Deposit type	Total through end of 2022	2023	2024	Total through end of 2024	2025 (expected)
Volcanic-related	211	0	0	211	0
Total	211	0	0	211	0

Net nuclear electricity generation (TWh net)

	2023	2024
Nuclear electricity generated (TWh net)	18.344	16.891

Installed nuclear generating capacity to 2050
(MWe net)

2023	2024	2025		2030		2035		2040		2045		2050	
		Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
2 302	2 302	2 302	2 742	2 742	2 742	2 282	2 742	1 349	3 742	NA	NA	NA	NA

Annual reactor-related uranium requirements to 2050 (excluding MOX)
(tonnes U)

2023	2024	2025		2030		2035		2040		2045		2050	
		Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
307	394	367	NA	435*	NA	441*	NA	441*	NA	NA	NA	NA	NA

* Data covers only nuclear power plants of Slovenské elektrárne.

Total uranium stocks
(tonnes natural U-equivalent)

Holder	Natural uranium stocks in concentrates	Enriched uranium stocks	Enrichment tails	LWR reprocessed uranium stocks	Total
Government	0	NA	NA	0	NA
Producer	0	0	0	0	0
Utility	0	NA	0	0	NA
Total	0	NA	NA	0	NA

Slovenia

Uranium exploration and mine development

Historical review

Exploration of the Žirovski Vrh area began in 1961. In 1968, the P-10 tunnel was developed to access the ore body. Mining began at Žirovski Vrh in 1982 and uranium concentrate production (as yellow cake) began in 1985. The mine ceased operations in 1991.

Recent and ongoing uranium exploration and mine development activities

Expenditures for exploration ended in 1990. There are no recent or ongoing uranium exploration activities in Slovenia.

Uranium resources

Identified conventional resources (reasonably assured and inferred resources)

A resource assessment of the Žirovski Vrh deposit was carried out in 1994. Reasonably assured resources were estimated to amount to 2 200 tU (in situ) with an average grade of 0.14% U in the <USD 80/kgU cost category. In situ inferred resources total 5 000 tU in the <USD 80/kgU cost category, and 10 000 tU in the <USD 130/kgU cost category, at an average grade of 0.13% U. This deposit occurs in the grey sandstone of the Permian Groeden Formation, where the orebodies occur as linear arrays of elongated lenses within folded sandstone.

Undiscovered conventional resources (prognosticated and speculative resources)

Undiscovered resource estimates remain the same as previously reported.

Uranium production

Historical review

The Žirovski Vrh uranium mine, located 20 km southwest of Škofja Loka, was the only uranium production centre in Slovenia. Ore production began in 1982, and the associated ore processing plant (annual production capability of 102 tU) began operations in 1984, initially treating stockpiled ore. The ore, which occurs in numerous small bodies in the mineralised coarse-grained sandstone, was mined selectively using a conventional underground room and pillar, cut-and-fill operation, with a haulage tunnel and ventilation shaft. In 1990, operations were terminated. Cumulative production from the Žirovski Vrh mine and mill complex totalled 386.7 tU (calculated). Mill tailings were disposed of in the Jazbec mine tailings disposal site and hydrometallurgical tailings were disposed of at the Boršt hydrometallurgical tailings disposal site.

Status of production capability

In 1992, a decision was made to close and decommission the Žirovski Vrh mine and mill complex, and there has been no production at the facility since. All production was carried out in the former Yugoslavia. In 1994, the Slovenian government adopted the plan for decommissioning the facility. The production facility was dismantled and no longer exists.

Environmental activities and socio-cultural issues

The government-owned former Žirovski Vrh Uranium Mine Company manages all activities connected with the rehabilitation of the former uranium production site, consisting of underground mining facilities, surface milling facilities, the waste rock pile and tailings disposal site. It obtains all remediation permits required, performs the remediation works and monitors the environmental impact of the site during the remediation phase. After finishing the remediation work, the remaining disposal sites and the mine water effluents are put under long-term environmental surveillance, which is carried out by the national Agency for Radioactive Waste Management. The mine effluents are monitored for uranium, radium and other chemical contaminants, and the disposal sites are monitored for radon exhalation, and uranium and radium in water effluents.

The annual dose contribution from all mine sites has significantly decreased as a result of remediation activities. Since 2011, it has dropped below 0.1 mSv/a, and in 2024 it was 0.256 mSv/a (for adults), which is below the prescribed annual exposure limit of 0.3 mSv. The difference between the annual dose contribution from all mine sites in 2022 (0.140 mSv/a) and 2024 (0.256 mSv/a) is due to the revised dose conversion factors in the regulation, which are now twice as high as before the change.

All remediation work is finished on the mine tailings disposal site, and in 2015, the long-term environmental surveillance of the site started.

Monitoring

The mine's air and water effluents have been monitored on a regular basis since the start of ore production in 1982. The programme was modified when production stopped in 1990 and is ongoing. Emissions to surface waters and air are monitored, and doses to the local population have been calculated since 1980. Treatment of the mine's effluents is not planned, considering the low concentrations of radioactive contaminants.

The monitoring of the environmental radioactivity of the former uranium mine consists of measuring radon releases, liquid radioactive discharges and concentrations of radionuclides in the environment. An integrated programme of measurements has been implemented, including the radionuclide-specific activities of the uranium-radium decay chain in environmental samples, the concentrations of radon and its decay products in the air, as well as external radiation. As part of the long-term surveillance and maintenance programme, the surfaces of the Jazbec mine tailings disposal site and the Boršt hydrometallurgical tailings disposal site are controlled regularly. In the event of heavy rain or an earthquake, additional site controls are implemented. The rate of sliding of the base of the Boršt hydrometallurgical tailings disposal site is measured in real time, using a GPS system, at control points on the hydrometallurgical tailings. Since 2018, geodetic surveillance has been carried out every year.

Tailings impoundment

There is one 4.2 ha specially designed long-term site for hydrometallurgical tailings at Boršt. It is situated on the slope of a hill between 535 and 565 m above sea level. At this disposal site, 610 000 t of hydrometallurgical waste, 111 000 t of mining waste and 9 450 t of material, collected during decontamination of the mill tailings in the Boršt site vicinity, have been disposed of, with a total activity of 48.8 TBq. The amount of excavated ore was about 630 000 t and the amount of processed ore was about 610 000 t.

The tailings have been stored in a dry condition as a result of the filtration of the leached liquor. The surface was topped with a 2.05 m thick, engineered multilayer soil cover with a clay base to prevent leaching of contaminants, and was covered with grass. Although remediation of the site was completed in 2010, it required drainage intervention measures to reduce the groundwater level and slow down landslide movement that was activated beneath the disposal site. The results of additional slope stabilisation work, performed in 2016 and 2017, will help determine if the disposal site meets the conditions for site closure and the beginning of long-term environmental surveillance.

To reduce the impact of precipitation on the increase in groundwater levels and thus the velocity of landslide, additional measures have been taken in recent years. In the period from 2011 to 2017, seven drainage wells were drilled, and in 2019, nine additional piezometers were installed. In 2021, a new automatic extensiometer was added to the existing mechanical extensiometer.

In 2015, 2016 and 2021, three studies were carried out. In the first study, the distribution of tailings in the case of an extraordinary event (e.g. intensive rain or an earthquake) was assessed. Based on the study, the former Ministry of the Environment and Spatial Planning ordered an additional study on the radiation exposure of residents and the workers who would carry out the remediation of the deposited material on the riverbeds of the Todraščica, Brebovščica and Poljanska Sora rivers. The results of both studies were included in the revised safety report. In the third study, the various scenarios, including the worst-case scenario and probabilities of possible movements of the landslide into the Potoška Grapa Valley and the possibility of temporary damming of Todraščica River, were assessed.

The safety report for the Boršt hydrometallurgical tailings disposal site was revised in 2024. This is the basic document for the closure of the disposal facility and the transition to long-term surveillance and maintenance, which will be carried out by the Agency for Radioactive Waste Management (ARAO) as part of a mandatory service of general economic interest.

Waste rock management

All waste rock piles were relocated to the central mine waste pile, Jazbec. All other sites have been restored to a green field condition. The 6.7 ha Jazbec facility contains 1 910 425 t of mining waste, low-grade uranium ore, red mud, filter cake from the mine water treatment station, and contaminated material from the decommissioning of mining and milling facilities, with a total activity of 21.7 TBq. It is covered with an engineered two-metre-thick multilayer of soil and planted grass. A concrete drainage tunnel was constructed at the bottom of the waste rock pile to drain seepage and groundwater into a local stream. Environmental remediation works at the Jazbec disposal site were completed and the administrative procedure for site closure finalised in 2015. The responsibility for long-term surveillance and maintenance of the site was transferred to the ARAO in 2015.

Uranium requirements

The sole nuclear power plant in Slovenia is the Krško Nuclear Power Plant. It started commercial operation in January 1983 and was modernised in 2000 with replacement steam generators that increased net capacity to 676 MWe. In 2006, net capacity was increased to 696 MWe with low-pressure turbine replacement, and in 2022 and 2024 to approximately 701 MWe after the installation of a new high-pressure turbine. The power plant is co-owned by Croatia and Slovenia, each with 50% ownership.

There has been no significant change in the Slovenian nuclear energy programme in the last few years. Uranium requirements for Krško Nuclear Power Plant are relatively stable and account for about 140-150 tU per year. The current fuel cycles are 18 months in duration and are planned to continue on this cycle basis. In 2012, the Slovenian Nuclear Safety Administration approved the ageing management programme, a prerequisite for the operation of Krško Nuclear Power Plant beyond 2023, until the year 2043. In January 2023, the Slovenian Ministry of

Environment and Spatial Planning issued the final approval for Krško Nuclear Power Plant until 2043, following the completion of an environmental assessment. In 2020, the Krško Nuclear Power Plant started the third periodic safety review (PSR3) which is required for operating licence extension of 10 years. The PSR3 was completed in 2023, with the approval of a summary report and an action plan that needs to be completed within five years.

Supply and procurement strategy

The total uranium requirement of Krško Nuclear Power Plant per operating cycle remains unchanged and as reported in previous editions of the Red Book. There are no operating or strategic uranium reserves in Slovenia and supply is imported based on requirement contracts.

The current uranium supply contract covers requirements until 2028. The current procurement strategy utilises enriched UF_6, supplied to the fuel manufacturer from the uranium supplier when it is required for fuel assembly construction. No physical deliveries of U_3O_8 or UF_6 are made to the Krško Nuclear Power Plant site. The manufactured fuel assemblies arrive just before they are used for power production. There are no plans in the foreseeable future to build a uranium stockpile by Krško Nuclear Power Plant. The strategy for commercial spent nuclear fuel management currently does not include the use of reprocessed uranium and Krško Nuclear Power Plant is not licensed for MOX use.

Uranium policies, uranium stocks and uranium prices

National policies relating to uranium

Slovenia is not a uranium-producing country. Uranium stocks are imported for the commercial operation of Krško Nuclear Power Plant as final products (manufactured nuclear fuel assemblies).

Uranium stocks

There is no uranium stock policy in Slovenia. Krško Nuclear Power Plant has no uranium stocks and there is no intention to create such a policy. All required uranium stocks are purchased on a "just-in-time" basis.

Uranium prices

This information is considered confidential.

Reasonably assured conventional resources by production method

(in situ tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Underground mining	0	2 200	2 200	2 200
Total	0	2 200	2 200	2 200

Reasonably assured conventional resources by processing method

(in situ tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Unspecified	0	2 200	2 200	2 200
Total	0	2 200	2 200	2 200

Reasonably assured conventional resources by deposit type

(in situ tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Sandstone	0	2 200	2 200	2 200
Total	0	2 200	2 200	2 200

Inferred conventional resources by production method

(in situ tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Underground mining	0	5 000	10 000	10 000
Total	0	5 000	10 000	10 000

Inferred conventional resources by processing method

(in situ tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Unspecified	0	5 000	10 000	10 000
Total	0	5 000	10 000	10 000

Inferred conventional resources by deposit type

(in situ tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Sandstone	0	5 000	10 000	10 000
Total	0	5 000	10 000	10 000

Prognosticated resources

(in situ tonnes U)

Cost ranges		
<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
0	1 060	1 060

Historical uranium production by production method

(tonnes U in concentrate)

Production method	Total through end of 2022	2023	2024	Total through end of 2024	2025 preliminary
Underground mining*	386.7	0	0	386.7	0
Total	386.7	0	0	386.7	0

* Pre-2020 totals may include uranium recovered by heap and in-place leaching.

Net nuclear electricity generation

	2023	2024
Nuclear electricity generated (TWh net)	5.33	5.55

Installed nuclear generating capacity to 2050

(MWe net)

2023	2024	2025		2030		2035		2040		2045		2050	
		Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
690	690	666	701	666	701	666	701	666	701	NA	NA	NA	NA

Note: Low and high values were taken as dependable power and maximum designed net power, respectively.

Annual reactor-related uranium requirements to 2050 (excluding MOX)

(tonnes U)

2023	2024	2025		2030		2035		2040		2045		2050	
		Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
140	140	112	168	112	168	112	168	112	168	NA	NA	NA	NA

Note: Krško Nuclear Power Plant operates 18-month cycles with a fresh fuel load of approximately 210 tonnes of natural uranium equivalent. In some years, no uranium supply will be required (e.g. 2027). The values in the table are the average yearly values (i.e. 210 tU x 12/18 = 140 tU). Low and high variability is ±20% from the expected value; this is calculated from the maximum change that could occur from a change in fuel assembly design or variation in cycle length (i.e. 12-24 months).

South Africa *

Uranium exploration and mine development

Historical review

South Africa has been an important player in the international market since it first started producing uranium in 1952. It has steadily and consistently produced uranium since then, albeit at a lower level in recent years. Eight of the 15 deposit types defined in the Red Book are found in South Africa, namely paleo-quartz-pebble conglomerate, sandstone, lignite, coal, intrusive, surficial, phosphate and granite-related deposits. A major part of the resource base is hosted by the quartz-pebble conglomerates and derived tailings, with significant amounts of resources in the sandstone and coal-hosted deposits. The other deposit types make a relatively small contribution to the national uranium resource inventory.

There are six distinct uranium provinces in South Africa. The oldest are the Palaeozoic-aged Mozaan basin in the northeast and the slightly younger Witwatersrand Basin in central South Africa. The Precambrian-aged Palabora and Pilanesberg carbonatite complexes lie in the north, with the Precambrian to Cambrian granite complexes in the northwest. The sandstone deposits of the Karoo in the south-central parts, as well as the coal-hosted deposits of the Springbok Flats, are of Permo-Triassic age. The youngest are the tertiary to recent surficial deposits in the Northwest Cape and the phosphorite deposits off the southwest coast.

The surge in uranium prices between 2005 and 2007 stimulated significant corporate interest in South Africa. Much of the ground over the Witwatersrand Basin was held by existing mining companies and extensive re-evaluations of uranium resource holdings were undertaken. Of great interest were the resources held in the vast tailings storage facilities (TSFs) created by over 100 years of gold mining. Gold Fields, Rand Uranium, Harmony and AngloGold Ashanti launched detailed feasibility studies into the resources contained in the tailings.

Available areas with known uranium occurrences, such as in the Karoo Basin and Springbok Flats, were quickly acquired by companies UraMin, Holgoun Energy and others. UraMin was subsequently acquired by Areva (now Orano), the assets of which included the Trekkopjie deposit in Namibia and the Ryst Kuil Channel in the Karoo Basin. Smaller companies obtained prospecting licences over lesser-known deposits in the Karoo Basin, as well as deposits in the granitic and surficial terrains in the northwest of the country.

Peninsula Energy operated in South Africa through its subsidiary Tasman RSA Holdings (Pty) Ltd and had a total of 41 prospecting rights covering 7 774 km^2 in the Karoo Uranium Province. Peninsula Energy identified new areas of uranium mineralisation in the stacked sandstone units which host extended uranium mineralisation beyond the historic drilling limits, thereby increasing the resource potential. In December 2012, Peninsula Energy acquired all of Areva's properties located in the Karoo Uranium Province, including the Ryst Kuil deposit. Since the commencement of exploration in 2006, Tasman has completed approximately 31 000 m of reverse circulation and diamond drilling, and geophysically logged an additional 15 000 m of open historic holes. In February 2013, Tasman commenced drilling along the Ryst Kuil channel in the Eastern Sector of its Karoo projects, which has returned encouraging initial results.

* Report prepared by the NEA/IAEA, based on previous Red Books and public data.

In 2012, HolGoun Uranium and Power Limited completed a pre-feasibility study of its project in the Springbok Flats Basin, where uranium is hosted by coal and then followed up with a more detailed economic feasibility study. The economic feasibility study comprised resource and reserve estimations, bulk sampling and pilot plant test work, geotechnical and groundwater study, mine and underground infrastructure design, overall environmental issues, financial and economic evaluations, and a mining rights application. The initial development of this project envisaged an annual production capacity of about 700 tU_3O_8 (595 tU) at a feed grade of 0.096% U of ore during the first seven years of production. Thereafter, the annual production was planned to be about 500 tU_3O_8 (425 tU) at a feed grade of 0.063% U of ore.

Gold One International Ltd acquired the Rand Uranium properties, as well as the Ezulwini mine, in 2012. One of the key objectives associated with these acquisitions was to re-establish the Cooke underground and Randfontein surface operations as gold mines and subsequently to develop uranium co-product potential. The Cooke underground operations comprise Cooke 1, 2, 3 and Ezulwini. Ezulwini was integrated into the Cooke underground complex as Cooke 4. Ongoing exploration and resource development work highlighted numerous potential resource extensions. A feasibility study was completed in 2012 on a high uranium-yielding area at Cooke 3, which consists of both unmined ground and several higher-grade pillars. The area is associated with existing underground development. The feasibility study considered uranium extraction through the Cooke 4 uranium plant (Ezulwini). The Randfontein surface operations host gold and uranium surface resources which present attractive opportunities for future extraction. These tailings include the Cooke tailings dam, the Millsite complex, Lindum, Dump 20 slime and the Old 4 dam.

In 2012, Harmony Gold Ltd developed two uranium projects to the feasibility stage: Harmony Uranium TPM (Tshepong, Phakisa and Masimong) and the Free State Tailings Uranium Project. The initial plans were that the TPM project would be extracting uranium from the Tshepong, Phakisa and Masimong underground mines, while the Free State Tailings Uranium Project would be extracting uranium from the old tailings storage facilities owned by Harmony. The feasibility study of the TPM project was supported by a demonstration plant campaign and associated metallurgical test work. However, these projects have been deferred because of financial constraints.

In 2013, Peninsula released positive results from an initial scoping study and commenced a pre-feasibility study in the second half of 2013, which included extensive metallurgical test work. In June 2014, the company submitted mining rights applications over all their prospecting areas in the Karoo region. The application process was expected to take up to two years and, hence, the planned start of mine development was delayed from 2016 to 2018.

Namakwa Uranium conducted uranium exploration on the Henkries Project in the Namaqualand, Northern Cape Province. Most of the delineated resources, mainly in Henkries Central, occur within 20 metres of the surface. Given the shallow and soft nature of the deposit, as well as good infrastructure serving the project area, the project was regarded as potentially viable for future uranium extraction. Xtract Resources conducted due diligence to acquire the Henkries Project in 2014 but decided not to proceed with the acquisition as it did not meet its investment criteria.

In 2014, Sibanye Gold Ltd acquired the Cooke assets and Randfontein operations from Gold One Ltd, and the Witwatersrand Consolidated Gold Resources Limited (Wits Gold) assets. A detailed feasibility study of the West Rand Tailings Retreatment Project (WRTRP) was completed by mid-2015. The definitive feasibility study focussed on leveraging existing surface infrastructure, as well as the available uranium treatment capacity at the Ezulwini gold and uranium processing plant, to sustain surface gold and uranium production before the development of the central processing plant. The Driefontein, Kloof, and Cooke surface operations and associated processing facilities are located on the West Rand of the Witwatersrand Basin, while Beatrix is in the southern Free State goldfields. Sibanye-Stillwater also has an interest in surface tailings retreatment facilities, located from the East Rand to the West.

Recent and ongoing uranium exploration, and mine development activities

In 2017, Peninsula completed a draft environmental impact assessment, and environmental management programme reports for the Ryst Kuil and Quaggasfontein areas (Karoo projects). The proposed mining operation was to be known as the Tasman RSA Mines and would be operated as a single entity, but with multiple production centres (Kareeport, Ryst Kuil and Quaggasfontein) feeding a central processing plant to be located near the main ore body within the Ryst Kuil project area. In April 2018, Peninsula announced its decision to withdraw from the Karoo projects in which it had a 74% interest. It suspended all development activities, including preparation of exploration and mining rights applications.

In August 2018, Mintails Mining South Africa (Pty) Ltd and several related companies announced their liquidation. Mintails used to mine and process gold and uranium from waste piles and open pits in Krugersdorp, near Johannesburg.

AngloGold Ashanti's operations in South Africa are all located in the Witwatersrand Basin, in two mining districts: the Vaal River and West Wits areas. The Vaal River Surface operations are located to the north of the Vaal River, close to the town of Orkney in the North West province. The Mine Waste Solution (MWS) operations are located approximately 15 km from the town of Klerksdorp, near Stilfontein, within 20 km of the Vaal River Surface operations. The MWS feed sources are scattered over an area that extends approximately 13.5 km north-south and 14 km east-west. The West Wits surface operations are located near the town of Carletonville, straddling the border between the North West and Gauteng provinces. These operations extract gold and uranium from the low-grade stockpile material emanating as a by-product of the reef mining activities within the mines in the Vaal River area. In October 2017, AngloGold Ashanti announced that it was selling assets, including the Moab Khotsong mine and related infrastructure, its interest in Nuclear Fuels Corp of South Africa and its interest in the Margaret Water Company to Harmony Gold Mining. Anglo Gold Ashanti kept the Mponeng mine and MWS surface operations. As of 1 January 2019, AngloGold Ashanti uranium resources of Vaal River and MWS operations amounted to 39 466 tU of reasonably assured resources (6 131 tU of measured resources and 33 335 tU of indicated resources).

As of 1 January 2019, Sibanye-Stillwater resources amounted to 10 338 tU of reasonably assured resources (3 288 tU of measured resources and 7 050 tU of indicated resources), 35 tU of inferred resources at the Beatrix underground mine, and 19 894 tU of reasonably assured resources (16 072 tU of measured resources and 3 822 tU of indicated resources) at WRTRP. In 2018, uranium resources declined due to the sale of a portion of WRTRP to DRDGOLD. The surface rock dumps at Driefontein were depleted in 2018.

In 2022, a pre-feasibility study was initiated to determine the optimal uranium extraction strategy for Cooke tailings. On 31 August 2023, Sunshine Mineral Reserve (Pty) Limited released a SAMREC compliant inferred resources of 34 320 tU and 2.63 M ounces of gold for Beisa North and South. The feasibility of the Beisa uranium project is being closely watched, as it could be a strategic development opportunity under favourable uranium market conditions.

Uranium resources

The last official country report by South Africa was in 2016. New resource estimates have been made since 2016, but mainly for tailings and a few deposits. In 2023 and 2024, resource re-estimations were completed for the following deposits: Beatrix (quartz-pebble conglomerate; QPC), Cooke surface dumps (tailings), Freestate-Harmony (tailings), Kopanang (tailings), Mine Waste Solution [formerly Hartebeestfontein/Buffelsfontein] (tailings), Mispah (tailings), Moab Knotsong (quartz-pebble conglomerate; QPC) and Vaal River (tailings). The following table shows the changes of recoverable resources (tU) between 1 January 2023 (Red Book 2024) and the date of re-estimation for these deposits. As for the previous estimates, the new resource estimates give a breakdown according to confidence level (RAR and IR), but not per cost category.

Uranium resource re-estimations to the <USD 260/kgU cost category for selected deposits

(as of 1 January 2025, recoverable tonnes U)

Deposit	Type	RAR 2023 (tU)	RAR 2025 (tU)	Change (tU)	IR 2023 (tU)	IR 2025 (tU)	Change (tU)
Beatrix	QPC	7 732	7 732	0	29	29	0
Cooke	Tailings	11 453	12 232	779	0	0	0
Freestate	Tailings	11 048	11 258	210	0	0	0
Kopanang	Tailings	910	855	(55)	0	0	0
Mine Waste Solutions	Tailings	11 764	10 880	(884)	0	0	0
Mispah	Tailings	5 770	5 482	(288)	0	0	0
Moab Knotsong	QPC	7 190	8 566	1 376	1 174	1 220	46
Vaal River	Tailings	12 479	9 016	(3 463)	0	1 883	1 883
Total		68 346	66 021	(2 325)	1 203	3 132	1 929

Identified conventional resources (reasonably assured and inferred resources)

Resource estimates, as of 1 January 2025, have been obtained by discounting the resource changes to the <USD 260/kgU cost category. The total recoverable identified conventional resources for South Africa, as of 1 January 2025, amount to 436 029 tU (a decrease of 396 tU, compared to resources as of 1 January 2023 (RAR: 246 111 tU, IR: 189 918 tU).

The Witwatersrand Basin contains about 80% of total identified uranium resources in South Africa, in both the underground (hosted by quartz-pebble conglomerates) and their resulting tailings storage facilities. Approximately 47% of the total national identified resources are in the Witwatersrand underground operations, 28% in their associated tailings facilities, 20% in the Springbok Flats Basin and about 5% in the sandstone-hosted deposits of the Karoo Basin. The uranium pay limit in most parts of the Witwatersrand Basin is calculated on a by-product basis, according to which the uranium is not classified as a resource unless it occurs in an area of gold mineralisation that satisfies the estimated gold cut-off grades. In addition, uranium production in these projects only includes the costs of transporting ore from the underground or tailings operations to the processing plants and the treatment of uranium, while gold carries all other costs.

Undiscovered conventional resources (prognosticated and speculative resources)

Undiscovered conventional resources amount to 850 000 tU, which includes the <USD 260/kgU and unassigned cost categories.

The Witwatersrand Basin has a total of about 470 tailings storage facilities with uranium resources, most of which are not included as reasonably assured and inferred conventional resource totals. The Karoo Uranium Province is estimated to contain between about 90 000 tU and 150 000 tU. This estimate has not changed since the last reporting period.

Unconventional resources and other materials

As reported in the 2011 edition of the Red Book, a field of manganiferous phosphate nodules was identified off the west and southwest coast of South Africa, on the continental shelf. The nodules contain low grades of uranium and are currently considered uneconomic with respect to both phosphate and uranium extraction. Renewed interest in phosphate-hosted uranium deposits, however, may generate future investigation. The unconventional resources have been previously estimated to amount to 180 000 tU and are unchanged for this reporting period.

Uranium production

Historical review

South Africa has been a consistent producer of uranium since 1952, but its international importance has declined in recent years. In the late 1970s and early 1980s, it ranked as the second- or third-largest producer in the world, but since the end of the 1990s output has declined significantly and, by 2022, South Africa ranked 10th in global uranium production. Peak production was achieved at over 6 000 tU/yr in the early 1980s when it accounted for 14% of total world output.

Most of South Africa's historical uranium production was derived from quartz-pebble conglomerate deposits, with a small proportion being from the Palabora copper-bearing carbonatite. Current production is sourced from the quartz-pebble conglomerate deposits and associated tailings.

Most of the past production was as a by-product of gold or, to a minor extent, copper. Only two primary uranium producers have existed in South Africa. The first was the Beisa mine in the Free State in the early 1980s, and the second was the Dominion Reefs Uranium Mine near Klerksdorp, which operated in the early 2000s.

In 2019 and 2020, estimated uranium production amounted to 346 tU and 250 tU respectively at the Harmony Gold Vaal River operation (Moab Knotsong mine). In 2021 and 2022, estimated uranium production amounted to 192 tU and 200 tU, respectively. Uranium is currently produced from Vaal River operations by processing the reef material from the Moab Khotsong mine (gold underground mine). In 2023 and 2024, uranium sales from the Moab Knotsong mine amounted to 132 tU and 235 tU, respectively (Harmony 2024 Annual Report).

Status of production facilities, production capability, recent and ongoing activities, and other issues

The Moab Khotsong mine is located in the northern part of South Africa, in North West province, about 180 kilometres southwest of Johannesburg. Moab Khotsong represents one of the largest gold and uranium reserves in South Africa, having indicated recoverable resources of 9 794 tU at 0.065 % U and inferred recoverable resources of 1 626 tU at 0.060% (estimate as of 30 June 2024). The mine exploits the Vaal Reef as its primary ore body. The economic reef horizons are mined between 1 791 m and 3 052 m below surface. Mined ore is processed at the Great Noligwa gold plant. The plant uses the reverse gold leach method, with gold and uranium recoveries achieved by gold cyanide and acid uranium leaching. Harmony Gold acquired Moab Khotsong from AngloGold Ashanti Limited on 1 March 2018 for USD 300 million. The assets were the Moab Khotsong mine and related infrastructure, its entire interest in Nuclear Fuels Corp of South Africa and its entire interest in the Margaret Water Company.

In 2024, Neo Uranium Resources Beisa Mine (Pty) Limited (NURB) signed a binding agreement with Sunshine Mineral Reserve (Pty) Limited to acquire a 100% interest in the uranium and gold resources of the Beisa North and Beisa South Uranium and Gold Projects. The Beisa Projects include two granted prospecting rights, Beisa North and Beisa South, extending over an area of approximately 80 km^2 in the Witwatersrand Basin, located in the Free State Province of South Africa. Total inferred resources in the Beisa Reef amount to 53.57 million tonnes, at an average grade of 780 ppm U_3O_8 (661 ppm U) for 89.23 Mlb of contained U_3O_8 (34 320 tU), and with a number of large zones of well-mineralised and high-grade uranium occurring at both Beisa North and Beisa South, at grades of up to 3 400 ppm U_3O_8 (2 900 ppm U) and 2 200 ppm U_3O_8 (1 900 ppm U), respectively. Gold resources amount to 4.17 million ounces of gold. This acquisition would include: The Beatrix 4 shaft complex with a fully permitted underground mine and shaft system, the processing plant complex with a capacity to process 120 000 tonnes of ore per month, and the surface and underground infrastructure.

Also in 2024, Neo Uranium Resources South Africa (Pty) Ltd (NURSA) entered into an agreement with Eagle Uranium SA (Pty) Ltd to acquire a 100% interest in the Henkries South Uranium Project located in the administrative district of Namaqualand in the Northern Cape

Province. The project is located immediately south and adjoins the Henkries Uranium Project, and comprises one granted prospecting licence extending over approximately 1 050 km^2. Uranium mineralisation in the southern area of the Henkries Project area is seen at surface and at shallow depths of up to 6.0 m. The Henkries Project comprises total JORC Code compliant resources of 4.7 million pounds of U_3O_8 (1 810 tU) at 399 ppm U_3O_8 (338 ppm U).

Ownership structure of the uranium industry

Most of the uranium projects in South Africa are controlled by gold mining companies. In 2022, Sibanye-Stillwater assumed control of the Beatrix (Beisa) underground mine, the Cooke surface operations (tailings), and the Driefontein, Kloof and Randfontein mines. Harmony Gold Mining Company controls the Moab Khotsong mine (the only producing mine in 2023 and 2024), the Mponeng projects, Mine Waste Solutions project, Vaal River and Klerksdorpgoldfield surface tailings. Shiva Uranium Pty controls the Dominium and Rietkuil deposits. In April 2018, Peninsula Energy announced its decision to withdraw from the Karoo projects, in which it had held a 74% interest. It suspended all development activities, including preparation of exploration and mining right applications.

Future production centres

Under favourable uranium market conditions, future production centres could include the Beisa (underground mine) and Cooke (tailings) projects.

Environmental activities and socio-cultural issues

Exploration and mining companies are committed to the responsible use and management of the natural resources under their prospecting and mining rights. Site visits and inspections are conducted regularly to verify that the commitments detailed in their environment management programmes are being adhered to. Exploration and drilling activities include a responsibility to rehabilitate each site once drilling has been completed. In terms of applications for mining rights, and as part of the Social and Labour Plan, companies are required to inform the interested and affected parties in the proposed mining area of its intended activities.

The Broad-Based Socio-Economic Empowerment Charter for the South African Mining and Minerals Industry (The Mining Charter), which gives effect to the Mineral and Petroleum Resources Development Act No. 28 of 2002, is aimed at transforming the mining industry to redress historical imbalances by substantially and meaningfully expanding opportunities for historically disadvantaged South Africans (HDSA).). Mining companies are required to procure a minimum of 40% of their capital goods, 70% of services and 50% of consumables from Black Economic Empowerment entities.

AngloGold Ashanti has designed a framework, following extensive stakeholder engagement, to integrate community development into core business activities, while providing support for national development policies and objectives, particularly those addressing youth unemployment. AngloGold Ashanti's contribution to education in both local and labour-sending communities is a priority. In addition, the Merafong Agricultural Project, which employs 20 people, is funded by AngloGold Ashanti. Other social responsibilities included economic initiatives in the labour-sending areas, such as the remote villages of the Eastern Cape Province.

Regulatory regime

The Department of Mineral Resources, the Department of Water Affairs, the Department of Environmental Affairs and the Department of Energy, including the National Nuclear Regulator, perform regulatory functions relating to the exploration and mining of uranium in South Africa.

According to the Mineral Resources and Development Act No. 28 of 2002, an applicant for prospecting or mining rights must make the prescribed financial provision for the rehabilitation or management of negative environmental impacts before the approval of such rights. If the holder of the prospecting or mining right fails to rehabilitate or is unable to undertake such rehabilitation, then part or all of the financial provision will be used for rehabilitation. The holder of a prospecting or mining right must annually assess their environmental liabilities and accordingly increase their financial provision to the satisfaction of the Minister of Mineral Resources. If the minister is not satisfied with the assessment and the financial provision, the minister may appoint an independent assessor to conduct the assessment and determine the financial provision. The requirement to maintain and retain the financial provision remains in force until a closure certificate has been issued after the closure of mining or prospecting operations. The minister may still retain a portion of the financial provision as may be required to rehabilitate the closed mining or prospecting operation in respect of latent or residual environmental impacts. No closure certificate will be issued until the rehabilitation has been done and the chief inspector, as well as all the governmental regulatory departments related to uranium exploration and mining, have confirmed that the provisions pertaining to health, safety, environment and management of potential pollution to water have been addressed.

Uranium requirements

Koeberg is South Africa's only nuclear power plant. It has two light-water thermal reactors: Koeberg I, commissioned in 1984, and Koeberg II, commissioned in 1985, with a combined installed capacity of 1 840 MW. Together, they require about 294 tU/yr.

In August 2018, the government announced that it had abandoned plans to build up to 9.6 GWe of new nuclear capacity by 2030. The Integrated Resources Plan (IRP) 2018, an update of that issued in 2010, did not include any new nuclear capacity by 2030. IRP 2010 had outlined a required 52 GWe of new capacity by 2030, with nuclear to provide at least 9.6 GWe of that capacity. An update to the IRP issued in November 2016 called for 1.4 GWe of new nuclear capacity by 2037, and a total of 20 GWe long-term. IRP 2016 was released in the context of the Integrated Energy Plan (IEP), which projected a more than threefold increase in electricity demand by 2050.

In May 2020, the Department of Mineral Resources and Energy of South Africa stated that it was to begin working on a roadmap for the construction of 2.5 GWe of new nuclear capacity. It was to consider all options, including small modular reactors. In August 2021, the National Energy Regulator of South Africa (NERSA) approved the plan. In January 2024, the government published plans to procure 2.5 GWe of new nuclear capacity. However, in August 2024 the government paused the procurement process to allow for further public consultation. On 16 July 2024, the National Nuclear Regulator (NNR) approved a 20-year extension for Koeberg Nuclear Power Station's Unit 1, ensuring its operation until July 2044. Unit 2 received a similar 20-year extension in November 2025, allowing its operation until November 2045.

Uranium policies, uranium stocks and uranium prices

National policies relating to uranium

The National Nuclear Regulator Act No. 47 of 1999, the Nuclear Energy Act No. 46 of 1999, the National Radioactive Waste Disposal Institute Act No. 53 of 2008, and the Mineral and Petroleum Resources Development Act No. 28 of 2002, are the basis of national policies relating to prospecting for and mining of uranium in South Africa, as well as the export of uranium and disposal of spent nuclear fuel. More information on these policies can be found at the following links:

- www.gov.za/documents/national-nuclear-regulator-act;
- www.gov.za/documents/nuclear-energy-act;
- www.energy.gov.za/files/policies/act_nuclear_53_2008_NatRadioActWaste.pdf;
- www.gov.za/documents/mineral-and-petroleum-resources-development-act.

Uranium stocks

The information and figures on uranium stocks are classified as confidential and hence could not be accessed from Eskom (a South African electricity public utility, established in 1923, as the Electricity Supply Commission by the South African Government in terms of the Electricity Act).

Uranium prices

No uranium prices were available.

Reasonably assured conventional resources by production method

(recoverable tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Open-pit mining (OP)*	0	0	7 261	9 672	80
Co-product and by-product	0	166 337	228 784	236 439	75
Total	0	166 337	236 045	246 111	75

* The resources for sandstone-hosted deposits in the Karoo Basin are included in the open-pit method; however, in reality the potential production will be conducted by both open-pit and underground mining. The ratio of resources to each method is unknown at present.

Reasonably assured conventional resources by processing method

(recoverable tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional from UG*	0	166 337	228 784	236 439	75
Conventional from OP	0	0	7 261	9 672	80
Total	0	166 337	236 045	246 111	75

* Conventional from UG also includes tailings resources from the Witwatersrand Basin.

Reasonably assured conventional resources by deposit type

(recoverable tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Sandstone	0	0	7 261	8 526
Paleo-quartz-pebble conglomerate*	0	166 337	228 784	236 439
Surficial	0	0	0	1 146
Total	0	166 337	236 045	246 111

* Paleo-quartz-pebble conglomerate resources include tailings resources as well.

Inferred conventional resources by production method

(recoverable tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining (UG)*	0	0	0	70 775	68.0
Open-pit mining (OP)**	0	0	10 467	14 080	80.0
Co-product and by-product	0	61 656	74 361	105 063	75.0
Total	0	61 656	84 828	189 918	72.5

* Underground mining resources only include resources from the Springbok Flats Basin. The resources from underground operations in the Witwatersrand Basin are included in the "co-product and by-product" category.

** Resources in the Karoo Basin are included in the open-pit mining method, even though both open-pit and underground mining method are expected to be used. The recovery factor used for the open-pit method (80%) is speculative only.

Inferred conventional resources by processing method

(recoverable tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional from UG	0	61 656	74 361	175 838	72.0
Conventional from OP	0	0	10 467	14 080	80.0
Total	0	61 656	84 828	189 918	72.5

Inferred conventional resources by deposit type

(recoverable tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Sandstone	0	0	10 467	13 491
Paleo-quartz-pebble conglomerate*	0	61 656	74 361	105 063
Surficial	0	0	0	589
Lignite and Coal	0	0	0	70 775
Total	0	61 656	84 828	189 918

* Includes tailings resources in the Witwatersrand Basin.

Prognosticated conventional resources

(in situ tonnes U)

Cost ranges		
<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
0	74 000	159 000

Speculative conventional resources

(in situ tonnes U)

Cost ranges		
<USD 130/kgU	<USD 260/kgU	Unassigned
243 000	411 000	280 000

Historical uranium production by production method

(tonnes U in concentrates)

Production method	Total through end of 2022	2023	2024	Total through end of 2024	2025 (expected)
Co-product/by-product	162 035	132	235	162 402	200
Total	162 035	132	235	162 402	200

Historical uranium production by processing method

(tonnes U in concentrates)

Processing method	Total through end of 2022	2023	2024	Total through end of 2024	2025 (expected)
Conventional	162 035	132	235	162 402	200
Total	162 035	132	235	162 402	200

Historical uranium production by deposit type

(tonnes U in concentrates)

Deposit type	Total through end of 2022	2023	2024	Total through end of 2024	2025 (expected)
Paleo-quartz-pebble conglomerate	162 035	132	235	162 402	200
Total	162 035	132	235	162 402	200

Ownership of uranium production in 2024

Domestic				Foreign				Totals	
Government		Private		Government		Private			
(tU)	(%)	(tU)	(%)	(tU)	(%)	(tU)	(%)	(tU)	(%)
0	0	235	100	0	0	0	0	235	100

Mid-term production projection

(tonnes U/year)

2025	2030	2035	2040	2045	2050
200	NA	NA	NA	NA	NA

Short-term production capability

(tonnes U/year)

2025				2030			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
1 000	1 000	1 000	1 000	1 000	3 000	1 000	3 000

2035				2040			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
1 000	3 000	1 000	3 000	NA	NA	NA	NA

2045				2050			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
NA	NA	NA	Na	NA	NA	NA	NA

Net nuclear electricity generation

	2023	2024
Nuclear electricity generated (TWh net)	8.1	7.8

Installed nuclear generating capacity to 2040

(MWe net)

2025		2030		2035		2040	
Low	High	Low	High	Low	High	Low	High
1 840	1 840	1 840	1 840	1 840	NA	1 840	NA

Annual reactor-related uranium requirements to 2040 (excluding MOX)

(tonnes U)

2025		2030		2035		2040	
Low	High	Low	High	Low	High	Low	High
294	294	294	294	294	NA	294	NA

Spain

Uranium exploration and mine development

Historical review

Uranium exploration in Spain started in 1951 and was carried out by the Junta de Energía Nuclear (JEN). The initial targets were the Hercynian granites of western Spain. In 1957 and 1958, the first occurrences in Precambrian-Cambrian schists were discovered, including the Fe deposit in the province of Salamanca. In 1965, exploration of sedimentary rocks began and the Mazarete deposit in Guadalajara province was discovered. In 1972, the Empresa Nacional del Uranio S.A., today Enusa Industrias Avanzadas S.A., S.M.E. (hereinafter ENUSA), a state-owned company, was established to take charge of all the nuclear fuel cycle front-end activities. Its shareholders are the Sociedad Estatal de Participaciones Industriales (SEPI), holding 60% of the capital, and the Centro de Investigaciones Energéticas Medioambientales y Tecnológicas (CIEMAT, previously JEN), with the remaining 40%. Exploration activities by ENUSA ended in 1992. Joint venture exploration between ENUSA and other companies continued until the end of 1994. During this period, most of the Spanish territory was surveyed using a variety of methods, adapted to different stages of exploration, and ample airborne and ground radiometric coverage of the most interesting areas was achieved.

Recent and ongoing uranium exploration, and mine development activities

Berkeley Minera España S.L.U. (hereinafter, Berkeley) was granted one mining licence in the province of Salamanca (covering 2 519 ha) and a total of 25 investigation licences (covering a total of 92 749 ha), as well as one exploration licence covering 19 547 ha spanning the provinces of Salamanca, Cáceres and Badajoz. They have been actively exploring for uranium for several years, with a focus on several historically known uranium projects, located within their tenements.

Berkeley's Salamanca Project comprised the Retortillo, Zona 7 and Alameda deposits (in Salamanca province), and also the Gambuta deposit in Cáceres province which, according to Berkeley, accounted for 12.3 Mlb U_3O_8 (4 730 tU) in the measured and 47.5 Mlb U_3O_8 (18 270 tU) in the indicated resource categories, with an additional 29.5 Mlb U_3O_8 (11 350 tU) in the inferred resource category. All deposits are the granite-related type (perigranitic subtype), hosted by a sequence of metasediments that are adjacent to a granite intrusion.

According to the company, Retortillo, Alameda and Zona 7 might have achieved a production capacity of 4.4 Mlb U_3O_8/yr (1 690 tU/yr) over a mine life of 14 years. However, the construction authorisation requested for the Retortillo milling radioactive facility for the manufacturing of yellowcake was denied in November 2021 by the Ministry for the Ecological Transition and the Demographic Challenge (MITECO), as were the site authorisations for the related projects in Zona 7 and Alameda. This denial is currently being challenged in the National Court.

Uranium resources

Identified conventional resources (reasonably assured and inferred resources)

Total reported in situ identified resources as of 1 January 2025 are 34 350 tU (89.3 Mlb U_3O_8), which include 23 000 tU (59.8 Mlb U_3O_8) in the reasonably assured category (12.3 Mlb U_3O_8 or 4 730 tU as measured resources and 47.5 Mlb U_3O_8 or 18 270 tU as indicated resources) and 11 350 tU (29.5 Mlb U_3O_8) of inferred resources. All resources are reported as in situ and mineable by conventional open pit. According to a feasibility study, 95% of resources may be recovered by open-pit mining, with a factor of 87% applied for processing recovery. The overall recovery factor is about 83%.

Uranium production

Historical review

Production started in 1959 at the Andújar plant (Jaén province) and continued until 1981. The Don Benito plant (Badajoz province) remained in operation from 1983 to 1990. Production at the Fe mine (Salamanca province) started in 1975 with heap leaching (Elefante plant). A new dynamic leaching plant (Quercus) started operation in 1993 and was shut down in December 2000. The licence for the definitive shutdown of production, submitted to regulatory authorities in December 2002, was approved in July 2003.

Status of production capability

Mining activities were terminated in December 2000 with the closure of Saelices el Chico uranium mines and production of uranium concentrates ended in November 2002 when the associated Quercus processing plant was shut down.

A dismantling plan for the Quercus processing plant and mines was presented to the regulatory authorities in 2005. However, it was put on standby a first time due to the need to dismantle the former Elefante processing plant and restore mines at that site before dismantling Quercus, and then a second time in 2009, due to an agreement between ENUSA and Berkeley to complete a feasibility study on the state reserves in Salamanca province. Despite these delays, once the Elefante processing plant was dismantled, the associated mines restored, and the agreement between ENUSA and Berkeley finalised, a new plan for dismantling Quercus was presented to the regulatory authorities in September 2015. This plan has been subject to several additional information requirements since 2016 and is still being evaluated by the Ministry for the Ecological Transition and the Demographic Challenge (MITECO) and the National Regulatory Body.

Ownership structure of the uranium industry

Quercus, the only production facility in Spain still pending dismantling, belongs to the company, ENUSA.

Employment in the uranium industry

There is no uranium production in Spain. Since there are no existing production centres, employment is associated with decommissioning and mine development activities only, as well as in the exploration of new deposits.

Employment at the former Fe mine totalled 23 at the end of 2024. All of these workers are dedicated to the mining remediation, monitoring and decommissioning programmes.

Employment at Berkeley is between 10-20 people (depending on the workload) who continue the investigation of new uranium deposits, as well as the compulsory monitoring and surveillance plans for the Retortillo, Zona 7 and Alameda deposits.

Secondary sources of uranium

Spain reports mixed oxide fuel, re-enriched tails, and reprocessed uranium production and use as zero.

Environmental activities and socio-cultural issues

The conditions of the former uranium production facilities in Spain are as follows:

- Fábrica de Uranio de Andújar (Jaén province): Mill and tailings piles have been closed and remediated, with an ongoing ten-year surveillance and control programme (groundwater quality, erosion control, infiltration and radon control). This programme has been extended.
- Mine and plant "LOBO-G" (Badajoz province): The open-pit and mill tailings dump have been closed and remediated, with a surveillance and control programme (groundwater quality, erosion control, infiltration and radon control) in place until 2004. A long-term stewardship and monitoring programme was begun after the declaration of closure.
- Old mines (Andalucía and Extremadura regions): Underground and open-pit mines were restored, with work completed in 2000.
- Two old mines in Salamanca (Valdemascaño and Casillas de Flores) were restored in 2007, following which a surveillance programme was initiated, ending in 2011. Results were evaluated by regulatory authorities, and it was determined that an extension of the surveillance period was required.
- Elefante plant (Salamanca province): The decommissioning plan, including industrial facilities and heap leaching piles, was approved by regulatory authorities in January 2001. The plant was dismantled, and ore stockpiles were levelled and covered in 2004. A monitoring and control programme has been in place since 2005.
- In 2004, the mining restoration plan of the open-pit exploitation in Saelices el Chico (Salamanca province) was approved by regulatory authorities. Implementation of this plan was finished in 2008 and the proposed surveillance and control programme was approved by regulatory authorities in March 2014. A monitoring and control programme has been in place since then.
- Quercus plant (Salamanca province): Mining activities ended in December 2000 and uranium processing ended in November 2002. A decommissioning plan was submitted to regulatory authorities in 2005. However, because of the need for the decommissioning of the former Elefante processing plant and for the restoration of some of the mines at that site before turning to the decommissioning of Quercus, as well as the 2009 agreement between ENUSA and Berkeley, this decommissioning plan was put on standby. In September 2015, a new plan for decommissioning was presented to the regulatory authorities, which after several additional information requirements (corrections submitted in 2017 and 2020), is still pending approval. During this time, a surveillance and maintenance programme has remained active for the plant and associated facilities.

Uranium mining regulatory regime

In Spain, the general mining regime is regulated by the Mines Act (Act 22/1973), modified by Act 54/1980 and by Royal Decree 2857/1978. As for the existing projects or ongoing permit requests submitted before May 2021, the investigation and use of radioactive ores is governed by this act in those areas that are not specifically considered in the Nuclear Energy Act (Act 25/1964), Chapter IV of which deals with the prospecting, investigation and use of radioactive ores, as well as the commercialisation of such ores and their concentrates.

According to Article 2 of the Mines Act, all-natural deposits and other geological resources in Spain are assets belonging to the public domain, investigation and use of which may be undertaken directly by the state or assigned in accordance with the rules. Pursuant to Article 1 of Act 54/1980, which amends the Mines Act, radioactive ores are part of Section D, i.e. resources of national energy interest.

Pursuant to Article 19 of the Nuclear Energy Act, the prospecting, investigation and use of radioactive ores and the obtaining of concentrates are declared to be open throughout the entire national territory, except in those areas set aside by the state. Individuals or companies who wish to prospect for radioactive ores are required to request an investigation permit from the state and, subsequently, if the existence of one or more resources open to rational exploitation is revealed, to request an exploitation licence. This licence confers the right to exploit the resources and is granted for a 30-year period, extendable by similar periods of time to a maximum of 90 years. The permits and licences are granted by the autonomous communities, in keeping with the transfer to them of state competences in mining and energy issues, except when the mining activity in question affects several autonomous communities or state reserves, in which case the competent authority is the MITECO, by virtue of the Mines Act.

The Nuclear Safety Council is the organisation responsible for nuclear safety and radiological protection. In accordance with Article 2 of the act creating the Nuclear Safety Council (Act 15/1980), one of the main competences of the Council is to issue reports to the MITECO on nuclear safety and radiological protection, prior to the resolutions adopted by the latter regarding the granting of authorisations for the operation, restoration or closure of uranium mines and production facilities. These reports are mandatory in all cases and binding when negative in their findings or denying authorisation, or with regard to the conditions established when they are positive.

Regarding restoration plans and financial guarantees for mining activities, according to the Royal Decree 975/2009 on the management of waste resulting from extractive industries, and the protection and restoration of the environment affected by mining activities, a restoration plan must be submitted for approval to the mining authority (the autonomous regional government or MITECO, in the case of those mining activities affecting several autonomous communities or state reserves), the approval of which will be given together with the granting of the exploitation licence. The mining authority will neither grant the licence nor approve the plan unless environmental restoration of the site is guaranteed. To that end, two financial guaranties must be set up by the company before starting any mining activity. One must be set up for the rehabilitation of the environment affected by the exploitation of the ores and the second must be set up for the management of the generated waste. Both must comply with the objectives and conditions established in the authorised restoration plan, even in the case that the company does not exist at the time of the restoration.

Dismantling of the associated milling facilities is pursuant to the Regulation on Nuclear and Radioactive Installations (RINR, approved by Royal Decree 1836/1999 and modified several times afterwards). As radioactive facilities of the nuclear fuel cycle, existing facilities are subject to all previous site, construction and exploitation licences. An exploitation licence requires the applicant to submit decommissioning and closure forecasts, including, among other things, the final management of the radioactive wastes as well as the economic and financial calculations to guarantee closure of the site.

However, it must be emphasised that the Climate Change Law 7/2021 of May 2021 on climate change and the energy transition, includes a section regarding uranium mining and milling facilities in Spain, where: a) As of the entry into force of this law, no new applications will be accepted for the granting of exploration permits, research permits or direct exploitation concessions, nor their extensions, regulated under Law 22/1973, of 21 July 1973, on mines, of radioactive minerals, as defined in Law 25/1964, of 29 April 1964, on nuclear energy, when such resources are extracted for their radioactive, fissionable or fertile-producing properties ; and

b) As from the entry into force of this law, no new requests for authorisation of radioactive facilities of the nuclear fuel cycle for the processing of such radioactive minerals will be accepted, such facilities being understood as those so defined in the Regulation on nuclear and radioactive facilities, i.e. milling facilities for the manufacturing of yellow cake.

Uranium requirements

As of 1 January 2025, the net capacity of the seven Spanish nuclear reactors under commercial operation (Almaraz units 1 and 2, Ascó units 1 and 2, Cofrentes, Vandellós 2 and Trillo nuclear power plants) was about 7.1 GWe. No new reactors are expected to be built in the near future.

In 2020, the Spanish government approved licence renewals for Almaraz unit 1 until 2027, Almaraz unit 2 until 2028 and Vandellós unit 2 until 2030.

In 2021, the lone Cofrentes unit's licence was renewed until 2030 and both Ascó units I and II for another nine and ten years, respectively. In 2024, the Trillo Nuclear Power Plant received its renewal for operation until 2034. These renewals of the nuclear power plant licences and their terms were requested and authorised in line with the Comprehensive National Energy and Climate Plan 2021-2030. This plan forecasts the evolution of nuclear energy's contribution to the energy mix according to the subsequent Protocol signed in March 2019 by the electric companies and ENRESA agreeing to a scheduled closure of the nuclear power plants during the period 2027-2035.

Accordingly, for the coming years, uranium requirements for the Spanish nuclear fleet will range from 900 to 1 550 tU/yr, decreasing once the closure dates approach.

Supply and procurement strategy

All uranium procurement activities are carried out by ENUSA on behalf of the Spanish utilities that own the seven nuclear reactors under commercial operation in Spain.

Uranium policies, uranium stocks and uranium prices

National policies relating to uranium

Spain's uranium import policy provides for diversification of supply. As mentioned earlier, as of the entry into force of the Climate Change Law 7/2021 of May 2021, no new applications will be accepted for the granting of exploration permits, research permits or direct exploitation concessions, nor their extensions, regulated under Law 22/1973, of 21 July 1973, on mines, of radioactive minerals, as defined in Law 25/1964, of 29 April 1964, on nuclear energy, when such resources are extracted for their radioactive, fissionable or fertile-producing properties. This act applies for all public, private, national or foreign companies.

Uranium stocks

Spanish regulation provides that a strategic uranium inventory contained in enriched uranium should be held jointly by the utilities that own nuclear power plants. The current stock contains the equivalent of at least 608 tU. Additional inventories could be maintained depending on uranium market conditions.

Uranium exploration and development expenditures, and drilling effort – domestic

(EUR)

	2022	2023	2024	2025 (preliminary)
Industry* exploration expenditures	239 494	324 294	166 286	170 000
Total expenditures	239 494	324 294	166 286	170 000
Industry* exploration drilling (m)	0	0	0	0
Industry* exploration holes drilled	0	0	0	0
Total drilling (m)	0	0	0	0
Total number of holes drilled	0	0	0	0

* Non-government.

Reasonably assured conventional resources by production method

(in situ tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Open-pit mining (OP)	9 800	23 000	23 000	23 000	83
Total	9 800	23 000	23 000	23 000	83

Reasonably assured conventional resources by processing method

(in situ tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional from OP	9 800	23 000	23 000	23 000	83
Total	9 800	23 000	23 000	23 000	83

Reasonably assured conventional resources by deposit type

(in situ tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Granite-related	9 800	23 000	23 000	23 000
Total	9 800	23 000	23 000	23 000

Inferred resources by production method

(in situ tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Open-pit mining (OP)	0	11 350	11 350	11 350	83
Total	0	11 350	11 350	11 350	83

Inferred resources by processing method
(in situ tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional from OP	0	11 350	11 350	11 350	83
Total	0	11 350	11 350	11 350	83

Inferred resources by deposit type
(in situ tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Granite-related	0	11 350	11 350	11 350
Total	0	11 350	11 350	11 350

Historical uranium production by production method
(tonnes U in concentrates)

Production method	Total through end of 2022	2023	2024	Total through end of 2024	2025 (preliminary)
Open-pit mining*	5 028	0	0	5 028	0
Total	5 028	0	0	5 028	0

* Pre-2020 totals may include uranium recovered by heap and in-place leaching.

Historical uranium production by processing method
(tonnes U in concentrates)

Processing method	Total through end of 2022	2023	2024	Total through end of 2024	2025 (preliminary)
Conventional	4 961	0	0	4 961	0
Other methods*	67	0	0	67	0
Total	5 028	0	0	5 028	0

* Includes mine water treatment and environmental restoration.

Historical uranium production by deposit type
(tonnes U in concentrates)

Deposit type	Total through end of 2022	2023	2024	Total through end of 2024	2025 (preliminary)
Granite-related	5 028	0	0	5 028	0
Total	5 028	0	0	5 028	0

Net nuclear electricity generation

	2023	2024
Nuclear electricity generated (TWh net)	54.3	52.4

Installed nuclear generating capacity to 2050

(MWe net)

2023	2024	2025		2030		2035		2040		2045		2050	
		Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
7 069	7 069	7 069	7 069	3 020	5 059	NA	NA	NA	NA	NA	NA	NA	NA

Annual reactor-related uranium requirements to 2050 (excluding MOX)

(tonnes U)

2023	2024	2025		2030		2035		2040		2045		2050	
		Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
1 155	1 208	1 150	1 200	390	1 250	NA	NA	NA	NA	NA	NA	NA	NA

Total uranium stocks

(tonnes natural U-equivalent)

Holder	Natural uranium stocks in concentrates	Enriched uranium stocks	Enrichment tails	LWR reprocessed uranium stocks	Total
Government	NA	NA	NA	NA	NA
Producer	0	0	0	0	0
Utility	NA	608	0	NA	NA
Total	NA	608	0	NA	NA

Tanzania *

Uranium exploration and mine development

Historical review

Uranium was first discovered in Chiwiligo pegmatite in the Uluguru Mountains in 1953. The first general evaluation of uranium potential of Tanzania was a country-wide airborne geophysical survey for the government between 1976 and 1979. Results revealed a large number of radiometric anomalies in a variety of geological settings.

A uranium exploration programme was subsequently carried out by Uranerzbergbau GmbH between 1978 and 1983 but ended because of declining uranium prices. Targets of this survey were anomalies in the Karoo, in younger surficial sediments, in phosphatic sediments of Pleistocene age and carbonatite of the Gallapo. Numerous occurrences of surface uranium mineralisation have been identified and there is potential for several uranium deposit types in the country.

Interest in uranium exploration was revived after the rise of uranium prices in 2007 and the Tanzanian government issued over 70 licences. Major exploration activities were focussed on identification of sandstone-type uranium deposits in the Karoo Basin in the southern part and surficial-type deposits in the central part of the country.

Since 2007, four uranium deposits were discovered in Tanzania. Over 80% of the total resources are contained in the large Nyota sandstone-type deposit, also known as Mkuju River Project. The systematic exploration at Nyota started in 2007 and in 2009 a maiden in situ inferred resource estimate of 13 800 tU (35.9 Mlbs U_3O_8) and a pre-feasibility study were released. In 2011, Mantra Tanzania Ltd was acquired by the Russian JSC Atomredmetzoloto, and Uranium One Inc. was appointed as the project operator. An update of in situ resources of the Nyota deposit estimate in September 2011 boosted total in situ resources to 45 924 tU (119.4 Mlbs U_3O_8) and formed the basis of a feasibility study. During 2012 and 2013, Mantra Tanzania Ltdcontinued exploration focussed on new resource estimates and engineering optimisation.

Drilling activities and analysis of historical data resulted in a further in situ resource increase in June 2013 to 58 489 tU (152.1 Mlbs U_3O_8), including 47 927 tU (124.6 Mlbs U_3O_8) in the measured and indicated categories at an average grade of 303 ppm U_3O_8 (0.0257% U). The Mkuju River feasibility study was completed in 2013 and the Tanzanian government issued a special mining licence (SML) to Mantra for project development. During 2013-2014, the main exploration activities of Mantra Tanzania Ltd focussed on verifying Nyota deposit resources and on-site push-pull testing to identify amenability of the principal mineralisation to ISL mining. During 2015-2017, exploration was focussed on additional investigations to test the amenability of ISL extraction of resources. The laboratory tests resulted in high uranium recoveries with acceptable values of uranium content in sulphuric acid solutions, acid consumption and liquid-to-solid ratio. The results of the hydrogeological test confirmed acceptable aquifer permeability. An onsite ISL test was conducted over ten months in 2016 using a two-well pattern and the final report was issued in 2017. Results confirmed the amenability of ISL mining for the portion of the resources located below the water table. During 2017, rehabilitation of aquifers and the surface was completed after ISL tests.

* Report prepared by the NEA/IAEA based on previous Red Books and company reports.

The IAEA co-ordinated a Uranium Production Site Assessment Team (UPSAT) mission in 2013 focussed on the Mkuju River Project.

In December 2016, Mantra Tanzania Ltd applied to the Ministry of Energy and Minerals (MEM) for a suspension of the Special Mining Licence and the works programme for the project, due to the state of the uranium market. In 2017, the MEM accepted a temporary suspension of the works programme. During 2017-2019, further development of Mkuju River was suspended due to unfavourable uranium market conditions.

Exploration drilling by Uranex at the Likuyu North deposit during 2009-2012 identified a maiden resource of 2 346 tU (6.1 Mlb U_3O_8) with an average grade of 237 ppm U_3O_8 (0.02% U) reported at a 100 ppm U_3O_8 (0.0085% U) cut-off grade.

In 2010, Uranex reported resources of 11 146 tU for the shallow Manyoni deposit, also known as the Bahi project. The region incorporates an extensive closed draining system developed over weathered uranium-rich granites. This drainage captured dissolved uranium leached from underlying rocks and transported it to suitable precipitation trap sites (playa lakes). The Manyoni Project encompasses up to five playa lakes.

In 2013, Uranium Resources Plc. announced a maiden resource of 3.6 Mt ore containing 775 tU (2.014 Mlb U_3O_8) at a grade of 255 ppm U_3O_8 (0.0022% U) for the Mtonya deposit. The uranium mineralisation occurs to depths of 350 m in continuous 30 to 50-metre-wide roll fronts. The resource is potentially amenable to ISL mining.

Recent and ongoing uranium exploration, and mine development activities

Mantra Tanzania Ltd

In 2020 Mantra Tanzania Ltd decided to build a pilot processing plant to proceed with small-scale pilot open pit mining. Annual pilot plant capacity of 15 000 t of ore assumes production of 5 tU/yr. In 2022 Mantra Tanzania Ltd received all necessary approvals for construction works. At the beginning of 2023, construction of the main production facilities was completed, and the equipment of the processing complex was installed. In 2025, Mantra Tanzania Ltd obtained all required approvals from Tanzanian regulators and launched pilot operations in late July 2025. The pilot processing plant at the Nyota deposit will be used to test uranium processing technologies and gather data for the construction of a main processing plant. In 2025, the company also planned to restart exploration for resource base expansion and hydrological research works, focussed on extraction of a part of resources by the ISL method.

Gladiator Resources

In mid-2021, Australian company, Gladiator Resources Ltd., entered into an agreement to acquire Zeus Resources Ltd. and the granted Tanzanian tenements known as the Likuyu North, Mtonya, Minjingu, Mkuju, Liwale, SWC, Foxy and Eland uranium projects. In 2021 Gladiator began exploration at the Minjingu Uranium Project in northern Tanzania, completed radiometric traverses and drilled holes to evaluate historical intercepts. In 2022, Gladiator reviewed historical data of the Likuyu North deposit and issued a JORC compliant Mineral Resource Estimate that totals 7.7 Mt of ore at an average grade of 267 ppm U_3O_8 (0.0023% U) containing 1 770 tU (4.6 Mlb U_3O_8), 50% of which are in indicated and 50% in inferred categories. In 2024, Gladiator carried out an airborne radiometric survey at Mkuju to help define future drill targets, while exploration drilling activities were focussed on the SWC and Mtonya targets, and the Likuyu North deposit to test down-dip extension of mineralised layers. The drill holes at the Likuyu North deposit intercepted 0.4 metres at 0.1% U_3O_8 and 1.7 metres at 0.07% U_3O_8. These results led to a further review of historical air core drillholes in the area which indicated that mineralisation extends up to 350 metres. The area is a target for future drilling aimed at expanding the deposit focussing on ISL recovery. Key results of the SWC target included a 3.8 metre thick intersection at 0.25% U_3O_8 and 2.4 metres at 0.35% U_3O_8.

AuKing Mining

In January 2023, AuKing Mining Ltd. acquired uranium projects in Tanzania (Mkuju, Manyoni, Itigi and Magaga) and started an exploration programme that includes near-surface drilling and associated soil sampling exploration at Manyoni Uranium Project in Central Tanzania, to verify historical resources. In early 2023, the Tanzanian Mining Commission revoked five of the issued Prospecting Licences (PLs) that comprise much of the known historical resources at the Manyoni Project, and the company immediately filed an appeal. As of the end of 2024, it had not yet received a response regarding the resolution of the matter. In early 2024, the company reported assay results from a soil sampling and auger drilling programme at the Mkuju project, including 3.0 metres grading 0.13% U_3O_8. Furthermore, in 2024, AuKing commenced a Stage 2 drilling programme at Mkuju, consisting of 75 drill holes for 11 000 m of air core/RC drilling.

Identified conventional resources (reasonably assured and inferred resources)

As of 1 January 2025, total in situ resources amounted to 72 151 tU, including 50 471 tU in RAR (measured and indicated) and 21 680 tU in inferred categories. Identified JORC and NI 43-101 compliant uranium resources (measured, indicated and inferred) are presented in the following table. There are no changes in resources when compared to the Red Book 2024 report.

In situ uranium resources of Tanzania (company reports)

Deposit name	Resources (tU)		Grade (% U)	Estimated in	Type	Subtype	Current owner
	Measured + indicated	Inferred					
Nyota (Mkuju River)	47 927	10 562	0.026	2013	Sandstone	Tabular	Uranium One Group
Likuyu North	875	866	0.023	2022	Sandstone	Tabular	Gladiator Resources
Mtonya		775	0.022	2013	Sandstone	Tabular/ roll-front	Gladiator Resources
Manyoni (Bahi)	1 669	9 477	0.012	2010	Surficial	Lacustrine-playa	AuKing Mining
TOTAL	50 471	21 680					

Over 80% of the total relates to the Nyota sandstone deposit at the Mkuju River Project. It contains 47 927 tU of in situ measured and indicated resources and 10 562 tU of inferred resources, all in the <USD 80/kgU cost category. The Manyoni playa lake calcrete deposits make up 11 146 tU of identified resources, of which 9 477 tU are inferred. The remaining inferred resources include two sandstone-type deposits: Likuju North with 1 741 tU and the Mtonya deposit, which comprises 775 tU and is potentially amenable to ISL extraction. An 80% recovery factor was applied to convert all in situ resources into recoverable resources.

Undiscovered conventional resources (prognosticated and speculative resources)

Undiscovered resources are not reported. There is, however, a high potential for sandstone-type uranium deposits in Karoo sediments in several areas of Tanzania.

Uranium production

There has been no uranium produced in Tanzania.

Future production centres

The Mkuju River feasibility study was completed in 2013 and the Tanzanian government issued an SML to Mantra for project development. Front-end engineering and design (FEED) and Pre-FEED initiatives continued until June 2014.

According to the current Definitive Feasibility Study the resources will be mined in multiple pits, feeding a single mill with conventional acid leach and resin-in-pulp recovery. Sulphuric acid ISL mining may be employed, particularly for about 15% of resources lying outside designed pits and below the water table. One-third of the total resource is situated below the water table, so the ISL potential could be greater. Activities at the project during 2015 and 2016 were focussed on an ISL pilot test programme.

In late December 2016, Mantra Tanzania Ltd applied to the Ministry of Energy and Minerals of Tanzania (MEM) for suspension of its SML due to the unfavourable uranium market. In September 2017, the MEM approved an amendment to the SML, which permitted construction work to start in 2020. During 2018 and 2019, Mantra Tanzania Ltd and the MEM negotiated conditions for a further suspension of the SML until uranium demand increased.

During 2021-2023, Mantra Tanzania Ltd built a pilot processing plant to proceed with small-scale pilot open-pit mining. In 2023, construction of the pilot production facilities was completed and the equipment of the processing complex installed. In 2025, Mantra Tanzania Ltd obtained all required approvals from Tanzanian regulators and launched pilot operations in late July 2025. In 2024, Mantra Tanzania Ltd issued an updated Definitive Feasibility Study for the main mining complex construction with a planned capacity of up to 3 000 tU per year over a 12-year period. Preparatory works started in 2025 and construction is planned for 2026.

Uranium production centre technical details

(as of 1 January 2025)

	Centre #1
Name of production centre	Mkuju River
Production centre classification	Planned
Date of first production (year)	NA
Source of ore:	
Deposit name(s)	Nyota
Deposit type(s)	Sandstone
Recoverable resources (tU)	41 040
Grade (% U)	0.0425
Mining operation:	
Type (OP/UG/ISL)	OP
Size (tonnes ore/day)	18 000
Average mining recovery (%)	90
Processing plant:	
Acid/alkaline	Acid
Type (IX/SX)	Resin-in-pulp
Average process recovery (%)	85
Nominal production capacity (tU/year)	3 000
Plans for expansion (yes/no)	no
Other remarks	ISL option is not assumed

Environmental activities and socio-cultural issues

The Tanzanian government has worked to allay public concerns over the prospect of uranium mining. The environmental, health, economic and social impacts are to be carefully considered, and the government indicated that it is aware of the high safety standards required for uranium mining in order to protect people and the environment.

Elephant poachers have taken advantage of the road constructed for access to the Mkuju River Uranium Project, located in the area excised from the Selous Game Reserve. In May 2014, the operator entered into a memorandum of understanding with the Ministry of Natural Resources and Tourism to conduct combined anti-poaching initiatives. The UNESCO World Heritage Committee is monitoring the situation since all of its demands must be met in order to fulfil the Mkuju River Project requirements.

National policies relating to uranium

In 2010, the Tanzanian government substantially amended the Mining Act of 1998. The revised act increased royalty payments for mineral extraction on the gross value of minerals produced (from 3% to 5% for uranium) and mandated the government the ability to acquire shareholdings in future mining projects through a development agreement negotiated between the government and the mineral rights holder. The Parliamentary Committee for Energy and Minerals in Tanzania has directed that no mining of uranium can take place until a policy and legislation on extraction are in place.

In 2017, the Tanzanian government amended the Mining Act No.14 of 2010 and introduced new miscellaneous amendments No. 7 in 2019. The amended legislations and regulations are:

1. The Written Laws (Miscellaneous Amendments) Act, 2017 amending the Mining Act 2010 (Amendment Act);
2. The Natural Wealth and Resources (Permanent Sovereignty) Act, 2017 (Sovereignty Act), and the Natural Wealth and Resources Contracts (Review and Renegotiation of Unconscionable Terms) Act, 2017 (Unconscionable Terms Act);
3. The Wildlife Conservation (Protecting, Mining of Uranium, Exploring, and Production of Oil and Gas in Game Reserve) Regulations, 2017;
4. The Mining (Radioactive Minerals) Regulations, 2018;
5. The Mining (Minerals and Mineral Concentrates Trading) (amendments) Regulations, 2019.

The IAEA conducted a Uranium Production Site Appraisal Team review in 2013, providing recommendations to the country, a newcomer to uranium mining, in the application of international good practices and preparations for planned uranium mining activities. The scope of the appraisal process included exploration, resource assessment, planning, environmental and social impact assessment, mining, processing, waste management, site management, remediation and final closure.

Reasonably assured conventional resources by production method

(recoverable tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Open-pit mining (OP)	0	38 342	40 377	40 377	80
Total	0	38 342	40 377	40 377	80

Reasonably assured conventional resources by processing method

(recoverable tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional from OP	0	38 342	40 377	40 377	80
Total	0	38 342	40 377	40 377	80

Reasonably assured conventional resources by deposit type

(recoverable tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Sandstone	0	38 342	39 042	39 042
Surficial	0	0	1 335	1 335
Total	0	38 342	40 377	40 377

Inferred conventional resources by production method

(recoverable tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Open-pit mining (OP)	0	8 450	16 724	16 724	80
In situ leaching acid	0	0	620	620	80
Total	0	8 450	17 344	17 344	80

Inferred conventional resources by processing method

(recoverable tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional from OP	0	8 450	16 724	16 724	80
In situ leaching acid	0	0	620	620	80
Total	0	8 450	17 344	17 344	80

Inferred conventional resources by deposit type

(recoverable tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Sandstone	0	8 450	9 762	9 762
Surficial	0	0	7 582	7 582
Total	0	8 450	17 344	17 344

Short-term production capability

(tonnes U/year)

2025				2030			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
0	0	0	0	0	0	0	0
2035				**2040**			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
0	3 000	0	3 000	0	3 000	o	3 000
2045				**2050**			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
0	NA	0	NA	0	NA	o	NA

Thailand

Uranium exploration and mine development

Historical review

Intensive uranium exploration was carried out in the early 1970s by the Royal Thai Department of Mineral Resources (DMR). Uranium occurrences were found in various types of geological settings, particularly in sandstone and granite-related rocks. Sandstone-type mineralisation occurs in the Phu Wiang District of Khon Kaen Province, in northeastern Thailand. This area was first independently investigated by DMR, then in co-operation with foreign organisations. Granite-related uranium occurrences are associated with fluorite veins, discovered in Doi Tao District and Omkoi District, in the Chiang Mai Province, in northern Thailand.

The most significant uranium exploration activity carried out in Thailand was the nationwide airborne geophysical survey, completed between 1985 and 1987, covering an area of approximately 570 000 square kilometres. The survey was conducted by Kenting Earth Sciences International Limited, of Canada, under a contract with DMR. In 1994, based on available data, a series of airborne radioactive maps were generated as well as a uranium potential map.

Other uranium exploration-related activities were associated with reconnaissance/regional surveys of rare earth element (REE) deposits, which started in 2011 by DMR. Based on the preliminary results of reconnaissance/regional surveys, low contents of uranium and thorium had been found within granitic weathering crusts in some areas.

Recent and ongoing uranium exploration, and mine development activities

From 2017 to 2018, DMR conducted reconnaissance/regional survey activities for REE deposits in various parts of Thailand, to define areas of high potential, focussing on granitic weathering crusts. According to the preliminary results, uranium and thorium have been identified, associated with some weathered granitic profiles in the vicinities of Mae Hong Son, Chiang Mai and Tak Provinces. Since 2019, Thailand has had no activity related to uranium exploration and mine development.

Uranium resources

Identified conventional resources (reasonably assured and inferred resources)

Based on the results of intensive exploration during the 1970s, the total inferred resources of uranium are 17 tU (in situ), including sandstone-type deposits (4 tU at 0.01% U_3O_8 cut-off) and granite-related deposits (13 tU at 0.02% U_3O_8 cut-off).

Inferred conventional resources by deposit type
(in situ tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	<USD 390/kgU
Sandstone	0	0	0	4	4
Granite-related	0	0	0	13	13
Total	0	0	0	17	17

Undiscovered conventional resources (prognosticated and speculative resources)

Undiscovered conventional resources have not been estimated.

Unconventional resources and other materials

A study on uranium extraction from Thailand's seawater has been ongoing, since the end of 2011. To date, no uranium has been separated and purified. The objective of the study is to improve the extraction technique, rather than to recover uranium.

It should be noted that unconventional resources of uranium had been found associated with some rare earth element (REE) deposits. Although a significant amount of uranium may be removed as a by-product, those REE deposits are not yet regarded as economic deposits.

Uranium production

Historical review

There has been no historical uranium production in Thailand.

Status of production facilities, production capability, recent and ongoing activities, and other issues

There are no past or current production facilities in Thailand.

Ownership structure of the uranium industry

Not applicable.

Employment in the uranium industry

None.

Future production centres

There are no uranium production centres planned in Thailand.

Secondary sources of uranium

Production and/or use of mixed oxide fuels

There is no production or use of mixed oxide fuels in Thailand.

Production and/or use of re-enriched tails

There is no production or use of re-enriched fuels in Thailand.

Production and/or use of reprocessed uranium

There is no production or use of reprocessed uranium in Thailand.

Regulatory regime

There is no regulatory regime for uranium mining in Thailand because there is no uranium industry. The Office of Atoms for Peace (OAP) is the regulator on the use of atomic energy in Thailand. If there is a uranium mining industry in Thailand in the future, the OAP will most likely be the main agency responsible for regulation.

Uranium requirements

Thailand's new Power Development Plan (PDP) (drafting ongoing) outlines the country's electricity management strategy to the end of 2037. Nuclear energy, particularly Small Modular Reactors (SMRs), has also been a topic of significant debate. Despite the plan that is still being developed, some energy companies are already taking proactive steps. Thailand has committed to achieving carbon neutrality by 2050 and net zero emissions by 2065. The new power plan focusses on expanding the use of renewable energy, efficiently managing the power supply and incorporating nuclear energy (probably <1%).

Supply and procurement strategy

Not applicable.

Uranium policies, uranium stocks and uranium prices

National policies relating to uranium

Although there is no government policy on uranium, there are laws and regulations on the use of atomic energy, and radioactive materials. Uranium importation and exportation is included in these laws. The applicable laws are the Atomic Energy for Peace Act B.E. 2504 (1961), and the Ministerial Act on Licensing and Management Procedures for Special Nuclear Materials B.E. 2550 (2007).

Uranium stocks

There is no uranium stock for use in nuclear power reactors in Thailand.

Türkiye

Uranium exploration and mine development

Historical background

Uranium exploration in Türkiye began in 1956-1957 and was directed towards the discovery of vein-type deposits in crystalline terrain, such as acidic igneous and metamorphic rocks. As a result of these activities, some uneconomic occurrences of pitchblende mineralisation were found. Since 1960, studies have been conducted in sedimentary rocks that surround the crystalline rocks, and some small, mineralised occurrences containing autunite and torbernite mineralisation have been found in various parts of the country. In the mid-1970s, the first uranium deposit was found in the Köprübaşı area of Manisa, consisting of black-coloured ore located below the water table. After 2010, the Avanos-Gülşehir and Malatya-Kuluncak uranium fields were discovered by the General Directorate of Mineral Research and Exploration (MTA). Uranium mineral resources were increased after intensive exploration and drilling operations by MTA and the private sector.

The state-owned organisation, General Directorate of Eti Mining Operations (Eti Maden), is responsible for the exploration and development activities of five uranium deposits with identified resources. MTA has performed geological exploration at these sites in the past. Between 1960 and 1980, uranium exploration included aerial prospecting, general and detailed prospecting, geologic mapping and drilling. The uranium deposits were transferred from MTA to Eti Maden as potential mines, which can be operated by the state under Law No. 2840, "Operation of Boron Salts, Trona and Asphaltite Mines and Nuclear Energy Raw Materials", issued on 10 June 1983.

Recent and ongoing uranium exploration, and mine development activities

In 2023 and 2024, granite, acidic igneous and sedimentary rocks within the Nevşehir, Yozgat, Afyonkarahisar, Isparta, Manisa, Uşak, Kütahya and Denizli provinces were explored for radioactive mineralisation. Drilling was conducted at sites licensed by MTA within the Nevşehir, Yozgat, Uşak and Manisa provinces. In 2023 and 2024, a total of 177 holes were drilled (71 812 m of drilling).

Uranium resources

Identified conventional resources (reasonably assured and inferred resources)

As of 1 January 2025, identified in situ conventional uranium resources in Türkiye amounted to 45 421 tU (53 562 tonnes U_3O_8), including 4 340 tU of reasonably assured resources and 41 081 tU of inferred resources. There are no changes compared to the previous Red Book report.

Inferred resources are distributed in the following deposits:

- Manisa-Köprübaşı: 3 011 tU in ten ore bodies at grades of 0.04-0.05% U_3O_8 (0.034-0.042% U) in fluvial Neogene sediments;
- Uşak-Eşme: 416 tU at 0.044% U_3O_8 (0.037% U) in Neogene lacustrine sediments;

- Aydın-Koçarlı: 176 tU at 0.05% U_3O_8 (0.042% U) in Neogene sediments;
- Aydın-Söke-Nazilli: 1 466 tU at 0.08% U_3O_8 (0.068% U) in gneiss fracture zones;
- Avanos-Gülşehir: 24 795 tU at 0.03% U_3O_8 (0.028% U) in carbonate bearing Eocene sediments;
- Malatya-Kuluncak: 10 449 tU at 0.02% U_3O_8 (0.017% U) in nepheline syenite.

The Yozgat/Sorgun (formerly known as Temrezli) deposit is potentially amenable to in situ leach (ISL) mining. This Eocene basal sandstone channel-type uranium deposit is one of Türkiye's largest and highest-grade uranium deposits, with a mineral resource estimate of 13 282 Mlb U_3O_8 (5 108 tU) at an average grade of 0.116% U_3O_8 (0.098% U), and at an average depth of 120 m. A detailed mineral resource estimate follows:

Resource category	Tonnes	Grade (ppm U_3O_8)	Contained resources (pounds U_3O_8)	Contained resources (tonnes U)
Measured*	2 008 000	1 378	6 100 000	2 346
Indicated*	2 178 000	1 080	5 185 000	1 994
Inferred*	1 020 000	888	1 997 000	768
Total resource*	5 206 000	1 157	13 282 000	5 108

* Numbers rounded for reporting purposes.

Uranium production

Historical review

In the past, pilot laboratory studies for uranium extraction were carried out during uranium exploration. The pilot plant established by MTA in Köprübaşı (Manisa) operated between 1974 and 1982. Approximately 1 200 kg of yellow cake was produced from the uranium ores mined in the Köprübaşı and Fakılı (Uşak) regions, and handed over to the Turkish Atomic Energy Authority (TAEK) in 1996. Between 1996 and 2000, research on uranium extraction was performed as part of the Seventh National Development Plan of the Republic of Türkiye.

Status of production facilities, production capability, recent and ongoing activities, and other issues

None reported.

Environmental activities and socio-cultural issues

Uranium exploration is assessed within the scope of Article 55 of the Annex-II list in the by-law on environmental impact assessments (EIAs) by the Ministry of Environment, Urbanisation and Climate Change. Mine production activities for 25 ha and above, together with the mine enrichment activities, are evaluated within the scope of the Annex-I list of the EIA by-law.

Regulatory regime

As the regulatory authority of Türkiye, the Nuclear Regulatory Authority (NDK) undertakes regulatory activities concerning facilities, including nuclear power plants, devices, substances, and activities related to nuclear energy and ionising radiation. NDK was originally established by a decree, Law No. 702 dated 2 July 2018, as an independent authority associated with the Ministry of Energy and Natural Resources (MENR). However, this decree has been revoked and the current legal framework governing the activities of the NDK is provided by the Nuclear Regulation Law No. 7381 (NRL 7381).

In addition to Law No. 7381, Presidential Decree on the Organization and Duties of the Nuclear Regulatory Authority No. 95 (PD No. 95), which entered into force on 8 March 2022, lays out the functions and organisational structure of the NDK.

According to Law No. 7381, a nuclear facility is defined as a facility established or operated for the purpose of extracting, producing, processing, using, holding, reprocessing or storing nuclear material. It is mandatory to obtain a licence from NDK to operate a nuclear facility, radiation facility, radioactive waste facility, or to carry out radiation applications. The Regulation on Authorizations Regarding Nuclear Facilities (published in the Official Gazette No. 32135 on 17 March 2023) outlines the procedures and requirements for licensing nuclear facilities, including mines. According to this Regulation, the licensing procedure for nuclear mining facilities is initiated by an application from the owner. The licensing process comprises a construction permit and an operating licence for nuclear mining facilities. The documents required for review and assessment in terms of safety, security, safeguard and radiological protection issued by NDK are defined in the Regulation on Authorizations Regarding Nuclear Facilities.

Also, the uranium mining activities are subject to notification pursuant to Protocol Additional to the Agreement between the Government of Türkiye and the International Atomic Energy Agency for the Application of Safeguards in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons (INFCIRC/295/Add.1), in force since 17 July 2001. The Regulation on Nuclear Safeguards covers Additional Protocol Declarations. Those who carry out the mining activities are obliged to notify NDK on an annual basis, in accordance with Regulation on Nuclear Safeguards.

The duties and responsibilities of NDK are defined in the Presidential Decree on Organization and Duties of the Nuclear Regulatory Authority No. 95 (PD 95), and TAEK was reorganised as a research and development, and technical support service organisation. In 2020, the Turkish Energy, Nuclear and Mineral Research Authority (TENMAK) was founded as an affiliate to the Ministry of Energy and Natural Resources, with Presidential Decrees No. 4 and 57 by incorporating three governmental institutions related to nuclear, boron and rare earth elements research (named as TAEK, BOREN and NATEN, respectively). The Nuclear Energy Research Institute (NUKEN) was established within TENMAK to carry out studies on nuclear science and technologies. Nuclear fuel cycle research and fuel development studies are conducted on a laboratory scale within the Istanbul campus of NUKEN.

Uranium requirements

There are no nuclear power plants in operation or decommissioning activities underway. However, four reactor units are under construction in Türkiye.

Türkiye has considered building a nuclear power plant since the 1970s. Rising energy demand, import dependence and industrial activity are the driving forces behind Türkiye's move towards developing a civil nuclear power generation programme. Türkiye's recent efforts in this area can be characterised as a first-of-a-kind approach in the nuclear sector and have been referred to as an intergovernmental agreement (IGA) model, with long-term contracts of power purchase agreements. In this approach, a project company undertakes to design, build, operate and maintain a power plant, whereas the government of Türkiye is responsible for providing the site, various financial and non-financial guarantees, construction support and licensing. The project company is also responsible for managing waste and decommissioning the facility.

The construction and operation of a nuclear power plant, through an intergovernmental agreement between the government of the Russian Federation and the government of Türkiye, is being carried out at Akkuyu, Mersin Province, Türkiye. The Akkuyu Nuclear Power Plant includes the construction and operation of four VVER-1200 reactors, with a total capacity of 4 800 MWe. Türkiye plans to build three more nuclear power plants. Negotiations continue with the People's Republic of China and Korea.

Supply and procurement strategy

According to Article 12 of the IGA on co-operation in the construction and operation of the Akkuyu Nuclear Power Plant, nuclear fuel will be sourced from suppliers based on long-term agreements between the project company and the fuel suppliers. The Akkuyu Nuclear Joint-Stock Company is planning to secure a supply of nuclear fuel from TVEL, a subsidiary of Rosatom. The first fresh nuclear fuel assemblies were delivered to the Akkuyu Nuclear Power Plant site on 27 April 2023.

Uranium policies, uranium stocks and uranium prices

National policies relating to uranium

The law on the "Operation of Boron Salts, Trona, and Asphaltite Mines and Nuclear Energy Raw Materials" No. 2840, dated 10 June 1983, states that exploration and mine operations are to be carried out by the state.

Uranium stocks

TENMAK-NUKEN holds natural uranium stocks in different forms for research activities.

Uranium exploration and development expenditures, and drilling effort – domestic

(TRY [Turkish lira] – excluding VAT)

	2023	2024
Government exploration expenditures	66 782 121	95 050 558
Total expenditures	66 782 121	95 050 558
Government exploration drilling (m)	41 844	29 968
Government exploration holes drilled	109	68
Total drilling (m)	41 844	29 968
Total number of holes drilled	109	68

Reasonably assured resources by production and processing method

(in situ tonnes U)

Production method	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
ISL	0	4 340	4 340
Total	0	4 340	4 340

Reasonably assured resources by deposit type

(in situ tonnes U)

Deposit type	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Sandstone	0	4 340	4 340
Total	0	4 340	4 340

Inferred resources by production and processing method

(in situ tonnes U)

Production method	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Conventional OP	0	28 398	28 398
ISL	0	768	768
Unspecified	0	0	11 915
Total	0	29 166	41 081

Inferred resources by deposit type

(in situ tonnes U)

Production method	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Sandstone	0	4 371	4 371
Carbonate	0	24 795	24 795
Intrusive	0	0	10 449
Unspecified (fracture zones in gneiss)	0	0	1 466
Total	0	29 166	41 081

Installed nuclear generating capacity to 2045

(MWe net)

2025		2030		2035		2040		2045	
Low	High	Low	High	Low	High	Low	High	Low	High
1 200	1 200	4 800	4 800	7 200	7 200	12 600	12 600	15 600	15 600

Annual reactor-related uranium requirements to 2045 (excluding MOX)

(tonnes U)

2025		2030		2035		2040		2045	
Low	High	Low	High	Low	High	Low	High	Low	High
190	190	380	380	1 150	1 150	2 000	2 000	2 500	2 500

Total uranium stocks

(tonnes natural U-equivalent)

Holder	Natural uranium stocks in concentrates	Enriched uranium stocks	Enrichment tails	LWR reprocessed uranium stocks	Total
Government	4.1	0	0	0	4.1
Total	4.1	0	0	0	4.1

Ukraine

Uranium exploration and mine development

Historical review

Prospecting for uranium in Ukraine began in 1944 with the analysis of geological exploration data and mining activity results in the Northern Kryvyy Rig ore basin. The Pervomayske and Zhovtorechenske uranium deposits were discovered in the 1950s. These deposits were depleted in 1967 and 1989, respectively. During the same period sandstone-type deposits were discovered such as Safonivske, Novogurivske, Sadove, Surske, and many other uranium occurrences.

From the mid-1960s until present, the main geological exploration was concentrated in the Kirovograd ore area for the discovery of metasomatite-type uranium deposits. The Michurinske, Vatutinske, Severinske, Tsentralne and Novokostyantynivske deposits were discovered in this area as well as Aprelske, Dokuchayivske, Lisne, Litne, Partizanske, Yuriyvske and other deposits.

Metasomatite-type deposits constitute the main part of the uranium resources of Ukraine. The average ore grade in these deposits is 0.1-0.2% U. The second type is represented by sandstone-type deposits, with an average ore grade between 0.02-0.06% U, suitable for mining by the in situ leaching (ISL) method.

Uranium exploration and development expenditures, and drilling efforts – domestic

(UAH million as of 1 January 2025)

	2022	2023	2024	2025
Industry* exploration expenditures	0	0	0	N/A
Government exploration expenditures	0	0	0	N/A
Industry* development expenditures	0	0	0	N/A
Government development expenditures	4.7	2.9	9.8	N/A
Total expenditures	4.7	2.9	9.8	N/A
Industry* exploration drilling (m)	0	0	0	N/A
Industry* exploration holes drilled	0	0	0	N/A
Government exploration drilling (m)		0	0	N/A
Government exploration holes drilled		0	0	N/A
Industry* development drilling (m)	0	0	0	N/A
Industry* development holes drilled	0	0	0	N/A
Government development drilling (m)	2 065	706	2 203	N/A
Government development holes drilled	98	35	71	N/A
Subtotal exploration drilling (m)	0	0	0	N/A
Subtotal exploration holes drilled	0	0	0	N/A
Subtotal development drilling (m)	2 065	706	2 203	N/A
Subtotal development holes drilled	98	35	71	N/A
Total drilling (m)	2 065	706	2 203	N/A
Total number of holes drilled	98	35	71	N/A

* Non-government.

Ongoing uranium exploration and mine development activities

During 2023-2024, State Enterprise, Kirovgeology (the state company responsible for uranium prospecting and exploration in Ukraine) undertook analytical research of existing geological data to identify areas prospective for uranium exploration within Ukraine. Ukrainian companies do not carry out any exploration for uranium in other countries.

Uranium resources

Identified conventional resources (reasonably assured and inferred resources)

As of 1 January 2025, identified uranium resources (reasonably assured and inferred) at ≤USD 390/kgU amounted to 352 692tU, <USD 260/kgU – 306 788 tU, ≤USD 130/kgU – 184 474 tU and <USD 80/kgU – 5 630 tU. All resources are reported as in situ and consider the uranium resource depletion by production during 2023-2024.

During 2023-2024, the reassessment of Ukrainian identified uranium resources was made due to favourable changes in global uranium market conditions. This reassessment resulted in a significant increase by 142 351 tU of identified in situ resources compared to resources reported as of 1 January 2023. Reasonably assured resources (RAR) increased by 82 611 tU and inferred resources increased by 59 740 tU.

The increase is supported by the following factors:

- An increase of RAR resources due to the evaluation of the Tsentralne, Severinske and Pidgaytsevske deposits.
- The addition of resources in the new cost category ≤ USD 390/kgU.
- An increase in inferred resources as a result of the reassessment of almost 50 deposits and occurrences, which are at different stages of development.

The main uranium resources of economic interest consist of two types of deposits:

- Metasomatite-type deposits, which are located within the Kirovograd block of the Ukrainian Shield. The uranium ore grade is 0.1-0.2% U. All deposits are suitable for underground mining.
- Sandstone-type deposits located within the Dnieper-Bug metallogenic area (17 300 km^2). The uranium ore grade is 0.02-0.06% U. Molybdenum, selenium and lanthanide group rare earth elements are also present within these deposits. These deposits are amenable to mining by ISL.

Undiscovered resources (prognosticated and speculative resources)

Undiscovered in situ uranium resources amount to 277 500 tU, including:

- Prognosticated resources of 22 500 tU, situated on the flanks of identified deposits.
- Speculative resources of 255 000 tU, based on the data from the uranium prognostic map (scale of 1:500 000), which was created by SE Kirovgeology. Speculative resources are subdivided according to geological types as follows:
  - 133 500 tU metasomatite-type;
  - 20 000 tU in sandstone deposits on the Ukrainian Shield;
  - 16 500 tU in sandstone (in bitumen) on the slopes of the Ukrainian Shield;
  - 40 000 tU in “unconformity-related” type deposits;
  - 30 000 tU in granite-related type deposits;
  - 15 000 tU in “intrusive” potassium metasomatite deposits.

Uranium production

Historical review

Uranium mining began in 1946 at the Pervomayske and Zhovtorechenske deposits using conventional underground methods. In 1949, the first uranium production began at the Pridniprovskyy Chemical Plant (PCP), in the town of Dniprodzerzhinsk (now Kamyanske).

In 1951, the government founded the State Enterprise,Eastern Ore Dressing Complex, (VostGOK) in Zhovti Vody in the Dnipropetrovsk region, for the mining and processing of ore from the Pervomayske and Zhovtorechenske deposits. In 1959, a second uranium processing plant was built in Zhovti Vody. The Pervomayske deposit was depleted in 1967, and the Zhovtorechenske deposit was mined out in 1989.

ISL uranium mining development commenced in the late 1950s, with the first production from the Devladovske deposit in 1961. From 1966 to 1983, uranium from the Devladovske and Bratske deposits was recovered by the sulphuric acid ISL method at a depth of about 100 m. At present, aquifers of both deposits are undergoing monitoring.

Status of production facilities, production capability, recent and ongoing activities, and other issues

VostGOK (Vostochny Gorno-Obogatitel'niy Kombinat) is Ukraine's state-owned uranium mining and processing enterprise. VostGOK operates three underground uranium mines in the Kirovohrad Region: Ingulskaya, Smolinskaya and Novokonstantinovskoye. All mined ore is processed at the Zhelty Vody mill in the Dnipropetrovsk region, which produces uranium oxide concentrate. The government approved the decision to shut down mining at the Smolinskaya mine for the period 2023-2027, due to mining resource depletion.

In 2023 and 2024, VostGOK produced 350 tU and 329 tU, respectively.

Hydrometallurgical processing plants

Ukraine has two processing plants. The Pridniprovskyy Chemical Plant (Kamyanske, Dnepropetrovsk region) has been idled since 2005. So, at present, only the VostGOK hydrometallurgical processing plant situated in the town of Zhovti Vody is in operation. The annual capacity of the plant is 1.5 Mt of ore. Each working shift employs 30 to 35 people. Uranium ore is transported to the plant by specially equipped trains from the Ingulskaya, Smolinskaya and Novokonstantinovskoye mines, located 100-150 km from the plant.

Uranium production method

Metasomatite-type deposits in Ukraine have a uranium ore grade of about 0.1-0.2% U on average, with disseminated mineralisation (uraninite, brannerite, coffinite and pitchblende) throughout the steeply dipping ore bodies. Mining is by the conventional underground method. Processing of mined ore begins with crushing, followed by extraction by sulphuric acid leaching in autoclaves at the hydrometallurgical processing plant. Low-grade uranium ore, expensive underground mining technology, processing technology and transportation (mines are located some 100 km and 150 km from the processing plant) are factors related to high production costs. To decrease production costs, some innovative technologies, such as underground radiometric ore sorting, in-place leaching, heap leaching and reprocessing of material from dumps of operating mines, are being introduced.

A multistage radiometric separator, designed by VostGOK for different particle sizes of crushed ore, allows sorting of both mined ore and material from the mine dumps. After the radiometric sorting, the uranium content in the ore may reach 0.03-0.3% U. The uranium content in tails after radiometric sorting is 0.006% U or less.

At the Smolinskaya mine, crushed uranium ore undergoes heap leaching (HL) with a recovery factor of about 82-83%. The uranium production cost of HL is 15% lower than at the hydrometallurgical processing plant due to lower logistical expenses. Four heaps with a total volume of 160 Kt of ore were built. Each heap contains 40 Kt of ore. After radiometric sorting, the ore grade is 0.05-0.08% U.

Although most metasomatite-type ore deposits are suitable for HL, additional ore treatment for effective HL is necessary since the degree of crushing and permeability are the most important parameters that determine uranium recovery. The maximum size of uranium mineral particles is usually from 1 to 5 mm. With an optimum size of ore material of 10 mm, 80-90% uranium recovery can be achieved after 2 to 3 months of leaching.

Uranium production centres technical details

(as of 1 January 2025)

	Centre #1	Centre #2	Centre #3
Name of production centre	VostGOK	Safonivske mine	Pridniprovskyy Chemical Plant
Production centre classification	Existing	Planned	Idled since 2005
Date of first production (year)	1959	N/A	1949
Source of ore:			
Deposit name(s)	Michyrinske, Tsentralne, Novokostyantynivske, Vatutinske	Safonivske	N/A
Deposit type(s)	Metasomatite	Sandstone	N/A
Recoverable resources (tU)	97 243	2 248	N/A
Grade (% U)	0.14	0.02	N/A
Mining operation:			N/A
Type (OP/UG/ISL)	UG	ISL	N/A
Size (tonnes ore/day)	4 000	N/A	N/A
Average mining recovery (%)	95	75	N/A
Processing plant:			
Acid/alkaline	Acid	Acid	Acid
Type	acid leaching in autoclaves	Sorption – desorption from resin	acid leaching in autoclaves
Size (tonnes ore/day) For ISL (mega or kilolitre/day or litre/hour)	N/A	20 000 kilolitre/day	N/A
Average process recovery (%)	93	95	93
Nominal production capacity (tU/year)	2 000	150	2 500
Plans for expansion (yes/no)	No	No	No

Ownership of uranium industry

At present all enterprises in the Ukrainian uranium industry (geology, mining and processing) are owned by the state. The State Enterprise VostGOK belongs to the Ministry of Energy of Ukraine. The State Enterprise, Kirovgeology, is responsible for geological surveys, resource evaluations and exploration of deposits in Ukraine. It is part of the State Service of Geology and Resources of Ukraine, in the Ministry of Economy, Environment and Agriculture of Ukraine.

Secondary sources of uranium

Mixed oxide fuel (MOX), re-enriched tails and reprocessed spent nuclear fuel have never been produced in Ukraine or used in its nuclear power plants.

Environmental activities and socio-cultural issues

The main environmental impacts of uranium mining come from ore stockpiles, tailings, radiometric ore-sorting sites, waste dumps, ventilation systems, infrastructure and transport (railways and technological roads).

The main environmental impacts from the hydrometallurgical process plant and heap leaching sites are harmful chemical and ore dust emissions, airborne transportation of aerosols and groundwater contamination from tailings impoundments. Permanent monitoring is conducted to control the environmental impacts.

At the hydrometallurgical plant (Zhovti Vody), process water is recycled for the technological process. There are two tailings impoundments. One is situated 9 km from the hydrometallurgical plant, consisting of two sections (614.9 ha containing 45.3 Mt of waste) with total activity of 455.68*1 012 Bq, and the second is 0.5 km from the plant (55 ha containing 16 Mt of waste) with total activity of 93.3*1 012 Bq. The second one is no longer used and reclamation is ongoing.

There are also issues connected with the decommissioning of uranium mining and uranium processing enterprises.

At the Prydniprovskyy Chemical Plant, which is idle, there are nine tailing impoundments (covering a total area of 268 ha containing 42 Mt of waste), with a total activity of 3.14*1 015 Bq and some buildings and other facilities are contaminated by radioactive elements. The Cabinet of Ministers of Ukraine has had a state programme for the reclamation of sites since 2005.

The total cost of improving radiological protection across all enterprises in the nuclear industry, and all contaminated areas resulting from the mining and processing of uranium is expected to amount to USD 360 million, including decontamination of polluted soils, environmental monitoring, installation of monitoring systems where necessary and improved technology for the management of water flows, radioactive rocks in dumps, polluted equipment and land areas.

Uranium requirements, supply and procurement strategy

Uranium production in Ukraine meets 25% of domestic nuclear energy requirements. The Ukrainian nuclear power fleet consists of 15 reactors. As of 1 January 2025, nine reactors were operating at three nuclear power plants: 3 VVER-1000 units at Pivdenno-Ukrainian Nuclear Power Plant, 2 VVER-1000 units and 2 VVER-400 units at the Rovenskyy Nuclear Power Plant, and 2 VVER-1000 units at the Khmelnitskyy Nuclear Power Plant. Six VVER-1000 units at Zaporizhzhia Nuclear Power Plant are idled.

The Ukrainian operator of nuclear power plants SE NNEGC, Energoatom, imports nuclear fuel from Westinghouse Electric and uranium for fuel manufacturing from Cameco Corporation, in Canada. Until 2022, nuclear fuel was imported from Russia (TVEL) and Westinghouse Electric (United States). At present, all contracts with Russia are nullified and fuel will be imported from Westinghouse Electric. Annual fuel loadings of the three operating nuclear power plants (comprised of 7 VVER-1000 units and 2 VVER-440 units) are nine sets of fuel elements amounting to around 1 500 tU per year.

Ukraine joined the declaration of countries at the COP28 Climate Conference, committing to tripling nuclear generation capacity by 2050. This includes the development and construction of both large power units and small modular reactors (SMR).

The forward installed nuclear generating capacity was calculated, based on the Ministry of Energy of Ukraine and JSC Energoatom plans for reactor construction, including 2 VVER 1000 and 2 AP 1000 reactors at the Khmelnitsky Nuclear Power Plant, as well as 20 SMR 160 on other sites. The high scenario for uranium requirements considers the Zaporizhzhia Nuclear Power Plant will be back in operation by 2030.

Uranium policy, uranium stock and uranium price

In August 2021, Ukrainian Energoatom signed a memorandum with Westinghouse Electric (United States) for the construction of five nuclear power units, and in the summer of 2022, signed an agreement to increase the number of nuclear units using AP1000 technology, to nine. A nuclear power unit (AP 1000) will be constructed at the Khmelnitsky Nuclear Power Plants as a pilot project, with a plan to build other reactors in the future. The total cost of the project is estimated at USD 30 billion.

The “Energy Strategy of Ukraine until 2050” was approved on 21 April 2023, by Resolution No. 373-r of the Cabinet of Ministers of Ukraine. It identifies nuclear energy as one of the key components in ensuring energy security, sustainable development and the achievement of climate goals. The document envisions the preservation and expansion of nuclear generation capacities, maintaining a share of no less than 50% in the country's electricity production structure by 2050.

As part of the strategy implementation, it is planned to extend the operational life of existing nuclear power units, construct new capacities including VVER-1000 and AP-1000 reactors and introduce SMRs. Particular attention is given to the diversification of nuclear fuel supplies, the complete phase-out of imports from Russia, and the development of partnerships with international suppliers. The strategy also emphasises localisation of fuel fabrication in Ukraine, support for domestic uranium production and the development of elements of a full nuclear fuel cycle.

The Ukrainian government’s uranium policy includes the following goals:

- improvement of the uranium resource base through exploration and the discovery of new uranium deposits;
- increase uranium production by mining of existing uranium deposits to meet domestic requirements;
- extension of the range of components that Ukraine manufactures for nuclear fuel assemblies;
- creation of a stock of uranium concentrate (U_3O_8);
- diversification of the nuclear fuel supply.

Reasonably assured conventional resources by production method

(in situ tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	≤USD 390/kgU	Recovery factor (%)
Underground mining	0	0	126 812	195 886	213 390	88
In situ leaching acid	0	3 630	5 662	5 662	5 662	75
Total	0	3 630	132 474	201 548	219 052	

Reasonably assured conventional resources by processing method

(in situ tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	≤USD 390/kgU	Recovery factor (%)
Conventional from UG	0	0	126 812	195 886	213 390	88
In situ leaching acid	0	3 630	5 662	5 662	5 662	75
Total	0	3 630	132 474	201 548	219 052	

Reasonably assured conventional resources by deposit type

(in situ tonnes U)

Deposits type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	≤USD 390/kgU	Recovery factor(%)
Sandstone	0	3 630	5 662	5 662	5 662	75
Metasomatite	0	0	126 812	195 886	213 390	88
Total	0	3 630	132 474	201 548	219 052	

Inferred conventional resources by production method

(in situ tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	≤USD 390/kgU	Recovery factor (%)
Underground mining	0	0	50 000	103 240	131 640	88
In situ leaching acid	0	2 000	2 000	2 000	2 000	75
Total	0	2 000	52 000	105 240	133 640	

Inferred conventional resources by processing method

(in situ tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	≤USD 390/kgU	Recovery factor (%)
Conventional from UG	0	0	50 000	103 240	131 640	88
In situ leaching acid	0	2 000	2 000	2 000	2 000	75
Total	0	2 000	52 000	105 240	133 640	

Inferred conventional resources by deposit type

(in situ tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	≤USD 390/kgU	Recovery factor (%)
Metasomatite	0	0	50 000	103 240	131 640	88
Sandstone	0	2 000	2 000	2 000	2 000	75
Total		2 000	52 000	105 240	13 3640	

Prognosticated conventional resources

(in situ tonnes U)

Cost ranges			
<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	≤USD390/kgU
0	8 400	22 500	N/A

Speculative conventional resources

(in situ tonnes U)

Cost ranges			
<USD 130/kgU	<USD 260/kgU	≤USD390/kgU	Unassigned
0	120 000	N/A	255 000

Historical uranium production by production method

(tonnes U in concentrate)

Production method	Total through end of 2022	2023	2024	Total through end of 2024	2025 (expected)
Open-pit mining*	10 000	0	0	10 000	0
Underground mining*	111 131	350	329	111 810	300
In situ leaching	3 925	0	0	3 925	0
Co-product/by-product	10 000	0	0	10 000	0
Total	135 056	350	329	135 735	300

* Pre-2018 totals may include uranium recovered by heap and in-place leaching.

Historical uranium production by processing method

(tonnes U in concentrate)

Processing method	Total through end of 2022	2023	2024	Total through end of 2024	2025 (expected)
Conventional	130 692	350	329	131 371	300
In situ leaching	3 925	0	0	3 925	0
In-place leaching*	26	0	0	26	0
Heap leaching**	413	0	0	413	0
Total	135 056	350	329	135 735	300

* Also known as stope leaching or block leaching.

** A subset of open-pit and underground mining, since it is used in conjunction with them.

Historical uranium production by deposit type

(tonnes U in concentrate)

Deposits type	Total through end of 2022	2023	2024	Total through end of 2024	2025 (expected)
Sandstone	3 925	0	0	3 925	0
Metasomatite	131 131	350	329	131 810	300
Total	135 056	350	329	135 735	300

Ownership of uranium production in 2024

Domestic				Abroad				Total	
Government		Private		Government		Private			
(t U)	(%)	(t U)	(%)	(t U)	(%)	(t U)	(%)	(t U)	(%)
329	100	0	0	0	0	0	0	329	100

Uranium industry employment at existing production centres

(persons/years)

	2023	2024	2025 (expected)
Total employment at existing production centres.	3 828	3 943	4 000
Direct employment in uranium production.	1 927	1 780	1 837

Mid-term production projections* (tonnes U/year)

2025	2030	2035	2040	2045	2050
300	500	800	1 500	2 000	2 500

* Production projections consider current VostGOK infrastructure and can be adjusted after reorganisation and capital investments.

Mid-term production capability* (tonnes U/year)

2025				2030			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
N/A	N/A	800	1 000	N/A	N/A	1 500	1 700

2035				2040			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
N/A	N/A	1 700	2 000	N/A	N/A	2 000	2 500

2045				2050			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
N/A	N/A	2 000	3 000	N/A	N/A	2 000	3 500

* Production capability projections consider current VostGOK infrastructure and can be adjusted after reorganisation and capital investments.

Net nuclear electricity generation

	2023	2024
Net nuclear electricity generation (TWh net)	52.0	53.0

Installed nuclear generating capacity to 2050

(GWe net)

2023	2024	2025		2030		2035		2040		2045		2050	
		Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
13.8	13.8	13.8	13.8	13.8	14.8	14.8	16.8	16.8	18.8	18.8	20.8	N/A	N/A

Annual reactor-related uranium requirements to 2050 (excluding MOX)

(tonnes U)

2023	2024	2025		2030		2035		2040		2045		2050	
		Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
1 500	1 500	1 500	1 500	1 500	2 680	2 680	3 080	3 080	3 480	3 080	3 480	N/A	N/A

United States

Uranium exploration and mine development

Historical review

From 1947 through 1970, the US government fostered a domestic private-sector uranium exploration and production industry to procure uranium for military uses, and to promote research and development in peaceful atomic energy applications. By late 1957, both the number of new deposits that private industry brought into production and production capability had increased sufficiently to meet projected requirements. Federal exploration programmes ended at that time. Exploration has been primarily for sandstone-type uranium deposits in locations such as the Colorado Plateau, the Wyoming Basin and the Texas Coastal Plain.

Private exploration by the US uranium industry increased throughout the 1970s and early 1980s, in response to rising prices and projected high demand for uranium to fuel an increasing number of nuclear reactors under construction or planned for construction. Total annual surface drilling peaked in 1978. Mining and milling facilities remained in operation through the mid-1980s, but uranium price declines caused the closure of most facilities as the outlook for new nuclear reactor projects diminished.

Recent and ongoing uranium exploration, and mine development activities

In 2023 and 2024, the uranium industry in the United States continued to contract most of its uranium requirements from non-domestic sources. Total uranium industry expenditures increased from USD 84.7 million in 2022, to USD 107.4 million in 2023 and USD 160.0 million in 2024.

Private companies that explore for and produce uranium in the United States have continued to increase activity due to sustained higher uranium prices and uranium purchases by the federal government to be held in a national reserve. Increased uranium prices – reaching over USD 80/lb U_3O_8 (USD 208/kg U) in 2023 and peaking at over USD 100/lb U_3O_8 (USD 260/kg U) in early 2024 – spurred exploration for sandstone-hosted deposits in the Powder River Basin, the Gas Hills and the Shirley Basin in Wyoming. Exploration also increased in the South Texas Coastal Plain, including the Goliad and Oakville formations, and in the Colorado Plateau in parts of Utah, Colorado, Arizona and New Mexico, where sandstone-hosted deposits are found in the Morrison and Chinle geologic formations. Companies such as Cameco, Uranium Energy Corp. (UEC), and enCore Energy focussed on delineating and expanding known roll-front deposits for ISR projects.

Compared to sandstone-hosted deposits, less extensive exploration was carried out for collapsed breccia-type uranium deposits in the northern Arizona Grand Canyon region, where companies conducted resource assessments and permitting activities to restart or expand existing operations.

Due to improved market conditions, a renewed interest in exploration of volcanic-related uranium deposits took place in the Marysvale mining district in Utah and in the McDermitt Caldera in Nevada, Oregon, and parts of New Mexico, but these exploration activities were significantly smaller than sandstone-hosted and collapsed breccia-type deposits. In addition, as calcrete-hosted deposits were being explored in the Southern High Plains, metasomatite-type deposits were the focus of ongoing permitting efforts in the southeastern United States (Coles

Hill, Virginia). No active exploration was conducted of Phosphate, Black Shale and other unconventional uranium deposit types.

Domestic uranium production increased during 2023 and 2024, in response to significantly increased federal and state government support for existing and new nuclear energy.

United States uranium expenditures, 2010-2024 (USD million)

Year	Drilling	Production	Land and other				Total expenditures
			Total land and other	Land	Exploration	Reclamation	
2010	44.6	133.3	99.5	20.2	34.5	44.7	277.3
2011	53.6	168.8	96.8	19.6	43.5	33.7	319.2
2012	66.6	186.9	99.4	16.8	33.3	49.3	352.9
2013	49.9	168.2	90.6	14.6	21.6	54.4	308.7
2014	28.2	137.6	74.0	11.6	10.7	51.7	239.7
2015	28.7	118.5	76.2	12.1	4.7	59.4	223.5
2016	22.3	98.0	49.6	9.9	2.5	37.2	169.9
2017	4.0	78.3	40.2	8.9	3.7	27.7	122.5
2018	W	65.9	W	W	W	W	108.8
2019	W	38.0	W	W	W	W	81.0
2020	W	40.0	W	W	W	W	87.0
2021	W	29.2	W	8.6	W	W	72.5
2022	9.4	22.2	53.1	11.4	5.4	36.4	84.7
2023	28.5	22.5	56.4	8.3	16.5	31.6	107.4
2024	53.7	57.4	48.9	9.4	6.1	33.5	160.0

Source: US Energy Information Administration, *Domestic Uranium Production Report*, 2024, Table 8.

Notes: Expenditures are in nominal USD. Totals may not equal the sum of components because of independent rounding.

W = Data withheld to avoid disclosure of individual company data.

Drilling = All expenditures directly associated with exploration and development drilling.

Production = All expenditures for mining, milling, processing of uranium and facility expense.

Total land and other = All expenditures for land; geological research; geochemical and geophysical surveys; costs incurred by field personnel during exploration, reclamation, and restoration work; and overhead and administrative charges directly associated with supervising and supporting field activities.

United States uranium drilling activities, 2010–2024

Year	Exploration drilling		Development drilling		Exploration and development drilling	
	Number of holes	Metres (thousand)	Number of holes	Metres (thousand)	Number of holes	Metres (thousand)
2010	2 439	445	4 770	1 050	7 209	1 495
2011	5 441	1 013	5 156	915	10 597	1 928
2012	5 112	1 051	5 970	1 131	11 082	2 181
2013	1 231	280	4 013	892	5 244	1 172
2014	W	W	W	W	1 752	396
2015	W	W	W	W	1 518	268
2016	W	W	W	W	1 158	231
2017	W	W	W	W	420	60
2018	W	W	W	W	W	W
2019	W	W	W	W	W	W
2020	W	W	W	W	W	W
2021	W	W	W	W	W	W
2022	259	46	749	117	1 008	163
2023	877	156	1 053	170	1 930	326
2024	1 324	187	2 462	384	3 786	571

Source: US Energy Information Administration, *Domestic Uranium Production Report*, 2024, Table 1.

Note: Totals may not equal the sum of components because of independent rounding.

W = Data withheld to avoid disclosure of individual company data.

Conventional and in situ recovery mine development

In 2024, the United States had nine uranium production facilities producing uranium concentrate. These facilities include both ISR operations and one conventional uranium mill. Uranium production in Q4 2024 occurred at the following nine facilities:

- Lost Creek, Wyoming: ISR facility operated by Ur-Energy.
- Ross CPP (Central Processing Plant), Wyoming: Part of Peninsula Energy's Lance Project, restarted in December 2024.
- Alta Mesa Project, Texas: ISR facility operated by enCore Energy.
- Rosita, Texas: ISR facility operated by enCore Energy.
- Crow Butte, Nebraska: ISR facility operated by Cameco.
- Nichols Ranch, Wyoming: ISR facility operated by Energy Fuels.
- Smith Ranch, Wyoming: ISR facility operated by Cameco.
- Willow Creek Project, Wyoming: ISR facility operated by Uranium Energy Corp.
- White Mesa Mill, Utah: The only operating conventional uranium mill in the United States, operated by Energy Fuels, which resumed production in 2024.

Crow Butte and Smith Ranch had limited production related to restoration activities.

The United States has conventional and ISR-amenable mines and deposits with some degree of permitting or development. Most of these were indefinitely paused, awaiting more favourable market conditions, which started to dramatically improve in Q3 of 2021, reaching a 24-year uranium spot price high of USD 106/lb U_3O_8 (USD 275.6/kg U) in January 2024. Although this report is not a comprehensive review of the status of these uranium mines and properties, noteworthy activities or developments during 2023 and 2024 are described in this report. Developments not directly related to uranium production, such as property transfers, incremental permitting, resource updates and financial actions, are not included.

In 2023 and 2024, a number of ISR and conventional mine production restarts were announced:

- Lost Creek Project (ISR), Wyoming, Q2 2023: Commercial scale production by Ur-Energy restarted in May 2023. Production in 2023 was 76 tU. The target for initial production was 230 tU/yr, with the Lost Creek Mill having a licensed production capacity of 846 tU/yr.
- Rosita (ISR), Texas, Q4 2023: enCore Energy announced the restart of ISR production at the South Texas Rosita processing plant (mill) in November 2023, which had its last production in 2008. Target production was 200 tU in 2024, with the mill licensed to produce 308 tU/yr.
- Pinyon Plain (conventional), Arizona, Q4 2023: Energy Fuels announced that in response to strong market conditions the Pinyon Plain (formerly Canyon), La Sal and Pandora mines (both in the La Sal complex), began producing at the end of 2023. The La Sal complex mines had been on standby status since 2019, while Pinyon Plain had never been mined. Production is anticipated to be 384-538 tU/yr, to be stockpiled at the White Mesa Conventional Mill until 2025.
- Alta Mesa (ISR), Texas, Q1 2024: enCore Energy announced the proposed restart of ISR production at Alta Mesa in 2024, with the last production being in 2013. Initial target production amounts were not announced, but the mill production capacity is 577 tU/yr.
- Christensen Ranch (ISR), Wyoming, Q2 2024: Uranium Energy Corp. (UEC) announced plans to begin production from their Christensen Ranch (formerly Willow Creek) ISR mine with first product expected to be produced by August 2024. Uranium was to be processed at UEC's Irigaray Central Processing Plant, with a licensed capacity of 962 tU/yr.
- Nichols Ranch (ISR), Wyoming, Q3 2024: Energy Fuels announced the planned restart of production from the Nichols Ranch mine as early as Q2 2025, contingent on market conditions. The last production was in 2018. Initial target production amounts were not announced, but the licensed production capacity of the mill is 769 tU/yr (historically drying and processing were carried out at the White Mesa Mill, Utah).
- Lance (ISR), Wyoming, Q4 2024: Peninsula Energy announced production from Lance project (Ross, Kendrick, and Barber resource areas) to begin in December 2024. A small amount of uranium was produced in 2022 (1.9 tU), but no production occurred in 2023 or 2024. The initial production target was 423 tU/yr.

Uranium resources

Identified conventional resources (reasonably assured and inferred resources)

At the end of 2024, estimated uranium resources (in situ reasonably assured resources) were 180 053 tU at a maximum forward cost of less than USD 260 per kilogram of uranium (kgU), compared to 168 182 tU as of the end of 2022.

Private companies prepare the estimates of uranium resources. These estimates change each year due to production (resource depletion), changes in resource estimation, site boundary expansions and evolving production costs. Industry participants prepare the uranium resource estimates and report them to the US Energy Information Administration (EIA), which aliases the resources by tabulating them into states or regions without further analysis.

Undiscovered conventional resources (prognosticated and speculative resources)

A 1984 Memorandum of Understanding between the US Department of the Interior, US Geological Survey (USGS) and US Department of Energy (US DOE) assigns responsibilities for assessing potential or undiscovered uranium resources to the USGS. In 2022, the USGS removed uranium from the second edition of its critical minerals list, which had been listed as critical in the first edition in 2018, but has since restored uranium to the third edition of the critical minerals list, published at the end of 2025. The US DOE has included uranium as "near critical" in the short term (2020-2025) and medium term (2025-2030) as well, in their assessment of critical materials published in 2023 [1].

Prognosticated and speculative uranium resources for the United States were last comprehensively evaluated during the National Uranium Resource Evaluation (NURE) programme, which was a major initiative by the USGS and DOE to assess uranium resources across the United States, conducted primarily from 1973 to 1983. Given that this effort is now over four decades old, NURE resources are no longer reported in the Red Book. The last time NURE resources were reported was in the 1989 edition of the Red Book, and they were subsequently summarised in the 2020 edition.

The USGS has been in the process of re-estimating undiscovered resources for the United States using the USGS "3-Part" quantitative mineral resource assessment method [2]. Estimates for various regions and deposit types had been prioritised and were to be completed in an ongoing fashion. Two assessments have been completed, estimating about 84 000 tU recoverable in the Texas Coastal Plain [3, 4] and 15 500 tU in place in the Southern High Plains region [5, 6]. The 3-Part methodology used to estimate undiscovered resources produces probabilistic estimates of possible resources, but these estimates are not subdivided into cost categories; therefore, the estimates are not included in the undiscovered resource compilations in this report. More detailed results of these two assessments of undiscovered uranium resources are provided in the 2022 edition of the Red Book.

Since completion of the Texas Coast Plain and Southern High Plains assessments, the USGS has undertaken preparatory work or contributed to several efforts related to undiscovered uranium resources, although no new fully comprehensive national or regional quantitative uranium resource assessments were undertaken in 2023 or 2024 due to staffing shortfalls. Only

1. U.S. Geological Survey (2025), "Interior Department releases final 2025 List of Critical Minerals", Science Snippet, November 14, 2025, www.usgs.gov/news/science-snippet/interior-department-releases-final-2025-list-critical-minerals; U.S. Geological Survey (2022), "U.S. Geological Survey Releases 2022 List of Critical Minerals", *National New Release, February 22 2022*, https://www.usgs.gov/news/national-news-release/us-geological-survey-releases-2022-list-critical-minerals; U.S. Geological Survey (2018), "Interior Releases 2018's Final List of 35 Minerals Deemed Critical to U.S. National Security and the Economy", *National News Release, May 18 2018*, https://www.usgs.gov/news/national-news-release/interior-releases-2018s-final-list-35-minerals-deemed-critical-us; U.S. Department of Energy (2023), "Critical Materials Assessment 2023", www.energy.gov/sites/default/files/2023-07/doe-critical-material-assessment_07312023.pdf.
2. Singer, D. W.D. and Menzie (2010), "Quantitative Mineral Resource Assessments: An Integrated Approach", Oxford University Press, 232 p.
3. Mihalasky, M.J, S.M. Hall, J.M. Hammarstrom, K.R. Tureck, M.T. Hannon, G.N. Breit, R.A. Zielinski and B. Elliott (2015), Assessment of undiscovered sandstone-hosted uranium resources in the Texas Coastal Plain, 2015: U.S. Geological Survey Fact Sheet 2015–3069, 4 p., accessed 30 September 2025 at URL https://dx.doi.org/10.3133/fs20153069.
4. U.S. Energy Information Administration (2020), "Uranium - Identified Resource Areas", U.S. Energy Atlas, https://atlas.eia.gov/datasets/eia::uranium-identified-resource-areas/about.
5. Hall, S.M., M.J. Mihalasky and B.S. Van Gosen (2017), Assessment of undiscovered resources in calcrete uranium deposits, Southern High Plains region of Texas, New Mexico, and Oklahoma (2017), U.S. Geological Survey Fact Sheet 2017-3078, 2 p., accessed 30 September 2025 at URL https://doi.org/10.3133/fs20173078.
6. The difference in estimation of in-place or recoverable uranium is a result of the different grade and tonnage models used for the estimates: one where in situ uranium data were available; the other where only recovered uranium data were available.

about 10% of the undiscovered uranium resources in the United States have been assessed by the USGS using modern methods. Future assessments have not been scheduled but could include undiscovered resource assessments of metasomatite-type deposits in the southeastern United States (e.g. Coles Hill, Virginia), sandstone-hosted deposits on the Colorado Plateau and collapsed breccia-type deposits in the southwestern United States.

Nonetheless, progress has been made towards completing some of the elements that are required for 3-Part assessments. These activities centred on refining methodologies, updating geological models and leveraging prior assessments for ongoing research. A review of sandstone-hosted uranium deposits on the Colorado Plateau and development of a uranium-vanadium deposit model was published in 2023 [7]. The Colorado Plateau model includes new research that supports: 1) alternative sources for uranium; 2) a novel preservation mechanism; and 3) methods to predict the location of additional deposits in the Morrison and Chinle mineral systems in Utah, New Mexico and Colorado using analysis of paleogeography, paleoclimate and subsurface facies analysis. A database of uranium occurrences for the Colorado Plateau region was compiled using a "cluster method" of analysis. Because of the large number of occurrences in the region (over 4 000 occurrences, of which over 1 200 were mined), occurrences within the same host rock were compiled into circular 25-mile diameter areas for analysis. Furthermore, an updated deposit model for breccia-pipe deposits in the Colorado Plateau was in preparation during 2023 and 2024, and published in 2025 [8].

Uranium production

Historical review

Following the passage of the Atomic Energy Act of 1946 (AEA), designed to meet the US government's uranium procurement needs, the Atomic Energy Commission (AEC) fostered the development of a domestic uranium industry (chiefly in the western United States) from 1947 through 1970, through incentive programmes for exploration, development and production. To ensure the supply of uranium ore would be sufficient to meet future needs, the AEC, in April 1948, announced a domestic ore procurement programme designed to stimulate prospecting and build a domestic uranium mining industry. The AEC also negotiated concentrate procurement contracts, under the AEA (as amended in 1954), with guaranteed prices for source materials delivered within specified times. Contracts were structured to allow milling companies that built and operated mills the opportunity to repay plant costs during the procurement-contract period. By 1961, 27 mills were operating. Overall, 32 conventional mills and several pilot plants, concentrators, upgraders, heap leach and solution-mining facilities were operating at various times. The AEC, as the sole government purchasing agent, provided the only US market for uranium. Although many of the mills closed soon after completing deliveries scheduled under AEC purchase contracts, several mills continued to produce concentrate for the commercial market after fulfilling their AEC commitments.

The AEA, as amended, legalised the private ownership of nuclear reactors for commercial electricity generation. By late 1957, domestic ore reserves and milling capacity were sufficient to meet government needs. In 1958, the AEC's procurement programmes were reduced in scope, and to foster atomic energy use for peaceful purposes, domestic ore and concentrate producers were allowed to sell uranium to private domestic and foreign buyers. The first US commercial-market contract was finalised in 1966. The AEC announced in 1962 an extension of its procurement programme that committed the government to take only set annual quantities of uranium from 1967 through 1970. This programme change also helped sustain a viable domestic uranium industry. The US government's natural uranium procurement programme ended in

7. Hall, S.M., B.S. Van Gosen and R.A. Zielinksi (2023), "Sandstone-hosted uranium deposits of the Colorado Plateau", United States, *Ore Geology Reviews*, v. 155, 39 p.
8. Van Gosen B.S., S.M. Hall, C.A. Johnson and W.M. Benzel (2025), "Solution-collapse breccia pipe uranium deposits of the southern Colorado Plateau, northwestern Arizona, USA", *Ore Geology Reviews*, v. 181, 22 p.

1970, and the industry became a private sector, commercial enterprise with no government purchases. The government, however, continues to monitor private industry exploration and development activities to the extent of meeting federal information and data needs.

Exploration by the US uranium industry increased through the 1970s in response to rising prices and the projected large demand for uranium to be used to fuel an increasing number of commercial nuclear power plants that were under construction or planned. US production peaked in 1980 (16 809 tU) and generally declined until 2003. Beginning in 2004, production began increasing again in response to rising uranium prices. Production began decreasing in 2013 in response to an oversupply of uranium on the world market and the resulting lower uranium prices.

In the latter half of 2021, exploration and mine development activities began to rebound in response to a rise in uranium prices, which in January 2024 peaked at a 24-year high spot price of USD 106/lb U_3O_8 (USD 275.6/kg U). In 2022, following the initial rise in uranium prices, exploration and development drilling activities began to increase again, and the US EIA released exploration and drilling activity data again, after four years of withholding them due to low levels of drilling activity to protect the identities of individual producers. With the declaration made at 2023 United Nations Climate Change Conference (COP28) by 22 countries to double or triple their nuclear energy capacities by 2050, as well as the ongoing development and possible widespread deployment of small modular reactors (SMRs), uranium exploration and mine development are expected to further increase.

Status of production facilities, production capability, recent and ongoing activities, and other issues

US uranium mines produced 260 tU in 2024, a significant increase compared to 19 tU in 2023. Production in 2024 came from a total of nine facilities: six operating ISR plants in Texas (Alta Mesa, Rosita) and Wyoming (Lost Creek, Ross CPP, Nichols Ranch and Willow Creek Project), one conventional mill in Utah (White Mesa Mill), and a small amount of uranium produced from restoration activities at two ISR facilities that remain in standby mode in Nebraska (Crow Butte) and Wyoming (Smith Ranch-Highland Operation).

Centres that produced uranium in 2024 are listed in the table below.

Ownership structure of the uranium industry

Uranium facilities that produced uranium in 2023 and 2024 are owned by public and privately held firms with both foreign and domestic participation.

Employment in the uranium industry

Employment in the raw materials sector (exploration, mining, milling and processing) of the US uranium industry generally declined from 1998 to 2003, and then steadily increased from 2004 to 2008. Employment in the uranium industry in 2009 decreased significantly for the first time after five years of gains, but from 2009 through 2012, total uranium employment made marginal gains. In 2024, total employment in the US uranium production industry was 506 person-years (including reclamation employment), the highest level since 2016. In 2024, employment in the uranium production industry spanned at least three states: Texas, Utah and Wyoming.

Uranium production centre technical details

(Centres that produced uranium between 2023 and 2024)

	Centre #1	Centre #2	Centre #3	Centre #4	Centre #5	Centre #6	Centre #7	Centre #8	Centre #9
Name of production centre	Alta Mesa Project	Lost Creek Project	Rosita Central Processing Plant	Willow Creek Project	White Mesa Mill	Smith Ranch-Highland and North Butte-Brown Ranch	Ross CPP	Crow Butte	Nichols Ranch
Production centre classification	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
Date of first production	1985	2013	2023	1978	1980	1988	2015	1991	2014
Source of ore	NA	NA	NA	NA	NA	NA	NA	NA	NA
Deposit name	Alta Mesa	Loss Creek	Rosita	Willow Creek	Alternative feed material and pond returns	Smith Ranch, Highland, North Butte and Brown Ranch	Ross (Lance Projects)	Crow Butte	Nichols Ranch, Jane Dough and Hank
Deposit type	Sandstone	Sandstone	Sandstone	Sandstone	Sandstone, breccia pipe	Sandstone	Sandstone	Sandstone	Sandstone
Recoverable resources (tU)	W	W	W	W	W	W	W	W	NA
Grade (% U)	W	W	W	W	W	W	W	W	NA
Mining operation									
Type (OP/UG/ISR)	ISR	ISR	ISR	ISR	UG and Other	ISR	ISR	ISR	ISR
Size (metric tonnes of ore/day)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Average mining recovery (%)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Processing plant									
Acid/alkaline	Alkaline	Alkaline	Alkaline	Alkaline	Acid	Alkaline	Acid	Alkaline	Alkaline
Type (IX/SX)	IX	IX	IX	IX	SX	IX	IX	IX	IX
Size (metric tonnes of ore/day)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Average process recovery (%)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nominal production capacity (tU/year)	577	769	308	500	NA	2 116	144	385	769
Plans for expansion	Planned stage expansion depending on market conditions	Planned stage expansion depending on market conditions	Planned stage expansion depending on market conditions	Unknown	Unknown	Deferred	Planned stage expansion, depending on market conditions		Unknown
Other remarks	Operating	Operating	Operating	Operating	Operating	Operating	Operating	Restoration	Standby
State	Texas	Wyoming	Texas	Wyoming	Utah	Wyoming	Wyoming	Nebraska	Wyoming

Source: US Energy Information Administration, *Domestic Uranium Production Report*, 2024, Tables 4 and 5.

NA = not available, W = Withheld.

Future production centres

Several future production centres are currently in either the permitting or licensing process or under development. Significant activities affecting these production centres are described in the previous sections on conventional and ISR mine development. At the end of 2024, seven uranium mills, heap leach facilities, and ISR operations were on standby, in development, or undeveloped but not producing, indicating potential for future production growth. These facilities include:

Mills and heap leach facilities:

- Shootaring Canyon Uranium Mill, Utah – Standby
- Sheep Mountain, Wyoming – Undeveloped
- Sweetwater Uranium Project, Wyoming – Standby

In situ recovery operations:

- Hobson ISR Processing Plant, Texas – Standby
- La Palangana ISR Uranium Project, Texas – Standby
- Nichols Ranch ISR Project, Wyoming – Standby
- Kingsville Dome, Texas – Standby

The aggregate ore processing capacity of the mills and heap leach facilities is estimated to be about 4 600 t/day. The aggregate uranium production capacity of the ISR operations is estimated to be about 3 845 tU/yr. Another eight ISR operations were partially permitted and licensed or permitted and licensed [9].

As of 2024, the NRC was reviewing two uranium recovery licence applications for ISR facilities.

US NRC uranium recovery licence applications

Facility	Facility type	Applicant
Crownpoint	ISR – Renewal (NRC)	Hydro Resources, Inc.
North Trend	ISR – Expansion (NRC)	Crow Butte Resources

Secondary sources of uranium

Production and/or use of mixed oxide fuels

The United States does not currently use secondary sources of uranium or produce or use mixed oxide fuel.

Production and use of re-enriched tails

The US DOE and the Bonneville Power Administration initiated a pilot project to re-enrich a portion of the US DOE's tails inventory. This project produced approximately 1 940 metric tonnes of low-enriched uranium between 2005 and 2006 for Energy Northwest's 1 190-megawatt electric (MWe) Columbia Generating Station's use between 2007 and 2015. In mid-2012, Energy

9. U.S. Energy Information Administration (2025), "Domestic Uranium Production Report First-Quarter 2025", www.eia.gov/uranium/production/quarterly/pdf/1stqtr_dupr_2025.pdf.

Northwest and the United States Enrichment Corp. (USEC), with the DOE, developed a new plan to re-enrich a portion of the US DOE's high assay tails. The 2013 project produced approximately 3 738 metric tonnes of natural uranium, which will be used through 2029 to fuel the Energy Northwest and Tennessee Valley Authority (TVA) reactors.

In 2016, the US DOE agreed to sell depleted uranium to GE-Hitachi Global Laser Enrichment, LLC, (GLE) for enrichment at a proposed GLE facility over a 40-year period. GLE will finance, construct, own and operate the Paducah Laser Enrichment Facility (PLEF), next to the DOE site. Silex Systems Ltd, an Australian-owned company developing the laser enrichment technology, has licensed GLE to supply the depleted uranium.

In February 2019, Silex Systems Ltd and Cameco Corp. agreed to restructure ownership of GLE with a joint purchase of GE-Hitachi Nuclear Energy's (GEH) share of GLE. Silex holds the majority at 51% and Cameco increased its share to 49%.

Production and/or use of reprocessed uranium

The United States does not currently use or produce reprocessed uranium.

Environmental activities and socio-cultural issues

Remediation activities

Navajo Nation

Within the Colorado Plateau uranium province, an estimated 523 occurrences were mined between 1944 and 1986 in the Navajo Nation. Historic mining and mine remediation practices were not compatible with modern techniques and resulted in environmental contamination throughout the Nation. Funded by legal settlements with private companies who operated the mines and the US Atomic Energy Commission that promoted uranium mining in the area, assessment and environmental remediation of 230 of the mines is planned or in process. The priority is to remediate those mines or areas that pose the highest risk of radiation exposure to the Navajo people. In addition, legal action is progressing that targets companies that developed the additional uranium mines not covered in previous settlement agreements.

Vasquez

The Vasquez project is owned by URI, Inc., in Duval County, Texas. The project is situated on a leased tract of land that is being held until final restoration has been completed. The Vasquez ISR mine was constructed in 2004. Uranium recovery efforts took place between 2004 and 2008. The site is currently in the final stages of reclamation, which continued through 2024.

Defense-Related Uranium Mines (DRUM) Program

Federal land management agencies, state abandoned mine land programmes, and tribal governments created the US DOE Office of Legacy Management's Defense-Related Uranium Mines (DRUM) Program to locate and evaluate hazards of the mines that supplied uranium to the US Atomic Energy Commission for defence-related activities. Field crews are validating the locations of these mines and scanning them for health hazards to human populations and wildlife. The programme is divided into three campaigns:

- Campaign 1 (in progress) has evaluated 2 158 of an estimated 2 362 mines on public land and was scheduled for completion in March 2024.
- Campaign 2 (in progress) has evaluated 27 of an estimated 221 mines on tribal lands and is scheduled for completion by 2027.
- Campaign 3 focusses on mines on private land and began in 2024.

Information on the hazards identified by the DRUM programme is shared with partner agencies who can work to safeguard physical hazardous mine features such as open mine entries, areas of subsidence or unstable highwalls.

Legislation/policy

Federal

In 2018, the USGS included uranium on a list of 35 minerals that are critical to the national security and economy of the United States. The USGS in 2019 initiated the Earth Mapping Resources Initiative (Earth MRI) to identify focus areas that likely contain critical minerals and to fund geophysical and geochemical surveys and mapping to help identify additional resources.

Although the USGS dropped uranium from its critical minerals list in 2022, it was subsequently added to the final 2025 critical minerals list. Uranium was also added as a focus in Phase 3 (2022-2024) of Earth MRI, particularly for uranium mineral systems such as sandstone-hosted deposits (e.g. Wyoming, Texas) and metasomatite deposits (e.g. Coles Hill, Virginia). In 2023 and 2024, Earth MRI focussed on mapping critical mineral resources, including uranium, through geophysical surveys, geochemical sampling and geological mapping. Results included follow-up work on new discoveries (e.g. mapping the extent and assessing the economic viability of Pennington Mountain's uranium-related anomaly), extensive airborne radiometric, geophysical and remotely-sensed imagery survey coverage, and co-operative agreements with 14-16 states annually.

By 2024, Earth MRI identified approximately 40-70 high-priority data collection focus areas for undiscovered uranium resources, with 22 explicitly documented in Alaska (USGS Open-File Report 2019-1023E) and an estimated 20-50 in the conterminous United States, based on uranium-bearing regions like Wyoming, Texas, Arizona and Maine (e.g. Pennington Mountain). State geological surveys evaluated these sites and applied for funding to initiate studies of the mineral potential of select focus areas.

Although uranium is part of the Earth MRI focus, the initiative's broad scope limits detailed uranium-specific assessments compared to historical programmes like NURE. As such, and because the USGS dropped uranium from its critical minerals list in 2022, funding for follow-on studies of uranium focus areas identified by Earth MRI is no longer prioritised.

The relative emphasis on uranium has been overshadowed by a stronger focus on other critical minerals, such as rare earth elements, lithium, cobalt and graphite, which were deemed more immediately critical for technology and renewable energy applications. Although uranium remained a key component of Earth MRI's Phase 3 (2022-2024) work, the allocation of resources, project prioritisation, and market-driven demand suggest that uranium-related studies were receiving less attention compared to other minerals. However, given the recent (post-2024) renewed interest in nuclear power generation and energy independence, a focus on potential uranium resource areas may become a priority.

In 2022, the US Congress passed the Inflation Reduction Act (IRA), which contains several key financial provisions for the nuclear industry. The zero-emission nuclear power production credit provides up to USD 15 per megawatt-hour for electricity produced by nuclear power plants. The credit became available for operating nuclear power plants in 2024 and would last through 2032.

The US Congress also enacted the Bipartisan Infrastructure Law (BIL) in 2021 that established the USD 6 billion Civil Nuclear Credit Program to be administered by the US DOE Office of Nuclear Energy. Under the new programme, owners or operators of commercial nuclear power plants can apply for certification to bid on credits to support their continued operations. Credits will be allocated to selected certified reactors over a four-year period, beginning on the date of the selection, and credits can be awarded through 30 September 2031, if funds remain available. In November 2021, the US DOE announced a conditional award of credits valued at up to USD 1.1 billion to Diablo Canyon, effectively reversing plant owner-operator Pacific Gas and Electric's decision to retire the facility by August of 2025.

Regulatory regime

The US Nuclear Regulatory Commission (US NRC), the US Environmental Protection Agency, and individual states regulate uranium recovery, but mining regulations for federal lands are administered through the federal agency that controls the land (such as the Bureau of Land Management). Before mining begins, Environmental Impact Statements must be completed, adequate bonding must be posted, and additional regulatory requirements specified by federal and state agencies must be satisfied.

Uranium requirements

Annual US maximum anticipated uranium requirements are expected to decrease from 22 149 tU in 2025 to 10 665 tU by 2034. The total maximum anticipated uranium requirement from 2025 to 2034 is 160 985 tU. This is based on 2024 US EIA survey responses from owners and operators of US civilian nuclear power reactors (civilian owners and operators, or COOs). [10] The main reasons for this decline could be related to a number of related factors that were taken into consideration at the time that these projections were derived, such as the following:

- The Nuclear Energy Institute (NEI) lists a cluster of nuclear reactor operating licences (9-10 reactors) that are set to expire in 2034, which represent approximately 8% of the current US total nuclear capacity, reducing uranium demand. But, with the renewed interest in nuclear power, uranium requirements may increase in the future.
- US uranium demand projections are sensitive to policy changes, such as incentives for life extensions or new builds.
- Refuelling cycles may have an impact on the projections. Uranium requirements vary annually due to staggered refuelling schedules.

Supply and procurement strategy

In late 2024, the US DOE selected six companies with which it can sign contracts to procure low-enriched uranium (LEU) to incentivise new uranium production capacity in the United States. The US DOE selected six companies that will be able to compete for future work to supply LEU as a strong commercial sector investment:

- American Centrifuge Operating, LLC;
- General Matter, Inc.;
- Global Laser Enrichment, LLC;
- Louisiana Energy Services, LLC;
- Laser Isotope Separation Technologies, Inc.;
- Orano Federal Services, LLC.

Developing new domestic production capacity for LEU ensures an adequate fuel supply is available from trusted sources to maintain the current fleet of US reactors, and builds a strong base to supply future deployments of advanced nuclear reactors both at home and abroad. Through these contracts, the US DOE will acquire LEU generated by new domestic sources from new facilities or from projects that expand existing capacity. All contracts will last for up to 10 years.

Four of the six companies were awarded initial contracts in October 2024, to produce high assay low-enriched uranium (HALEU) to be used in advanced reactors. The four were American Centrifuge Operating, General Matter, Louisiana Energy Services and Orano Federal Services. Advanced reactors are expected to use HALEU in traditional and smaller designs for longer operating cycles and increased efficiencies.

10. Data source, US EIA 2024 Uranium Marketing Annual Report, Table 12.

Uranium policies, uranium stocks and uranium prices

National policies relating to uranium

Currently, most of the uranium oxide (U_3O_8) commodity and technology used in the uranium enrichment process in the United States comes from foreign sources. US-sourced material accounted for 5% of total deliveries in 2022. The government intends to augment development of domestically enriched uranium and produce domestically fabricated light-water nuclear reactor fuel. The US DOE's National Nuclear Security Administration is overseeing the direct purchase of an estimated 385 tU of domestically produced uranium oxide (U_3O_8), in up to four separate awards. The first awards were approved in December 2022. The United States operates only one commercial enrichment facility, located in New Mexico, which is owned by the British-German-Dutch consortium, Urenco. The plan to expand domestic enrichment capabilities could include firms such as Centrus Energy and ConverDyn.

Advanced small modular reactors (SMRs) are an increasing part of the DOE goal to develop clean energy technologies with nuclear power options. The US DOE envisions SMRs that vary in size from tens of megawatts up to hundreds of megawatts. The US DOE has provided substantial support for the development of light water-cooled SMRs, which are under licensing review by the US Nuclear Regulatory Commission (NRC) and are expected to initially deploy in the late 2020s to early 2030s.

The existing US fleet of traditional full-sized reactors uses uranium fuel that is enriched up to 5% with uranium-235 – the main fissile isotope that produces energy during a chain reaction. High assay low-enriched uranium (HALEU) is enriched between 5% and 20% and is required for most US advanced reactors to achieve smaller designs that get more power per unit of volume. HALEU is expected to allow developers to optimise generation systems for longer reactor core life, increased efficiencies and better fuel utilisation. A three-year demonstration project is underway to send a strong signal to potential vendors that there will be a proven domestic capability to produce HALEU to meet demand. The US DOE is partnering with Centrus to manufacture 16 advanced centrifuges for deployment at an enrichment facility in Piketon, Ohio. The company's AC-100M machine was developed through the years with support from DOE and will demonstrate enrichment of uranium hexafluoride gas to produce HALEU. The HALEU will be used for advanced reactor fuel qualification testing and reactor demonstration projects. The AC-100M technology will be available for commercial deployment at the conclusion of the demonstration.

Uranium stocks

As of 2024, total commercial inventories (producer and utility stocks) were 64 236 tU, a 6% increase from the 60 389 tU of inventories held in 2023. Owners and operators of commercial reactors held 75% of commercial inventories, or 48 465 tU. This holding was an 11% increase from the 43 850 tU owned by this group at the end of 2023. Uranium inventories owned by US suppliers (converters, enrichers, fabricators, producers, brokers and traders) totalled 15 770 tU at the end of 2024, down 5% from 2023 year-end levels.

Uranium prices

Owners and operators of US civilian nuclear power reactors (civilian owners and operators, or COOs) purchased 21 502 tU of deliveries from US and foreign suppliers during 2024 at a weighted-average price of USD 137.03/kgU. As stated above, most uranium delivered in 2024 was of foreign origin. Canada was the top source, at 38% of total deliveries, followed by Kazakhstan and Australia, with 24% and 17% of total deliveries, respectively. Uzbekistan-origin material accounted for 9% of total deliveries, and Namibia-origin and Russian-origin material accounted for 4% of total deliveries each. Domestically sourced material accounted for 8% of total deliveries in 2024, up from 5% in 2023. COOs purchased three material types of uranium for 2024 deliveries from 35 sellers. During 2024, 9% of the uranium delivered was purchased under spot contracts at a weighted-average price of USD 140.62/KgU. The remaining 91% was purchased under long-term contracts at a weighted-average price of USD 132.51/KgU. (Spot contracts are contracts that typically have a one-time uranium delivery for the entire contract, and the delivery typically occurs within one year of contract execution (signed date). Long-term contracts are contracts with one or more uranium deliveries.)

In 2024, COOs signed 21 new purchase contracts, with deliveries in 2024 of 1 154 tU at a weighted-average price of USD 224.10/kgU, specifically USD 186.98/kgU for spot contracts and USD 130.93/kgU for long-term contracts. COOs report minimum and maximum quantities of future deliveries under contract to allow the option of either decreasing or increasing quantities. Total contracted deliveries and unfilled market requirements combined represent the maximum anticipated market requirements of 160 985 tU over the next 10 years for COOs.

Average US uranium prices, 2008-2024

(USD per kilogram U-equivalent)

Year	Spot contracts	Long-term contracts
2024	186.98	130.93
2023	134.26	110.28
2022	105.82	100.90
2021	79.45	90.24
2020	74.6	90.3
2019	72.5	98.1
2018	71.52	106.56
2017	58.13	108.10
2016	76.82	119.59
2015	95.45	119.41
2014	95.26	129.29
2013	113.95	140.39
2012	132.69	144.68
2011	142.18	145.33
2010	114.36	131.11
2009	120.76	118.91
2008	174.06	108.12

Source: US Energy Information Administration, Uranium Marketing Annual Report, 2024, Table 7.

Reasonably assured conventional resources by production method

(in situ tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Underground mining (UG)	0	W	W	W	NA
Open-pit mining (OP)	0	W	W	W	NA
In situ leaching alkaline	0	W	W	W	NA
Unspecified	0	0	0	0	NA
Total	0	W	W	180 053	NA

Source: US Energy Information Administration, *Domestic Uranium Production Report, 2024*, Table 10.

Note: US reserves data do not draw a distinction between UG and OP; the combined value is assigned to UG.

kgU = kilogram of uranium; W = data withheld to avoid disclosure of individual company data; NA = not available.

Reasonably assured conventional resources by processing method

(in situ tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Conventional from UG	0	NA	NA	NA	NA
Conventional from OP	0	NA	NA	NA	NA
In situ leaching acid	0	NA	NA	NA	NA
In situ leaching alkaline	0	NA	NA	NA	NA
In-place leaching*	0	NA	NA	NA	NA
Heap leaching** from UG	0	NA	NA	NA	NA
Heap leaching** from OP	0	NA	NA	NA	NA
Unspecified	0	NA	NA	NA	NA
Total	0	W	W	180 053	NA

Source: US Energy Information Administration, *Domestic Uranium Production Report*, 2024, Table 10.

* Also known as stope leaching or block leaching.

** A subset of open-pit and underground mining, because the category is used in conjunction with both.

NA = not available; kgU = kilogram of uranium; UG = underground mining; OP = open-pit mining.

Reasonably assured conventional resources by deposit type

(in situ tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Unconformity-related	0	0	0	0	NA
Sandstone	0	W	W	W	NA
Intrusive	0	0	W	W	NA
Volcanic and caldera-related	0	0	W	W	NA
Other*	0	0	W	W	NA
Total	0	W	W	180 053	NA

Source: US Energy Information Administration, *Domestic Uranium Production Report*, 2024, Table 10.

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

NA = not available; kgU = kilogram of uranium.

Historical uranium production by production method

(tonnes U in concentrate)

Production method	Total through end of 2022	2023	2024	Total through end of 2024	2025 (preliminary)
Open-pit mining*	W	0	0	W	0
Underground mining*	W	W	W	W	NA
In situ leaching	W	W	W	W	NA
Co-product/by-product	W	W	W	W	NA
Total**	377 073	19	260	377 352	NA

Source: US Energy Information Administration, *Domestic Uranium Production Report*, 2024, Table 2.

Note: Data are not available prior to 1968. Due to production data being withheld to avoid disclosure of individual company data, the total through the end of 2022 does not include production from 2020.

* Pre-2018 totals may include uranium recovered by heap and in-place leaching.

** also includes, in various years, mine water, mill site clean-up and mill tailings, and well field restoration as sources of uranium.

W = Data withheld to avoid disclosure of individual company data; NA = not available.

Historical uranium production by processing method[a]

(tonnes U in concentrate)

Processing method	Total through end of 2022	2023	2024	Total through end of 2024	2025 (preliminary)
Conventional	W	W	W	W	NA
In-place leaching*	W	W	W	W	NA
In situ leaching	W	W	W	W	NA
Other methods**	W	W	W	W	NA
Total	377 073	19	260	377 352	NA

Source: US Energy Information Administration, *Domestic Uranium Production Report*, 2024, Table 2.

Note: Data are available from 1947 to present. Due to production data being withheld to avoid disclosure of individual company data, the total through the end of 2022 does not include production from 2020.

[a] May not equal production by method because it produces concentrates, and may include ore mined and shipped to a mill during the same year, ore that was mined during a previous year and later shipped from mine-site stockpiles, or ore obtained from drawdowns of stockpiles maintained at a mill site. Uranium production by processing method may also include uranium from mill clean-up, mine water, tailings water and other materials in various years.

* Also known as stope leaching or block leaching.

** Includes mine water treatment and environmental restoration.

W = data withheld to avoid disclosure of individual company data; NA = not available.

Historical uranium production by deposit type

(tonnes U in concentrate)

Deposit type	Total through end of 2022	2023	2024	Total through end of 2024	2025 (Preliminary)
Unconformity-related	NA	NA	NA	NA	NA
Sandstone	NA	NA	NA	NA	NA
Hematite breccia complex	NA	NA	NA	NA	NA
Quartz-pebble conglomerate	NA	NA	NA	NA	NA
Vein	NA	NA	NA	NA	NA
Intrusive	NA	NA	NA	NA	NA
Volcanic and caldera-related	NA	NA	NA	NA	NA
Metasomatite	NA	NA	NA	NA	NA
Other*	NA	NA	NA	NA	NA
Total	377 073	19	260	377 352	NA

Note: Due to production data being withheld to avoid disclosure of individual company data, the total through the end of 2022 does not include production from 2020.

* Includes surficial, collapse breccia pipe, phosphorite and other types of deposits, as well as rocks with elevated uranium content. Pegmatite, granites and black shale are not included.

NA = not available.

Ownership of uranium production in 2024

Domestic				Foreign				Totals	
Government		Private		Government		Private			
(tU)	(%)	(tU)	(%)	(tU)	(%)	(tU)	(%)	(tU)	(%)
0	0	W	W	0	0	W	W	W	W

Source: US Energy Information Administration, *Domestic Uranium Production Report*, 2024, Table 2.

W = data withheld to avoid disclosure of individual company data; tU = metric tonnes of uranium.

Uranium industry employment at existing production centres

(person-years)

	2022	2023	2024	2025 (expected)
Total employment related to existing production centres.[1]	91	183	506	NA
Employment directly related to uranium production.[2]	W	73	395	NA

1. Source: US Energy Information Administration, *Domestic Uranium Production Report*, 2024, Table 6, all sectors except Reclamation.

2. Source: US Energy Information Administration, *Domestic Uranium Production Report*, 2024, Table 6, all sectors except Exploration and Reclamation.

NA = not available; W = data withheld to avoid disclosure of individual company data.

Short-term production capability

(tonnes U/year)

2025				2030				2035			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

2040				2045				2050			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

NA = not available.

Re-enriched tails production and use[1]

(tonnes of natural U-equivalent)

Re-enriched tails	Total through end of 2020	2021	2022	2023	Total through end of 2024	2025 (expected)
Production	NA	NA	5 677.8	0	0	0
Use	NA	NA	1 939.8	0	0	0

1. 2017 and 2022 Data provided by Energy Northwest, owner-operator of the Columbia Generating Station.

Net nuclear electricity generation

(TWh net)

	2023	2024
Nuclear electricity generated	774.9	782.0

Installed nuclear generating capacity to 2050

(GWe net)

2023	2024	2025		2030		2035		2040		2045		2050	
		Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Annual reactor-related uranium requirements to 2050 (excluding mixed oxide fuel)

(metric tonnes U)

2023	2024	2025		2030		2035		2040		2045		2050	
		Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Total uranium stocks

(tonnes natural U-equivalent)

Holder	Natural uranium stocks	Enriched uranium stocks	Depleted uranium stocks	LWR reprocessed uranium stocks[2]	Total
Government	NA	NA	NA	NA	NA
Producer[1]	NA	NA	NA	NA	2 347
Utility[1]	NA	NA	NA	NA	48 610
Total	NA	NA	NA	NA	64 393

1. US Energy Information Administration, *Uranium Marketing Annual Report*, 2024, Tables 22 and 23.Total commercial inventory, excluding government inventory.

2. Light water reactor (LWR)

Uzbekistan *

Uranium exploration and mine development

Historical review

Uranium exploration in Uzbekistan predates the 1945 start-up of uranium mining at the small vein type deposits (Shakaptar, Uiguz Sai and others) in the Fergana Valley and volcanic type deposits (Alatanga, Chauli and others) in the Karamazar region of Eastern Uzbekistan. Exploration conducted during the early 1950s, including airborne geophysical surveys, ground radiometry and underground work over the remote Kyzylkum desert in central Uzbekistan, led to the discovery of the Uchkuduk and Ketmenchi uranium deposits in 1952, the Bukinai deposit in 1959, the Sabyrsai deposit in 1960, and the South Bukinai, Sugraly and Lyavlyakan deposits in 1961. All deposits were discovered by the Krasnokholmskaya exploration company, which was renamed Kyzyltepageologia in 1990. Drilling confirmed the initial discovery and development of the first mine at the Uchkuduk deposit in 1959, followed by development of the Sabyrsai deposit. Both deposits were initially mined using open pit and underground mining methods until 1975. Other deposits were considered at that time as unfavourable for conventional mining.

In the early 1960s, development of the in situ leaching (ISL) mining technique for recovery of uranium from sandstone deposits led to the re-evaluation of previously ignored deposits including Lavlyakan and Ketmenchi and to an increase in exploration efforts in the sedimentary basins of the Kyzylkum desert. Three uranium districts with 24 sandstone type deposits amenable to ISL mining have been established since the Uchkuduk discovery in 1952.

Several black shale-type uranium deposits, including Dzhantuar, Rudnoye, Koscheka, Voskhod and Dzitym, were identified during the 1960s in the Auminzatau Mountains district. Mineralisation is in black shale related to strata-structure-type and occurs in stratiform and stockwork lodes. Resources of individual deposits are relatively small and grades range from 0.02 to 0.13% U, averaging 0.05% U.

Since 1994, the Navoiy Mining and Metallurgy Combinat (NMMC) has funded all uranium exploration activities in Uzbekistan. In 1995-1996, Kyzyltepageologia developed the known resources of the Severny (Northern) Kanimekh, Alendy, Kendykijube and Tokhumbet deposits. In addition, assessments of undiscovered resources were completed in the Kyzylkum, Bukhara-Khiva and Fergana Provinces. Between 1997 and 2000, Kyzyltepageologia evaluated the known resources of the Kendyktyube, Severny, Kanimekh, Tokhumbet and Ulus deposits, some of which were handed over to NMMC for further development. In the early 2000s Kyzyltepageologia completed exploration and evaluation works in the Kendyktyube and Tokhumbet deposits, the southwestern flanks of the Sugraly deposit, and the western and eastern flanks of the Ketmenchi deposit. Kyzyltepageologiya further explored the northern and southern areas of Central Kyzylkum with government funding.

In August 2009, GoscomGeology (State Geology and Mineral Resources Committee of Uzbekistan) and the CGN subsidiary China Guangdong Nuclear Uranium Resources Co Ltd (CGN-URC), set up a 50%-50% uranium exploration joint venture “Uz-China Uran” to focus on the black shale deposits in the Boztau area of the Central Kyzylkum Desert in the Navoi region.

* Report prepared by the NEA/IAEA, based on previous Red Books, a report submitted by the Navoiyuran and public data.

Approximately 5 500 tU of inferred resources have been reported. From 2011-2013, CGN-URC was to develop technology to produce uranium and vanadium from these black shale deposits. No activities have been reported since that time.

In July 2013, the Japan Oil, Gas and Metals National Corporation (JOGMEC) received a five-year licence for uranium exploration at two prospective areas in the country's Navoi region. JOGMEC implemented geological exploration work in the Tamdiykuduk-Tulyantash prospective ore fields and identified 2 367 tU of inferred resources. No activities have been reported since that time.

Development of Uzbekistan's black shale deposits was indefinitely delayed due to complicated processing technology and unfavourable uranium prices.

Recent and ongoing uranium exploration and mine development activities

In July 2022, Uzbekistan's President Shavkat Mirziyoyev signed a resolution to double the country's uranium production from 3 500 tU in 2021 to 7 100 tU in 2030 and increase uranium resources to 100 000 tU by 2030. Uzbekistan's ability to reach this target will depend on rapid expansion of its resource base to continue replacing deposits that are being exhausted.

The Navoiyuran subsidiary, Scientific and Production Center "Geology of Uranium and Rare Metals", is responsible for all uranium exploration activities in the country. It has three geological expeditions (Bukantau, Nuratinsk and Zirabulak) and one drilling company, which conduct exploration within the Bukantau, Nuratin, Ziyavutdin-Zirabulak and Syrdaria uranium ore regions, respectively. Exploration is focussed on ISL amenable resources expansion of known operating deposits and on resources identification at new prospective areas.

Navoiyuran reports on significant recent exploration drilling activities focussed on execution of the above-mentioned Presidental resolution. Navoiyuran drilled 2 623 holes (1 047 000 m) in 2023, 3 978 holes (1 566 000 m) in 2024 and planned to increase drilling to 4 622 holes (1 849 000 m) in 2025. Intensive exploration resulted in an additional 6 119 tU resources in 2023 and 10 805 tU in 2024, about 95% of which are in the RAR category. Resources identified near to existing mines may be involved in rapid development.

Navoiyuran plans to proceed with active exploration in areas both near existing mines and at new prospective areas. The target is to achieve an increase in annual resources to 10 500 tU in 2030. The aggregated amount of targeted additional resources through this period is about 63 000 tU.

In December 2019, France and Uzbekistan established the French-Uzbek uranium joint venture, the Nurlikum Mining LLC, which is 51% owned by Orano and 49% by Navoiyuran. Nurlikum Mining will conduct uranium exploration and mining operations throughout Uzbekistan, focussing on sandstone type uranium mineralisation in the North and Southeast Djengeldi region of Kyzylkum province. Orano contributes to the joint venture capital and technology, while the Uzbekistan side contributes historical exploration results.

Nurlikum's first field exploration commenced in 2020. In 2022, Nurlikum Mining had drilled 114 hydrogeological and exploratory holes, 43 holes in 2023 and 66 holes in 2024. In June 2023, the company commissioned and launched the pilot plant at the Dzhengeldi deposit in order to confirm the feasibility of ISL mining. In November 2023, Orano reported that it extracted its first 350 kgU from the Southeastern part of Dzhengeldi deposit. In 2024 Nurlikum Mining approved 6 484 tU of the Dzhengeldi deposit resources in the Uzbekistan State Reserves Committee. In 2025, Nurlikum continued exploration in the northern part of the region to increase the resource base.

In 2024, the State Institute of Mineral Resources of Uzbekistan and China Nuclear Uranium Co. Ltd (CNUC) conducted experimental laboratory research on the development of optimal processing technology for black shale type deposits. Completion of experimental studies was expected at the end of 2025.

Uranium exploration drilling effort – domestic (USD millions)

	2022	2023	2024	2025 (expected)
Government exploration expenditures*	17.69	34.11	53.41	75.49
Private exploration expenditures**	2.68	1.78	3.05	NA
Total expenditures	20.37	35.89	56.46	75.49
Government exploration drilling (m)	608 282	1 046 720	1 565 615	1 849 050
Private exploration drilling (m)	35 390	13 748	14 216	NA
Government exploration holes drilled	1 647	2 623	3 978	4 622
Private exploration holes drilled	114	43	66	NA
Total drilling (metres)	643 672	1 060 468	1 579 831	1 849 050
Total number of holes drilled	1 761	2 666	4 044	4 622

* Navoiyuran expenditures and drilling efforts.

** ORANO expenditures and drilling efforts for the Nurlikum Mining LLC.

Navoiyuran 2023-2024 uranium exploration results (estimated additional resources, tU)

	2021	2022
At existing deposits RAR	4 460	7 036
At new areas RAR	1 659	3 769
TOTAL	6 119	10 805

Uranium resources

Uzbekistan's uranium resources occur primarily in sandstone type and black shale-type deposits. All sandstone roll-front type uranium resources are found in the Central Kyzylkum area, comprising a 125 km-wide belt, extending over about 400 km from Uchkuduk in the northwest, to Nurabad in the southeast. Only sandstone type deposits have been exploited.

As of 1 January 2025, Uzbekistan's total identified in situ uranium resources reported by Navoiyuran in the <USD 260/kgU cost category, amounted to 116 870 tU (81 809 tU recoverable resources assuming a 70% recovery factor), 94 382 tU (81%) of these belong to RAR category and 22 488 tU to inferred. About 86% of the total are sandstone type resources amenable to ISL mining, while the remaining 14% refer to black shale type deposits requiring open-pit or underground mining. In the RAR category, 77 651 tU belong to sandstone type deposits for ISL mining, 89% of which (69 031 tU) are in the <USD 130/kgU cost category. The table below gives 50 648 tU of resources, which were under Navoiyuran development in 2024, with a breakdown by deposits, categories and mining units. The remaining 27 003 tU refer to deposits that are planned for development in the near future.

Compared with the data as of 1 January 2023, this is a significant increase of 25 967 tU in total identified in situ resources (an increase of 16 930 tU in the RAR category and of 9 037 tU in the inferred category). The main reason of this increase is successful exploration results and reassessment of some deposits. These numbers include annual resources depletion by mining which amounted to 13 143 tU during 2023-2024. Mining losses are assumed in the resources depletion. Some inconsistency in resources numbers with previous Red Books may be explained by a long interval when Uzbekistan did not officially report to the IAEA on their uranium resources and production.

Prognosticated resources (P1 in national classification) are estimated at about 20 000 tU and speculative (P2) resources in Uzbekistan are estimated at about 44 600 tU.

In situ resources of sandstone type deposits mined by the Navoiyuran

(tonnes U as of 1 January 2025)

Deposit	Resources category *		
	C_1 + B	C_2	B+C_1+C_2
Uchkuduk Mining Unit			
Meilisoi	1 695	28	1 723
Uchkuduk	3 165	0	3 165
Kyzylkok	298	214	513
Total Uchkuduk Mining Unit	**5 158**	**242**	**5 401**
Zafarobad Mining Unit			
Shimolij Bukinoi	4 531	398	4 929
Istiklol	2 666	109	2 775
Kukhnur	5 708	83	5 791
Aulbek	4 246	0	4 246
Zhanubij Bukinoi	788	0	788
Shimoiliy Kanimekh	3 796	1 172	4 968
Egdy	317	43	360
Ketmonchi	145	16	161
Maibulok	2 601	0	2 601
Aksai -1	113	0	113
Terekuduk	38	0	38
Dzhengeldy South East	1 880	52	1 931
Nurkon	596	78	674
Sugrali	23	1 865	1 888
Zhanubij Sugrali	4 057	0	4 057
Aktau	4 891	0	4 891
Total Zafarobad Mining Unit	**36 396**	**3 816**	**40 211**
Nurobod Mining Unit			
Sobirsay	608	0	608
East Agron	2 396	0	2 396
Ingichki	2 032	0	2 032
Total Nurobod Mining Unit	**5 036**	**0**	**5 036**
TOTAL Navoiyuran	**46 590**	**4 058**	**50 648**

* Resource categories according to the national Uzbekistan classification system. B C1 and C2 resources correlate with RAR (see Appendix 3, Figure A3.1) after the country reports. Minor differences in totals are possible due to rounding.

Uranium production

Historical review

Uranium production in Uzbekistan began in 1946 at several small volcanic vein deposits in the Fergana Valley and Kazamazar uranium district. The two largest deposits, Alatanga and Chauli, contained 4 500 tU each. Underground mining was undertaken from the late 1940s to the early 1960s. Cumulative production is estimated in the order of 5 to 10 thousand tU. The ore was processed in the Leninabad uranium production centre in Tajikistan.

The mining operator for the sandstone type Uchkuduk and Sabyrsai deposits was Mining Complex No. 2, which was established in September 1958. In 1967, it was renamed the Navoi Mining and Metallurgy Combinat (NMMC). NMMC is part of the Uzbekistan state holding company Kyzylkumredmetzoloto, which undertakes all uranium mining in the country.

In the late 1950s, NMMC commenced operation focussing on uranium and gold production in the desert region of Central Kyzylkum province. Early uranium mining was by underground (to 1990) and open pit (to 1994). The first ISL tests occurred at the Uchkuduk deposit in 1963, followed by ISL tests at the Sabyrsai, South Bukinai and Ketmenchi deposits in 1968. Commercial ISL mining in Uzbekistan began in 1975. In 1980, ISL accounted for 29% of total uranium production and by 1985 ISL comprised 56% of total production. Since 1995, NMMC has been producing uranium using only ISL technology. Annual production peaked in the 1980s, when 3 700 to 3 800 tU were recovered.

In 2008, NMMC started mining the major new Northern Kanimekh deposit, northwest of Navoi. Northern Kanimekh ore occurs 260-600 m below the surface, with 77% of the uranium resources present at a depth of 400-500 m depth. NMMC has also started building a pilot plant for ISL at the Alendy and Zharkuduk deposits, and began operating the Aulbek ISL mine in Central Kyzylkum, as well as developing the Meilysai deposit. The Aulbek mine commenced production in 2013 and Meilysai in 2015.

NMMC has developed and implemented three new technologies of acid ISL for ores with high carbonate content. The first is a bicarbonate-acid method that is used for ores with a carbonate content above 2%. It is based on bicarbonate ion generation during the soft acidification stage, which oxidises and dissolves uranium minerals. This method reduces the kinetics of the leaching process, but chemical plugging may occur at the final leaching stage. The repair and restoration procedures for wells is reduced by 2.5-3 times using this method.

The second method uses a mini-reagent technology that is applied for ores with a carbonate content >0.5% located in an artesian aquifer. At the first stage, a preliminary ore oxidation occurs by pumping compressed air into the aquifer. At the second stage, slightly acidic solutions, formed during aquifer saturation with atmospheric oxygen, dissolve the contained uranium.

The third is the oxygen method. This method was introduced in 2016 for uranium extraction from high carbonate ores (above 2% CO_2). ISL method using technical oxygen has a number of advantages. It allows the effective development of high carbonate ores with low costs, to increase intensity of uranium leaching, to eliminate plugging of pipelines and wells, and to reduce sulphuric acid specific consumption. Currently, more than 50% of uranium production in Uzbekistan is carried out using technical oxygen as an oxidising agent.

The implementation of these three technologies has significantly reduced acid consumption and, in turn, operating costs by 20-30%. Another important advantage has been the low impact of ISL mining on the total mineralisation and chemical composition of productive aquifers during and after the leaching process.

Status of production capability, and recent and ongoing activities

In January 2022 NMMC was split into three independent entities – Navoi Mining and Metallurgical Plant (production of precious metals such as gold), Navoiyuran (mining and processing of natural uranium and rare earth metals), and Navoi Mining and Metallurgical Plant Foundation.

In July 2022, Uzbekistan's President signed a resolution to increase the country's uranium production from 3 500 tU in 2021 to 7 100 tU by 2030. Navoiyuran currently is among the top six uranium mining companies in the world and has rapidly increased uranium production since 2022. Annual production amounted to 5 200 tU in 2024. This is 29% above 2023 output and 46% more than in 2022.

Twenty-two uranium deposits were in operation by ISL method in 2024 and three more deposits were planned for development during 2025-2026. Mineralisation occurs at depths between 120 to 700 metres. Three mining divisions produce uranium:

- Uchkuduk Mining Unit (former Northern Unit) operates the Uchkuduk, Kyzylkok and Meilisay deposits.
- Nurabad Mining Unit (former Southern Unit) operates the Sabyrsai, Ingichki and Agron deposits.

- Zafarabad Mining Unit (former Unit No. 5) is the largest division of the three and operates 17 deposits (for details see table above).

All mining units produce "yellowcake" uranium concentrates on-site and send it by rail to the hydrometallurgical plant, located in Navoi, for further processing and purification. Navoiyuran exports all produced uranium to Canada, India, Japan, Korea and the United States.

From 2025 to 2030, Navoiyuran plans to modernise operating mines, conduct technical and technological reequip, and expand existing uranium production facilities. To meet these plans, investment projects will be launched to construct new ISL mining and processing complexes at new sandstone-type uranium deposits.

In the future, Navoiyuran will also consider development of black shale type uranium deposits by open-pit and underground methods. These deposits were explored in the 1970s and contain REE and vanadium as by-products to uranium. However, the known processing flowsheet for this type of ore is not effective and Navoiyuran conducts research studies for its improvement.

Environmental activities

Navoiyuran promotes monitoring of working conditions and environmental protection. Local and central divisions of the national health monitoring authority, the National Committee for Nature Protection and the National Mining Monitoring Authority, conduct radiation monitoring of all Navoiyuran's activities. Monitoring data from peripheral observation wells shows that for productive aquifers at all ISL sites, the natural geochemical background of the formation water is unchanged at 200-300 m from the ore body boundary, regardless of the leaching technology used (sulphuric acid, bicarbonate-acid, or mini-reagent). Radiation monitoring at work locations, supervised areas and the environment, shows that the average annual effective radiation dose does not exceed permitted levels. For example, for a critical group of the population, radiation does not exceed one millisievert per year, which corresponds to the basic limit adopted by the International Commission on Radiological Protection (ICRP).

Ownership structure of the uranium industry

All uranium produced by Navoiyuran is owned by the government of Uzbekistan. Currently, Navoiyuran is the sole state enterprise in Uzbekistan that mines and exports uranium.

Employment in the uranium industry

Four towns support uranium production activities: mining divisions are based in Uchkuduk, Zafarabad and Nurabad, while the main processing plant for yellowcake purification and administrative staff is based in Navoi. Uranium industry employment in 2020 was about 7 500, then increased to 8 372 in 2022 after NMMC completed a reorganisation and, in 2024, it reached 9 459 employees.

Reasonably assured conventional resources by production method

(in situ tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
In situ leaching acid	0	38 077	69 031	77 651	70
Open pit	0	0	0	7 586	70
Underground	0	0	0	9 145	70
Total	0	38 077	69 031	94 382	

Reasonably assured conventional resources by processing method

(in situ tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
In situ leaching acid	0	38 077	69 031	77 651	70
Unspecified	0	0	0	16 731	70
Total	0	38 077	69 031	94 382	

Reasonably assured conventional resources by deposit type

(in situ tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Sandstone	0	38 077	69 031	77 651	70
Black shales	0	0	0	16 731	70
Total	0	38 077	69 031	94 382	

Inferred conventional resources by production method

(in situ tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
In situ leaching acid	0	0	22 488	22 488	70
Total	0	0	22 488	22 488	

Inferred conventional resources by processing method

(in situ tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
In situ leaching acid	0	0	22 488	22 488	70
Total	0	0	22 488	22 488	

Inferred conventional resources by deposit type

(in situ tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Sandstone	0	0	22 488	22 488	70
Total	0	0	22 488	22 488	

Prognosticated and speculative conventional resources

(tonnes U)

Cost ranges		
<USD 130/kgU	<USD 260/kgU	Unassigned
NA	NA	44 600

Historical uranium production by production method

(tonnes U in concentrates)

Production method	Total through end of 2022	2023	2024	Total through end of 2024	2025 (expected)
Open pit mining*	36 249	0	0	36 249	0
Underground mining*	19 719	0	0	19 719	0
In situ leaching	98 597	4 050	5 200	107 847	6 000
Total	154 565	4 050	5 200	163 815	6 000

* Pre-2018 totals may include uranium recovered by heap and in-place leaching.

Ownership of uranium production in 2024

Domestic				Foreign				Totals	
Government		Private		Government		Private			
(tU)	(%)	(tU)	(%)	(tU)	(%)	(tU)	(%)	(tU)	(%)
5 200	100	0	0	0	0	0	0	5 200	100

Uranium industry employment at existing production centres

(Person-years)

	2022	2023	2024	2025 (expected)
Employment directly related to uranium production.	8 372	8 958	9 459	9 700

Short-term production capability[1]

(tonnes U/year)

2025				2030			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
6 000	6 000	6 000	6 000	3 000	3 000	4 000	7 000

2035				2040			
A-I	B-I	A-II	B-II	A-I	B-I	A-II	B-II
NA	NA	NA	NA	NA	NA	NA	NA

1. Secretariat estimate.

Viet Nam

Uranium exploration and mine development

Historical review

The first exploration programmes were started before 1955 by French geologists of the geological department of Indochina. Beginning in 1978, a systematic regional exploration programme was conducted over the entire country using radiometric methods combined with geological observations. About 25% of the country was also covered by an airborne radiometric/magnetic survey at a scale of 1:25 000 and 1:50 000. This led to the discovery of many promising areas in the provinces of Cao Bang, Lao Cai, Yen Bai and Quang Nam. Uranium mineralisation in Viet Nam is associated with rare earth deposits (Lao Cai province), phosphate deposits (Cao Bang province), and sandstone and coal deposits (Quang Nam province).

Between 1997 and 2002, the Geological Division for Radioactive and Rare Elements (GDRRE), in the Ministry of Natural Resources and Environment, carried out detailed uranium exploration and evaluation (including drilling, trenching and bulk sampling), in the Palua and Parong areas of the Quang Nam province.

From the 2000s to the present, uranium exploration activities have been ongoing and are now focussed on assessing thorium and uranium reserves in rare earth deposits in Viet Nam, with particular emphasis on the Th and U reserves in monazite ore.

Recent and ongoing uranium exploration, and mine development activities

Since 2010, the GDRRE has been carrying out uranium exploration in the Parong area in the Quang Nam province of central Viet Nam. The project consists of an investigation and evaluation of Triassic sandstone-type deposits.

Exploration activities on the Parong deposit, covering an area of 1.9 km^2, consist of geophysical and geological surveys, trenching, drilling and mining tests. Over the main part of the deposit, 712 holes (60 954 m) have been drilled on a 25 x 25 m^2 grid to depths of between 30 and 150 m. Extensions of the deposit have also been drilled on a more widely spaced grid (between 50 x 50 m^2 and 50 x 25 m^2).

A mining test was conducted via a 130 m adit from which three holes have been drilled to 300 m for hydrogeological tests. Results show a limited amount of water in the formations.

Mineralisation at Parong is associated with medium- to coarse-grained sandstone with organic matter. Three main levels of mineralisation in reduced formations have been defined, separated by oxidised sandstones. Mineralisation has been intersected over a lateral extension of 200-300 m, varying in thickness from a few centimetres to a few metres.

Between 2010 and 2014, research on the heap leaching method, including laboratory and pilot-scale tests, as well as investigations on the management of mining wastes and tailings, was carried out by the Institute for Technology of Radioactive and Rare Elements (ITRRE). The results show that the heap leach method is suitable for the low-grade Palua-Parong ore, with uranium recovery greater than 75% achieved.

Between 2018 and 2024, research on the recovery of thorium and uranium from rare earth concentrates has also been carried out by the ITRRE. A continuous counter-current extraction process for simultaneous recovery of thorium and uranium was developed for testing of the Yen Phu and Dong Pao rare earth concentrates leach solutions. The results show that the extraction method is suitable for the recovery of thorium and uranium from rare earth concentrates, with thorium and uranium purities of greater than 99%.

Uranium exploration and research on uranium extraction from uranium ores are continuing.

Uranium resources

Identified conventional resources

In 2011 to 2012, the uranium potential of part "A" of the Parong area (drilled at a 25 x 25 m grid) was assessed. Uranium resources, estimated using a 0.0085% U cut-off grade, amounted to 1 200 tU at an average grade of 0.034% U. These resources are classified as reasonably assured resources in the highest cost category (<USD 260/kgU or <USD 100/lb U_3O_8).

From 2013 to 2015, the uranium potential of part "G" of the Parong-Palua area was assessed. Inferred uranium resources are estimated at 1 081 tU.

From 2016 to 2019, estimates of the uranium potential of the remaining parts "B", "C", "D" and "F" of the Palua-Parong area were also completed.

Results of a previous evaluation of uranium resources as of 31 December 2008 in the main area of the Quang Nam province showed that:

- The Palua deposit consists of five deposits with total resources amounting to 4 596 tU, including 984 tU inferred resources and 3 612 tU prognosticated.
- The Parong deposit consists of seven deposits with total resources amounting to 3 867 tU, including 1 200 tU inferred resources and 2 667 tU prognosticated.
- The Khehoa-Khecao deposit consists of four deposits with total resources amounting to 5 803 tU, including 1 125 tU inferred resources and 4 678 tU prognosticated.
- The Dong Nam Ben Giang deposit consists of eight deposits with total resources amounting to 1 556 tU, including 337 tU inferred resources and 1 219 tU prognosticated.
- Resources of the An Diem deposit amount to 1 853 tU, including 354 tU inferred and 1 499 tU prognosticated.

The deposits of the Quang Nam province described above amount to a total of 4 000 tU inferred resources, 13 675 tU prognosticated resources, and 17 675 tU combined inferred and prognosticated resources.

Since 2020, the assessment of RAR and IR reserves of Th and U have focussed on the associated Th and U in rare earth deposits, and monazite minerals.

Undiscovered conventional resources (prognosticated and speculative resources)

The results of geological exploration conducted by the GDRRE show that there are more than ten uranium occurrences and deposits located in the northern provinces (Lai Chau, Lao Cai, Yen Bai, Son La, Ha Giang, Cao Bang, Phu Tho and Thai Nguyen), as well as in the highlands and central provinces.

Uranium deposits in the Lai Chau province are associated with rare earth element deposits. In the Cao Bang province, uranium mineralisation is associated with phosphate deposits, and in the Quang Nam province, uranium is associated with sandstones and coal deposits.

The undiscovered conventional uranium resources as of 31 December 2008 amounted to a total of 81 200 tU prognosticated and 321 600 tU speculative resources. Some of the prognosticated resources include: 3 612 tU at Palua; 2 667 tU at Parong; 4 678 tU at Khehoa-Khecao; 1 219 tU at Dong Nam Ben Giang; and 1 499 tU at An Diem.

Speculative U and Th resources in rare earth deposits located in Lai Chau province include the North Dong Pao deposit (1 400 tU and 4 500 tTh) and the Phong Tho deposit (255 tU and 2 700 tTh). Monazite minerals in beach sand have known speculative resources that include about 100 tonnes of U_3O_8 (85 tonnes of U metal) and 300 tonnes of ThO_2 (270 tonnes of Th metal).

Unconventional resources and other materials

Uranium exploration activities associated with rare earth element ores (Dong Pao bastnaesites, Namxe bastnaesite, YenPhu xenotime and beach sand monazite, etc.) continue.

Uranium production

No uranium has been produced in Viet Nam.

Future production centres

The objective of the current uranium exploration programme is to increase the resource base to a total of 5 500 tU_3O_8 (4 665 tU) inferred and 8 000 tU_3O_8 (6 780 tU) prognosticated, as well as to determine the feasibility of mining these deposits. The ITRRE has researched ore processing and has started to survey the environmental conditions of future mining operations. A future production centre is being considered.

Environmental activities and socio-cultural issues

Environmental activities, such as monitoring the environmental impacts of exploration, are being carried out.

Uranium requirements

Viet Nam had a plan to develop several nuclear power plants with up to 14 nuclear reactors for a total net nuclear electricity generating capacity of about 15 000 MWe to 16 000 MWe by the year 2030. Seven potential build sites had been selected, with each site having the potential to accommodate four to six units. In March 2010, the Prime Minister of Viet Nam approved the plan for the implementation of the Ninh Thuan Nuclear Power Project, which included the PhuocDinh and Vinh Hai nuclear power plants. Under this plan, the first nuclear power plant would have consisted of two VVER-type pressurised water reactors (PWRs) with a total net nuclear electricity generating capacity of about 2 000 MWe, built in co-operation with Rosatom. This plant would have been in the PhuocDinh commune, Thuan Nam district, Ninh Thuan province. The second nuclear power plant, to have been built in co-operation with Japan Atomic Power Co., would have had the same generating capacity (2 x 1 000 MWe) sited in the Vinh Hai commune, Ninh Hai district, Ninh Thuan province. The expected annual reactor-related uranium requirements would have been satisfied by imports and domestic production. Because of a lack of funding at the end of 2016, the Vietnamese government decided to abandon plans to build the Ninh Thuan Nuclear Power Project.

However, in November 2024, Viet Nam's government proposed to the National Assembly that the Ninh Thuan Nuclear Power Project, which was put on hold in 2016, be revived, and is expected to be completed in five years. The Ninh Thuan 1 plant is located in Phuoc Dinh commune, Thuan Nam District, while the Ninh Thuan 2 plant is in Vinh Hai commune, Ninh

Hai District. Vietnam Electricity (EVN) and the National Energy Industry (PVN) are the respective investors for these two plants. It is expected that the two nuclear power plants in Ninh Thuan will have a total capacity of four units (4 x 1 200 MW), reaching 4 800 MW will be commissioned after 2030. This is 800 MW higher than the government's plan at the end of 2009.

Reasonably assured conventional resources by production method

(in situ tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Underground mining (UG)	0	0	0	1 200
Total	0	0	0	1 200

Reasonably assured conventional resources by processing method

(in situ tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Heap leaching*	0	0	0	1 200
Total	0	0	0	1 200

* From open-pit and underground mining.

Reasonably assured conventional resources by deposit type

(in situ tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Sandstone	0	0	0	1 200
Total	0	0	0	1 200

Inferred conventional resources by production method

(in situ tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Unspecified	0	0	0	4 000
Total	0	0	0	4 000

Inferred conventional resources by processing method

(in situ tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Unspecified	0	0	0	4 000
Total	0	0	0	4 000

Inferred conventional resources by deposit type

(in situ tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Sandstone	0	0	0	4 000
Total	0	0	0	4 000

Prognosticated conventional resources

(in situ tonnes U)

Cost ranges		
<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
NA	NA	81 200

Speculative conventional resources

(in situ tonnes U)

Cost ranges		
<USD 130/kgU	<USD 260/kgU	Unassigned
NA	NA	321 600

Zambia

Uranium exploration and mine development

Historical review

Uranium was first identified in Zambia (then Northern Rhodesia) at the site of the Mindola copper mine in Kitwe, leading to the mining of this small deposit between 1957 and 1959. A total of 102 tU_3O_8 (86 tU) was produced. Although no uranium has been produced from that mine or any other in Zambia since then, exploration activity has been carried out periodically by the government and by private companies.

Sporadic uranium exploration activities took place during the 1980s-1990s, but attention was primarily focussed on copper. It was only in the mid-2000s that interest in uranium was stimulated by the dramatic rise in the spot market price for uranium.

The exploration environment in Zambia underwent a fundamental change in 1969 when all mineral rights, which were then held privately, reverted to the state. That same year, the state also effectively nationalised mining by becoming a majority shareholder in all mining companies active in the country (principally copper). Financial realities, including a decline in copper prices, along with recommendations from external bodies, such as the World Bank and International Monetary Fund, encouraged the state to enter into a process of privatisation. This became a reality in 1997, with the primary objective of encouraging foreign investment in the country.

During the 1980s, active exploration for uranium by government and private companies within the Katanga metasediments revealed small, isolated medium-grade deposits in the Dome areas of North-Western Province. The Karoo sediments were also prospected by private companies and revealed some small low-grade deposits at shallow depths. Speculative resources were estimated at 35 000 tU.

The initial identification of uranium mineralisation in the Siavonga District occurred in 1957, with further exploration activities revealing that the majority of the uranium mineral resources are made up of three main deposits, Muntanga, Dibwe and Dibwe East, with additional smaller deposits also discovered. Muntanga is a sandstone-type deposit, which formed in permeable sandstone aquifers, below the water table at low temperatures. The majority of the uranium found at Muntanga is contained within uranium-calcite-potassium minerals of autunite and minor meta-autunite, with approximately 2% of the U-bearing mineralisation comprised of brannerite and coffinite.

The discovery and exploration of the Muntanga Project is as follows:

1957	Uranium was identified after a ground survey at Bungua hill.
1958-1959	Low-grade uranium was found over an 800 m strike extent.
1974	Additional uranium mineralisation was defined by regional airborne magnetic and radiometric surveys.
1973-1977	Geological Survey Department conducted ground investigations.
1974-1984	Azienda Generale Italiana Petroli (AGIP) discovered and drilled the Muntanga and Njame deposits.
2004	AGIP’s prospecting licence was granted to Okurusu Flourspar Pty Ltd.

2005	Licence transferred to OMEGA Corp.
2006	OMEGA Corp. drilled 11 holes to confirm the Muntanga deposit.
2007	Denison acquired OMEGA and drilled 45 598 m at the Muntanga and Dibwe deposits, and 27 341 m of exploration drilling on 12 previously untested prospects.
2011	Discovery and delineation of the Dibwe East deposit.

In June 2016, GoviEx acquired Denison's Muntanga Project, and in October 2017 completed the acquisition of Africa Energy's Chirundu uranium project. GoviEx is a mineral resource company focussed on the exploration and development of uranium properties in Zambia. The principal objective is to become a significant uranium producer through the continued exploration and development of its Muntanga Project in Zambia, among other projects in Africa. The company holds three mining licences granted by the Ministry of Mines and Minerals Development to mine uranium in the Siavonga and Chirundu Districts. Additionally, the Company has three exploration licences. GoviEx has not started mining and is expanding on feasibility studies for costing and mine design.

In mid-2011, Equinox Minerals was taken over by Barrick Gold Corp. At that time, a total of 4.2 Mt of uraniferous ore at a grade of 0.118% U3O8 (0.1% U) was stockpiled at the Lumwana copper mine, which could be processed in the future if Barrick decided to build a uranium mill.

Total uranium resources, including the uranium ore stockpiled at Malundwe, amounted to 7 492 tU at an average grade of 0.07% U. However, the ore body did not meet economic expectations. The drilling defined significant additional mineralisation, some at higher grades. Much of the mineralisation was deep and would therefore require a significant amount of waste stripping, making it uneconomic, based on the expected operating costs and current market copper prices.

In 2019, the reclamation process of the stockpiled copper at Malundwe and Chimiwungo which covered an approximate area of 148 000 m^2 and a volume of 6 409 969 billion cubic metres began. The stockpiles contained about 0.5% Sulphur, 0.79% copper and 920 ppm uranium. The waste with elevated uranium was channelled to an existing Tailing Storage Facility (TSF) with a capacity of 600 million tonnes; only 20 million tonnes of waste have been deposited there. The waste with elevated uranium covered about 4 million tonnes representing 0.7% of the total capacity of the TSF.

Recent and ongoing uranium exploration, and mine development activities

In 2021 and 2022, GoviEx conducted an extensive infill drilling programme at the Dibbwi East deposit, which targeted conversion of the 29 million pounds U_3O_8 (11 150 tU) from inferred into indicated resources. A total of 5 980 m were drilled in 2021, and 27 634 m in 2022 (for a 2-year total of 33 614 m in 262 holes). Over four tonnes of ore have been delivered to Zambia's Copperbelt University where confirmatory metallurgical test work is ongoing. This will be used to support the feasibility study process, design and costing. Analysis of the 2022 drilling results has highlighted that the Dibbwi East deposit is open both up and down dip, as several sections have not closed off the uranium resource.

In 2023, GoviEx completed a 15 835 m drilling programme (160 holes) on the Muntanga and Dibbwi East deposits. The objectives were to target the areas of open mineralisation and potential extensions at the Dibbwi East deposit and further enhance its understanding of the deposit's potential in support of a feasibility study of the Muntanga Project and the related Environmental and Social Impact Assessment.

Uranium exploration and development expenditures, and drilling effort – domestic

(USD)

	2022	2023	2024	2025 (preliminary)
Private* exploration expenditures	3 751 000	5 174 000	5 627 000	NA
Government exploration expenditures				
Private* development expenditures				
Government development expenditures				
Total expenditures	3 751 000	5 174 000	5 627 000	NA
Private exploration drilling (metres)	19 990	15 835	0	3 500
Private exploration holes drilled	NA	160	0	35
Private exploration trenches (metres)				
Private trenches (number)				
Government exploration drilling (metres)				
Government exploration holes drilled				
Government exploration trenches (metres)				
Government trenches (number)				
Private development drilling (metres)				
Private development holes drilled				
Government development drilling (metres)				
Government development holes drilled				
Subtotal exploration drilling (metres)				
Subtotal exploration holes drilled				
Subtotal development drilling (metres)				
Subtotal development holes drilled				
Total drilling (metres)	19 990	15 835	0	3 500
Total number of holes drilled	NA	160	0	35

Uranium resources

Identified conventional resources (reasonably assured and inferred resources)

In October 2017, GoviEx published an NI 43-101 technical report on a preliminary economic assessment of the Muntanga Project. GoviEx's Muntanga and Chirundu deposits were estimated to hold 21.6 Mt of measured ore resources grading 269 ppm U (0.0269% U) and containing 5 810 tU. Inferred resources were estimated to be 74.6 Mt of ore grading 231 ppm U (0.0231% U) and containing 17 270 tU.

In June 2023, GoviEx released a new NI 43-101 compliant resource estimate (effective date of 31 March 2023) for the Muntanga Project, including the results from the extensive 2021 to 2022 drilling programme. Based on this March 2023 resource estimate, the Muntanga Project was estimated to contain 42.6 Mt of ore at an average grade of 304 ppm U (measured and indicated resources), and 15.0 Mt tonnes at 280 ppm U (inferred resources). These resources are contained in five deposits (Muntanga, Dibbwi East, Dibbwi, Gwabi and Njame) located over a 65 km strike.

In January 2025, GoviEx released the results of a feasibility study incorporating a new NI 43-101 compliant resource estimate (effective date of 31 January 2024) for the Muntanga Project, including the results from the 2023 drilling programme. Based on this updated resource estimate, the Muntanga Project is estimated to contain 50.4 Mt of ore at an average grade of 305 ppm U (measured and indicated resources: 15 380 tU), and 12.8 Mt tonnes at 223 ppm U (inferred resources; 2 850 tU).

Compared to the 2023 resource estimate, the 2024 estimate shows an increase of 2 420 tU in the measured and indicated categories, and a decrease of 1 350 tU in the inferred category.

Identified conventional resources by deposit

2023 Resources

Category	Deposit	Ore (Mt)	Grade (ppm U)	U (tU)
Measured	Njame	2.2	317	690
	Gwabi	1.1	215	230
Indicated	Muntanga	7.5	305	2 270
	Dibbwi	3.1	216	690
	Dibbwi East	25.2	317	8 000
	Gwabi	2.7	317	850
	Njame	0.8	272	230
Total M&I		**42.6**	**304**	**12 960**
Inferred	Muntanga	4.0	271	1 080
	Dibbwi	0.6	212	120
	Dibbwi East	9.1	292	2 650
	Gwabi	0.2	237	40
	Njame	1.1	276	310
Total Inferred		**15.0**	**280**	**4 200**

Resources, as of 31 January 2024, are reported in the following table:

2024 Resources

Category	Deposit	Cut-off (ppm U)	Ore (Mt)	Grade (ppm U)	U (tU)
Measured	Gwabi	93	1.1	215	230
	Njame	76	2.5	304	770
Indicated	Muntanga	76	8.6	313	2 690
	Dibbwi	76	3.2	215	690
	Dibbwi East	76	31.3	315	9 885
	Gwabi	93	2.7	317	845
	Njame	76	1.0	259	270
Total M & I			50.4	305	15 380
Inferred	Muntanga	76	3.4	236	810
	Dibbwi	76	1.0	181	190
	Dibbwi East	76	7.1	214	1 500
	Gwabi	93	0.2	231	40
	Njame	76	1.1	279	310
Total Inferred			12.8	223	2 850

To conform with NI 43-101 standards, as part of the feasibility study for the Muntanga Project, mineral reserves were estimated for Muntanga and Dibbwi East as of 1 January 2025. The conversion of the Mineral Resource estimate to a Mineral Reserve estimate followed a conventional approach, commencing with open-pit optimisation techniques, incorporating economic parameters. The ultimate pit outlines were used to create a practical and detailed open pit.

Mineral Reserve Class	Ore (Mt)	Grade (%U)	U (tU)
Muntanga Pit			
Probable	8.4	281	2 355
Dibbwi Pit			
Probable	31.2	269	8 410
Total Project			
Probable	39.6	271	10 765

The Lumwana copper mine, where resources are hosted by mica-quartz-kyanite schists of the Katangan Supergroup, contains identified recoverable uranium resources of 6 967 tU.

Potential for the discovery of additional uranium resources exists in various parts of the country that have been poorly explored. Of particular interest is the Copperbelt, where many copper orebodies are associated with uranium mineralisation.

Uranium production

Historical review

A total of 102 tU_3O_8 (86 tU) was produced at the Mindola mine in Kitwe during the late 1950s. Production ceased in 1960 and no uranium has been produced since. Uraniferous ore was stockpiled at Lumwana while mining the higher-grade Malundwe copper deposit. As of May 2019, the stockpile amounted to 4 Mt of ore grading 910 ppm U (3 640 tU). Copper was reclaimed from the stockpile in 2020 and the material with elevated uranium, considered as waste, was channelled into the Tailings Storage Facility.

Future projects

On 25 June 2020, the Mining Cadastre Department of Zambia issued a letter to GoviEx revoking the Chirundu mining permit due to failure to develop the permitted mining areas and carry out mining operations. However, on 10 May 2021, the Chirundu mining permit was reinstalled subject to the completion of exploration and development milestones to advance the project towards a feasibility study.

In 2024, GoviEx completed an extensive metallurgical test work programme. The work programme was designed to demonstrate the viability of the heap leach process. The main deposits of Muntanga and Dibbwi East, which account for 80% of the M&I resources, achieved uranium recoveries of 90% or better. Results improve confidence on recovery rates and validate the efficiency of the acid heap leach process.

On 10 March 2025, GoviEx presented the results of the feasibility study realised for the Muntanga Uranium Project.

Ore would be mined by shallow open-pit and processed by heap leaching. Based on Probable Mineral Reserves in two deposits (Mutanga and Dibbwi East), and further potential for upgrading Inferred Resources, a production averaging 2.2 million pounds U_3O_8 (850 tU) per annum over 12 years has been considered. Because of their different geochemical properties, the U recovery rate differs from ore body to ore body. The recovery for Dibbwi East oxide ore was estimated at 91.3%, 89.7% was estimated for the Dibbwi East reduced ore, and the Muntanga reduced ore recovery was estimated at 93.0%. Operating costs have been estimated at USD 32.2/lb (USD 83.7/kgU). Initial capital was estimated at USD 281.9 million with a further USD 100.7 million in sustaining capital.

The project holds a 25-year mining licence, environmental approval and a radioactive materials licence.

Uranium production centre technical details

(as of 1 January 2025)

	Centre #1	Centre #2
Name of production centre	Lumwana	Muntanga
Production centre classification	Prospective	Planned
Date of first production (year)	NA	NA
Source of ore:		
Deposit name(s)	Malundwe-Chimiwungo	Dibbwi East-Mutanga
Deposit type(s)	Metasomatic (metamorphosed schists)	Sandstone
Recoverable resources (tU)	6 967	10 765
Grade (% U)	0.07	0.027
Mining operation:		
Type (OP/UG/ISL)	OP	OP
Size (tonnes ore)	2 800 t/day	3.5 Mt/year
Average mining recovery (%)	NA	NA
Processing plant:		
Acid/alkaline	Acid	Acid
Type (IX/SX/HL)	SX	HL
Size (tonnes ore/day)		
Average process recovery (%)	93	NA
Nominal production capacity (tU/year)	650	840
Plans for expansion (yes/no)		
Other remarks	Mine currently operated by Barrick	

Environmental activities and socio-cultural issues

Waste rock management

Equinox Minerals' original plan in 2003 was to excavate, stockpile and return the uraniferous ore to the Malundwe pit at the Lumwana copper mine, following completion of mining, as it was considered uneconomic at the time to recover the uranium. However, in 2006, with a uranium spot price in excess of USD 50 lb/U_3O_8 (USD 130/kgU), the project was re-evaluated. In January 2011, Equinox Minerals reported that the portion of the stockpile containing 0.09% U and 0.8% Cu could be treated at a later date, if and when a uranium plant is built. The stockpile is currently classified and expensed as "waste" in the copper project.

In May 2019, Lumwana Mining Company (LMC) presented an Environmental and Socioeconomic Impact Assessment Report for the proposed Stockpile Reclamation Project within the Lumwana Mining Licences. LMC has been mining from the Malundwe open pit since 2007. Initially, LMC investigated the feasibility of processing the stockpile for both copper and uranium. The uranium project was shelved in 2009/2010 following the decline of the uranium price and low availability of uranium ore. The proposed stockpile for reclamation covers an area of approximately 148 000 m^2 and contains about 4 Mt of "ore". The stockpiles contain about 0.5% sulphur, 0.79% copper and 920 ppm uranium (3 640 tU). The Chimuwungo resource contains less than 0.5% of copper and less than 200 ppm of uranium. Copper was reclaimed from the stockpile in 2020 and the waste with elevated uranium was channelled to the Tailing Storage Facility within the Lumwana Mine premises.

Environmental activities and socio-cultural issues

The Mines and Minerals Development Act (1995) makes provision for the preparation of a project brief when applying for a mining licence. This must include an environmental impact statement detailing all potential impacts of the project. Annual environmental audits must be carried out to ensure compliance and contributions must be made to an environmental management fund for rehabilitation.

Local inhabitants around the Mutanga Project were involved in public hearings organised by the Environmental Council of Zambia. Agreements were reached regarding the displacement of 107 families in two villages to allow for the construction of the mine infrastructure.

Denison/GoviEx has been providing funding to several communities and sustainability projects including the construction of schools and clinics, water boreholes, and agricultural programmes.

As of March 2025, a full Environmental and Social Impact Assessment was submitted to the Zambian Environmental Management Agency.

African Energy assisted with the construction of a community health post and completed a water borehole at Sikoongo Village, near their Chirundu Project.

Barrick invested in a wide range of sustainable development initiatives in 2012, including funding for infrastructure (such as schools and health centres), literacy and agricultural programmes, community sports and recreation, and an initiative to provide microcredit and small business loans to women.

Uranium requirements

Zambia has no nuclear generating capacity. In May 2016, Russia's Rosatom signed an intergovernmental agreement on co-operation in the peaceful uses of nuclear energy that provides a framework for opportunities to construct nuclear power facilities. Further co-operation agreements were signed with Rosatom in December 2016 and June 2017. The agreements include training of Zambian specialists in Russia so that within 15 years, Russia will assist Zambia with training young nuclear energy engineers, planning for nuclear power plant personnel, developing a nuclear energy regulator and building a research reactor. Zambia sent students to Russia to be trained in nuclear energy and a number of students graduated in 2020.

Zambia aims to become a regional centre for nuclear medicine. With respect to energy, nuclear power is needed to prevent load shedding due to unreliable supply. Zambia also developed the Nuclear Energy Policy and the National Nuclear and Radiation Safety Bill, which is a comprehensive nuclear law for the peaceful, safe, and secure use of nuclear science and technology.

Uranium policies, uranium stocks and uranium prices

National policies relating to uranium

Mining activities, in general, were regulated until 2008 by the Mines and Minerals Act (1995), but until recently there was no legislation specifically relating to the exploration and mining of uranium. The act was repealed in 2008, following widespread criticism of what was perceived to be excessive scope for granting tax concessions. This act was replaced by the Mines and Minerals Development Act 2008, which ruled that no special agreements should be entered into by the government for the development of large-scale mining licences. It also effectively ended development agreements concluded under the previous act. The Mines and Minerals Development (Prospecting, Mining, and Milling of Uranium Ores and Other Radioactive Mineral Ores) and Regulations of 2008 deal with the mining, storage and export of uranium. Mining and export licences will only be granted when the Radiation Protection Authority is satisfied that the operations pose no environmental and health hazards. Applicants for export licences will also have to prove the authenticity of the importers in terms of International Atomic Energy Agency (IAEA) guidelines.

A study by the Council of Churches concluded that current legislation and enforcement was inadequate for uranium mining. It recommended that current regulations be revised to address the concerns of local communities and that education and awareness programmes be initiated prior to any uranium exploration and mining activities.

In 2011, Zambia and Finland signed co-operation projects aimed at helping Zambia review regulations on uranium mining as well as the management of the mineral. The two projects are aimed at evaluating current regulations on uranium and other radioactive minerals as well as developing a modern geographical information infrastructure. These projects are designed to help the country evaluate, update and review regulations regarding the safety of uranium mining.

Zambia has upgraded its mining legislation to include uranium, following detailed consultations with the IAEA. It started issuing uranium mining licences late in 2008, and in 2017 was undertaking a further revision of regulations regarding uranium exploration and mining.

Zambia, through the Radiation Protection Authority, uses the Ionising Radiation Protection Act No. 16 of 2005 and its amendments No. 19 of 2011, the Ionising Radiation Protection (General) Regulations No. 98 of 2011, and its amendments, and Statutory Instrument No. 58 of 2014, to regulate all activities involving ionising radiation. The Radiation Protection Authority developed the Nuclear Energy Policy and the National Nuclear and Radiation Safety Bill which is the comprehensive nuclear law that will cover uranium mining, exploration and prospecting activities. The Nuclear Energy Policy and Nuclear and Radiation Safety bill are still in draft form.

Reasonably assured conventional resources by production method

(recoverable tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Open-pit mining (OP)	0	0	13 840	13 840	91
Co-product/By-product			6 967	6 967	80
Total	0	0	20 807	20 807	87

Reasonably assured conventional resources by processing method

(recoverable tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Heap leaching from OP	0	0	13 840	13 840	91
Conventional from OP	0	0	6 967	6 967	80
Total	0	0	20 807	20 807	87

Reasonably assured conventional resources by deposit type

(recoverable tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Sandstone	0	0	13 840	13 840
Metasomatite	0	0	6 967	6 967
Total	0	0	20 807	20 807

Inferred conventional resources by production method

(recoverable tonnes U)

Production method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Open-pit mining (OP)	0	0	2 565	2 565	91
Co-product/By-product	0	0	951	951	80
Total	0	0	3 516	3 516	88

Inferred conventional resources by processing method

(recoverable tonnes U)

Processing method	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU	Recovery factor (%)
Heap-leaching from OP	0	0	2 565	2 565	91
Conventional from OP	0	0	951	951	80
Total	0	0	3 516	3 516	88

Inferred conventional resources by deposit type

(recoverable tonnes U)

Deposit type	<USD 40/kgU	<USD 80/kgU	<USD 130/kgU	<USD 260/kgU
Sandstone	0	0	2 565	2 565
Metasomatite	0		951	951
Total	0	0	3 516	3 516

Historical uranium production by production method

(tonnes U in concentrates)

Production method	Total through end of 2020	2023	2024	Total through end of 2024	2025 (expected)
Underground mining[1]	86	0	0	86	0
Total	86	0	0	86	0

1. Pre-2020 totals may include uranium recovered by heap and in-place leaching.

Historical uranium production by processing method

(tonnes U in concentrates)

Processing method	Total through end of 2020	2023	2024	Total through end of 2024	2025 (expected)
Conventional	86	0	0	86	0
Total	86	0	0	86	0

Historical uranium production by deposit type

(tonnes U in concentrates)

Deposit type	Total through end of 2020	2023	2024	Total through end of 2024	2025 (expected)
Metasomatite	86	0	0	86	0
Total	86	0	0	86	0

Short-term production capabilities

(tonnes U/year)

2025				2030			
A-I	A-II	B-I	B-II	A-I	A-II	B-I	B-II
0	0	0	0	NA	NA	NA	NA

2035				2040			
A-I	A-II	B-I	B-II	A-I	A-II	B-I	B-II
NA	NA	NA	NA	NA	NA	NA	NA

Appendix 1. List of reporting organisations and contact persons

NEA	OECD Nuclear Energy Agency – Division of Nuclear Technology Development and Economics, Paris Contact persons: Mr Franco Michel-Sendis, Mr Jamie Fairchild, Ms Kateryna Poliakovska (Scientific Secretary)
IAEA	International Atomic Energy Agency, Division of Nuclear Fuel Cycle and Waste Technology, Vienna Contact persons: Ms Adrienne Hanly, Ms Katrin Kaerner (Scientific Secretary)
Algeria	Commissariat à l'Energie Atomique (COMENA), Centre de Recherche Nucléaire de Draria, BP 43, Sebala, Draria, Alger 16003 Algérie Contact person: Mr Jamel Eddine Nacer
Argentina	Comisión Nacional de Energía Atómica (CNEA), División Gestión de Proyectos, Avenida del Libertador 8250, (C1429BNP) Ciudad, Buenos Aires Contact person: Mr Luis López
Armenia	Ministry Territorial Administration and Infrastructure, Energy Department, Atomic Energy Division, Government House 3, Republic Square, Yerevan Contact person: Ms Margarita Balayan
Australia	Geoscience Australia, Cnr Jerrabomberra Avenue and Hindmarsh Drive, Symonston, ACT 2609, Canberra Contact person: Mr Andrew Cross
Austria	University of Natural Resources and Life Sciences (BOKU Wien), Peter-Jordan Strasse 76/I 1190, Vienna, Austria Contact person: Ms Friederike Friess
Bangladesh	Institute of Nuclear Minerals (IBN), Bangladesh Atomic Energy Commission, Atomic Energy Research Establishment, Ganakbari, Savar-1349, Dhaka Contact person: Mr Golam Rasul
Belgium	SYNATOM, Fuel Supply Department, ENGIE TOWER – 6th Floor, 36 Boulevard Simon Bolivar, 1000 Brussels Contact person: Ms Françoise Renneboog
Bolivia	Electricity And Nuclear Technology Supervision Authority, Nuclear Technology Department, Av. 16 de Julio N°1571 Zona Central (El Prado), La Paz, Bolivia Contact person: Mr Luis Pablo Diaz Vidal
Botswana	Eastport Ventures Botswana (Pty) LTD, South-East District, Botswana Contact person: Ms Gomotsang Tshoso
Brazil	Indústrias Nucleares do Brasil, Rio de Janeiro Contact person: Mr Felipe Mattos Tavares

Bulgaria	Ministry of Energy, Natural Resources, Concession and Control Direcorate, 8 Triaditsa Str., 1000 Sofia Contact person: Ms Valeri Trendafilov
Burkina Faso	Bureau des Mines et de la Géologie du Burkina, Ouagadougou Contact person: Mr Alphonse Kambou
Cameroon	Ministry of Mines,Industries and Technological Development, Yaounde Contact person: Ms Ngaffo Florence Tchoff
Canada	Natural Resources Canada, Uranium and Radioactive Waste Division, 580 Booth Street, Ottawa, Ontario K1A OE4 Contact person: Ms Aisha Samuel
Chad	Ministère du Pétrole, des Mines et de la Géologie, N'Djamena Contact person: Mr Mahamat Hassana Abakar
Chile	Comisión Chilena de Energía Nuclear, Centro Nuclear Lo Aguirre, Ruta 68, km 28 Region Metropolitana Contact person: Mr Pedro Orrego
China	East China University of Technology, No.48 Guanglan Road, Nanchang, Jiangxi Province China Contact person: Mr Xiaodong Liu
Congo, Democratic Republic of	Congo Atomic Energy Commission, Kinshasa Contact person: Mr François Kazadi Kabuya
Czechia	DIAMO State Enterprise, Máchova 201, 471 27 Stráz Pod Ralskem Contact person: Mr Jiří MUŽÁK
Denmark/ Greenland	Geological Survey of Denmark and Greenland, Danish Ministery of Climate, Energy and Utilities, Øster Volgade 10, 1350 Copenhagen, Denmark Contact person: Ms Kristine Thrane
Ecuador	Geological and Energy Research Institute, Innovation Directorate, Sky Building, Planta Baja, Av, de la República E7-263, Quito 170503 Contact person: Ms Jenny Alexandra Zambrano Rojas
Egypt	Nuclear Materials Authority of Egypt, P.O. Box 530, El-Maadi, Cairo Contact persons: Mr Amer Bishr
Finland	Ministry of Economic Affairs and Employment, Energy Department, Geological Survey of Finland, Vuorimiehentie 5 P.O. Box 96, FI-02151, Espoo Contact person: Mr Esa Pohjolainen
France	Commissariat à l'énergie atomique et aux énergies alternatives, Centre de Saclay, 91191 Gif-sur-Yvette Cedex Contact person: Ms Sophie Gabriel
Gabon	Ministère des Mines et des Ressources géologiques, Libreville Contact person : Ms Patricia Oussou
Germany	Federal Institute for Geosciences and Natural Resources (BGR), Stilleweg 2, D-30655 Hannover Contact person: Mr Michael Schauer

Guyana	Guyana Geology and Mines Commission, Main Office, Upper Brickdam, Georgetown Contact person: Ms Xiomara Smith
Hungary	Hungarian Atomic Energy Authority, 4 Fényes Adolf Street, H-1036 Budapest Contact person: Mr András Barabás
India	Atomic Minerals Directorate for Exploration and Research, Department of Atomic Energy (DAE), AMD Complex, 1-10-153-156, Begumpet, Hyderabad 500 016, Telangana Contact person: Mr Baskaran Saravanan
Indonesia	Research Center for Nuclear Fuel Cycle and Radioactive Waste Technology, Research Organization for Nuclear Energy, National Research and Innovation Agency, 720 Building, KST BJ Habibie, Serpong, Tangerang Selatan, Banten Province, 15314 Contact person: Mr Heri Syaeful
Iran	Atomic Energy Organization of Iran (AEOI), P.O. Box 14155-1339, Tehran 1439951113, Iran, North Karegar Avenue Contact person: Mr Davood Jamaliesfahlan
Japan	Office for International Nuclear Energy, Ministry of Economy, Trade and Industry, 1-3-1 Kasumigaseki, Chiyoda-ku, Tokyo Contact person: Mr Urara Kida
Jordan	Jordanian Uranium Mining Company, Al Madena Al Munawarah Str., Building No. 269, Amman 11953 Contact person: Mr Mohammad Al-Shannag
Kazakhstan	National Atomic Company Kazatomprom JSC NAC, 17/12, Syganak Street, Z05T1X3 Astana Contact person: Ms Aliya Akzholova
Kenya	Nuclear Power & Energy Agency, Kawi Complex, off Red Cross Road, P.O. Box 26374-00100, Nairobi Contact person: Mr Joe Mwangi Mburu
Kyrgyzstan	Institute of Mining and Mining Technologies, Bishkek Contact person: Ms. Aigul Sulaimanova
Madagascar	Office des Mines Nationales et des Industries Strategiques, 21, Rue Razanakombana Ambohijatovo Antananarivo Contact person: Ms Dinamalala Julia Ranaivosaona
Malawi	Ministry of Lands, Housing and Urban Development Contact person: Mr Chimwemwe Bandazi
Mali	Direction Nationale de la Géologie et des Mines, BP 223 –route de Sotuba, Bamako Contact person: Mr Emmanuel Thera
Mauritania	National Authority of Radiation Protection, Safety and Nuclear Security (ARSN), Nouakchott Contact person: Mr Cheikh Yacoub Tomy
Mexico	Ministry of Energy of Mexico, General Direction of International Affairs, 890 Insurgentes Sur, Del Valle, PC 03100, Benito Juarez, Mexico City Contact person: Mr Francisco José Escandón Valle

Mongolia	Government of Mongolia Executive office of the Nuclear Energy Commission, Executive Office of Nuclear Energy Commission, 17032 Uildverchdiin street 2, 20th khoroo, Khan-Uul district, Ulaanbaatar Contact person: Mr Baatartsogt Baldorj
Morocco	Ministère de l'Energie, des Mines, de l'Eau et de l'Environnement, Rabat Contact person: Mr Karim EL-ASSEFRY
Mozambique	National Atomic Energy Agency, Maputo Contact person: Mr Manuel Luis CHENENE
Namibia	Ministry of Mines and Energy, Department of Mines, 6 Aviation Road, Windhoek Contact person: Ms Helena Itamba
Nepal	Department of Mines and Geology, Lainchaur, Kathmandu Contact person: Mr Dharma Raj Khadka
Niger	Ministère des mines et de l'énergie (MME), Niamey Contact person: Mr Mamane Kache
Nigeria	Nigeria Atomic Energy Commission, Abuja Contact person: Mr Abdulmalik Ismaila
Pakistan	Pakistan Atomic Energy Commission, Lahore Contact person: Mr Arshad Farooqi
Paraguay	Autoridad Reguladora Radiológica y Nuclear (ARRN), San Lorenzo Contact person: Mr Felipe Rafael Mitjans Amarilla
Peru	Instituto Geológico, Minero y Metalúrgico, 1470 Canada Av., San Borja, Lima 15034 Contact person: Mr Michael Valencia Muñoz
Poland	Ministry of Climate and Environment, Nuclear Energy Department, 52/54 Wawelska Street, 00-922 Warsaw Contact person: Mr Andrzej Chwas
Portugal	Direção Geral de Energia e Geologia, Av. 5 de Outubro 208, 1069-039, Lisboa Contact person: Ms Paula Dinis
Romania	SN Nuclearelectrica S.A., Bucharest Contact person : Mr Gelu Agafiel Maracineanu
Russia	Rosatom State Corporation, TENEX Joint-Stock Company, 28/3 Ozerkovskaya nab., Moscow Contact person: Mr Alexander Boytsov
Saudi Arabia	Ministry of Energy, 5 Nakhiel Neighbourhood, 6744 Riyadh, 21382 Contact person: Mr Fahad Al Sayyari (National Liaison Officer)
Senegal	Ministry of Energy and Mining, Regulatory Body, Experts Comity, Allée Papa Gueye Fall, Immeuble Adja Fatou Nourou Diop, Dakar Contact person: Mr Mamadou Kanoute
Slovak Republic	Štátny geologický ústav Dionýza Štúra, Mlynská dolina 1, 817 04 Bratislava 11 Contact persons: Mr Dušan Kúšik
Slovenia	Slovenian Nuclear Safety Administration, Litostrojska cesta 54, 1000 Ljubljana Contact person: Ms Vesna Logar Zorn

South Africa	Council for Geoscience, Mineral Resources Development Unit, 280 Pretoria Road, Silverton, Private Bag X112, Pretoria 001 Contact person: Mr Abdul Kenan
Spain	ENUSA Industrias Avanzadas, S. A. S.M.E., Santiago Rusiñol, 12, E- 28040, Madrid Contact person: Ms Lourdes Guzmán
Sri Lanka	Geological Survey and Mines Bureau, 569 Epitamulla Road, Pitakotte Contact person: Mr C.H.E.R. Siriwardana
Sweden	Ministry of the Environment, Chemicals Division, SE-103 33 Stockholm Contact person: Mr Carl Bladh
Tajikistan	Chemical, Biological, Radiological And Nuclear Safety And Security Agency, 734025, 33 Rudaki Ave, Dushanbe Contact person: Mr Ilhom Mirsaidzoda
Tanzania, United Republic of	Tanzania Atomic Energy Comm., Arusha Contact person: Mr Justin Emmanuel Ngaile
Thailand	Department of Mining and Petroleum Engineering, Chulalongkorn University, Bangkok, 10330 Contact person: Mr Pipat Laowattanabandit
Tunisia	Centre National des Sciences et Technologies Nucléaires (CNSTN), Sidi Thabet Contact person: Mr Adel Trabelsi
Türkiye	Ministry of Energy and Natural Resources, General Directorate of Nuclear Energy and International Projects, Türk Ocağı Street No:2 06520 Çankaya, Ankara Contact person: Ms Çisem Tuba Ünaldi
Uganda	Ministry of Energy and Mineral Development, Kampala Contact person: Mr Zachary Baguma
Ukraine	Ministry of Energy, Department of Nuclear Energy and Atomic Industry, 30 Khreschatyk Street Kiev, 01601 Contact person: Mr Yuri Bakarzhiyev
United States	Energy Information Administration, US Department of Energy, Washington, D.C. 20585 Contact person: Mr Slade Johnson
	US Geological Survey, Geology, Minerals, Energy and Geophysics Science Center in Spokane, WA Contact person: Mr Mark Mihalasky
Uzbekistan	Navoi Mining and Metallurgy Combinat (JSC NMMC), Navoi Contact person: Mr Umid Mavlanovich FAYZIEV
Viet Nam	Institute for Technology of Radioactive and Rare Elements, Vietnam Atomic Energy Institute (VNATOM), 48 Langha Street, Dongda District, Hanoi Contact person: Mr Nguyen Trong Hung
Zambia	Radiation Protection Authority of Zambia, P.O Box 50002, Exploration Houise, Government Road, Ridgeway, Lusaka Contact persons: Ms Linda Kumwenda, Mr Brian Kashimu

Appendix 2. Members of the Joint NEA-IAEA Uranium Group participating in 2025-2026 meetings

IAEA	Ms Adrienne Hanly *(Uranium Group Scientific Secretary)*	Division of Nuclear Fuel Cycle and Waste Technology, Vienna
IAEA	Ms Katrin Kärner (*Uranium Group Scientific Secretary*)	Division of Nuclear Fuel Cycle and Waste Technology, Vienna
NEA	Mr Franco Michel-Sendis (*Uranium Group Scientific Secretary*)	Division of Nuclear Technology Development and Economics, Paris
NEA	Mr Jamie Fairchild (*Uranium Group Scientific Secretary*)	Division of Nuclear Technology Development and Economics, Paris
NEA	Ms Kateryna Poliakovska (*Uranium Group Scientific Secretary*)	Division of Nuclear Technology Development and Economics, Paris
Algeria	Mr Daoud Groune	Commissariat à l'énergie atomique (COMENA); Centre de recherche nucléaire de Draria, Draria
Argentina	Mr Luis Eduardo López (*Uranium Group Vice-Chair)*	Comisión Nacional de Energía Atómica, Buenos Aires
Australia	Mr Andrew Cross (*Uranium Group Vice-Chair*)	Geoscience Australia, Canberra
Austria	Ms Friederike Friess	University of Natural Resources and Life Sciences, Vienna
Belgium	Ms Françoise Renneboog	SYNATOM Market Analysis Division, Brussels
Belgium	Ms Berta Picamal Vicente	Nucleareurope, Brussels

Brazil	Ms Jamyle Franco	Indústrias Nucleares do Brasil, Rio de Janeiro
Brazil	Mr Felipe Mattos Tavares	Indústrias Nucleares do Brasil, Rio de Janeiro
Canada	Mr Liam Goulding	Natural Resources Canada, Uranium and Radioactive Waste Division, Ontario
Canada	Ms Aisha Samuel	Natural Resources Canada, Uranium and Radioactive Waste Division, Ontario
Canada	Mr Roya Andarz	Ontario Power Generation, Ontario
China	Mr Ziying Li	Beijing Research Institute of Uranium Geology, China National Nuclear Corporation, Beijing
China	Mr Xiaodong Liu	Jiujiang University, Jiujiang
Czechia	Mr Jiri Muzak (*Uranium Group Vice-Chair*)	DIAMO, State Enterprise, Department of Ecology, Stráž Pod Ralskem
Denmark	Ms Kristine Thrane	Geological Survey of Denmark and Greenland (GEUS), Department of Petrology and Economic Geology, Copenhagen
Egypt	Mr Amer Bishr	Nuclear Materials Authority (NMA) of Egypt, Cairo
Euratom	Mr Dariusz Kozak	Euratom Supply Agency, Nuclear Fuel Market Observatory Sector, European Commission, Luxembourg
Finland	Mr Esa Pohjolainen	Geological Survey of Finland (GTK), Energy Department, Ministry of Economic Affairs and Employment, Espoo
Finland	Mr Olli Tapani Okko	Radiation and Nuclear Safety Authority (STUK), Vantaa
France	Mr Benjamin Wal	Électricité de France (EDF), Saint Denis

France	Mr Pierre Chambre	Électricité de France (EDF), Saint Denis
France	Mr Christian Polak (*Uranium Group Chair*)	Orano Mining, Paris
France	Ms Josephine Mouze	Électricité de France (EDF), Saint Denis
France	Ms Sophie Gabriel	French Alternative Energies and Energy Commission (CEA), Centre De Saclay, Gif-sur-Yvette
Germany	Mr Michael Schauer	Federal Institute for Geosciences and Natural Resources (BGR), Hannover
Germany	Mr Frank Winde	Wismut GmbH, Chemnitz
Germany	Mr Johannes Raff	Helmholtz-Zentrum Dresden-Rossendorf, Dresden
Hungary	Mr András Barabás	Mining and Geological Survey of Hungary, Budapest
India	Mr Dheeraj Pande	Atomic Minerals Directorate (AMD) for Exploration and Research, Hyderabad
Japan	Mr Akira Yoshizawa	Nuclear Energy, Energy & Metal Division, Sojitz Corporation, Tokyo
Jordan	Mr Mohammad Al Shannag	Jordanian Uranium Mining Company, Amman
Jordan	Mr Sayel Aladaileh	Jordanian Uranium Mining Company, Amman
Kazakhstan	Ms Aliya Akzholova	National Atomic Company “Kazatomprom” JSC, Astana
Kenya	Mr Jeremiah Monari Kebwaro	Karatina University, Karatina

Kenya	Mr Joe Mburu	Nuclear Power and Energy Agency (NuPEA), Nairobi
Malawi	Mr Winford Nelson Kanyika	Atomic Energy Regulatory Authority (AERA), Lilongwe
Malawi	Mr Chimwemwe Bandazi	Ministry of Lands, Housing and Urban Development, Lilongwe
Mongolia	Ms Baatartsogt Baldorj	Nuclear Energy Commission Mongolia, Ulaanbaatar
Namibia	Ms Helena Itamba	Ministry of Mines and Energy, Department of Mines, 6 Aviation Road, Windhoek
Namibia	Mr Titus Nortin	Ministry of Mines and Energy, Department of Mines, 6 Aviation Road, Windhoek
Pakistan	Mr Arshad Farooqi	Pakistan Atomic Energy Commission, Islamabad
Paraguay	Ms Monica Elizabeth Urbieta Sanabria	Independent Consultant
Peru	Mr Michael Meliton Valencia Muñoz	Instituto Geológico, Minero y Metalúrgico (INGEMMET), Lima
Philippines	Mr Angel VII Bautista	Philippine Nuclear Research Institute, Metro Manila
Poland	Mr Andrzej Chwas	Ministry of Climate and Environment, Warsaw
Portugal	Ms Maria Joao Batista	Laboratório Nacional de Energia e Geologia, Lisbon
Romania	Mr Gelu Agafiel Maracineanu	SN Nuclearelectrica S.A., Bucharest
Russia	Mr Alexander Boytsov (*Uranium Group Vice Chair*)	TENEX (JSC Techsnabexport, ROSATOM State Corporation), Moscow

Russia	Mr Mikhail Platov	TENEX (JSC Techsnabexport, ROSATOM State Corporation), Moscow
Saudi Arabia	Mr Abdullah Aljehani	Saudi Geological Survey, Jeddah
Saudi Arabia	Mr Fahad Sulaiman S Al Sayyari	Ministry of Energy, Riyadh
Saudi Arabia	Ms Saleh O Alkubaisi Munirah	Ministry of Energy, Riyadh
Slovenia	Ms Vesna Logar Zorn	Slovenian Nuclear Safety Administration, Ljubljana
Spain	Ms Maria Lourdes Guzmán Gómez-Sellés	Direction of Procurement and I+D+I, ENUSA Industrias Avanzadas, S.A., S.M.E. (Grupo SEPI), Madrid
Thailand	Mr Pipat Laowattanabandit	Chulalongkorn University, Bangkok
Türkiye	Ms Çisem Tuba Ünaldi	Nuclear Infrastructure Development Department, General Directorate of Nuclear Energy and International Projects, Ministry of Energy and Natural Resources, Ankara
Ukraine	Mr Yuri A. Bakarzhiyev	State Enterprise “Kirovgeology”, Kyiv
United Republic of Tanzania	Mr Justin Ngaile	Tanzania Atomic Energy Commission (TAEC), Arusha
United States	Mr Slade Johnson	Energy Information Administration, US Department of Energy, Washington, DC
United States	Mr Mark Mihalasky	US Geological Survey, Geology, Minerals, Energy and Geophysics Science Center in Spokane, WA
United States	Mr Jack Britt	Nuclear Energy Institute, Washington, DC
United States	Mr Brian Robinson	DOE Office of Nuclear Energy

United States	Mr Doug True	Nuclear Energy Institute, Washington, DC
Uzbekistan	Mr Bahodir Fayzullaev	State Committee of Industrial Safety of the Republic of Uzbekistan, Tashkent
Viet Nam	Mr Trong Hung Nguyen	Institute for Technology of Radioactive and Rare Elements, Vietnam Atomic Energy Institute (VNATOM), 48 Langha Street, Dongda District, Hanoi
Zambia	Mr Desiderius Chapewa	Ministry of Mines and Minerals Development, Lusaka
Zambia	Ms Linda Kumwenda	Radiation Protection Authority, Lusaka

Appendix 3. **Glossary of definitions and terminology**

Units

Metric units are used in all tabulations and statements. Resources and production quantities are expressed in terms of tonnes (t) contained uranium (U) rather than uranium oxide (U_3O_8).

1 short ton U_3O_8	=	0.769 tU
1% U_3O_8	=	0.848% U
1 USD/lb U_3O_8	=	USD 2.6/kg U
1 tonne	=	1 metric ton

Resource terminology

Resource estimates are divided into separate categories reflecting different levels of confidence in the quantities reported. The resources are further separated into categories based on the cost of production.

Definitions of resource categories

Uranium resources are broadly classified as either conventional or unconventional. Conventional resources are those that have an established history of production where uranium is a primary product, co-product or an important by-product (e.g. from the mining of copper and gold). Very low-grade resources, or those from which uranium is only recoverable as a minor by-product, are considered unconventional resources. In some instances, however, unconventional resources that are of atypical uranium grades (i.e. higher than what is normally a very low-grade for deposit types such as phosphate-hosted or black shale-hosted uranium) may, by some countries, be regarded as an important by-product and therefore considered to be conventional.

Conventional resources, as well as unconventional resources when sufficient data are available, are further divided according to different confidence levels of occurrence into four categories:

1. Reasonably assured resources (RAR)
2. Inferred resources (IR)
3. Prognosticated resources (PR)
4. Speculative resources (SR)

The correlation between these resource categories and those used in selected national resource classification systems is shown in Figure A3.1.

Reasonably assured resources (RAR) refers to uranium that occurs in known mineral deposits of delineated size, grade and configuration such that the quantities, which could be recovered within the given production cost ranges with currently proven mining and processing technology, can be specified. Estimates of tonnage and grade are based on specific sample data and measurements of the deposits and on knowledge of deposit characteristics. Reasonably assured resources have a high assurance of existence. Unless otherwise noted, RAR are expressed in terms of quantities of uranium recoverable from mineable ore (see: recoverable resources).

Inferred resources (IR) refers to uranium, in addition to RAR, that is inferred to occur based on direct geological evidence, in extensions of well-explored deposits, or in deposits in which geological continuity has been established but where specific data, including measurements of the deposits, and knowledge of the deposit's characteristics, are considered to be inadequate to classify the resource as RAR. Estimates of tonnage, grade and cost of further delineation and recovery are based on such sampling as is available and on knowledge of the deposit characteristics as determined in the best known parts of the deposit or in similar deposits. Less reliance can be placed on the estimates in this category than on those for RAR. Unless otherwise noted, inferred resources are expressed in terms of quantities of uranium recoverable from mineable ore (see: recoverable resources).

Figure A3.1. **Approximate correlation of terms used in major resources classification systems**

<table>
<tr><td></td><td colspan="3">Identified resources</td><td colspan="3">Undiscovered resources</td></tr>
<tr><td>Red Book (NEA/IAEA)</td><td colspan="2">Reasonably assured</td><td>Inferred</td><td>Prognosticated</td><td colspan="2">Speculative</td></tr>
<tr><td rowspan="2">Australia</td><td colspan="2">Demonstrated</td><td rowspan="2">Inferred</td><td colspan="3" rowspan="2">Undiscovered</td></tr>
<tr><td>Measured</td><td>Indicated</td></tr>
<tr><td>Canada (NRCan)</td><td>Measured</td><td>Indicated</td><td>Inferred</td><td>Prognosticated</td><td colspan="2">Speculative</td></tr>
<tr><td>United States (DOE, USGS)</td><td colspan="2">Reasonably assured</td><td>Inferred</td><td colspan="3">Undiscovered</td></tr>
<tr><td>Russia, Kazakhstan, Ukraine, Uzbekistan</td><td>A + B + C1</td><td>C2</td><td>C2+P1</td><td>P1</td><td>P2</td><td>P3</td></tr>
</table>

The terms illustrated are not strictly comparable as the criteria used in the various systems are not identical. "Grey zones" in correlation are therefore unavoidable, particularly as the resources become less assured. Nonetheless, the chart presents a reasonable approximation of the comparability of terms.

Work to align the NEA/IAEA and national resource classification systems outlined above with the United Nations Framework Classification system remains under consideration. (For a summary of recent efforts, see: www.unece.org/fileadmin/DAM/energy/se/pdfs/egrc/egrc5_apr2014/ECE.ENERGY.GE.3.2014.L1_e.pdf.)

Prognosticated resources (PR) refers to uranium, in addition to inferred resources, that is expected to occur in deposits for which the evidence is mainly indirect and which are believed to exist in well-defined geological trends or areas of mineralisation with known deposits. Estimates of tonnage, grade and cost of discovery, delineation and recovery are based primarily on knowledge of deposit characteristics in known deposits within the respective trends or areas and on such sampling, geological, geophysical or geochemical evidence as may be available. Less reliance can be placed on the estimates in this category than on those for inferred resources. Prognosticated resources are normally expressed in terms of uranium contained in mineable ore (i.e. in situ quantities).

Speculative resources (SR) refers to uranium, in addition to prognosticated resources, that is thought to exist, mostly on the basis of indirect evidence and geological extrapolations, in deposits discoverable with existing exploration techniques. The location of deposits envisaged in this category could generally be specified only as being somewhere within a given region or geological trend. As the term implies, the existence and size of such resources are speculative. SR are normally expressed in terms of uranium contained in mineable ore (i.e. in situ quantities).

Cost categories

The cost categories, in United States dollars (USD), used in this report are defined as: <USD 40/kgU (<USD 15/lbs U_3O_8), <USD 80/kgU (<USD 30/lbs U_3O_8), <USD 130/kgU (<USD 50/lbs U_3O_8), and <USD 260/kgU (<USD 100/lbs U_3O_8). The resource tonnages across the cost categories are cumulative, from lowest cost to highest cost category. This means that uranium resource tonnage for any cost category also includes uranium resource tonnage from the lower cost categories:

- Resources categorised at <USD 40/kgU are the lowest cost, most economically attractive to recover.
- Resources categorised at <USD 80/kgU include those recoverable at <USD 40/kgU, plus resources that are more expensive to recover, up to USD 80/kgU.
- Resources categorised at <USD 130/kgU include those recoverable at <USD 80/kgU and <USD 40/kgU, plus resources that are more expensive to recover, up to USD 130/kgU.
- Resources categorised at <USD 260/kgU include those recoverable at all lower cost categories, plus resources that are more expensive, up to USD 260/kgU.

All resource categories are defined in terms of costs of uranium recovered at the ore processing plant.

Note: It is not intended that the cost categories should follow fluctuations in market conditions.

Conversion of costs from other currencies into USD is done using an average exchange rate for the month of June in that year, except for the projected costs for the year of the report.

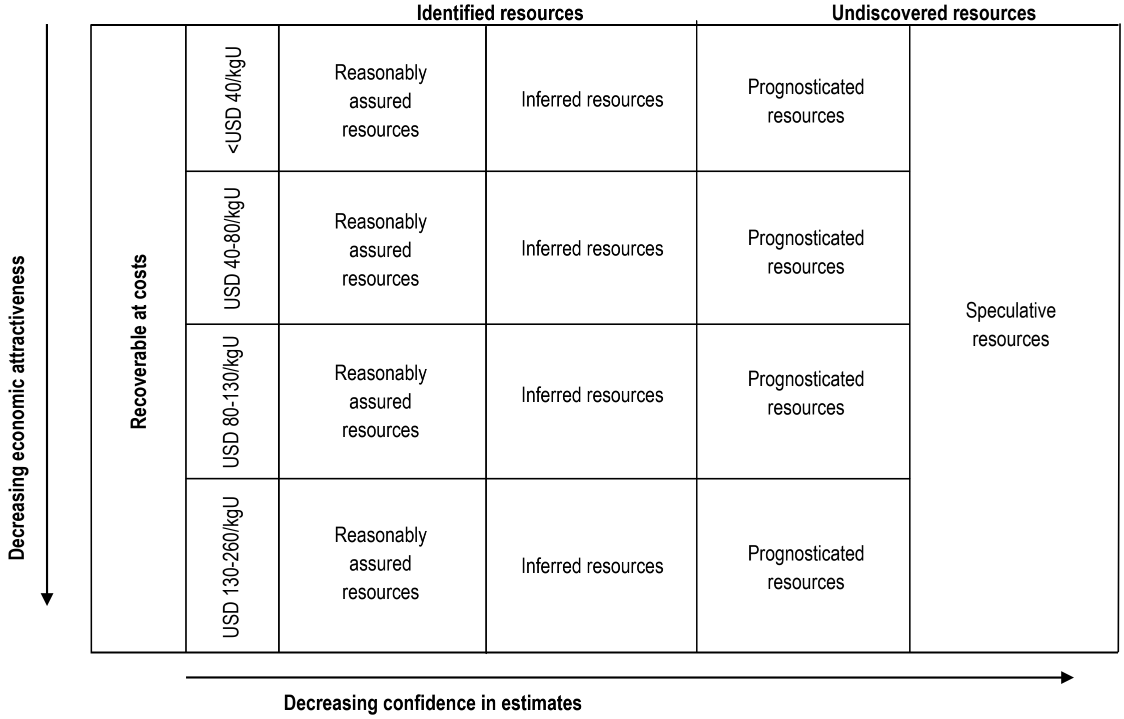
When estimating the cost of production for assigning resources within these cost categories, account has been taken of the following costs:

- the direct costs of mining, transporting and processing the uranium ore;
- the costs of associated environmental and waste management during and after mining;
- the costs of maintaining non-operating production units where applicable;
- in the case of ongoing projects, those capital costs that remain non-amortised;
- the capital cost of providing new production units where applicable, including the cost of financing;
- indirect costs such as office overheads, taxes and royalties where applicable;
- future exploration and development costs wherever required for further ore delineation to the stage where it is ready to be mined;
- sunk costs are not normally taken into consideration.

Relationship between resource categories

Figure A3.2 illustrates the inter-relationship between the different resource categories. The horizontal axis expresses the level of assurance about the actual existence of a given tonnage based on varying degrees of geologic knowledge while the vertical axis expresses the economic feasibility of exploitation by the division into cost categories.

Figure A3.2. **NEA/IAEA classification scheme for uranium resources**



Recoverable resources

RAR and IR estimates are expressed in terms of recoverable tonnes of uranium (i.e. quantities of uranium recoverable from mineable ore), as opposed to quantities contained in mineable ore, or quantities in situ (i.e. not taking into account mining and milling losses). Therefore, both expected mining and ore processing losses have been deducted in most cases. If a country reports its resources as in situ and the country does not provide a recovery factor, the NEA/IAEA assigns a recovery factor to those resources based on geology and projected mining and processing methods to determine recoverable resources. The recovery factors that have been applied are:

Mining and milling method	Overall recovery factor (%)
Open-pit mining with conventional milling	80
Underground mining with conventional milling	75
In situ leaching (acid)	85
In situ leaching (alkaline)	70
Heap leaching	70
Block and stope leaching	75
Co-product or by-product	65
Unspecified method	75

Secondary sources of uranium terminology

Mixed oxide fuel (MOX): MOX is the abbreviation for a fuel for nuclear power plants that consists of a mixture of uranium oxide and plutonium oxide. Current practice is to use a mixture of depleted uranium oxide and plutonium oxide.

Depleted uranium: Uranium where the ^{235}U assay is below the naturally occurring 0.7110%. Natural uranium is a mixture of three isotopes, uranium-238 – accounting for 99.2836%, uranium-235 – 0.7110%, and uranium-234 – 0.0054%. Depleted uranium is a by-product of the enrichment process, where enriched uranium is produced from initial natural uranium feed material.

Production terminology [1]

Production centres

A production centre, as referred to in this report, is a production unit consisting of one or more ore processing plants, one or more associated mines and uranium resources that are tributary to these facilities. For the purpose of describing production centres, they have been divided into four classes, as follows:

- Existing production centres are those that currently exist in operational condition. Production projections continue until the identified resources (costs < USD 130/kgU) are exhausted.
- Committed production centres are those that are either under construction or are firmly committed for construction.
- Planned production centres are those for which feasibility studies are completed and regulatory approvals are at an advanced stage.
- Prospective production centres are those for which some level of feasibility study has been completed, and the centres are supported by tributary RAR and Inferred resources. Indicative start-up dates should have been announced.

Production, production capacity and production capability

Production: Denotes the amount of uranium output, in tonnes U contained in concentrate, from an ore processing plant or production centre (with milling losses deducted).

Production capacity: Denotes the nominal level of output, based on the design of the plant and facilities over an extended period, under normal commercial operating practices.

Production capability: Refers to an estimate of the level of production that could be practically and realistically achieved under favourable circumstances from the plant and facilities at any of the types of production centres described above, given the nature of mined ore flow to them. Projections of production capability are supported only by RAR and/or IR. Production capability is divided into two scenarios: **Scenario A** is based on **EXISTING** and **COMMITTED** production centres; **Scenario B** is based on **EXISTING**, **COMMITTED**, **PLANNED** and **PROSPECTIVE** production centres. The A and B scenarios are further subdivided based on cost category:

- The **A-I** scenario reflects production capability that is supported only by Reasonably Assured Resources (RAR) and Inferred Resources (IR) recoverable at costs **<USD 80/kgU** which are available to feed and be processed at **EXISTING** and **COMMITTED** production centres.

1. IAEA (1984), *Manual on the Projection of Uranium Production Capability,* General Guidelines, Technical Report Series No. 238, IAEA, Vienna.

- The **A-II** scenario reflects production capability that is supported only by Reasonably Assured Resources (RAR) and Inferred Resources (IR) recoverable at costs **<USD 130/kgU** which are available to feed and be processed at **EXISTING** and **COMMITTED** production centres.
- The **B-I** scenario reflects production capability that is supported by Reasonably Assured Resources (RAR) and Inferred Resources (IR) recoverable at costs **<USD 80/kgU** which are available to feed and be processed at **EXISTING**, **COMMITTED**, **PLANNED** and **PROSPECTIVE** production centres.
- The **B-II** scenario reflects production capability that is supported by Reasonably Assured Resources (RAR) and Inferred Resources (IR) recoverable at costs **<USD 130/kgU** which are available to feed and be processed at **EXISTING**, **COMMITTED**, **PLANNED** and **PROSPECTIVE** production centres.

The unit used for production capability is tonnes U/yr.

Mining and milling

Open-pit mining: The extraction of near-surface uranium-bearing rock (ore) from an exposed pit open to the air, typically excavated as a series of benches or steps cut into the pit walls using drilling, blasting, and heavy machinery.

Underground mining: The extraction beneath the surface of uranium-bearing rock (ore) through horizontal, sub-horizontal and vertical tunnels (shafts, slopes, adits, declines and other openings that access the ore body), using drilling, blasting and various types of specialised heavy machinery. More commonly applied to high-grade, low-tonnage deposits where the ore body is too deep to be mined economically by open pit methods.

In situ leaching mining (ISL, sometimes referred to as in situ recovery, or ISR): The extraction of uranium from sandstone using chemical solutions and the recovery of uranium at the surface. ISL extraction is conducted by injecting a suitable uranium-dissolving leach solution (acid or alkaline) into the ore zone below the water table thereby oxidising, complexing and mobilising the uranium; then recovering the pregnant solutions through production wells and finally pumping the uranium bearing solution to the surface for further processing.

Heap leaching (HL): Heaps of ore are formed over a collecting system underlain by an impervious membrane. Dilute sulphuric acid solutions are distributed over the top surface of the ore. As the solutions seep down through the heap, they dissolve a significant (50-75%) amount of the uranium in the ore. The uranium is recovered from the heap leach product liquor by ion exchange or solvent extraction.

In-place leaching (IPL): involves leaching of broken ore without removing it from an underground mine. This is also sometimes referred to as stope leaching or block leaching.

Co-product: Uranium is a co-product when it is one of two commodities that must be produced to make a mine economic. Both commodities influence output; for example, uranium and copper are co-produced at Olympic Dam in Australia. Co-product uranium is produced using either the open-pit or underground mining methods.

By-product: Uranium is considered a by-product when it is a secondary or additional product. By-product uranium can be produced in association with a main product or with co-products (e.g. uranium recovered from the Palabora copper mining operations in South Africa). By-product uranium is produced using either the open-pit or underground mining methods.

Uranium from phosphate rocks: Uranium has been recovered as a by-product of phosphoric acid production. Uranium is separated from phosphoric acid by a solvent extraction process. The most frequently used reagent is a synergetic mixture of tri-n-octyl phosphine oxide (TOPO) and di 2-ethylhexyl phosphoric acid (DEPA).

Ion exchange (IX): Reversible exchange of ions contained in a host material for different ions in solution without destruction of the host material or disturbance of electrical neutrality. The process is accomplished by diffusion and occurs typically in crystals possessing – one or two – dimensional channels where ions are weakly bonded. It also occurs in resins consisting of three-dimensional hydrocarbon networks to which are attached many ionisable groups. Ion exchange is used for recovering uranium from leaching solutions.

Solvent extraction (SX): A method of separation in which a generally aqueous solution is mixed with an immiscible solvent to transfer one or more components into the solvent. This method is used to recover uranium from leaching solutions.

Idled mine: A temporarily closed operation. Idled mines are those with associated identified uranium resources and processing facilities that have all necessary licences, permits and agreements for operation and have produced commercially in the past, but were not producing as of the middle to end of the second year of the current Red Book reporting period. Annual production capacity of an idled mine could be potentially increased relatively rapidly if the operation is brought back into service. Although each mine operation is unique in terms of operational costs and a threshold price for reopening, the ability to raise capital as required to resume operation and to meet regulatory requirements, idled mines could be returned to production in roughly one year, given that all permits and licences remain in place.

Demand terminology

Reactor-related requirements: Refers to natural uranium acquisitions *not* necessarily consumption during a calendar year.

Environmental terminology [2]

Close-out: In the context of uranium mill tailings impoundment, the operational, regulatory and administrative actions required to place a tailings impoundment into long-term conditions such that little or no future surveillance and maintenance are required.

Decommissioning: Actions taken at the end of the operating life of a uranium mill or other uranium facility in retiring it from service with adequate regard for the health and safety of workers and members of the public, and protection of the environment. The time period to achieve decommissioning may range from a few to several hundred years.

Decontamination: The removal or reduction of radioactive or toxic chemical contamination using physical, chemical or biological processes.

Dismantling: The disassembly and removal of any structure, system or component during decommissioning. Dismantling may be performed immediately after permanent retirement of a mine or mill facility, or it may be deferred.

Environmental restoration: Clean-up and restoration, according to predefined criteria, of sites contaminated with radioactive and/or hazardous substances during past uranium production activities.

Environmental impact statement: A set of documents recording the results of an evaluation of the physical, ecological, cultural and socio-economic effects of a planned installation, facility or technology.

Groundwater restoration: The process of returning affected groundwater to acceptable quality and quantity levels for future use.

2. Definitions based on those published in OECD (2002), *Environmental Remediation of Uranium Production Facilities*, Paris.

Reclamation: The process of restoring a site to predefined conditions, which allows new uses.

Restricted release (or use): A designation, by the regulatory body of a country, that restricts the release or use of equipment, buildings, materials or the site because of its potential radiological or other hazards.

Tailings: The remaining portion of a metal-bearing ore consisting of finely ground rock and process liquids after some or all of the metal, such as uranium, has been extracted.

Tailings impoundment: A structure in which the tailings are deposited to prevent their release into the environment.

Unrestricted release (or use): A designation, by the regulatory body of a country, that enables the release or use of equipment, buildings, materials or the site, without any restriction.

Geological terminology

Uranium occurrence: A naturally occurring, anomalous concentration of uranium.

Uranium deposit: A mass of naturally occurring mineral from which uranium could be economically exploited at present or in the future.

Geologic types of uranium deposits [3]: uranium resources can be assigned on the basis of the following 15 major categories of uranium ore deposit types (arranged according to their approximate economic significance):

1. Sandstone deposits
2. Proterozoic unconformity deposits
3. Polymetallic Fe-oxide breccia complex deposits
4. Paleo-quartz-pebble conglomerate deposits
5. Granite-related
6. Metamorphite
7. Intrusive deposits
8. Volcanic-related deposits
9. Metasomatite deposits
10. Surficial deposits
11. Carbonate deposits
12. Collapse breccia-type deposits
13. Phosphate deposits
14. Lignite and coal
15. Black shale

Detailed descriptions with examples follow. Note that for Red Book reporting purposes, only the major categories are used. However, descriptions of the sub-types for sandstone and Proterozoic unconformity deposits have also been included due to their importance.

1. Sandstone deposits: Sandstone-hosted uranium deposits occur in medium- to coarse-grained sandstones deposited in a continental fluvial or marginal marine sedimentary environment. Uranium is precipitated under reducing conditions caused by a variety of reducing agents within the sandstone, such as carbonaceous material, sulphides (pyrite), hydrocarbons and ferro-magnesian minerals (chlorite), bacterial activity, migrated fluids from underlying hydrocarbon reservoirs, and others. Sandstone uranium deposits can be divided into five main sub-types (with frequent transitional types between them):

   - Basal channel deposits: Paleodrainage systems consist of wide channels filled with thick, permeable alluvial-fluvial sediments. The uranium is predominantly associated with detrital plant debris in ore bodies that display, in a plan view, an elongated lens or ribbon-like configuration and, in a section-view, a lenticular or, more rarely, a roll shape. Individual deposits can range from several hundred to 20 000 t of uranium, at grades ranging from 0.01% to 3%. Examples are the deposits of Dalmatovskoye (Transural Region), Malinovskoye (West Siberia), Khiagdinskoye (Vitim District) in Russia, deposits of the Tono District (Japan), Blizzard (Canada) and Beverley (Australia).

3. This classification of the geological types of uranium deposits was updated in 2011-2012 through a number of IAEA consultancies that included an update of the World Distribution of Uranium Deposits (UDEPO).

- Tabular deposits consist of uranium matrix impregnations that form irregularly shaped lenticular masses within reduced sediments. The mineralised zones are largely oriented parallel to the depositional trend. Individual deposits can contain several hundred tons up to 150 000 tons of uranium, at average grades ranging from 0.05% to 0.5%, occasionally up to 1%. Examples of deposits include Hamr-Stráz (Czechia), Akouta, Arlit, Imouraren (Niger) and those of the Colorado Plateau (United States).

- Roll-front deposits: The mineralised zones are convex in shape, oriented down the hydrologic gradient. They display diffuse boundaries with reduced sandstone on the down-gradient side and sharp contacts with oxidised sandstone on the up-gradient side. The mineralised zones are elongate and sinuous approximately parallel to the strike, and perpendicular to the direction of deposition and groundwater flow. Resources can range from a few hundred tons to several thousands of tons of uranium, at grades averaging 0.05% to 0.25%. Examples are Budenovskoye, Tortkuduk, Moynkum, Inkai and Mynkuduk (Kazakhstan); Crow Butte and Smith Ranch (United States) and Bukinay, Sugraly and Uchkuduk (Uzbekistan).

- Tectonic/lithologic deposits are discordant to strata. They occur in permeable fault zones and adjacent sandstone beds in reducing environments created by hydrocarbons and/or detrital organic matter. Uranium is precipitated in fracture or fault zones related to tectonic extension. Individual deposits contain a few hundred tons up to 5 000 tons of uranium at average grades ranging from 0.1-0.5%. Examples include the deposits of the Lodève District (France) and the Franceville basin (Gabon).

- Mafic dykes/sills in Proterozoic sandstones: mineralisation is associated with mafic dykes and sills that are interlayered with or crosscut Proterozoic sandstone formations. Deposits can be subvertical along the dyke's borders, sometime within the dykes, or stratabound within the sandstones along lithological contacts (Westmoreland District, Australia; Matoush, Canada). Deposits are small to medium (300-10 000 t) with grades low to medium (0.05-0.40%).

2. Proterozoic unconformity deposits: Unconformity-related deposits are associated with and occur immediately below and above an unconformable contact that separates Archean to Paleoproterozoic crystalline basement from overlying, redbed clastic sediments of Proterozoic age. In most cases, the basement rocks immediately below the unconformity are strongly hematised and clay altered, possibly as a result of paleoweathering and/or diagenetic/hydrothermal alteration. Deposits consist of pods, veins and semimassive replacements consisting of mainly pitchblende. They are preferentially located in two major districts, the Athabasca Basin (Canada) and the Pine Creek Orogen (Australia). The unconformity-related deposits include three sub-types:

   - Unconformity-contact deposits: Except for the low-grade Karku deposit (Russia), these all occur in the Athabasca Basin (Canada). Deposits develop at the base of the sedimentary cover directly above the unconformity. They form elongate pods to flattened linear ore bodies typically characterised by a high-grade core surrounded by a lower grade halo. Most of the ore bodies have root-like extensions into the basement. While some mineralisation is open space infill, much of it is replacement style. Often, mineralisation also extends up into the sandstone cover within breccias and fault zones forming "perched mineralisation". Deposits can be monometallic (McArthur River) or polymetallic (Cigar Lake). Deposits are medium to large to very large (1 000-200 000 t) and are characterised by their high grades (1-20%).

   - Basement-hosted deposits are strata-structure bound in metasediments below the unconformity on which the basinal clastic sediments rest. The basement ore typically occupies moderately to steeply dipping brittle shear, fracture and breccia zones hundreds of metres in strike length that can extend down-dip for several tens to more than 500 m into basement rocks below the unconformity. Disseminated and vein uraninite/pitchblende occupies fractures and breccia matrix but may also replace the host rock. High-grade ore is associated with brecciated graphitic schists. These deposits have small to very large resources (300-200 000 t), at medium grade (0.10-0.50%).

Examples are Kintyre, Jabiluka and Ranger in Australia, Millennium and Eagle Point in the Athabasca Basin and Kiggavik and Andrew Lake in the Thelon Basin (Canada).

- Stratiform structure-controlled deposits: low-grade (0.05-0.10%), stratabound, thin (1-5 m) zones of mineralisation are located along the unconformity between Archean, U-Th-rich granites and Proterozoic metasediments with minor enrichments along fractures. This type of deposit (Chitrial and Lambapur) has only been observed in the Cuddapah basin (India). Resources of individual deposits range between 1 000-8 000 t.

3. Polymetallic iron-oxide breccia complex deposits: This type of deposit has been attributed to a broad category of worldwide iron oxide-copper-gold deposits. Olympic Dam (Australia) is the only known representative of this type with significant by-product uranium resources. The deposit contains the world's largest uranium resources with more than 2 Mt of uranium. Deposits of this group occur in hematite-rich granite breccias and contain disseminated uranium in association with copper, gold, silver and rare earth elements. At Olympic Dam, this breccia is hosted within a Mesoproterozoic highly potassic granite intrusion that exhibits regional Fe-K-metasomatism. Significant deposits and prospects of this type occur in the same region, including Prominent Hill, Wirrda Well, Carrapeteena, Acropolis and Oak Dam, as well as some younger breccia-hosted deposits in the Mount Painter area.

4. Paleo-quartz pebble conglomerate deposits: Deposits of this type contain detrital uranium oxide ores, which are found in quartz pebble conglomerates deposited as basal units in fluvial to lacustrine braided stream systems older than 2 400-2 300 Ma. The conglomerate matrix is pyritic and contains gold, as well as other accessory and oxide and sulphide detrital minerals that are often present in minor amounts. Examples include deposits in the Witwatersrand basin, South Africa, where uranium is mined as a by-product of gold as well as deposits in the Blind River/Elliot Lake area of Canada.

5. Granite-related deposits include: i) true veins composed of ore and gangue minerals in granite or adjacent (meta-) sediments and ii) disseminated mineralisation in granite as episyenite bodies. Uranium mineralisation occurs within, at the contact or peripheral to the intrusion. In the Hercynian belt of Europe, these deposits are associated with large, peraluminous two-mica granite complexes (leucogranites). Resources range from small to large and grades are variable, from low to high.

6. Metamorphite deposits correspond to disseminations, impregnations, veins and shear zones within or affecting metamorphic rocks of various ages. These deposits are highly variable in sizes, resources and grades.

7. Intrusive deposits are contained in intrusive or anatectic igneous rocks of many different petrochemical compositions (granite, pegmatite, monzonite, peralkaline syenite and carbonatite). Examples include the Rossing and Rossing South (Husab) deposits (Namibia), the deposits in the Bancroft area (Canada), the uranium occurrences in the porphyry copper deposits of Bingham Canyon and Twin Butte (United States), the Kvanefjeld and Sorensen deposits (Greenland), and the Palabora carbonatite complex (South Africa).

8. Volcanic-related deposits are located within and near volcanic calderas filled by mafic to felsic, effusive and intrusive volcanic rocks, and intercalated clastic sediments. Uranium mineralisation is largely controlled by structures as veins and stockworks with minor stratiform lodes. This mineralisation occurs at several stratigraphic levels of the volcanic and sedimentary units, and may extend into the basement where it is found in fractured granite and metamorphic rocks. Uranium minerals (pitchblende, coffinite, U_6+ minerals, less commonly brannerite) are associated with Mo-bearing sulphides and pyrite. Other anomalous elements include As, Bi, Ag, Li, Pb, Sb, Sn and W. Associated gangue minerals comprise violet fluorite, carbonates, barite and quartz. The most significant deposits are located within the Streltsovska caldera in Russia. Other examples are known in China (Xiangshan District), Mongolia (Dornot and Gurvanbulag Districts), the United States (McDermitt caldera) and Mexico (Pena Blanca District).

9. Metasomatite deposits are confined to Precambrian shields in areas of tectono-magmatic activity affected by intense Na-metasomatism or K-metasomatism, which produced

albitised or illitised facies along deeply rooted fault systems. In Ukraine, these deposits are developed within a variety of basement rocks, including granites, migmatites, gneisses and ferruginous quartzites, which produced albitites, aegirinites, alkali-amphibolic, as well as carbonate and ferruginous rocks. Principal uranium phases are uraninite, brannerite and other Ti-U-bearing minerals, coffinite and hexavalent uranium minerals. The reserves are usually medium to large. Examples include Michurinskoye, Vatutinskoye, Severinskoye, Zheltorechenskoye, Novokonstantinovskoye and Pervomayskoye deposits (Ukraine), deposits of the Elkon District (Russia), Espinharas and Lagoa Real (Brazil), Valhalla (Australia), Kurupung (Guyana), Coles Hill (US), Lianshanguan (China), Michelin (Canada) and small deposits of the Arjeplog region in the north of Sweden.

10. Surficial deposits are broadly defined as young (Tertiary to Recent), near-surface uranium concentrations in sediments and soils. The largest of the surficial uranium deposits are in calcrete (calcium and magnesium carbonates) found mainly in Australia (Yeelirrie deposit) and Namibia (Langer Heinrich deposit). These calcrete-hosted deposits mainly occur in valley-fill sediments along Tertiary drainage channels and in playa lake sediments in areas of deeply weathered, uranium-rich granites. Carnotite is the main uraniferous mineral. Surficial deposits also occur less commonly in peat bogs, karst caverns and soils.

11. Carbonate deposits are hosted in carbonate rocks (limestone, dolostone). Mineralisation can be syngenetic stratabound or more commonly structure-related within karsts, fractures, faults and folds. The only example of a stratabound carbonate deposits is the Tummalapalledeposit in India, which is hosted in phosphatic dolostone. Another example includes deposits developed in solution collapse breccias occurring in limestone with intercalations of carbonaceous shale such as the Sanbaqi deposit in China.

12. Collapse breccia-type deposits occur in cylindrical, vertical pipes filled with down-dropped fragments developed from karstic dissolution cavities in underlying thick carbonate layers. The uranium is concentrated as primary uranium ore, mainly uraninite, in the permeable breccia matrix, and in the arcuate, ring-fracture zone surrounding the pipe. The pitchblende is intergrown with numerous sulphide and oxide minerals variably containing Cu, Fe, V, Zn, Pb, Ag, Mo, Ni, Co, As and Se. Type examples are the deposits in the Arizona Strip north of the Grand Canyon and those immediately south of the Grand Canyon, in the United States. Resources are small to medium (300-2 500 t), with grades around 0.20-0.80%.

13. Phosphate deposits are principally represented by marine phosphorite of continental-shelf origin containing syn-sedimentary, stratiform, disseminated uranium in fine-grained apatite. Phosphorite deposits constitute large uranium resources (millions of tonnes), but at a very low grade (0.005-0.015%). Uranium can be recovered as a by-product of phosphate production. Examples include the Land Pebble District in Florida (land-pebble phosphate) (United States), Gantour (Morocco) and Al-Abiad (Jordan). Another type of phosphorite deposit consists of organic phosphate, including argillaceous marine sediments enriched in fish remains that are uraniferous (Melovoye, Kazakhstan). Deposits in continental phosphates are not common.

14. Lignite-coal deposits consist of elevated uranium contents in lignite/coal mixed with mineral detritus (silt, clay), and in immediately adjacent carbonaceous mud and silt/sandstone beds. Pyrite and ash contents are high. Lignite-coal seams are often interbedded or overlain by felsic pyroclastic rocks. Examples are deposits of the southwestern Williston basin, North and South Dakota (United States), Koldjat and Nizhne Iliyskoe (Kazakhstan), Freital (Germany), Ambassador (Australia) and the Serres basin (Greece).

15. Black shale deposits include marine, organic-rich shale or coal-rich pyritic shale, containing synsedimentary, disseminated uranium adsorbed onto organic material, and fracture-controlled mineralisation within, or adjacent to, black shale horizons. Examples include the uraniferous alum shale in Sweden and Estonia, the Chattanooga shale (United States), the Chanziping deposit (China) and the Gera-Ronneburg deposit (Germany).

Appendix 4. List of abbreviations and acronyms

ARMZ	Atomredmetzoloto
BHP	BHP Billiton
CAREM	Central Argentina de Elementos Modulares
CCHEN	Chilean Nuclear Energy Commission
CGNPC	China General Nuclear Power Corporation
CEA	Commissariat à l'Energie Atomique et aux Energies Alternatives
CNEA	National Atomic Energy Commission (Argentina)
CNEN	National Nuclear Energy Commission (Brazil)
CNNC	China National Nuclear Corporation
CNPC	China National Petroleum Corporation
CNSC	Canadian Nuclear Safety Commission
COGEMA	Compagnie Générale des Matières Nucléaires
CRA	Conzinc Riotinto of Australia
DFS	Definitive feasibility study
DOE	Department of Energy (United States)
DU	Depleted uranium
EC	European Commission
EDF	Électricité de France
EIA	Environmental impact assessments
EPA	Environmental Protection Authority (United States)
EPL	Exclusive prospecting licence
EPR	European pressurised reactor
ENAMI	National Mining Company of Chile
ENUSA	Industrias Avanzadas, S.A. S.M.E. (Spain)
ERA	Energy Resources of Australia
ESA	Euratom Supply Agency
EU	European Union
Ga	Giga-years
GAC	Global Atomic Corporation
GDR	German Democratic Republic
GDRRE	Geological Division for Radioactive and Rare Elements
GWe	Gigawatt electric

ha	Hectare
HEU	Highly enriched uranium
HL	Heap leaching
IAEA	International Atomic Energy Agency
IBAMA	Brazilian Institute for the Environment and Renewable Natural Resources
INB	Industrias Núcleares do Brasil S.A
IPEN	Peruvian Institute Nuclear Energy
IPL	In-place leaching
IR	Inferred resources
ISL	In situ leaching
ISR	In situ recovery
IX	Ion exchange
JAEA	Japan Atomic Energy Agency
JAEC	Jordan Atomic Energy Commission
JOGMEC	Japan Oil, Gas and Metals National Corporation
JORC	Joint Ore Reserves Committee
KEPCO	Korea Electric Power Corporation
kg	Kilogram
km	Kilometre
lb	Pound
LEU	Low-enriched uranium
MOX	mixed oxide fuel
MRE	Mineral resource estimate
MTA	General Directorate of Mineral Research and Exploration (Türkiye)
MWe	Megawatt electric
NatU	Natural uranium
NEA	Nuclear Energy Agency
NMMC	Navoi Mining and Metallurgical Complex
NNSA	National Nuclear Security Administration (United States)
NPP	Nuclear power plant
NRC	Nuclear Regulatory Commission (United States)
NUA	Namibian Uranium Association
NWMO	Nuclear Waste Management Organization (Canada)
OECD	Organisation for Economic Co-operation and Development
OP	Open pit
ppm	Parts per million
PMCPA	Priargunsky Mining-Chemical Production Association
PR	Prognosticated resources

Pu	Plutonium
RAR	Reasonably assured resources
REE	Rare earth elements
RepU	Reprocessed uranium
RMRE	Reptile Mineral Resources & Exploration (Namibia)
SDAG	Sowjetisch-Deutsche Aktiengesellschaft
SMR	Small modular reactors
SR	Speculative resources
STUK	Radiation and Nuclear Safety Authority (Finland)
SWU	Separative work unit
SX	Solvent extraction
t	Tonnes (metric tons)
TAEK	Turkish Atomic Energy Authority
TENEX	Techsnabexport
Th	Thorium
tHM	Tonnes heavy metal
TOE	Tonnes oil equivalent
tU	Tonnes uranium
tU_3O_8	Tonnes triuranium octoxide
tUnat	Tonnes natural uranium equivalent
TVA	Tennessee Valley Authority
TVEL	TVEL Fuel Company
TVO	Teollisuuden Voima Oyj
TWh	Terawatt-hour
U	Uranium
UCIL	Uranium Corporation of India Limited
UThDEPO	World Distribution of Uranium and Thorium Deposits and Occurrences database (IAEA)
UEC	Uranium Energy Corporation
UG	Underground
USEC	United States Enrichment Corporation
USGS	US Geological Survey
US EIA	US Energy Information Administration
VostGOK	Vostochnyi Mining-process Combinat (Ukraine)
VVER	Water-water energetic reactor
WNA	World Nuclear Association

Appendix 5. Energy conversion factors

The need to establish a set of factors to convert quantities of uranium into common units of energy has become increasingly evident with the growing frequency of requests in recent years in relation to the various types of reactors.

Conversion factors and energy equivalence for fossil fuel for comparison

1 cal	=	4.1868 J
1 J	=	0.239 cal
1 tonne of oil equivalent (TOE) (net, lower heating value [LHV])	=	42 GJ* = 1 TOE
1 tonne of coal equivalent (TCE) (standard, LHV)	=	29.3 GJ* = 1 TCE
1 000 m^3 of natural gas (standard, LHV)	=	36 GJ
1 tonne of crude oil	=	approx. 7.3 barrels
1 tonne of liquid natural gas (LNG)	=	45 GJ
1 000 kWh (primary energy)	=	9.36 MJ
1 TOE	=	10 034 Mcal
1 TCE	=	7 000 Mcal
1 000 m^3 natural gas (atmospheric pressure)	=	8 600 Mcal
1 tonne LNG	=	11 000 Mcal
1 000 kWh (primary energy)	=	2 236 Mcal **
1 TCE	=	0.698 TOE
1 000 m^3 natural gas (atmospheric pressure)	=	0.857 TOE
1 tonne LNG	=	1.096 TOE
1 000 kWh (primary energy)	=	0.223 TOE
1 tonne of fuelwood	=	0.3215 TOE
1 tonne of uranium: light-water reactors	=	10 000-16 000 TOE
open cycle	=	14 000-23 000 TCE

* World Energy Council standard conversion factors (from WEC, 1998 Survey of Energy Resources, 18th Edition).

** With 1 000 kWh (final consumption) = 860 Mcal as WEC conversion factor.

Appendix 6. List of all Red Book editions (1965-2026) and national reports

Listing of Red Book editions (1965-2024)

OECD/ENEA *	World Uranium and Thorium Resources, Paris, 1965
OECD/ENEA	Uranium Resources, Revised Estimates, Paris, 1967
OECD/ENEA-IAEA	Uranium Production and Short-Term Demand, Paris, 1969
OECD/ENEA-IAEA	Uranium Resources, Production and Demand, Paris, 1970
OECD/NEA-IAEA	Uranium Resources, Production and Demand, Paris, 1973
OECD/NEA-IAEA	Uranium Resources, Production and Demand, Paris, 1976
OECD/NEA-IAEA	Uranium Resources, Production and Demand, Paris, 1977
OECD/NEA-IAEA	Uranium Resources, Production and Demand, Paris, 1979
OECD/NEA-IAEA	Uranium Resources, Production and Demand, Paris, 1982
OECD/NEA-IAEA	Uranium Resources, Production and Demand, Paris, 1983
OECD/NEA-IAEA	Uranium Resources, Production and Demand, Paris, 1986
OECD/NEA-IAEA	Uranium Resources, Production and Demand, Paris, 1988
OECD/NEA-IAEA	Uranium Resources, Production and Demand, Paris, 1990
OECD/NEA-IAEA	Uranium 1991: Resources, Production and Demand, Paris, 1992
OECD/NEA-IAEA	Uranium 1993: Resources, Production and Demand, Paris, 1994
OECD/NEA-IAEA	Uranium 1995: Resources, Production and Demand, Paris, 1996
OECD/NEA-IAEA	Uranium 1997: Resources, Production and Demand, Paris, 1998
OECD/NEA-IAEA	Uranium 1999: Resources, Production and Demand, Paris, 2000
OECD/NEA-IAEA	Uranium 2001: Resources, Production and Demand, Paris, 2002
OECD/NEA-IAEA	Uranium 2003: Resources, Production and Demand, Paris, 2004
OECD/NEA-IAEA	Uranium 2005: Resources, Production and Demand, Paris, 2006
OECD/NEA-IAEA	Uranium 2007: Resources, Production and Demand, Paris, 2008
OECD/NEA-IAEA	Uranium 2009: Resources, Production and Demand, Paris, 2010
OECD/NEA-IAEA	Uranium 2011: Resources, Production and Demand, Paris, 2012
OECD/NEA-IAEA	Uranium 2014: Resources, Production and Demand, Paris, 2014
OECD/NEA-IAEA	Uranium 2016: Resources, Production and Demand, Paris, 2016
OECD/NEA-IAEA	Uranium 2018: Resources, Production and Demand, Paris, 2018
OECD/NEA-IAEA	Uranium 2020: Resources, Production and Demand, Paris, 2020
OECD/NEA-IAEA	Uranium 2022: Resources, Production and Demand, Paris, 2023
OECD/NEA-IAEA	Uranium 2024: Resources, Production and Demand, Paris, 2025
OECD/NEA-IAEA	Uranium 2026: Resources, Production and Demand, Paris, 2026

* ENEA: European Nuclear Energy Agency; former name of the Nuclear Energy Agency (NEA).

Index of national reports in Red Books

(The following index lists all national reports by the year in which these reports were published in the Red Books)

	1965	1967	1969	1970	1973	1976	1977	1979	1982	1983	1986	1988	1990	1992	1994
Algeria						1976	1977	1979	1982						
Argentina		1967	1969	1970	1973	1976	1977	1979	1982	1983	1986	1988	1990	1992	1994
Armenia															
Australia		1967	1969	1970	1973	1976	1977	1979	1982	1983	1986	1988	1990	1992	1994
Austria							1977								
Bangladesh											1986	1988			
Belgium									1982	1983	1986	1988	1990	1992	1994
Benin													1990		
Bolivia							1977	1979	1982	1983	1986				
Bophuthatswana [1]									1982						
Botswana								1979		1983	1986	1988			
Brazil				1970	1973	1976	1977	1979	1982	1983	1986			1992	1994
Bulgaria													1990	1992	1994
Cameroon							1977		1982	1983					
Canada	1965	1967	1969	1970	1973	1976	1977	1979	1982	1983	1986	1988	1990	1992	1994
Central African Republic				1970	1973		1977	1979			1986				
Chad															
Chile							1977	1979	1982	1983	1986	1988		1992	1994
China													1990	1992	1994
Colombia							1977	1979	1982	1983	1986	1988	1990		
Congo		1967													
Costa Rica									1982	1983	1986	1988	1990		
Côte d'Ivoire									1982						
Cuba												1988		1992	
Czechia															1994
Czech and Slovak Rep.													1990		
Denmark (Greenland)	1965	1967		1970	1973	1976	1977	1979	1982	1983	1986		1990	1992	
Dominican Republic									1982						
Ecuador							1977		1982	1983	1986	1988			
Egypt							1977	1979			1986	1988	1990	1992	1994
El Salvador										1983	1986				
Estonia															
Ethiopia								1979		1983	1986				
Finland					1973	1976	1977	1979	1982	1983	1986	1988	1990	1992	1994
France	1965	1967	1969	1970	1973	1976	1977	1979	1982	1983	1986	1988	1990	1992	1994
Gabon		1967		1970	1973				1982	1983	1986				
Germany				1970		1976	1977	1979	1982	1983	1986	1988	1990	1992	1994

1. Bophuthatswana is a former republic, dissolved in 1994, in the north-western region of South Africa.

Index of national reports in Red Books *(cont'd)*

1996	1998	2000	2002	2004	2006	2008	2010	2012	2014	2016	2018	2020	2022	2024	2026	
			2002	2004	2006	2008		2012	2014	2016	2018	2020	2022	2024	2026	Algeria
1996	1998	2000	2002	2004	2006	2008	2010	2012	2014	2016	2018	2020	2022	2024	2026	Argentina
		2000	2002	2004	2006		2010	2012	2014	2016	2018	2020	2022	2024		Armenia
1996	1998	2000	2002	2004	2006	2008	2010	2012	2014	2016	2018	2020	2022	2024	2026	Australia
																Austria
													2022	2024		Bangladesh
1996	1998	2000	2002	2004	2006	2008										Belgium
																Benin
											2018		2022	2024		Bolivia
																Bophuthatswana
							2010	2012	2014	2016		2020	2022	2024	2026	Botswana
1996	1998	2000	2002	2004	2006	2008	2010	2012	2014	2016	2018	2020	2022	2024	2026	Brazil
1996	1998					2008	2010						2022	2024	2026	Bulgaria
														2024		Cameroon
1996	1998	2000	2002	2004	2006	2008	2010	2012	2014	2016	2018	2020	2022	2024	2026	Canada
													2022	2024		Central African Republic
									2014	2016						Chad
1996	1998	2000	2002	2004	2006	2008		2012	2014	2016	2018	2020	2022	2024	2026	Chile
1996	1998	2000	2002	2004	2006	2008	2010	2012	2014	2016	2018	2020	2022	2024	2026	China
1996	1998					2008										Colombia
																Congo
																Costa Rica
																Côte d'Ivoire
1996	1998															Cuba
1996	1998	2000	2002	2004	2006	2008	2010	2012	2014	2016	2018	2020	2022	2024	2026	Czechia
																Czech and Slovak Rep.
1996	1998			2004			2010	2012	2014	2016	2018	2020	2022	2024	2026	Denmark (Greenland)
																Dominican Republic
													2022	2024	2026	Ecuador
1996	1998	2000		2004	2006	2008	2010					2020	2022	2024		Egypt
																El Salvador
	1998			2004												Estonia
								2012								Ethiopia
1996	1998	2000	2002	2004	2006	2008	2010	2012	2014	2016	2018	2020	2022	2024	2026	Finland
1996	1998	2000	2002	2004	2006	2008	2010	2012	2014	2016	2018	2020	2022	2024	2026	France
1996	1998	2000	2002	2004	2006											Gabon
1996	1998	2000	2002		2006	2008	2010	2012	2014	2016	2018	2020	2022	2024	2026	Germany

Index of national reports in Red Books *(cont'd)*

	1965	1967	1969	1970	1973	1976	1977	1979	1982	1983	1986	1988	1990	1992	1994
Ghana							1977			1983					
Greece							1977	1979	1982	1983	1986	1988	1990	1992	1994
Guatemala											1986	1988			
Guyana								1979	1982	1983	1986				
Hungary														1992	1994
India	1965	1967		1970	1973	1976	1977	1979	1982	1983	1986		1990	1992	1994
Indonesia							1977				1986	1988	1990	1992	1994
Iran, Islamic Republic of							1977								
Iraq															
Ireland								1979	1982	1983	1986			1992	
Italy		1967		1970	1973	1976	1977	1979	1982	1983	1986	1988		1992	1994
Jamaica									1982	1983					
Japan	1965	1967		1970	1973	1976	1977	1979	1982	1983	1986	1988	1990	1992	1994
Jordan							1977				1986	1988	1990	1992	1994
Kazakhstan															1994
Kenya															
Korea						1976	1977	1979	1982	1983	1986	1988	1990	1992	1994
Kyrgyzstan															
Lesotho												1988			
Liberia							1977			1983					
Libyan Arab Jamahiriya [2]										1983					
Lithuania															1994
Madagascar						1976	1977	1979	1982	1983	1986	1988			
Malawi															
Malaysia										1983	1986	1988	1990	1992	1994
Mali											1986	1988			
Mauritania													1990		
Mexico				1970	1973	1976	1977	1979	1982		1986		1990	1992	1994
Mongolia															1994
Morocco	1965	1967				1976	1977	1979	1982	1983	1986	1988	1990		
Namibia								1979	1982	1983	1986	1988	1990		1994
Nepal															
Netherlands									1982	1983	1986		1990	1992	1994
New Zealand		1967					1977	1979							
Niger		1967		1970	1973		1977				1986	1988	1990	1992	1994
Nigeria								1979							
Norway								1979	1982	1983				1992	
Pakistan		1967													1994
Panama										1983		1988			
Paraguay										1983	1986				
Peru							1977	1979		1983	1986	1988	1990	1992	1994
Philippines							1977		1982	1983	1986		1990		1994
Poland															

Index of national reports in Red Books *(cont'd)*

1996	1998	2000	2002	2004	2006	2008	2010	2012	2014	2016	2018	2020	2022	2024	2026	
														2024		Ghana
1996	1998															Greece
																Guatemala
													2022	2024		Guyana
1996	1998	2000	2002	2004	2006	2008	2010	2012	2014	2016	2018	2020	2022	2024	2026	Hungary
1996	1998	2000	2002	2004	2006	2008	2010	2012	2014	2016	2018	2020	2022	2024	2026	India
1996	1998	2000	2002	2004	2006		2010	2012	2014	2016	2018	2020	2022	2024	2026	Indonesia
	1998	2000	2002	2004	2006	2008	2010	2012	2014	2016	2018	2020	2022	2024		Iran, Islamic Republic of
										2016						Iraq
	1998															Ireland
1996	1998	2000						2012	2014	2016						Italy
																Jamaica
1996	1998	2000	2002	2004	2006	2008	2010	2012	2014	2016	2018		2022	2024	2026	Japan
1996	1998	2000	2002	2004	2006	2008	2010	2012	2014	2016	2018	2020	2022	2024	2026	Jordan
1996	1998	2000	2002	2004	2006	2008	2010	2012	2014	2016	2018	2020	2022	2024	2026	Kazakhstan
														2024		Kenya
1996	1998	2000	2002	2004	2006	2008	2010									Korea
1996			2002													Kyrgyzstan
																Lesotho
																Liberia
																Libyan Arab Jamahiriya
1996	1998	2000	2002	2004	2006	2008										Lithuania
												2020		2024		Madagascar
		2000				2008	2010	2012	2014	2016		2020	2022	2024	2026	Malawi
1996	1998	2000	2002													Malaysia
									2014	2016	2018	2020	2022	2024		Mali
										2016		2020	2022	2024	2026	Mauritania
1996	1998	2000						2012		2016	2018	2020	2022	2024		Mexico
1996	1998						2010	2012	2014	2016	2018	2020	2022	2024	2026	Mongolia
	1998															Morocco
1996	1998	2000	2002	2004	2006	2008	2010	2012	2014	2016	2018	2020	2022	2024	2026	Namibia
													2022	2024		Nepal
1996	1998	2000	2002													Netherlands
																New Zealand
1996	1998	2000	2002	2004	2006	2008	2010	2012	2014	2016	2018	2020	2022	2024	2026	Niger
																Nigeria
1996	1998															Norway
	1998	2000												2024		Pakistan
																Panama
											2018		2022	2024	2026	Paraguay
1996	1998	2000		2004	2006	2008	2010	2012	2014	2016	2018		2022	2024	2026	Peru
1996	1998	2000	2002	2004	2006											Philippines
		2000	2002			2008	2010	2012	2014	2016			2022	2024	2026	Poland

2. Libya as of 2011.

Index of national reports in Red Books *(cont'd)*

	1965	1967	1969	1970	1973	1976	1977	1979	1982	1983	1986	1988	1990	1992	1994
Portugal	1965	1967	1969	1970	1973	1976	1977	1979	1982	1983	1986	1988	1990	1992	1994
Romania														1992	1994
Russia															1994
Rwanda											1986				
Saudi Arabia															
Senegal									1982						
Slovak Republic															1994
Slovenia															1994
Somalia							1977	1979							
South Africa	1965	1967	1969	1970	1973	1976	1977	1979	1982	1983	1986			1992	1994
Spain	1965	1967	1969	1970	1973	1976	1977	1979	1982	1983	1986	1988	1990	1992	1994
Sri Lanka							1977		1982	1983	1986	1988			
Sudan							1977								
Surinam									1982	1983					
Sweden	1965	1967	1969	1970	1973	1976	1977	1979	1982	1983	1986	1988	1990	1992	1994
Switzerland						1976	1977	1979	1982	1983	1986	1988	1990	1992	1994
Syrian Arab Republic									1982	1983	1986	1988	1990		1994
Tajikistan															
Tanzania													1990		
Thailand							1977	1979	1982	1983	1986	1988	1990	1992	1994
Togo								1979							
Türkiye					1973	1976	1977	1979	1982	1983	1986	1988	1990	1992	1994
Turkmenistan															
Ukraine															1994
United Kingdom						1976	1977	1979	1982	1983	1986	1988	1990	1992	1994
United States	1965	1967	1969	1970	1973	1976	1977	1979	1982	1983	1986	1988	1990	1992	1994
Uruguay							1977		1982	1983	1986	1988	1990		
USSR (former)														1992	
Uzbekistan															1994
Venezuela											1986	1988			
Viet Nam														1992	1994
Yugoslavia					1973	1976	1977		1982				1990	1992	
Zaire [3]					1973		1977					1988			
Zambia											1986	1988	1990	1992	1994
Zimbabwe									1982			1988		1992	1994

3. Zaire is the former name – between 1971 and 1997 – of the Democratic Republic of the Congo.

Index of national reports in Red Books *(cont'd)*

1996	1998	2000	2002	2004	2006	2008	2010	2012	2014	2016	2018	2020	2022	2024	2026	
1996	1998	2000	2002	2004	2006	2008	2010	2012	2014	2016		2020	2022	2024	2026	Portugal
1996	1998	2000	2002												2026	Romania
	1998	2000	2002	2004	2006	2008	2010	2012	2014	2016	2018	2020	2022	2024	2026	Russia
																Rwanda
													2022	2024	2026	Saudi Arabia
											2018	2020	2022	2024	2026	Senegal
1996	1998	2000	2002	2004	2006	2008	2010	2012	2014	2016			2022	2024	2026	Slovak Republic
1996	1998		2002	2004	2006	2008	2010		2014	2016	2018	2020	2022	2024	2026	Slovenia
																Somalia
1996	1998	2000	2002	2004	2006	2008	2010	2012	2014	2016		2020	2022	2024	2026	South Africa
1996	1998	2000	2002	2004	2006	2008	2010	2012	2014	2016	2018	2020	2022	2024	2026	Spain
												2020				Sri Lanka
																Sudan
																Surinam
1996	1998	2000	2002	2004	2006	2008	2010	2012	2014	2016		2020				Sweden
1996	1998	2000	2002	2004	2006	2008										Switzerland
																Syrian Arab Republic
			2002											2024		Tajikistan
							2010	2012	2014	2016	2018	2020	2022	2024	2026	Tanzania
1996	1998	2000	2002		2006				2014	2016	2018	2020		2024	2026	Thailand
																Togo
1996	1998	2000	2002	2004	2006	2008	2010	2012	2014	2016	2018	2020	2022	2024	2026	Türkiye
				2004												Turkmenistan
1996	1998	2000	2002	2004	2006	2008	2010	2012	2014	2016	2018	2020	2022	2024	2026	Ukraine
1996	1998	2000	2002	2004	2006	2008	2010		2014	2016	2018					United Kingdom
1996	1998	2000	2002	2004	2006	2008	2010	2012	2014	2016	2018	2020	2022	2024	2026	United States
																Uruguay
																USSR (former)
1996	1998	2000	2002	2004	2006			2012		2016	2018	2020	2022	2024	2026	Uzbekistan
																Venezuela
1996	1998	2000	2002	2004	2006	2008			2014	2016	2018	2020	2022	2024	2026	Viet Nam
																Yugoslavia
																Zaire
1996	1998							2012	2014	2016	2018	2020	2022	2024	2026	Zambia
1996	1998													2024		Zimbabwe

NEA PUBLICATIONS AND INFORMATION

The full catalogue of publications is available online at www.oecd-nea.org/pub.

In addition to basic information on the Agency and its work programme, the NEA website offers free downloads of hundreds of technical and policy-oriented reports. The professional journal of the Agency, *NEA News* – featuring articles on the latest nuclear energy issues – is available online at www.oecd-nea.org/nea-news.

An NEA monthly electronic bulletin is distributed free of charge to subscribers, providing updates of new results, events and publications. Sign up at www.oecd-nea.org/tools/mailing list/register.

Visit us on LinkedIn at www.linkedin.com/company/oecd-nuclear-energy-agency or follow us on X (formerly known as Twitter) @OECD_NEA.

Uranium 2026: Resources, Production and Demand

Uranium is the primary raw material fuelling all nuclear fission reactors today. Countries around the world use it to reliably generate low-carbon electricity, process heat and hydrogen, as part of their strategies to reduce carbon emissions and to increase energy security and supply. No form of nuclear fission power of any kind is possible without relying on uranium.

Uranium Resources, Production and Demand, also commonly known as the "Red Book", is a recognised world reference on uranium. Jointly prepared by the Nuclear Energy Agency (NEA) and the International Atomic Energy Agency (IAEA), this 31st edition provides analyses and information from 46 uranium producing and consuming countries. It reviews world uranium market fundamentals and presents data on global uranium exploration, resources, production and reactor-related requirements. This edition offers updated information on established uranium production centres and mine development plans, as well as projections of nuclear generating capacity and reactor-related requirements through 2050.

Nuclear Energy Agency (NEA)
46, quai Alphonse Le Gallo
92100 Boulogne-Billancourt, France
Tel.: +33 (0)1 45 24 10 15
nea@oecd-nea.org www.oecd-nea.org

NEA No. 7770