Uranium Mining at a Crossroads

As the nuclear fuel industries navigate the energy transition, the rise of Artificial Intelligence (AI), and a "national security" trend, the demand for nuclear energy and nuclear fuel is set to increase, necessitating a balance between scaling supply and maintaining affordability. And, uranium is increasingly under the supply security spotlight.

Uranium mining, often seen as one of the most traditional industries, will need a multidimensional transformation to meet growing demand, while addressing geopolitical tensions, trade issues, and financial and environmental-social challenges.

Although global political turmoil is creating a great deal of uncertainty, with supportive policy, a high level of capital investment, and by embracing innovative exploration and extraction, the uranium mining sector will be able to grow and provide supply options resilient to political shifts.

With Nuclear Power on the Rise, What's Next for Uranium?

A global energy transition includes higher expected demand for nuclear power and nuclear fuel, which means uranium is increasingly under the supply security spotlight.

More than 7 GW of nuclear power capacity was brought online in 2024—33 percent higher than in 2023, and the fifth-highest increase in 30 years. According to the OECD International Energy Agency (IEA), electricity generation from nuclear power in 2024 rose by 100 TWh, equaling the largest increase this century outside of the post-COVID rebound. As a result, 80 percent of the increase in global electricity generation in 2024 was provided by renewable sources and nuclear, which together contributed 40 percent of total generation for the first time (**Figure 1**).

Speaking at the launch of the IEA's *Global Energy Review 2025*, Agency Director Fatih Birol said, "We see that the nuclear is coming strongly."

However, fundamentals supporting the supply and demand outlook in the long-term show that primary uranium supply will struggle to keep pace with expected demand in the coming years. Additionally, higher inflation estimates, and a persistently high cost of financing, could exert greater pressure on production costs.

Birol outlined that "in the energy world we believe in a magic word—diversification—to reduce the risks. There is a need for diversification of mining and refining and processing and to increase the efforts for recycling of critical minerals. Otherwise, we are going to see serious challenges."

To boost production and meet long-term demand, uranium players will seek to overcome a long list of challenges (and opportunities). New ore deposits are generally deeper, more remote, and come with new financial, technical, or social-environmental challenges, and they are often in riskier jurisdictions. This means rethinking where and how best to invest in uranium exploration and extraction.

In terms of exploration investment, the flow of capital to either greenfield or brownfield deposit investigations will likely drive

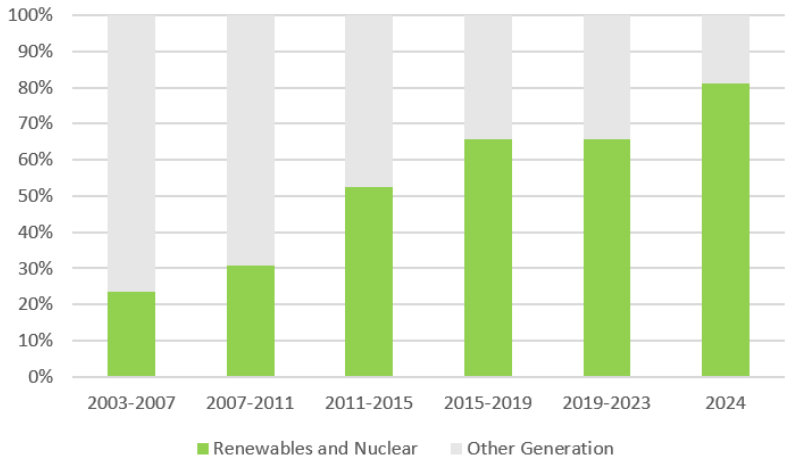

Figure 1 **Increase in Global Electricity Generation, 2003 – 2024**
Sources: International Energy Agency, 2025 / TradeTech

the next suite of future uranium mines beyond those currently under development. Greenfield exploration involves searching for new uranium mine sites in unexplored regions, relying on ore genesis models and surveys to confirm deposits. Advantages include the potential for discovering entirely new and potentially large deposits, but disadvantages involve the high risk of finding nothing, significant upfront costs for new mines, and the need for regulatory clearances.

Brownfield exploration, on the other hand, focuses on finding additional deposits within or near existing or previously mined sites. This process is typically simpler due to prior surveys. Its advantages are a higher certainty of success, potentially high returns on investment, existing nearby infrastructure, and greater clarity concerning permitting. However, a significant disadvantage is that brownfield deposit discoveries in proximity to mines nearing depletion may offer only modest returns.

The uranium mining industry itself will need a multidimensional transformation, while addressing geopolitical tensions, trade issues, and financial-environmental-social challenges.

Is Uranium Considered a "Critical" Mineral?

In recent years, critical minerals policy development has expanded, driven by supply chain security and national interests, with 85 policies introduced globally in 2023 alone. Critical minerals-related policies focus generally on:

- promoting mineral exploration, production, and innovation (e.g. geological surveys, financing, innovation funds, tax incentives),
- encouraging responsible mining practices, and
- ensuring supply reliability and resiliency.

These policies have implications on mining businesses and ultimately, investors.

Uranium ticks many of the criticality boxes. It is experiencing a step-change in demand, global supply is heavily concentrated, and with the exception of Canada, most countries with nuclear power generation facilities are almost totally dependent on uranium imports.

However, in many countries, uranium was not included in the national critical minerals list, generally because only a "non-fuel" mineral can be considered as a "critical mineral." But today, things may be different.

This article focuses on government responses in two countries, the USA and Canada.

USA

The inclusion of uranium on the USA's critical minerals list is one that has been debated for many years within government and industry. In 2022, the US Geological Survey (USGS) dropped uranium from its critical minerals list because it was a "fuel mineral."

More recently, on February 28, US Representative John McGuire (R-VA) introduced the Uranium for Energy Independence Act of 2025 (H.R.1622), legislation that would add uranium to the USGS list of critical minerals. The bill has been referred to the House Committee on Natural Resources and awaits review.

Furthermore, on March 20, President Donald Trump signed an executive order to increase production of critical minerals, including uranium, copper, potash, gold, and possibly coal.

The executive order seeks to strengthen US minerals security primarily by expediting permitting for priority mining projects on federal lands, invoking the Defense Production Act, and leveraging financing programs, including the US International Development Finance Corp., to invest capital into minerals projects domestically.

The executive order also directs the US Export-Import Bank to submit guidance as to how this program can be leveraged to secure offtake of feedstock mined abroad. The success of this initiative will be key to addressing concerns that domestic processing and refining facilities will not have access to enough raw materials to reach economies of scale. This has been a challenge for many minerals supply chains.

The nuclear fuel market will be closely watching for details associated with the program and whether it results in funding for purchases by the US government or other incentives designed to promote and increase domestic uranium production.

On April 15, President Trump signed a new executive order launching an investigation into the national security risks posed by US reliance

on imported processed critical minerals and their derivative products, including uranium. The order directs the Secretary of Commerce to initiate a Section 232 investigation under the Trade Expansion Act of 1962 to evaluate the impact of imports of these materials. It will assess vulnerabilities in supply chains, the economic impact of foreign market distortions, and potential trade remedies such as tariffs to ensure a secure and sustainable domestic supply.

Canada

Uranium appears on the list of the 34 minerals currently considered by Canada to be "critical." To qualify for inclusion on this list, a mineral must either be essential to the country's economic security and its supply is threatened; required for the national transition to a low-carbon economy; or a sustainable source of highly strategic critical minerals for Canadian partners and allies.

Since adopting the "Critical Minerals Strategy" in January 2023, the Government of Canada has implemented many initiatives supporting exploration, research, development, and innovation across the critical minerals sector. Canada has committed C$3.1 billion (US$2.3 billion) to mineral projects through various initiatives, including the Strategic Innovation Fund, Critical Minerals Infrastructure Fund, or the Critical Minerals Research, Development, and Demonstration Program.

Canada also offers tax incentives for mining activities, as well as exploration. These incentives from the federal and provincial/territorial governments reduce the tax load for mining companies. In 2022, the government also launched tax credits for critical minerals (**Figure 2**).

In early March, during PDAC 2025, the world's largest mining convention sponsored by the Prospectors & Developers Association of Canada, government officials announced a two-year extension of the tax credit on mineral exploration to boost investment in junior mining companies. The measure was due to expire on March 31. Mining associations, including PDAC, have promoted renewing and ideally making permanent the mineral exploration tax credit.

Despite some positive government actions, mining companies and industry associations have complained about what they see as a policy climate across Canada. Much of this criticism was focused on permitting of large mineral projects, considered "slow and burdened with too much red tape," especially in the context of the second Trump administration in the USA and its global trade war. Some of the criticism was also directed at the fiscal competitiveness of various mining jurisdictions across Canada, including the taxation policies.

During the PDAC convention, government officials acknowledged more must be done to accelerate the permitting process. Ontario Premier Doug Ford reproached the federal government "for time-consuming environmental approvals."

Prime Minister Mark Carney also announced his intent to streamline the approval process for big infrastructure projects. Carney said his plan would aim to get projects approved within two years.

Uranium market participants will be closely watching for details associated with a potential streamlined permitting system.

Overall, through various policy tools, Canada aims to reinforce its role as a reliable minerals and metals supplier amid unpredictable global markets.

Policy	Percentage	Objective
Critical Mineral Exploration Tax Credit (CMETC)	30%	The 30% non-refundable CMETC supports certain critical minerals exploration expenses incurred in Canada and renounced to flow-through share (FTS) investors. It is an additional income tax benefit for individuals who invest in mining FTSs.
Clean Technology Manufacturing Investment Tax Credit	30%	This refundable tax credit supports 30% of the cost of investments in machinery and equipment used to manufacture or process key clean technologies.
Mineral Exploration Tax Credit (METC)	15%	The METC is a 15% non-refundable tax credit designed to help exploration companies raise equity funds in addition to the regular tax deduction associated with FTS investments.

Figure 2 **Examples of Canada's Tax Incentives for Minerals Exploration & Mining**
Sources: National Resources Canada / TradeTech

Approaches to Mineral Financing: The Role of Government

Just as no two mineral projects are alike, so too are the solutions available to mineral exploration and development companies to finance their projects.

However, to diversify critical minerals value chains (including uranium), governments may turn to a range of financial mechanisms offered by various sources, such as government departments, policy banks, sovereign wealth funds, development finance institutions, and export credit/insurance agencies. These tools primarily focus on supporting capital and operational expenditures while derisking investments to encourage private sector involvement.

"After the Carrots, the Sticks" (Tariffs)

After a first review of President Trump's evolving tariff agenda (Annex II of the US President Executive Order issued on April 2), industry participants concluded that uranium will be exempt from both the baseline and reciprocal tariffs due to its inclusion on the tariff exemption list.

However, uranium companies should review their supply chains for dependencies on machinery, equipment, raw materials, or other supplies that could be subject to tariffs or restrictions.

Furthermore, although uranium seems to be exempt from tariffs, increasingly challenging capital markets create potential obstacles for uranium players looking to fund their ongoing and future operations.

In conclusion, keeping abreast of evolving policies, geopolitical alliances, and their respective impact on markets and mining supply chains has become central to maintaining the resilience of uranium mining companies.

Technological Innovations

Technological advancements are expected to have a profound impact on the global mining industry in general. The adoption of digital technologies, including AI, automation, and data analytics, will likely enhance efficiency and productivity. Sustainable, cost-effective mining at scale requires a great deal of innovation, particularly as resources deplete, market prices are volatile, costs rise, talent becomes scarce, and environmental pressures increase.

Historically, the mining and metals industry has not been recognized as very innovative, and in the uranium sector, technological innovation has been generally process-oriented, and motivated by cost reduction or enhanced environmental performance. However, more recent examples show that this has changed, and that some uranium companies are even making organizational changes to integrate innovation into their regular operations.

Furthermore, there has been a notable rise in more radical innovations that could disrupt and structurally change the industry, driven by progress in information technology and AI.

Automation and machine learning (ML) are pushing the industry beyond traditional expectations. Recent innovations in the industry include automated mining operations, ranging from autonomous trucks and drone surveys to AI for predictive maintenance and optimization of resource extraction. These solutions have enhanced safety and efficiency in operations.

As an example, Cameco Corp. is undergoing a major evolution in the way it extracts uranium at the Cigar Lake Mine in Canada, which began operating in 2014. Recently, the jet boring mining method system has used AI alongside machines to extract uranium ore. The ore is frozen before being cut using a high-pressure water jet, then transported via pipes to other parts of the mine where it is treated and prepared for transportation to the milling facility. ML and AI enter the process when providing the jet boring machine with instruction and direction. Cameco, in collaboration with Saskatchewan Polytechnic, developed a way to program the jet boring machine to adjust its extraction methods depending on the type of rock formation, which allows for great efficiency. Previously, this programming was completed manually.

And, when considering exploration, advances in satellite technology, three-dimensional (3D) multiphysics, and AI are converging to create faster and more sustainable solutions for mineral discovery. Mineral exploration is a process of reducing the scale of the physical search space. These cutting-edge tools represent a paradigm shift, narrowing search spaces and the time needed to complete exploration programs.

One example is district-scale surveys that can identify prospective geological features at greater resolution than in regional data sets.

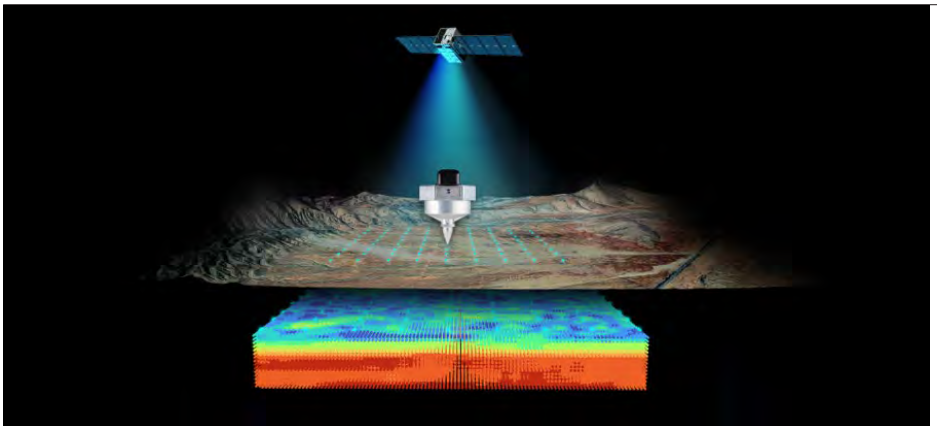

Figure 3 **Schematic Overview of the ExoSphere ANT System**
(Geodes deployed on a survey are connected via satellite that enables rapid delivery of data and 3D subsurface model.)
Source: Fleet Space Technology

Fleet Space Technology's ExoSphere ambient noise tomography (ANT) represents a data type that can assist in reducing exploration search space and has been also deployed in uranium exploration in the Athabasca Basin in Saskatchewan (**Figure 3**).

Should these technologies continue to advance at the same pace as in other fields, a wholly transformed uranium mining industry may emerge. However, this is likely to take time. The adoption and implementation of new technologies warrant considerable capital investment to advance from applications at a prototype level to commercially proven and fully integrated systems within the exploration and mining life cycle.

Final Thoughts

As energy security and decarbonization remain global priorities, nuclear energy and uranium will play a crucial role in shaping the future energy landscape.

Assuming supply chains fragment further and many countries take a more protectionist outlook, this is likely to add a new layer of complexity to the uranium mining landscape, which has been historically multifaceted. It requires uranium players to revisit how they prioritize efforts, diversify their geographical targets, divide investment between greenfield and brownfield deposit development, and optimize the tools at their disposal for success.

On the upside, political and technological support for the uranium sector is growing in some countries, which creates opportunity. Supportive policies and a high level of capital investment for uranium exploration, development, and production will be crucial in reshaping the uranium mining industry's role.

Technological advancements in uranium mining will drive efficiency and productivity, while sustainability will have to remain a strategic priority. The industry's commitment to workforce development, community investment, and decarbonization will be also important for long-term success.

Although global political and trade turmoil is creating uncertainty in the outlook for the uranium industry, with supportive policies and diversification, and by embracing innovative exploration and extraction, the uranium mining sector will be able to grow and provide supply options resilient to political shifts. Nevertheless, the industry must take the lead to seize the opportunities.