Sujet traité : Un aperçu du marché de l'uranium / An Overview of The Uranium Market

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Special Report

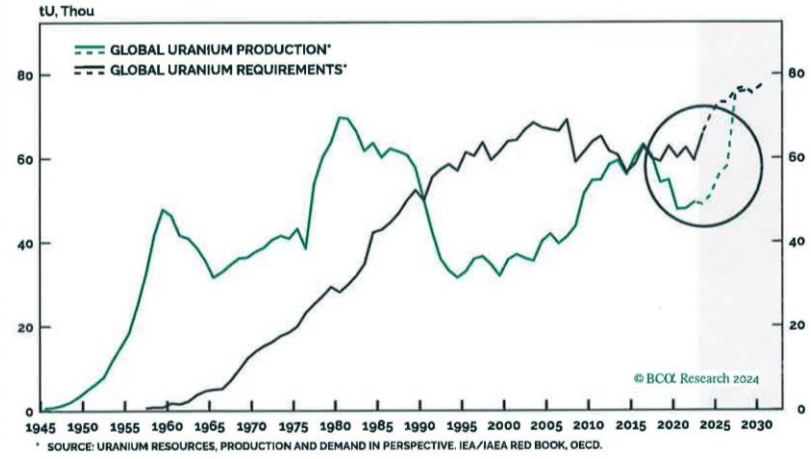
An Overview Of The Uranium Market

In this Issue

Executive Summary

- Uranium is the unsubstituted fuel source for 10% of the world's electricity.
- Yet, the uranium market is part of a small industry with a few actors, most of whom are state-owned companies.
- The supply deficit that formed in 2018 is here to stay.
- Supply will remain tight in the near term regardless of how high uranium prices get on the spot market given how capital-intensive the industry is.
- Meanwhile, the expansion of the global nuclear reactor fleet, led by China, continues. By 2030, annual uranium demand is expected to increase by 18% from current levels "...once nuclear reactors under construction, hit the grid."
- The current geopolitical context continues to exacerbate the supply deficit in the market.

The Uranium Supply Deficit Is What You Should Focus On In That Space



* SOURCE: URANIUM RESOURCES, PRODUCTION AND DEMAND IN PERSPECTIVE. IEA/IAEA RED BOOK, OECD.

Bottom Line: The uranium market is at a crossroads of economics and geopolitics. As the global nuclear reactor fleet continues to expand, adding to the demand for uranium, supply will remain tight in the near term. The geopolitical tensions between Russia and the West are making matters worse, especially on the supply side, and are shedding light on the urgent need for more geopolitical and commercial diversity in the industry.

An Overview Of The Uranium Market

This is the first of two reports on the uranium market. The present report provides an overview of the uranium market, introducing factors influencing prices. In a follow-up report, we will explore the fundamentals supporting a new uranium bull market.

Thank you for your readership.

Discovered in 1789, uranium was named for the recently unearthed planet at the time, Uranus, itself named after the Greek primordial deity of the sky. A fitting name for a revolutionary discovery. Cosmochemists posit that the Earth's uranium was either produced in one or more supernovae or by the merger of two neutron stars.[1]

For many years, uranium was used primarily as a colorant for ceramic glazes and for tinting in early photography. The metal's radioactive properties would be discovered a century later, and it would still take a few decades before the first sustained nuclear reaction was achieved under the Manhattan Project in 1942. An entirely new industry was born, and uranium found a market.

So, what is uranium? Natural uranium consists primarily of two isotopes: 99.27% is U-238 and 0.71% is U-235. Only U-235 is fissile – that is, capable of undergoing fission. Uranium occurs naturally in low concentrations in soil, rock, and water, and is about 500 times more abundant than gold and about as common as tin ore.

The uranium market is truly fascinating. From an energy standpoint, uranium is the unsubstituted fuel source for 10% of the world's electricity, and yet, from a commercial standpoint, the market comprises of only a handful of actors. From a supply/demand standpoint, 75% of the production of uranium comes from countries that consume no uranium at all, while 70% of global consumption comes from countries which do not produce any. This brings us to what is perhaps the most fascinating part: Geopolitics and uranium are inseparable. As discussed in the remainder of this report, geopolitics have shaped the uranium market, from its origins and key events in its short history, to the near-term outlook for the current supply deficit.

A Brief History Of Uranium Supply And Demand

In its teenage years, the uranium market only catered to military needs. It would take more than a decade after the first commercial nuclear power plant was operated, the Calder Hall-1 unit in the UK in 1957, before the demand from nuclear power plants started to matter.

[1] https://www.world-nuclear.org/information-library/nuclear-fuel-cycle/uranium-resources/the-cosmic-origins-of-uranium#:~:text=The%20Earth's%20uranium%20had%20been,enriched%20in%20the%20continental%20crust.

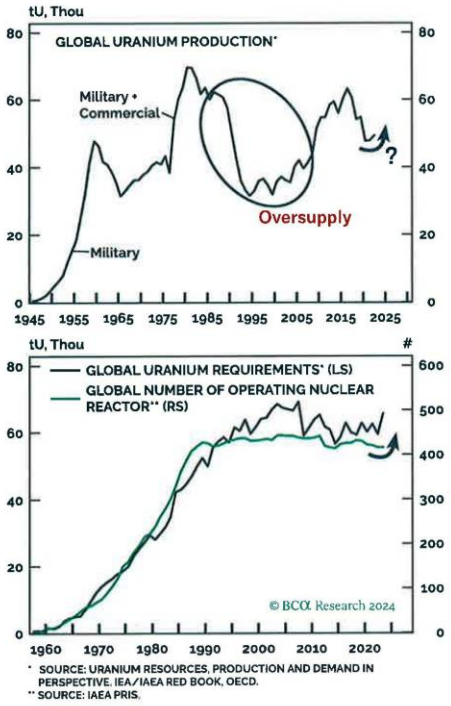
The rapid expansion of nuclear power plants starting in the late 1960s and the nuclear arms race between the US and the USSR during the Cold War eventually led to a peak in global uranium production in 1980 (**Chart 1**).

The end of the Cold War ultimately led to an oversupply of uranium. Not only did the nuclear arms race end, and with it a major source of demand, but the dismantlement of US and ex-Soviet warheads and government sales of excess uranium supply provided a large amount of secondary supply in the spot market. The *Megatons To Megawatts* program is estimated to have added about 7,700 tonnes of uranium (20 Mlbs U3O8) a year from 1993 to 2013, while the US Department of Energy's excess uranium management plan added more than 19,000 tU (50 Mlbs U3O8) in the spot market between 2008 and 2017.

By 1994, global uranium production had fallen 55% from its peak, right around the time when the global nuclear reactor fleet started to plateau. And as the market was working through all of the excess supply, the early 2000s saw the rapid and unforeseen rise of Kazakhstan, who would soon become the world's largest producer - the OPEC of uranium (**Chart 2**).

CHART 1

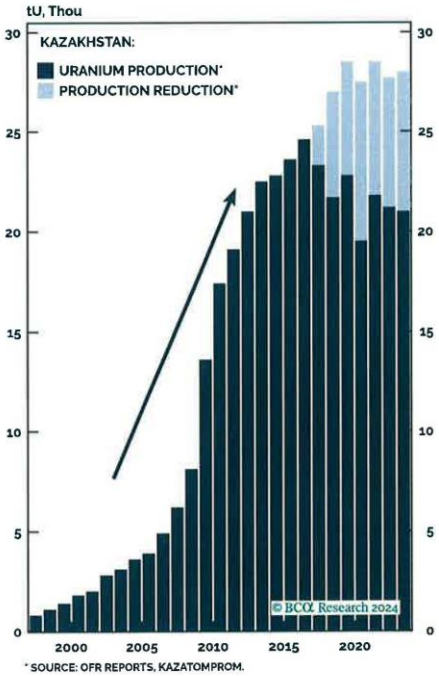
Uranium Market: From 1942 To Today



* SOURCE: URANIUM RESOURCES, PRODUCTION AND DEMAND IN PERSPECTIVE, IEA/IAEA RED BOOK, OECD.
** SOURCE: IAEA PRIS.

CHART 2

The Rise Of Kazakhstan



* SOURCE: OFR REPORTS, KAZATOMPROM.

Two accidents hit the nuclear industry hard in 2010/2011: Germany started phasing out its nuclear fleet and Japan shut down all 54 of its reactors after the Fukushima Daiichi accident. Japan and Germany represented about 10% and 5% of global demand for uranium, respectively.

That would be the straw that broke the camel's back for the uranium market. In the following years, uranium exploration and development expenditures collapsed (**Chart 3**), existing uranium mines went into care and maintenance, and producing countries such as Kazakhstan implemented disciplined supply cuts. In the meantime, annual uranium demand dwindled as countries around the world started questioning the future of their own nuclear reactor fleets.

The only ray of sunshine in these dark times came from China and its ambitious nuclear energy plan, which led to the quadrupling of its nuclear capacity between 2010 and 2018 (**Chart 4**). In the end, even China's insatiable appetite for uranium was not enough to prevent the formation of a supply deficit starting in 2018.

This brings us to the state of the uranium market today. The positive momentum building around nuclear energy since the 2022 energy crisis, including but not limited to the *Declaration to Triple Nuclear Energy* signed at the United Nations COP28 in Dubai last December, already has implications for both supply and demand.

CHART 3

An Abandoned Mining Industry

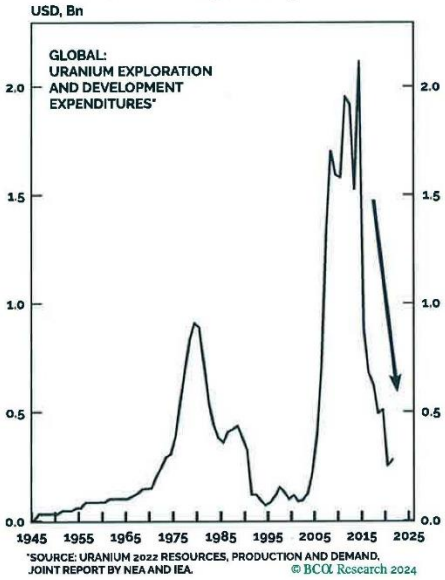
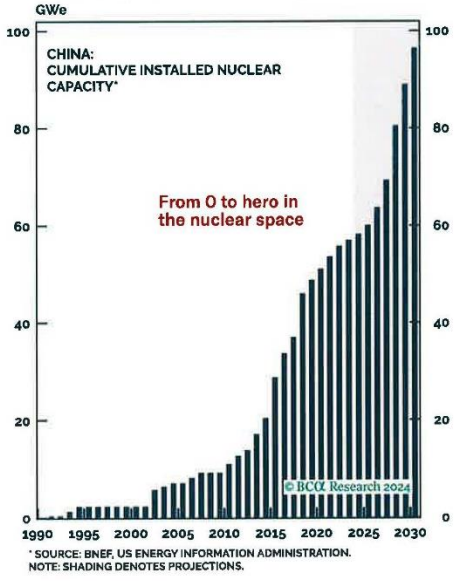


CHART 4

China's Rapid Nuclear Fleet Expansion



The Uranium Market Today

Uranium Production

Despite being the unsubstituted fuel source for 10% of the world's electricity, the uranium industry is rather small and highly concentrated all along the nuclear fuel cycle.

Only 15 countries produce uranium, with the top five producers accounting for 85% of world production (**Chart 5**, top panel). For the most part, ownership of uranium production is state-owned, whether the mining companies are domestic (45%) or foreign (36%). The private sector claims less than 20% of world production (**Chart 5**, panel 2). In China, Russia, and Uzbekistan, state-owned companies CNNC, ARMZ, and Navoi Mining claim full ownership. The largest uranium mine, Cigar Lake, is located in Canada and produced nearly 15% of global uranium in 2022, while the largest mines accounted for more than 55% of world production (**Chart 5**, panel 3). The largest identified resources recoverable are located in the same club of countries (**Chart 5**, bottom panel).

Conversion & Enrichment

Once mined, uranium ore is milled, turning it into uranium oxide (U3O8, also referred to as yellowcake) – and this is the uranium that is actually sold to utility companies. Since most nuclear power plants require fuel with a U-235 concentration between 3%-to-5%, but natural uranium only contains 0.71% U-235, the U-235 concentration has to be increased, or enriched. To be suitable for enrichment, yellowcake needs to be converted into gaseous form - uranium hexafluoride (UF6).

There are only five conversion plants operating commercially worldwide, and only four enrichers (**Chart 6**). Conversion and enrichment are capital intensive, and it usually takes three-to-five years to expand capacity. This means that either of these steps can rapidly turn into chokepoints for the nuclear industry. At least enrichers have the option to artificially increase capacity by "overfeeding," which means they are pushing more uranium into their centrifuges while using less energy (or separative work units). This is the case today with Western enrichers Urenco and Orano, which are confronted with a pickup in new enrichment contracts as many utility companies shy away from Russian state-owned Rosatom.

Overfeeding, however, implies that enrichers are using more uranium (UF6 at this stage) than was provided to them by the utility companies and have to buy more uranium on the market to make up for it. They do so by raising enrichment prices.

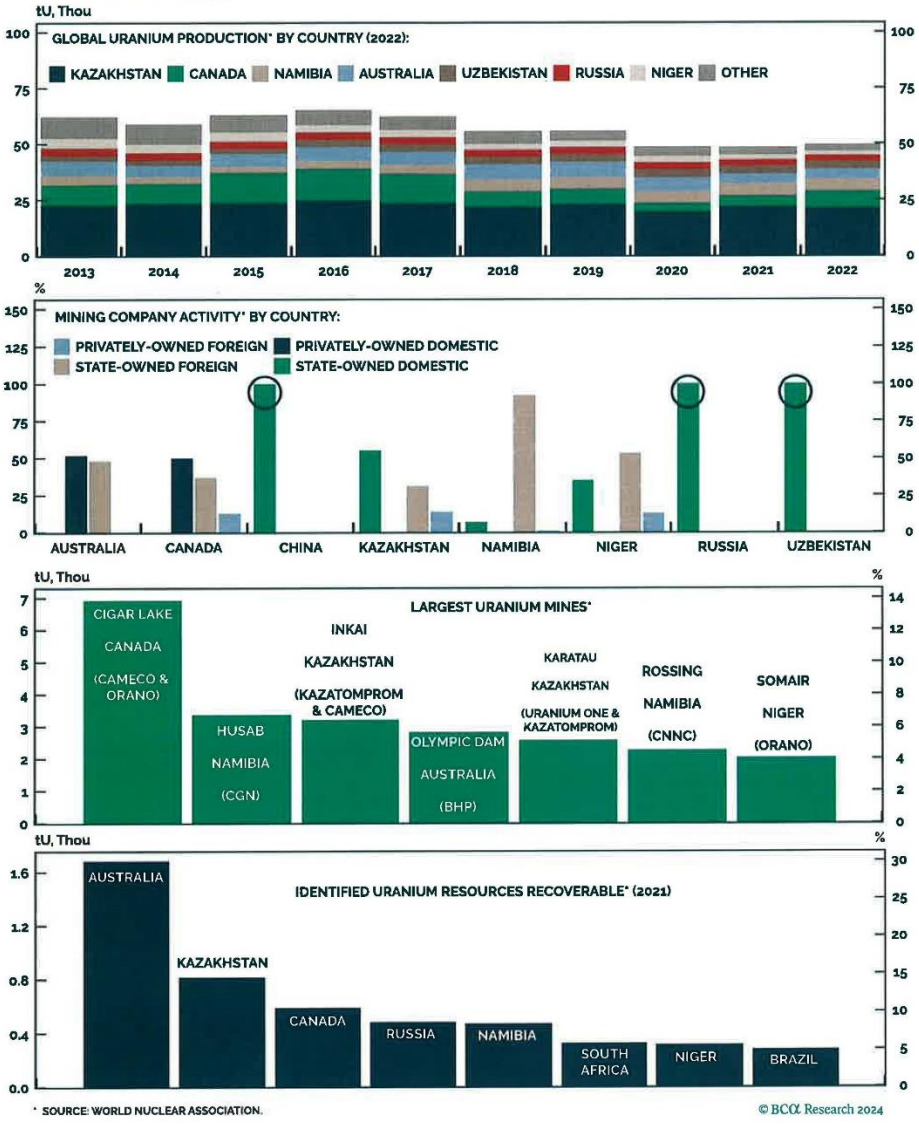
Uranium Demand

For the past 30 years, uranium has been almost exclusively used to produce fuel for commercial nuclear reactors. As a result, uranium demand has become rather predictable, being determined, to a large extent, by the number of nuclear reactors in operation and under construction.

There are 416 nuclear reactors currently in operation – for a net installed capacity of 375 GWe. According to the World Nuclear Association, the global operating nuclear reactor fleet will require 67,500 tonnes of uranium (175 Mlbs) in 2024. With 94 nuclear reactors, the US still operates the largest

CHART 5

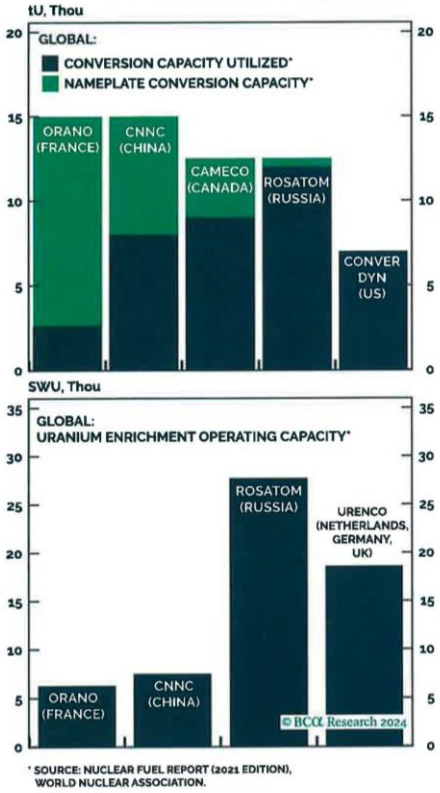
Global Uranium Supply



* SOURCE: WORLD NUCLEAR ASSOCIATION.

CHART 6

Small Circle Of State-Owned Companies



* SOURCE: NUCLEAR FUEL REPORT (2021 EDITION), WORLD NUCLEAR ASSOCIATION.

fleet in the world requiring 18,000 tU per year, or 27% of global uranium demand (**Chart 7**, top panel), followed by China and France. In recent years, China has been ramping up its purchases of uranium to match its nuclear fleet expansion. Of the 61 reactors under construction around the world, 26 are being built in China (**Chart 7**, bottom panel).

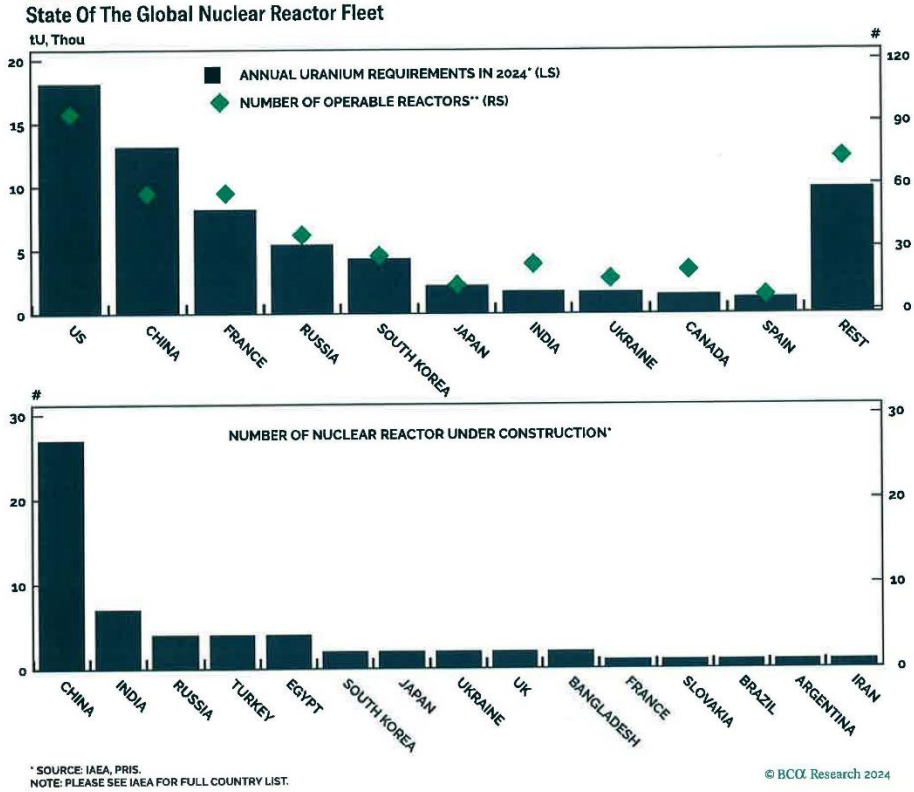
Other factors related to the operational performance of installed nuclear reactors have an impact on near-term uranium demand (**Table 1**):

- **Fuel cycle length:** Light water reactors and boiling water reactors typically operate on 12-month and 18-month cycles, respectively. Extending fuel cycle length by six-to-twelve months increases uranium requirements between 7% and 18%.
- **Capacity factor:** Capacity factor measures how often a nuclear plant is running at maximum power, or reference power capacity. A five percentage-point increase in capacity factor leads to a 6% increase in uranium required.
- **Burnup:** Burnup is an efficiency measure. It refers to how much energy is extracted from nuclear fuel, measured by actual energy released per mass of initial fuel (or GWd/tU). All else equal, a higher burnup reduces refueling outages, which means lower uranium requirements.
- **Tails assay selected:** The tails assays indicate the percentage of U-235 the waste stream contains. Historically, it has been around 0.2 tails. An increase in the tails assay implies an increase in the quantity of uranium feed used during the enrichment process.

Bottom Line: The uranium market is part of a small industry, relative to its importance. Few actors are involved, and most are state-owned companies. Several parts of the market are capital intensive; it usually takes several years for exploration,

CHART 7

State Of The Global Nuclear Reactor Fleet



* SOURCE: IAEA, PRIS.
NOTE: PLEASE SEE IAEA FOR FULL COUNTRY LIST.

TABLE 1

Other Factors Impacting Uranium Demand

FACTOR	BASE VALUE	CHANGE	IMPACT ON URANIUM REQUIREMENTS
FUEL CYCLE LENGTH	12 MONTHS	+6 MONTHS	+7%
		+12 MONTHS	+18%
CAPACITY FACTOR	80%	+5%	+6%
		-5%	-6%
BURNUP	40 GWd/tU	+5 GWd/tU	-3%
		+10 GWd/tU	-4% / -5%
TAILS ASSAYS	0.25%	+0.03%	+6%
		-0.03%	-6%

SOURCE: WNA, 2019; NEA/IAEA ESTIMATE.

mine development, conversion, and enrichment to expand capacity. Unlike supply, uranium demand is more or less predictable and is largely determined by nuclear reactors in operation and under construction.

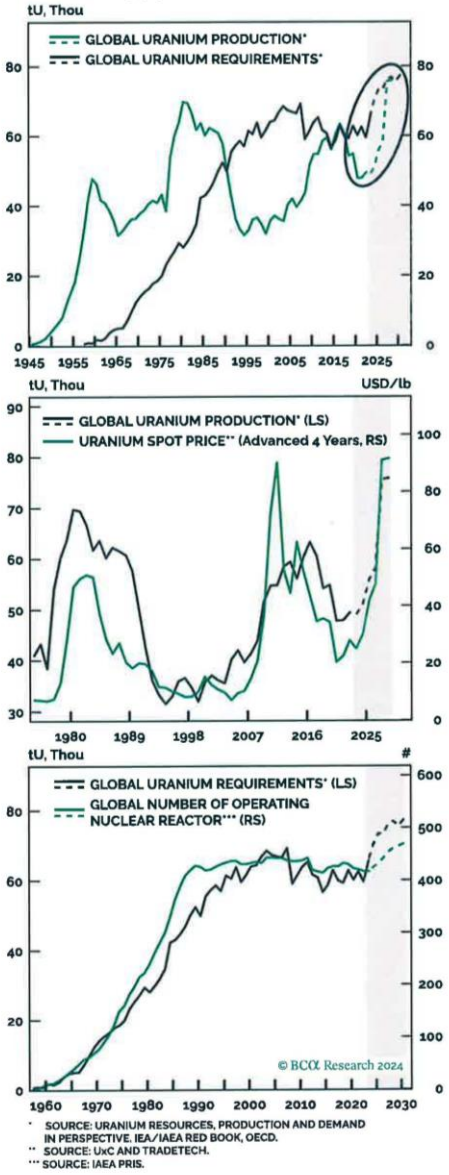
Global Uranium Squeeze Amid Rising Geopolitical Tensions

Since 2018, global nuclear reactor requirements have averaged 61,000 tU (150 Mlbs) per year but miners have only produced 51,000 tU (132 Mlbs). This structural supply deficit is here to stay (**Chart 8**).

Supply will remain tight in the near term, regardless of how high uranium prices rise on the spot market. Exploration and mine development do not happen overnight, and it takes several years for conversion and enrichment capacity to expand. Historically, global uranium production responds to uranium prices with a four-year lag (**Chart 8**, panel 2). However, current price levels would imply a new all-time high in production, a very optimistic scenario that would need many things to go right to happen.

There is far less uncertainty as to what future uranium demand will look like. Most nuclear reactors currently under construction are expected to hit the grid before 2030, and each new GWe of capacity (think of a large nuclear reactor operating for a year) adds around 150 tU per year of additional demand, and about two-to-three times this amount for the first fuel load.

CHART 8
Uranium Supply Deficit



* SOURCE: URANIUM RESOURCES, PRODUCTION AND DEMAND IN PERSPECTIVE. IEA/IAEA RED BOOK, OECD.
** SOURCE: UxC AND TRADETECH.
*** SOURCE: IAEA PRIS.

Doing the math for 53 new nuclear reactors expected to hit the grid between now and 2030, for a gross capacity installed of 61 GWe: Global uranium requirements would reach 77,000 tU by 2030, an 18% increase from current levels (**Chart 8**, bottom panel).

The current geopolitical context is not helping. Once more, the uranium market finds itself at the center of a geopolitical battleground involving the US and Russia.

The Russia/Ukraine war triggered a brutal reset of energy security, while it reminded nations that nuclear energy offers geopolitical stability in a multipolar world.

As shown earlier, state-owned Rosatom is one of the very few companies in the world to have mastered the entire nuclear fuel cycle. Through it, Russia controls 30% of conversion and 45% of enrichment global capacity. It also contributes 5% of global uranium production and sits on 8% of total identified uranium resources recoverable. In other words, Russia's nuclear power program transcends its own borders, which poses a risk to the West, especially the US.

The *Prohibiting Russian Uranium Imports Act*, signed into law earlier this month by President Biden, aims to de-risk the US nuclear energy supply chain from Russia while reshoring key activities at home. Cutting ties with Russia is proving more difficult for Europe given a higher level of integration with Rosatom, especially for Eastern European countries.

In the meantime, the conflict in Ukraine continues to cause transportation risks in the region, as the Trans-Caspian International Transport Route is used to move uranium to avoid Russian infrastructure.

Bottom Line: The uranium market is at a crossroads of economics and geopolitics. As the global nuclear reactor fleet continues to expand, adding to the demand for uranium, supply will remain tight in the near term. The geopolitical tensions between Russia and the West are making matters worse, especially on the supply side, and are shedding light on the urgent need for both geopolitical and commercial diversity in the industry.

Jeremie Peloso, CFA
Associate Vice President
JeremieP@bcaresearch.com