OCEAN WALL

THE CASE ON URANIUM

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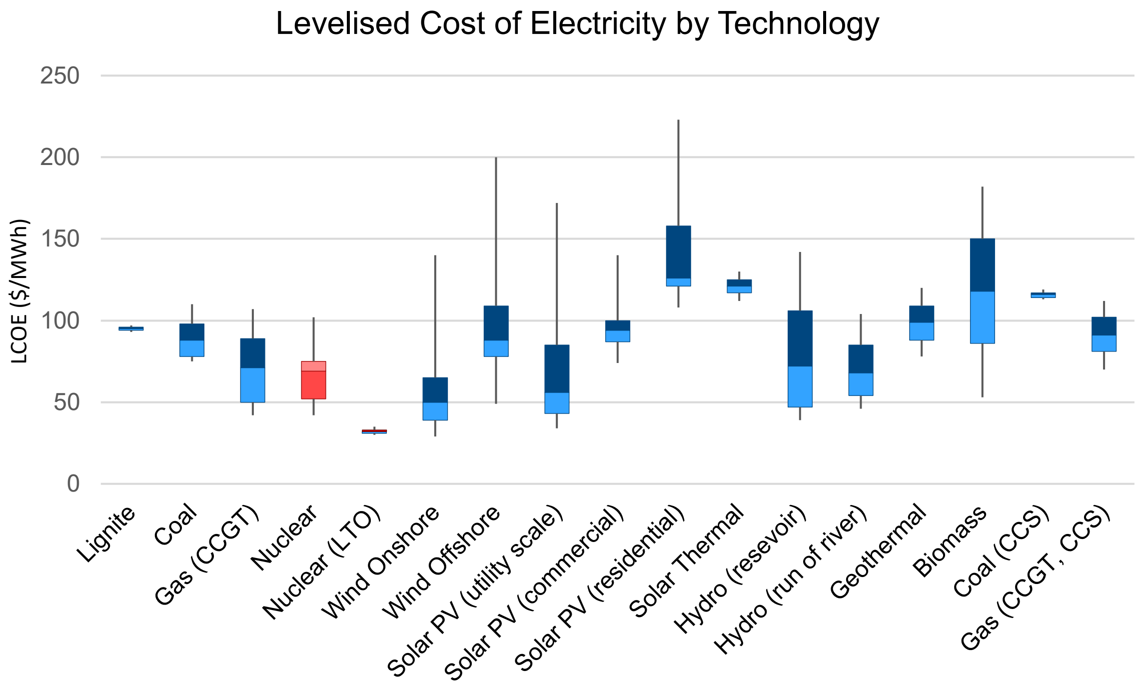
CONTENTS

THE THESIS

"I have spent 37 years in this wonderful uranium and nuclear energy industry. We've gone through all the highs and lows; I have to say we are probably in the most exciting phase in the nuclear energy industry's history in these years that lie ahead of us." – Scott Melbye, Uranium Royalty Corp & VP, Uranium Energy Corp

Nuclear energy is enjoying a renaissance. There is now an almost global political consensus that it presents a scalable, non-intermittent and zero-carbon solution. Intermittent power sources such as wind and solar cannot be relied on for continuous energy output and do not supply the same baseload power that nuclear energy can produce. One only needs to look at the images of frozen wind turbines in Texas in 2021 to visualise the importance of non-intermittency. Additionally, nuclear power presents one of the lowest operating costs and is extremely energy dense. One of the US' largest utilities, Constellation Energy, reported that it had 21 nuclear reactors operating at a 98.1% capacity factor during the months of June, July and August of 2024, providing around-the-clock power to its consumers.



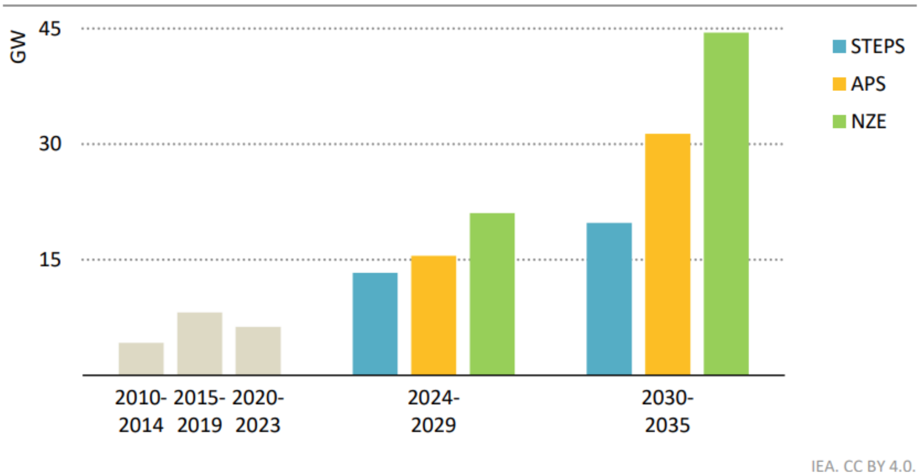
Source: IAEA

Currently ~10% of the world's electricity is delivered using nuclear energy. With the 'electrification of everything' and advancement in nuclear energy delivery through next generation reactors, there is a compelling proposition presented in terms of cost, scalability, and sustainability.

As COP28 only reinforced, all economies are coming under increasing scrutiny to deliver on initiatives to accelerate reductions in CO_2 output and meet the Paris climate goals. The US, EU, UK, France, Japan, Canada have all pledged to achieve carbon neutrality by 2050, with China committing to reach carbon neutrality by 2060. In addition, at COP28 in December 2023, 22 countries, including the UK, US, and Japan, pledged to triple global nuclear energy capacity by 2050 (from 2020 levels). This commitment was further expanded at COP29 in November 2024 when six additional countries—El Salvador, Kazakhstan, Kenya, Kosovo, Nigeria, and Turkey—joined the declaration, bringing the total number of signatories to 31.

Over 30 countries are now working with the International Atomic Energy Agency (IAEA) to explore introducing or expanding nuclear power capacity. The IAEA forecast nuclear-generation capacity to at least double by 2050.

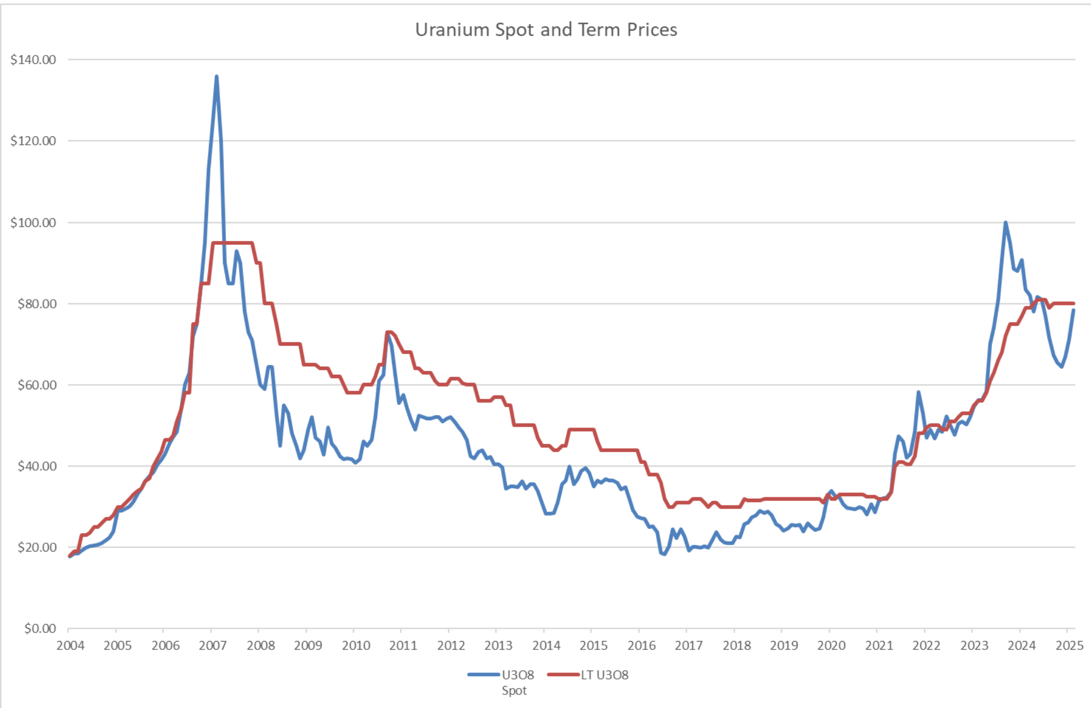
Annual Average nuclear power capacity additions by scenario, 2010-2035



Nuclear capacity additions accelerate in all scenarios, with China accounting for 40% of global additions in the STEPS by 2035 and nearly 50% in the NZE Scenario

Source: IEA

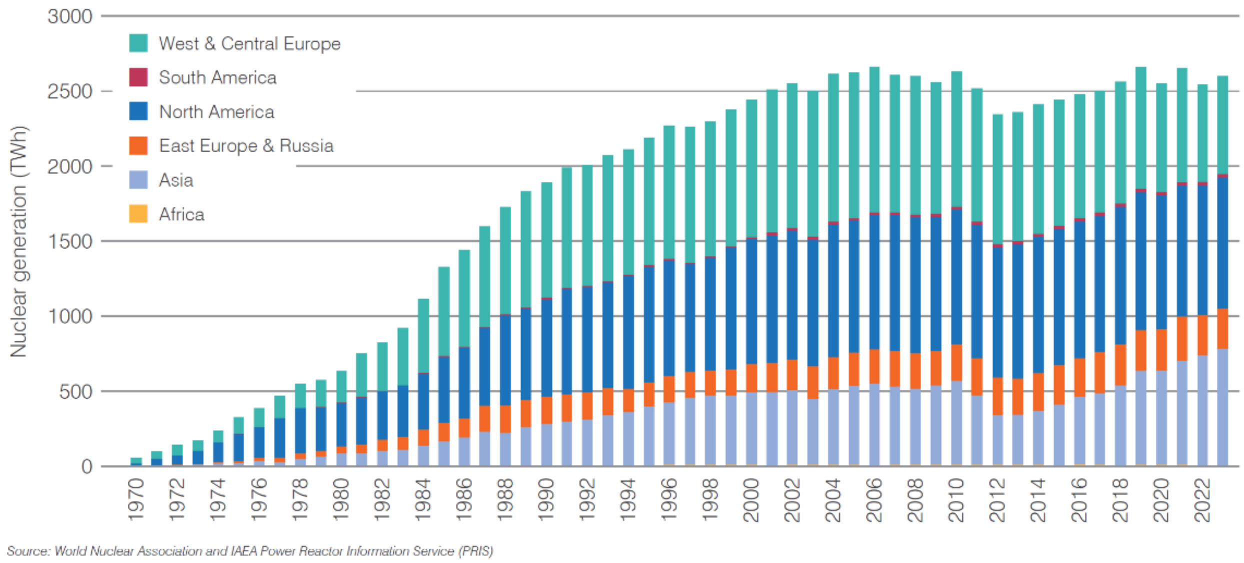
The host of benefits nuclear presents are becoming too apparent to ignore, particularly considering rising global energy prices and more frequent power outages. As the world concentrates on natural gas and oil prices, uranium (the fuel needed to run nuclear reactors) has quadrupled in the past 5 years. The move follows a 10-year secular bear market after the nuclear accident at the Fukushima Daiichi nuclear power plant in 2011. Having hit highs of ~$140/lb in 2007, uranium hit lows of $19/lb post Fukushima. The uranium spot price has since nearly than quadrupled and stabilised at $70-75/lb, reaching as high as ~$106/lb at the start of 2024.



Source: UxC

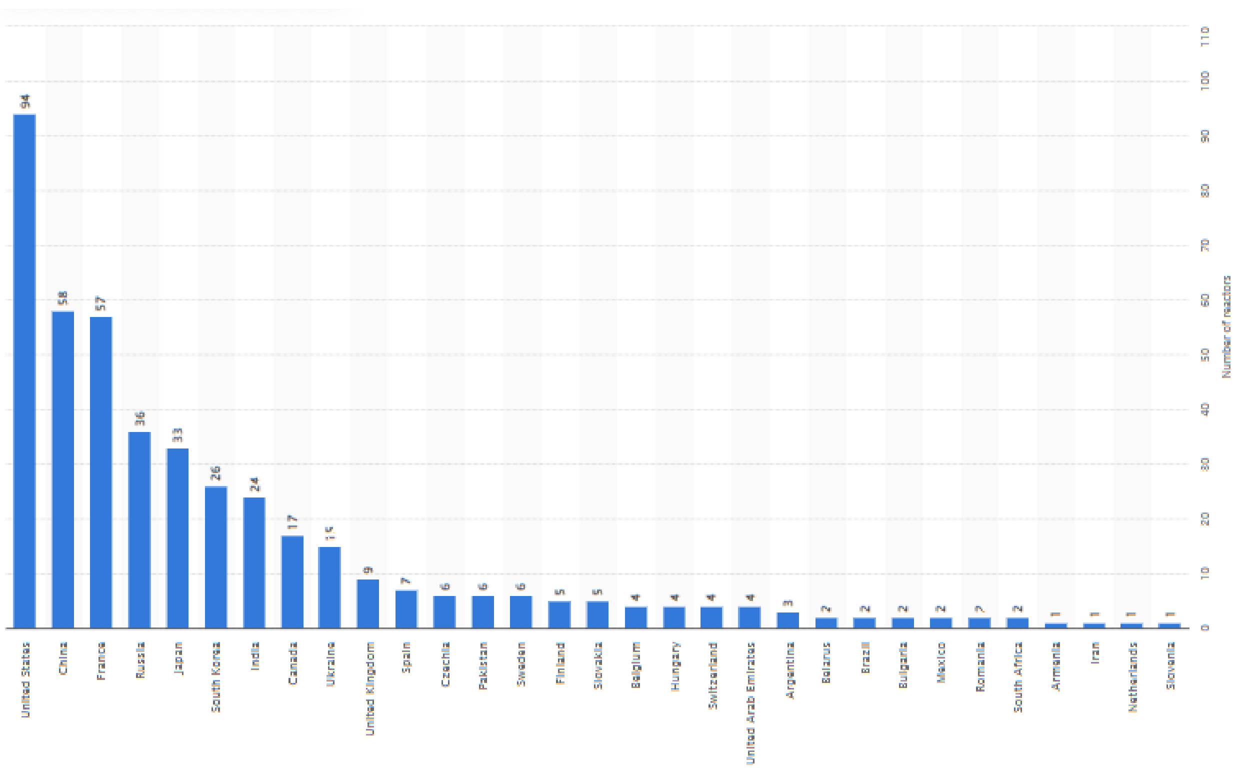
After Fukushima, the Japanese decommissioned their nuclear fleet and flooded the uranium spot market with inventory. As the chart shows, prices collapsed, approaching distressed levels that saw most uranium mining operations become cost ineffective. Incentive prices differ by location and company (e.g., Kazatomprom c.$30/lb compared to Cameco c.$80-90/lb), the average breakeven of a Western uranium mine was previously around $50-55/lb, however, given recent supply chain disruption and cost inflation, this is now estimated to be as high at $90/lb for operable mines, and $100/lb for greenfield production. Just as rising uranium prices have a compounded effect incentivising exploration and mining activities so too falling prices have the reverse effect and only in the past 3-4 years has investor capital begun to return.

Nuclear electricity production 1970-2023



Source: World Nuclear Association

As of July 2025, there are 439 operable nuclear reactors worldwide, 69 reactors under construction, a further 114 reactors planned, and 298 proposed. New plants coming online in recent years have largely been balanced by old plants being retired. Over the past 20 years, 107 reactors were retired as 100 started operation.



Source: Statista, Ocean Wall

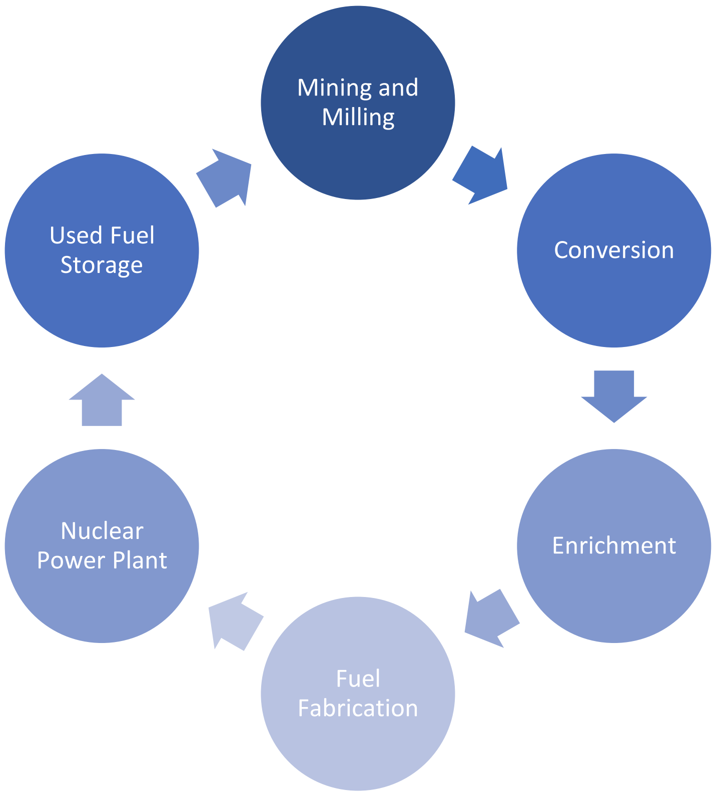
While there are standard designs for reactors such as Light Water Reactors in the US, and VVER reactors out of Russia, the common theme among them is that many are starting to age, with a production ramp up flattening out in the late 1980s.

As less uranium was required post-Fukushima, exploration companies and miners curtailed their operations because even though capacity was there, demand was not. Uranium is now in a long-term structural supply deficit to the tune of ~50m lbs a year, creating a significant draw on global inventories.

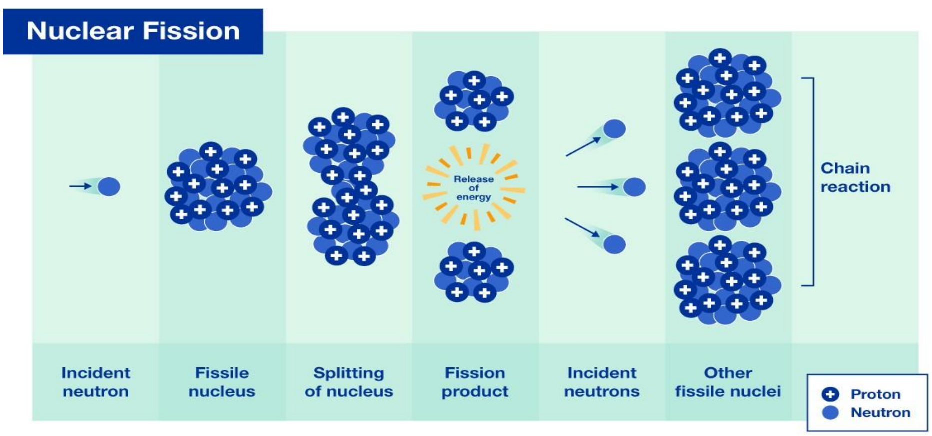
Primary supply is unlikely to reach previous levels even when the spot price exceeds incentive levels as idle mines take up to 2 years to restart due to government approvals, safety checks, capital, workers, and machinery all needs to be reengaged. In addition, exploring, permitting, developing, and putting into production a new mine can take as over ten years. Many contracts are coming to an end which will see utilities sign new contracts at above market prices.

THE NUCLEAR FUEL CYCLE

The nuclear fuel cycle describes the entire process of converting natural uranium (the raw material) to serviceable nuclear fuel. The infographic below outlines this process:



The atomic nucleus of U-235 will nearly always fission when struck by a free neutron, and the isotope is therefore said to be a "fissile" isotope. The nucleus of the U-235 isotope comprises 92 protons and 143 neutrons (92 + 143 = 235). When the nucleus of a U-235 atom is split in two by a neutron, some energy is released in the form of heat, and two or three additional neutrons are thrown off. If enough of these expelled neutrons split the nuclei of other U-235 atoms, releasing further neutrons, a chain reaction can be achieved. When this happens repeatedly, many millions of times, a very large amount of energy is released using a very small amount of uranium.



EXPLORATION

Geiger counter was the original radiation detector, recording the total count rate from all energy levels and scintillation counters.

Airborne radiation detectors or spectrometry are also methods used when surveying potential uranium deposits. Airbourne geophysics has evolved to permit deeper analysis and more resolute data extraction to better identify radioactive material.

Upon identification of radioactivity, geologists conduct ground surveys to pinpoint the best options to begin drilling.

EXTRACTION

Natural, or unenriched, uranium is removed from the earth in the form of ore and then delivered to a mill where it is crushed and concentrated before chemicals are added to dissolve the uranium. Naturally occurring uranium consists primarily of 0.71% isotope U-235.

MINING

- In Situ Recovery (ISR) – Recover uranium via boreholes drilled into the deposit. Dissolving the minerals by pumping sulphuric acid into the ore body via a borehole which dissolves the ore and is extracted via a second borehole. As of 2020, 57% of world uranium mined was by ISR methods. Most uranium mining in the USA, Kazakhstan and Uzbekistan deploys this method. ISR is used by Kazatomprom, the world's largest uranium producer, as well as large developers such as Uranium Energy Corp and enCore Energy. The process has environmental considerations at its core, and is considered the most environmentally friendly, and cost-efficient uranium extraction method.
- Heap Leach - The mined ore is usually crushed into small chunks and heaped on an impermeable plastic or clay lined leach pad where it can be irrigated with sulphuric acid to dissolve the valuable metals.
- Open Pit Mining – Also known as strip mining, the open pit method removes surficial soil and waste rock to get at the ore body beneath. Ore grades associated with this method are usually lower, and typically this type of mining is only possible at depths of up to 400 ft.
- Underground Mining - Underground uranium mining is in principle no different from any other hard rock mining and other ores are often mined in association (e.g., copper, gold, silver). The ore is drilled, then blasted to create debris, which is then transported to the surface, then on to a mill. This method is used to get higher grades of uranium that are too deep for open-pit mining.

MILLING

- Mined uranium ores are normally processed by grinding the ore materials to a uniform particle size and then treating the ore to extract the uranium by chemical leaching.
- The milling process commonly yields dry powder-form material consisting of natural uranium, "yellowcake", which is sold on the uranium market as U_3O_8.

CONVERSION

Usually milled uranium oxide, U_3O_8 is then processed into either of two substances depending on the intended use. For use in most reactors, U_3O_8 is usually converted to uranium hexafluoride (UF_6), the input stock for most commercial uranium enrichment facilities. A solid at room temperature, uranium hexafluoride becomes gaseous at 57 °C (134 °F). At this stage of the cycle, the uranium hexafluoride conversion product still has the natural isotopic mix (0.71% of U-235).

Conversion supply is extremely concentrated. With the closure of the Springfields plant in 2014, ~80% of the conversion needs for the West came from three facilities: Orano's COMURHEX (France), Cameco's Port Hope (Canada), and ConverDyn's Metropolis (US). There are other very small conversion facilities, but most of the balance of the world's UF_6 comes from Russia and China.

ENRICHMENT

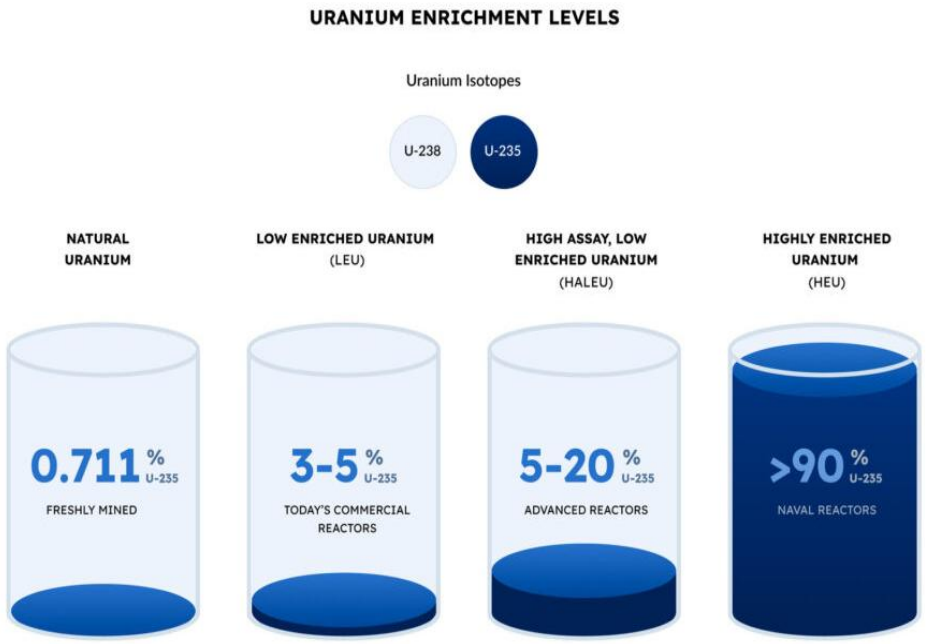
The natural concentration (0.71%) of the fissionable isotope U-235 is less than that required to sustain a nuclear chain reaction in light water reactor cores. Accordingly, UF6 produced from natural uranium sources must be enriched to a higher concentration of the fissionable isotope before being used as nuclear fuel in such reactors.

The level of enrichment for a particular nuclear fuel order is specified by the customer according to the application they will use it for: light-water reactor fuel normally is enriched to 3.5% U-235, but uranium enriched to lower concentrations is also required. Enrichment is accomplished using any of several methods of isotope separation. Gas centrifuge is the most common uranium enrichment method, but new enrichment technologies are currently being developed such as SILEX (global laser enrichment) and Quantum Enrichment (ASP Isotopes).

HALEU

In connection with a number of Small Modular Reactor (SMR – more on this later) designs, attention is turning to the need for high-assay low-enriched uranium (HALEU), with enrichment levels between 5%-19.75% U-235.

HALEU can be produced with existing centrifuge technology, but a number of arrangements would need to be made for this, as well as for deconversion and fuel fabrication. New transport containers would also be required as those for today's enriched UF6 could not be used due to criticality considerations.



Source: Centrus Energy

UNDER AND OVERFEEDING

In the uranium enrichment process, underfeeding and overfeeding refer to how operators balance the use of natural uranium (feed) against enrichment effort (measured in Separative Work Units, or SWU). These approaches affect both fuel production efficiency and uranium inventory levels.

Underfeeding occurs when enrichment facilities use less natural uranium but apply more SWU to extract additional U-235 from the same material. This is typically chosen when uranium prices are high and enrichment capacity is readily available. It results in lower uranium consumption, meaning inventories are drawn down more slowly, while demand for enrichment services increases.

Overfeeding, by contrast, involves using more natural uranium and applying less SWU to achieve the required enrichment levels. This method is preferred when uranium is relatively cheap or enrichment capacity is constrained (e.g., due to supply disruptions or limited global capacity). Overfeeding leads to faster depletion of uranium inventories and lower SWU usage.

The choice between underfeeding and overfeeding is highly responsive to market dynamics. When enrichment capacity is ample, utilities tend to underfeed, dampening uranium demand. When enrichment is tight, overfeeding becomes necessary, increasing natural uranium demand and accelerating inventory drawdown

FUEL FABRICATION

The Enriched Uranium Product ("EUP"), then needs to be converted to uranium dioxide (UO2) prior to pellet fabrication. Conditioned UO2 powder is fed into dies and pressed biaxially into a cylindrical pellet form using a load of several hundred MPa – this is done in pressing machines operating at high speed.

For most reactors, pellets are just under one centimetre in diameter and a little more than one centimetre long. A single pellet in a typical reactor yields about the same amount of energy as one tonne of steaming coal.

The physical structures for holding the fuel rods are therefore engineered with extremely tight tolerances. They must be resistant to chemical corrosion, high temperatures, large static loads, constant vibration, fluid, and mechanical impacts. Yet they must also be as neutron transparent as possible.

The fuel assemblies are loaded into nuclear reactors to create energy from a controlled chain reaction.

SPENT NUCLEAR FUEL

After the nuclear fuel has been in a reactor for several years its efficiency is reduced, and the assembly is removed from the reactor's core. The used fuel is warm and radioactive and is kept in a deep pool of water for several years.

Uranium comprises about 96% of used fuel. When used fuel is reprocessed, both plutonium and uranium are usually recovered separately.

Uranium recovered from reprocessing used nuclear fuel (RepU) is mostly U-238 with about 1% U-235, so it needs to be converted and re-enriched for recycling into most reactors. This is complicated by the presence of impurities and two isotopes, U-232 and U-236, which are formed by or following neutron capture in the reactor and increase with higher burn-up levels.

Approximately one-half of the spent nuclear fuel discharged annually around the world is slated for reprocessing, and the other half is slated for direct disposal.

REPROCESSING

Mixed uranium oxide + plutonium oxide (MOX) fuel has been used in about 30 light-water power reactors in Europe and about ten in Japan. It consists of depleted uranium (about 0.2% U-235), large amounts of which are left over from the enrichment of uranium, and plutonium oxide that derives from the chemical processing of used nuclear fuel (at a reprocessing plant). This plutonium is reactor-grade, comprising about one third non-fissile isotopes

REMIX (Regenerated Mixture) fuel is produced directly from a non-separated mix of recycled uranium and plutonium from reprocessing used fuel, with a LEU (up to 17% U-235) make-up comprising about 20% of the mix.

France's plutonium recycling program reduces its uranium requirements by only about 10 percent, which could be achieved at much less cost in other ways, such as by adjusting enrichment plants to extract a higher percentage of the U-235 isotopes in natural uranium. Second, with proper accounting, it is not at all clear that recycling produces a net reduction in the volume of radioactive waste requiring deep geological disposal.

DISPOSAL

Disposal of low-level waste is straightforward and can be undertaken safely almost anywhere. Storage of used fuel is normally under water for at least five years and then often in dry storage. Deep geological disposal is widely agreed to be the best solution for final disposal of the most radioactive waste produced.

REACTOR TYPES

Pressurised water reactors (PWRs) are the most common type of nuclear reactor accounting for two-thirds of current installed nuclear generating capacity worldwide.

Boiling water reactors (BWRs) are the second most common nuclear reactor type accounting for almost one-quarter of installed nuclear generating capacity. In a boiling water reactor, water is turned directly to steam in the reactor pressure vessel at the top of the core and this steam (at about 290°C and 7 MPa) is then used to drive a turbine.

Pressurised heavy water reactors (PHWRs) are originally a Canadian design (also called "CANDU") accounting for ~6% of world installed nuclear generating capacity.

The advanced gas-cooled reactor (AGR) is a second-generation UK-designed nuclear reactor only used in UK. AGRs account for about 2.7% of total global nuclear generating capacity.

INVENTORIES

Utilities can look to contract for fuel requirements multiple years ahead of time. This will affect market prices now as utilities look to secure fuel supply into the back end of the decade. Historically, inventories had been stockpiled and regularly replenished to satiate demand for uranium, however today, inventories held by some utilities are at risk of running out as the supply deficit for uranium widens year on year across the fuel cycle.

The IAEA recommend that utilities hold more than two years of inventory, while governments are not required to hold strategic stockpiles.

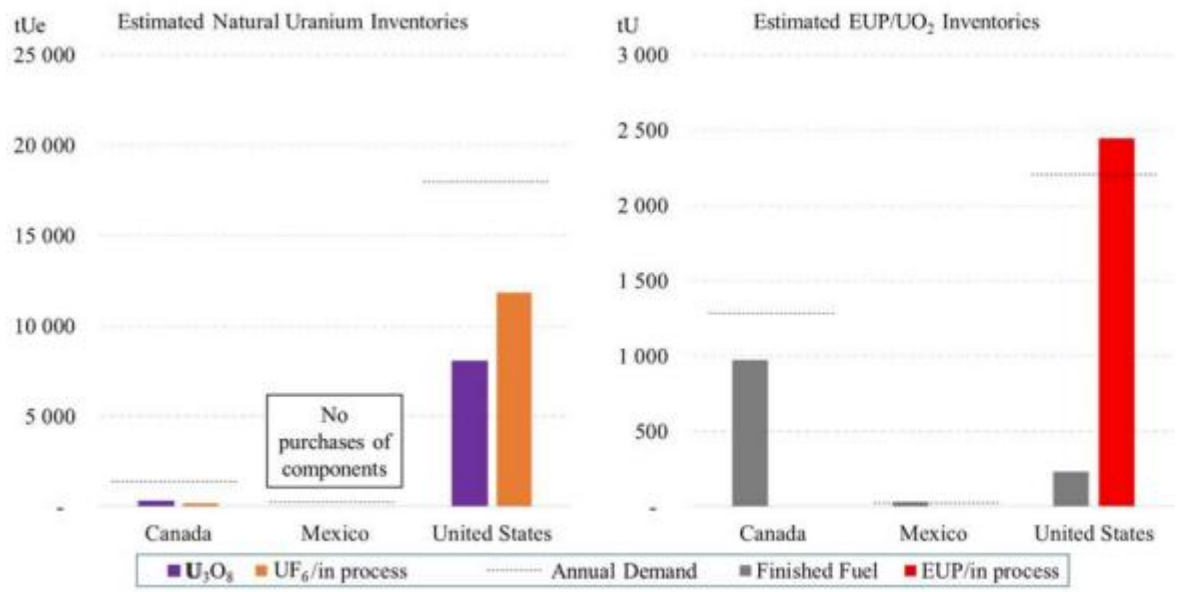
At the World Nuclear Fuel's conference in 2022, IAEA Department of Nuclear Energy Uranium Production Specialist, Adrienne Hanly, stated that "US utilities may have limited capability to independently manage a protracted supply disruption". Similarly, for the EU market, she warned that many individual EU utilities "fall far short" of the two-year benchmark.

According to the Latest EIA Uranium marketing report, US utility inventories at the end of 2023 were ~110m lbs U3O8e, about the same as was held in 2020. In 2023, total US commercial inventories (including those owned by reactor operators, brokers, converters, enrichers, fabricators, producers and traders/financials in the US) were 152 million lbs U_3O_8, reflecting a 6% increase from 2022. The largest holders of Uranium inventories are utilities:

Utiility inventory (Mlbs)			
United States Utilities		**Europe**	
U3O8	21.05	U3O8	10.77
UF6	30.93	UF6	21.04
		UO2	0.351
EUP	53	EUP	24.49
		Enriched UO2	3.14
Fabricated Fuel	5.01	Fabricated Fuel	38.14
Total	109.99	**Total**	97.931

Despite the steady headline inventory levels, a more detailed analysis by the IAEA reveals that US utility inventories are falling well below annual reactor demand requirements:

North American Utility Inventories 2023



Source: IAEA

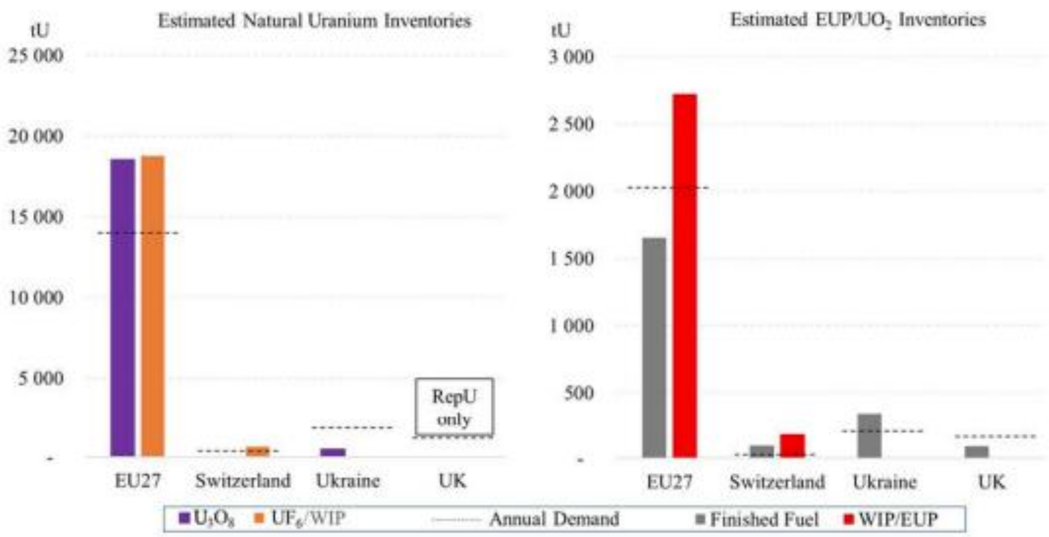
In the European Union, uranium inventories are slightly healthier, with inventory held by utilities averaging more than two years' fuel supply, and down around 7% since the end of 2018. EU utility inventories have declined for eight years in a row, dropping 30% since 2014. Total EU utility inventories were estimated to be ~98m lbs U3O8e at the end of 2023.

See below from the ESA's 2023 Annual Report:

"The ESA has long recommended that EU utilities maintain sufficient strategic inventories and use market opportunities to increase their stocks, depending on their individual circumstances. In contrast to the previous eight years, in 2023 the overall EU inventory level increased by 5.45%. Already in 2022, several utilities increased their stocks to manage the unstable market conditions following Russia's aggression against Ukraine. EU fresh fuel stocks grew by 15% over the course of 2023. In addition, there was a 13% increase in enriched uranium stocks held by utilities that – as part of security of supply measures – purchased higher quantities than required given the uncertainty of available open-market conversion and enrichment capacity in the coming years. All utilities have nuclear material in their inventory to cover between one to more than three reloads each, with the vast majority covered for more than two reloads. More than 60% of the inventory is kept in the form of enriched uranium or fresh fuel. Whether the inventory

level is sufficient for a particular utility depends on its profile and risk factors. The ESA considers that most utilities' inventories remain at a healthy level."

European Utility Inventories 2023



Source: IAEA

Given growing uranium requirements in Asia, particularly China, demand in this region could potentially surpass that of North America and the EU put together. UxC estimate that China have ~609.4m lbs of U3O8e stockpiled for their aggressive nuclear growth strategy (more on this later). While this may appear substantial, it falls short when viewed against future reactor fuel requirements. We estimate that China is expected to consume nearly 1 billion lbs between 2025 and 2040 alone, implying current holdings only cover about 11 years of forward demand. In this context, the inventory position appears underbuilt, not excessive, and reinforces expectations that China will continue securing material through both long-term contracts and joint ventures, particularly with key partners like Kazakhstan. This points to a structural tightening of mobile supply. Despite the headline size of China's stockpile, little of it is expected to return to the market.

Japanese owned materials have historically represented one of the largest sources of surplus inventories globally, and while current volumes are hard to accurately gauge, estimates show that ~100m lbs of U3O8 equivalent is currently held by Japanese utilities. Japanese utilities are considered 'well-covered' in terms of inventories, albeit we have seen stockpiles fall for the past 3-4 years. Some of this material has been sold into the market without having a major impact on prices which is indicative of the fact that we should not expect a block of Japanese material to find its way into the market in the near future.

It is assumed that these countries are holding these stocks in anticipation of increasing uranium requirements due to the significant number of reactors under construction and planned and also for strategic purposes.

In parallel with utility-driven procurement, financial vehicles have played an increasingly important role in sequestering mobile inventory. The two largest public uranium-holding funds—Sprott Physical Uranium Trust (SPUT) and Yellow Cake PLC (YCA)—currently hold 66.22 million lbs and 21.68 million lbs of U_3O_8 respectively. These holdings are effectively removed from the spot market, and with SPUT recently completing a US$200 million bought financing, further accumulation is expected as capital is deployed.

UxC revealed in their 2022 Global Nuclear Fuel Inventories report that the trend of declining inventories, which started around 2017, has remained over the last two years, ending the '*era of excessive inventories*'.

Some of the catalysts for this change include accelerated purchasing of U_3O_8 by financial entities such as Sprott, large procurement initiatives by China and India and uncertainty regarding future supply considering the Russia-Ukraine war and have resulted in an increase of buyers in the market.

Moreover, many holders who experienced inventory growth are expected to retain their stocks for the foreseeable future. As a result, there is no surplus of unwanted inventory saturating the market, and there are only minimal stockpiles that can be classified as readily available for movement (mobile inventories). The rest—whether in Chinese strategic reserves, financial trusts, or held by utilities for long-term operational use—is effectively locked away.

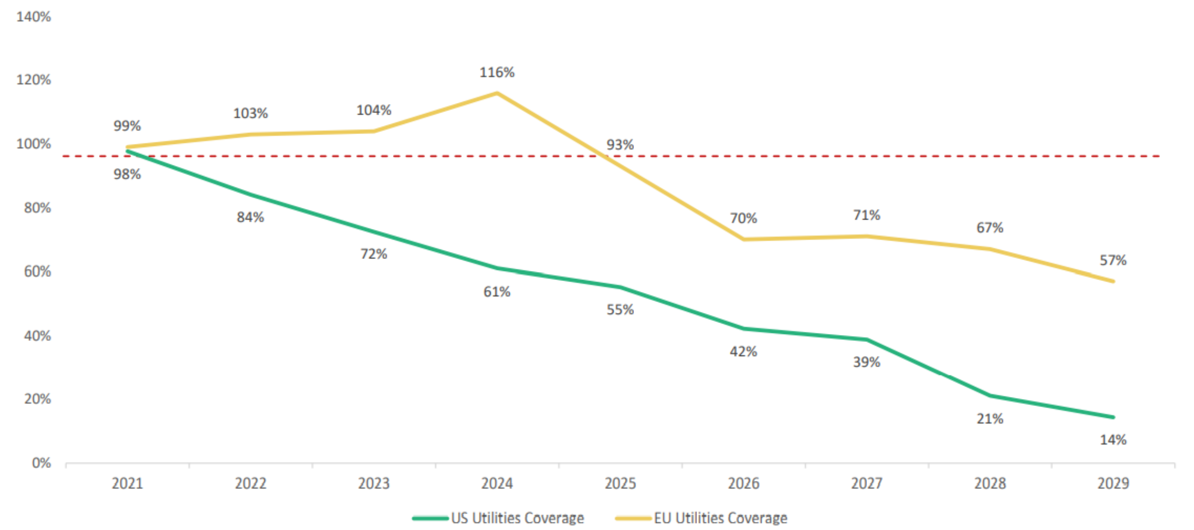
UF_6 inventories have significantly decreased from the substantial surpluses observed five years ago. Presently, there are limited instances, excluding China, where countries have the ability to increase or maximise their conversion capacity.

The uncommitted inventories of EUP have predominantly been depleted and any remaining holdings have increased in value due to the developments on the enrichment market including geopolitical issues, reactor life extensions, changes to policies, etc. Many utilities started to rebuild their SWU/EUP inventories as a precaution against potential supply disruptions from Russia, highlighting the changes in the market since the onset of Russia's invasion into Ukraine.

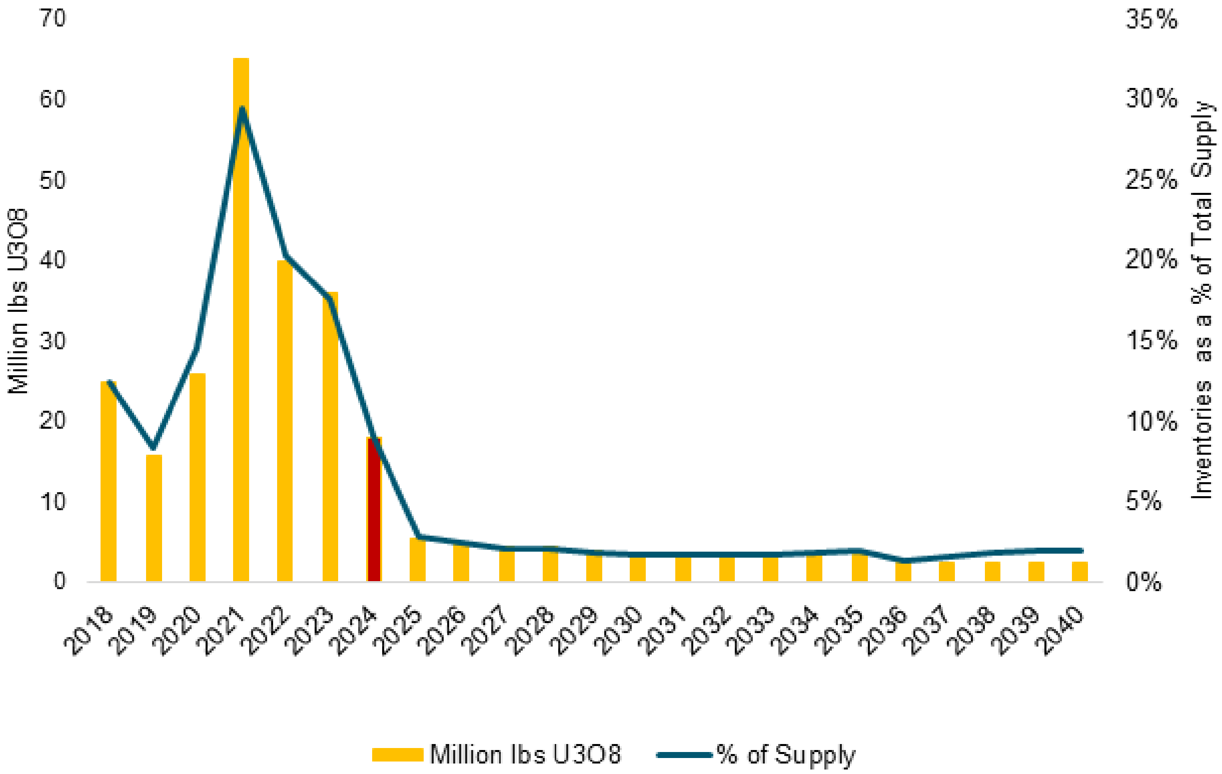
All things considered; global nuclear fuel inventories have undergone extensive change. Consequently, the market is now relieved from excessive stockpiles of nuclear fuel products.

Adding further pressure to an already constrained market, hedge funds and financial speculators have begun actively accumulating physical uranium. Dozens of funds are now believed to be storing yellowcake at facilities such as ConverDyn in the US, with some—like Anchorage Capital and BNF Capital's Tees River fund—openly backing a structural supply shortfall thesis.

Future contracted coverage rates of US and European utilities

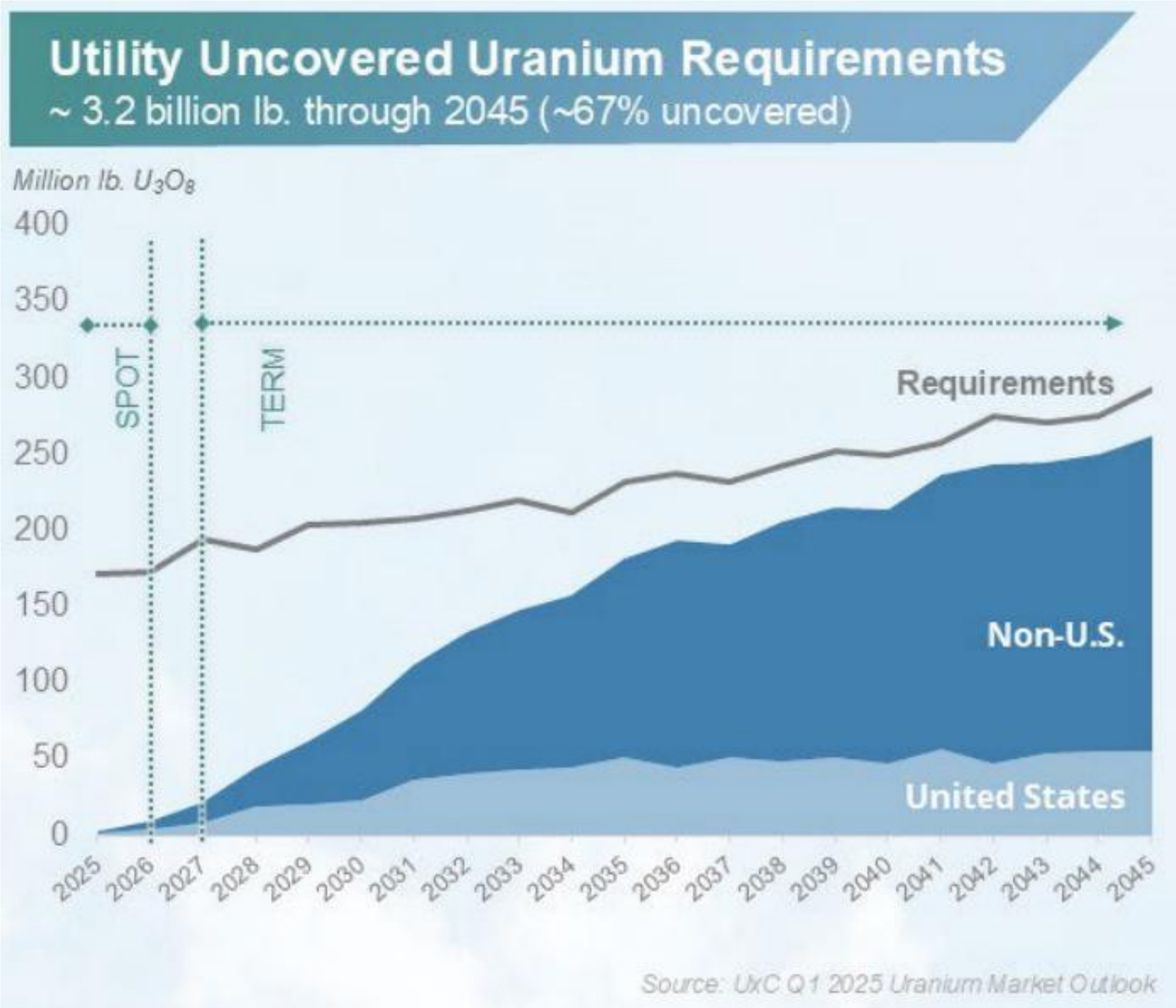


Source: EIA

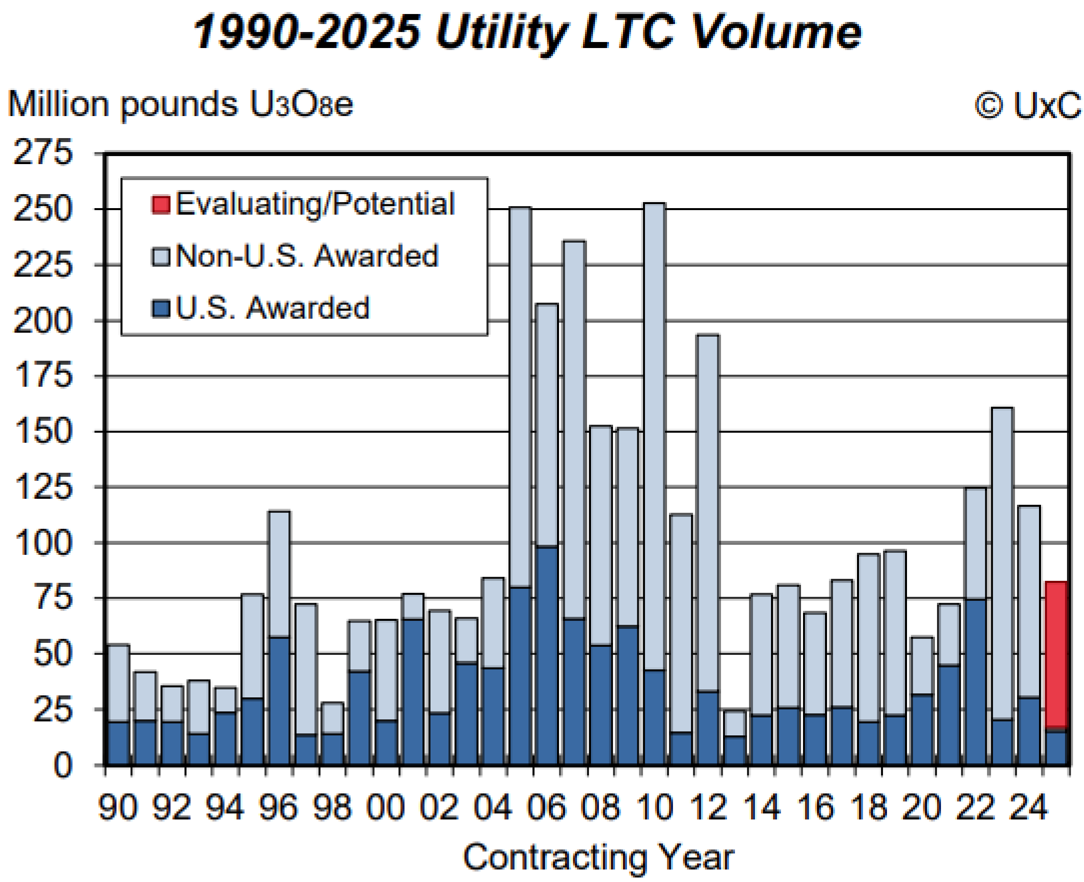


Source: UxC

Commercial Inventory Supplies 2018-2040



The uranium term market in 2024 saw a moderation from 2023's record activity, with 116.4 million pounds U3O8e awarded across 74 contracts, a 29% decrease in volume but an increase in contract count. This shift reflected a trend toward smaller, mid-term deals and fewer mega-contracts (>15 million pounds U3O8e) , with one large Chinese award making up nearly 40% of total volume. US utilities ramped up participation, awarding 50 contracts totalling 30.4 million pounds, up nearly 50% from 2023, though still modest by historical standards. Long term prices rose 22% over the year, ending at $79/lb, and for the first time in over a year, term prices regained a premium over spot, peaking at $81/lb in September. U3O8 dominated contract form preference, accounting for 87% of total volume, as UF6 volumes fell sharply amid high conversion costs. Despite geopolitical complexities and shifting utility strategies, the market remained robust, supported by long-term supply concerns and renewed interest in forward coverage.



Source: UxC

SUPPLY / DEMAND

"In the current pricing environment, another Kazatomprom-sized supply source will be needed to cover future market needs." – Meirzhan Yussupov CFO of Kazatomprom, 2023 Financial Results

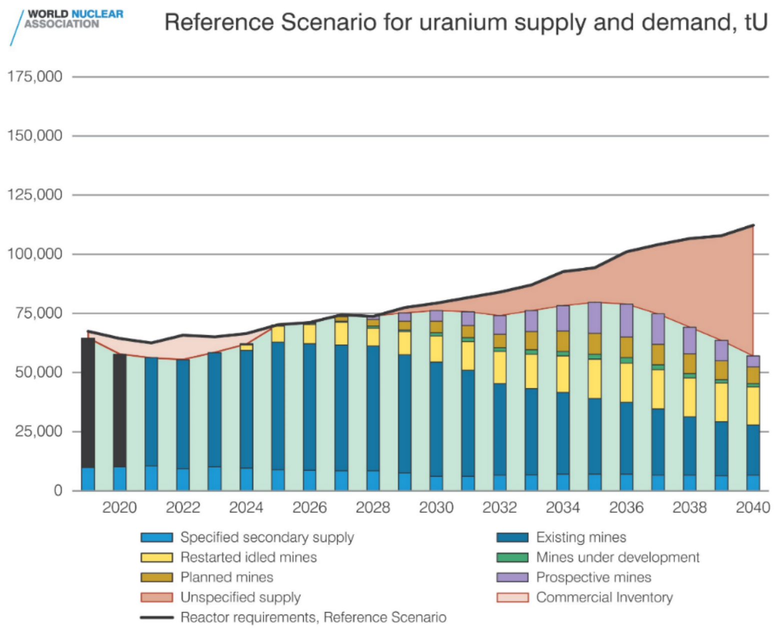
The fuel buyer at the nuclear power plant will rarely get in trouble for the price they pay for uranium, but instead for not securing the supply of it. To the world's nuclear power plants uranium is completely price inelastic – they must have it.

They are also price agnostic – uranium represents ~4-8% of a nuclear plant's ongoing costs. As history showed in 2007, buyers will pay $143/lb as readily as $20/lb because, if they ever run out, the restart costs of a nuclear plant are hundreds of millions of dollars. Adjusted for inflation, the 2007 uranium price would be $190/lb, or >300% above current prices.

It was this price inelasticity of demand that helped ignite a bull market which saw the uranium price explode. It went from around $23/lb in 2006 to peak at $140/lb in June 2007, a 7x increase in the space of 12-months. The trigger was the flooding of Cameco's Cigar Lake in October 2006 and hedge funds and other institutional investors, who began buying uranium in late 2004 to exploit the volatility in the relatively small market. For reference, Cigar Lake was not in operation and was expected to account for 10% of global uranium production. There was a 70m lb uranium surplus then, and half the world was against nuclear.

The uranium market has been in a state of sustained deficit since 2018, which is set to expand while incentive prices remain below the breakeven of Western producers, and the drivers highlighted above continue to grow demand.

We estimate a cumulative deficit of more than 250m lbs through 2030 in our base case, and more than 300m lbs in our bull case. These models do not factor in the influence of financial buyers, nor the emergence of SMRs and Hyperscaler demand. Factors that have the potential to widen the supply deficit further.



Source: World Nuclear Association

Broadly, supply gaps are expected to occur due to the gestation period associated with bringing online new production capacity. These projects can take over a decade from discovery to production and, as we have seen particularly in the West, incentive prices are not at financially viable levels for some producers, particularly considering ongoing inflationary pressures.

For context, the breakeven price for mining uranium in Western jurisdictions prior to the COVID-19 pandemic were approximately US$50–55/lb compared to today, where greenfield costs per lb are as high as $100/lb. Given these fundamental constraints, a lack of financing has meant that new projects are rarely being commissioned.

There are only five projects due to come online between now and 2030 that will produce more than five million lbs per annum. Meanwhile, we have seen production issues from the world' largest producers including Kazatomprom, Cameco and Paladin.

At the same time, even mothballed production capacity facing challenges due to rising costs, COVID-related supply disruptions, workforce availability issues. All these factors create additional uncertainty around availability of uranium.

When comparing these supply constraints with strong demand, particularly from East Asia and the Middle East, prices are expected to come under further pressure. Evidence of this has been the activity in the term market, which is indicative of utility uncertainty around future supply. Uranium term prices have mostly held at the $80 level for the past year and currently trade at a premium to the spot market.

Estimated demand of 204m lbs U3O8 in 2023 was met by primary production of 143m lbs U3O8. Base demand was therefore met by over 61m lbs U3O8e of secondary supplies (including inventories) in 2023.

While official figures have not yet been published for the year, demand in 2024 is set to be met by around 150 m lbs of primary supply albeit there have been various events in 2024 that we believe will have an outsized impact on future demand, particularly the involvement of "Big Tech" (more to come on this).

The only way to supplement this deficit is higher pricing that will incentivise a return to Western primary production, however, the exodus of nuclear expertise means that producers will face operational challenges in ramping up production to close this gap. Financial players are also clearly accelerating price discovery in a thinly traded spot market, but this would not be occurring were there not a fundamental supply deficit.

URANIUM EQUITIES

SEQUESTERS

The Sprott Physical Uranium Investment Trust (SPUT) catalysed gains in the uranium market at the end of 2021. Since launching in August 2021, SPUT quickly ran through its initial $300mn AUM and now has a total net asset value of $4.99bn, holding over to 68.27m lbs of uranium (as of July 22nd, 2025). SPUT is now the world's largest physical uranium fund. There are obvious parallels between what we are seeing with Sprott to what we saw with the Grayscale Bitcoin Trust, which gave investors direct exposure to Bitcoin. Sprott has done the same thing for uranium and as a result, a previously opaque spot market now has real price discovery and liquidity.

Sprott have two other vehicles to participate in the uranium sector. In April 2022, Sprott completed its acquisition of the North Shore Global Uranium Mining ETF (URNM) and have also listed the vehicle on the London Stock Exchange. URNM returned investors ~200% between IPO in December 2019 and September 2022 and saw net assets rise from $40m to close to $2bn (currently $1.75bn as of July 22nd, 2025). The Sprott Uranium Miners ETF (still URNM), aims to capitalise on a growing interest in uranium equities, bringing with it the same strategy initially implemented by North Shore. The ETF seeks investment opportunities in mining and exploration activities for nuclear fuel.

In February 2023, Sprott launched a third vehicle called the Sprott Junior Uranium Miners ETF (URNJ) which invests in mid, small, and micro-cap uranium mining companies. Net assets currently sit at $321m as of July 22nd, 2025.

The emergence of uranium sequesters like Sprott (SPUT) and Yellow Cake (YCA) continues to attract more institutional capital to the sector, bringing with it deeper and more widespread analyst coverage. An example of this is multi-billion-dollar macro hedge fund Caxton, who in March 2022 bought an estimated $250m of physical uranium via SPUT.

This trend was further underscored by SPUT's most recent $200 million equity financing, announced in June 2025. It's not the figure itself that makes it noteworthy—SPUT has raised capital before—but rather the context in which it has done so. This raise comes at a time when spot market volumes are thin, carry trades are largely unworkable, and the term market remains dormant. The $200 million raised is not for financial optics; it is capital intended for the direct acquisition of uranium.

History offers a clear lesson in what happens when financial buyers move ahead of physical consumers. In 2007, a wave of hedge fund buying, coupled with a utility sector that was slow to contract, drove the price of U_3O_8 from $20 per pound to $143 per pound in less than three years. That move began quietly—first the spot market tightened, then the term market shifted, and eventually procurement panic set in. We are now seeing a similar narrative unfold, though with different participants and far greater stakes.

The reawakening of buyer fear today is being led not by traders, but by sovereigns and hyperscalers. India's intent to import approximately 20 million pounds of uranium over the coming years underscores this shift. As noted in their official statement, this is part of a broader national strategy to meet clean baseload demand through 11 new reactors. To date, India has procured almost nothing, yet they are now openly signalling their entry into the market.

Simultaneously, SPUT's ability to raise and deploy nine figures of uranium capital amid a dormant term cycle illustrates the widening disconnect between paper prices and physical availability. Financial entities like SPUT do not bluff, they execute. Their activity removes visible inventory from the market and leaves fuel buyers in an increasingly precarious position.

The raise has effectively neutralised traders' ability to front-run the trust in the spot uranium market. Previously, whenever SPUT's share price approached a discount of less than 2% to its NAV, traders would anticipate a potential uranium purchase by the trust and buy in the spot market ahead of it. This would push up uranium prices and cause SPUT's discount to widen again, preventing the trust from issuing new units. With this raise, SPUT now has immediate capital available to deploy, allowing it to buy spot uranium without needing to wait for the premium to close — thereby removing traders' ability to manipulate the market in this way and restoring the trust's purchasing power.

CAPITAL MARKETS

The number of uranium sector stocks has dropped from approximately 600 in 2007 to just around 90 publicly traded names today. In fact, the total value of global uranium stocks stands at only ~$68.3 billion as of July 22nd, 2025. Stripping out the two primary producers, Kazatomprom and Cameco, the combined market capitalization of the rest of the sector is just $32.8 billion. For context, this means the entire uranium sector is worth only 14.6% of the market cap of ExxonMobil alone. Back in 2007, the global market cap of uranium stocks exceeded $150 billion. Yet, we believe the fundamentals of the uranium market today, coupled with a far more supportive global stance toward nuclear energy, present a significantly more bullish backdrop than in 2007.

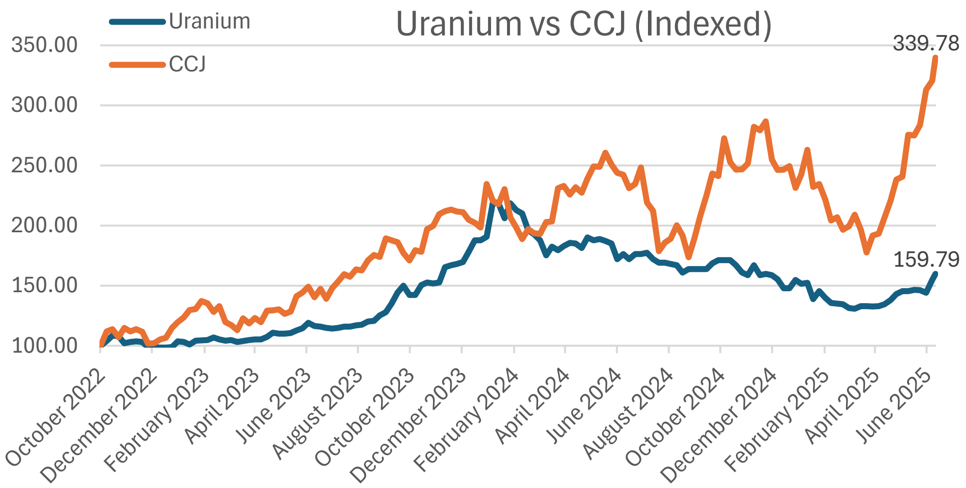
"We had the last bull market with half the world against nuclear" – Scott Melbye, Uranium Royalty Corp & VP, Uranium Energy Corp

As to the convexity some of the uranium explorers can have to uranium, in 2007 there was a 1,000x share price increase for the miner Paladin Energy and large-cap Cameco went from under $4 to $60, returning 15x.

M&A in the uranium sector has been quiet since the events in Fukushima. Since the disaster, spot prices remained low and companies with uranium resources presented little asset value. As the spot price continues its ascent, companies with these assets are becoming increasingly attractive, and we are starting to see M&A return to the sector. The most high-profile case recently was Paladin's takeover of Fission Uranium Corp, a deal worth $1.27 billion.

Additionally, In October 2022, Cameco, the world's second-largest uranium producer, partnered with Brookfield Renewable announced they would acquire Westinghouse Electric in a landmark US$7.8 billion deal. At the time, the market responded negatively; Cameco shares fell 17% as investors questioned the strategic pivot away from its core uranium mining business. Yet just two years on, the move has proven prescient. Westinghouse services over half the world's 436 nuclear reactors, with 85% of clients under long-term contracts, providing Cameco with stable, recurring revenue and positioning it as a vertically integrated player in the nuclear value chain.

Since the acquisition, Cameco has meaningfully outperformed the price of uranium itself. This underscores how the market now values full-spectrum exposure to the nuclear fuel cycle. Investors increasingly recognise that the real long-term value lies not just in uranium extraction but also in fuel fabrication, maintenance, and reactor technology. Cameco's estimated ~$170 million boost to 2025 EBITDA from its 49% stake in Westinghouse highlights how vertical integration is translating into tangible financial returns while capitalising on the global shift away from Russian nuclear services.



Source: Ocean Wall

Uranium Energy Corp has also been very active in M&A. In December 2021 they acquired Uranium One Americas for $112m. In June 2022, UEC bought UEX Corp for $192.7m in the largest M&A transaction in North American uranium sector history. In October 2022 UEC bought Roughrider uranium project from Rio Tinto for $109m. UEC has done more than $1 billion in acquisitions since its inception.

Other examples include:

- **2022 – Deep Yellow acquires Vimy Resources:** Merger formed a new global uranium developer by combining Deep Yellow's Tumas project in Namibia with Vimy's Mulga Rock project in Australia. Deal worth A$658 million (~US$492 million).

- **2023 – IsoEnergy merges with Consolidated Uranium** Strategic merger created a diversified uranium company with assets across top-tier jurisdictions including Canada and the U.S. Deal worth ~C$903.5million (~US$669.4 million).

- **2023 – Boss Energy acquires 30% stake in enCore's Alta Mesa Project:** This gave Boss Energy exposure to the high-grade, in-situ recovery (ISR) uranium project in Texas, contributing to its goal of becoming a multi-mine producer. Deal worth US$60 million.

- **2024 – Baseload Energy merges with Forum Energy Metals**: All-share merger created a diversified uranium explorer focused on the Athabasca Basin, Canada. The combined entity holds a portfolio of high-potential uranium projects including Baseload's ACKIO discovery and Forum's properties in the northeastern Athabasca region. Deal valued at ~C$24.5 million (~US$18 million).

Further validating the sector's re-rating and the evolving perception of nuclear energy, the World Bank recently signalled a major policy shift by opening its doors to nuclear and uranium-linked funding for the first time since 1959. This marks a significant departure from its longstanding position of excluding nuclear energy from its climate finance framework. While specific project approvals are still forthcoming, the policy change is emblematic of a growing institutional consensus that nuclear must play a central role in decarbonisation efforts.

GEOGRAPHICAL BREAKDOWN

RUSSIAN INVASION OF UKRAINE

Russia's invasion of the Ukraine in February 2022 highlighted the need for governments and utilities to reduce their reliance on Russian resources. The geographical supply of uranium is incredibly concentrated, the market is becoming increasingly bifurcated, as such, utilities remain at the mercy of ongoing geopolitical risk from the world's largest uranium producers.

The invasion saw investors flock to commodity markets seeking a safe haven to hedge their portfolios from what was already a volatile equity market. The prices of oil, natural gas, fertiliser and nickel – to name a few – skyrocketed, carrying other hard assets with them.

Russian forces went as far as attacking Europe's largest nuclear plant, Ukraine's Zaporizhzhia, starting a fire, and causing panic around Europe of a 'Chernobyl-like disaster'. Shortly after, it was reported that no radioactivity had been detected and a quick sell-off in uranium stocks reversed.

In addition, it was reported that security data was no longer being transmitted to the United Nations watchdog from Chernobyl. This came after fighting around the nuclear plant caused a power outage, sparking radiation concerns about spent nuclear fuel assemblies. The International Atomic Energy Agency said there was no immediate safety threat from the loss of power. In August 2022, an IAEA support team arrived at the plant for a safety and maintenance inspection.

The war in Ukraine has taught us three key lessons about uranium and nuclear power:

- Global governments and utilities must mitigate Russian interference from their supply chains
- As the West imposed sanctions on an array of Russian exports, uranium has been broadly exempt
- Nuclear reactors have, so far, withstood the brutality of war

The role uranium plays in the energy materials mix is integral. Most notably, unlike oil, there is not significant reserve inventories, and you cannot turn on the tap and start pumping uranium because the process from lbs out the ground to serviceable nuclear fuel is two years. The ongoing supply deficit has come into the spotlight over the past couple of years, uranium is completely demand inelastic, utilities must have it or run the risk of hundreds of millions of dollars in losses resulting from plant closures.

In May 2024, President Biden signed into law the much-anticipated ban on Russian uranium.

While the bill clearly states that an immediate legal ban on all Russian LEU imports from 90 days after the law going into effect will be implemented, this does not mean that Russian uranium will no longer enter the world's largest nuclear fuel market.

A gathering of utilities and stakeholders that took place on the morning of April 30th discussed how a waiver process that will run to the end of 2027, will allow utilities to keep receiving all deliveries under existing contracts. In addition, exemptions on new contracts can be made if:

1. There are no alternative sources of LEU to sustain continued operations of a domestic reactor
2. The importation of LEU is necessary on the grounds of national interest

From January 1st, 2028, however, no Russian LEU will be allowed to enter the US.

While it is unlikely that the DOE will rubber stamp all waivers, we believe that it will be fairly a straightforward process that will see Russian EUP continue to play a prominent role in the US nuclear fuel market, primarily due to a lack of alternative supply.

Almost immediately after the ban was announced, the Centrus Energy CEO said the company would apply for a waiver at the first possible opportunity, given their reliance on TENEX for all LEU enrichment capacity, and received a waiver from the DOE on July 18, 2024, allowing it to import Russian LEU for deliveries committed to U.S. customers in 2024 and 2025. A second waiver was granted on October 31, 2024, permitting imports for processing and re-export to foreign customers in 2025. Decisions on waivers for 2026 and 2027 deliveries have been deferred to a later date.

UxC highlighted that the impact of this ban has the potential to span far beyond the US:

"For many decades, Russian EUP has been shipped to the U.S. to be further processed or fabricated for use in reactors in other countries, including Japan and Mexico, to name a few."

What remains to be seen is whether Russia's JVs in Kazakhstan will be included in the ban. The majority of Russia's foreign mining projects are located in Kazakhstan (via Uranium One), where we have estimated that they have ~350m lbs worth of interest.

The global response to Russia's dominance has continued to solidify. This year, the EU took further steps via its REPowerEU roadmap, with a goal to phase out imports of Russian nuclear fuel by 2027. However, implementation is uneven across member states—Hungary and Slovakia, for example, remain heavily reliant on Russian-supplied VVER reactor fuel.

Similarly, on April 16th, 2023, G7 nations reached an agreement aimed to displace Putin and Russia from the nuclear fuel market. An alliance between the US, UK, Canada, Japan and France will look to leverage the respective resources and capabilities of each country's civil nuclear power sectors to undermine Russia's grip on supply chains.

In a further escalation of Western efforts to isolate Russia's energy sector, U.S. lawmakers proposed a 500% tariff on imports from countries that continue purchasing Russian oil, natural gas, uranium, and other energy products. The bipartisan Sanctioning Russia Act of 2025, led by Senators Graham and Blumenthal, seeks to penalise both Russia and its trade partners if Moscow refuses to engage in peace negotiations over Ukraine. While not yet law, the sweeping measure underscores a broader geopolitical push to dismantle Russia's dominance.

The possibility of retaliatory, or even pre-emptive sanctions from the Kremlin on the US was in our view a more immediate threat to global nuclear fuel markets. We could not find sufficient reasoning as to why the Russians would keep exporting nuclear fuel to the US when they knew an all-out ban was coming in the next few years.

The decision by Russia then, in November 2024, to embargo exports to the US would not come from state-owned nuclear giant, Rosatom, but from the Kremlin itself. Given Putin has just started his latest term and has been sabre rattling, the prospect of showing a tough image to passing Biden administration was one too tempting to pass by. The Russians followed up on this promise as it was reported shortly after that the main shipping vessel, Atlantic Action II, had left the Port of St Petersburg in December 2024 with no enriched uranium product onboard.

For a deep dive on Russia's involvement in the global nuclear industry please see our report from June 2023: '*A NUCLEAR STRANGLEHOLD: RUSSIA'S UNSANCTIONABLE POSITION IN THE NUCLEAR INDUSTRY'.*

KAZAKHSTAN

The war in Ukraine and its resulting geopolitical fallout had uranium investors watching Kazakhstan closely, the world's largest uranium producer, responsible for 43% of global supply. To provide perspective: Kazakhstan's dominance in uranium is roughly four times that of Saudi Arabia in oil. Kazatomprom (KAP), the state-controlled entity, remains the world's largest uranium producer, with approximately 20% of its equity available on the LSE for international investors.

Kazakhstan's political stability came into question after the 2022 protests triggered by rising fuel prices, which led to Russian military intervention. Despite this, the country has maintained its uranium output, though increasingly navigating logistical and geopolitical complexities. Russia, KAP's closest strategic partner, still holds ~350 million lbs of subsurface uranium interest through joint ventures with KAP.

Kazakhstan remains the pivotal swing producer in the uranium market. No other country can meaningfully tighten the market to the same degree.

Kazatomprom enters 2025 under a cloud of production uncertainty, cost escalation, and geopolitical friction, despite posting strong headline financials for the prior year. Officially, the company maintains guidance of 25,000–26,500 tU for 2025 uranium production, a figure that already reflects a significant 20% downward revision from the prior target of 30,500–31,500 tU. However, recent developments indicate that even the lower end of this guidance may prove optimistic.

The most immediate risk stems from the suspension of JV Inkai, one of Kazatomprom's largest and most geopolitically significant assets. Following operational underperformance in 2024, where production fell well below the 20% variance permitted under Subsoil Use Agreements (SUA), KAP was required to halt activities and reapply for production permits. While management has stated that this will not materially impact group-level output, the company now expects 2025 volumes to trend toward the lower end of the revised guidance range. The situation at Inkai is not isolated: other assets, including Budenovskoye, Katco, Semizbai, and Zarechnoye, also underperformed in 2024, in some cases materially. Should these shortfalls persist into 2025, or should additional SUAs be breached, further suspensions and production delays could follow.

More broadly, KAP has acknowledged that it expects mining entities in 2025 to post varying percentage deviations from their Subsoil Use Agreement levels. While deviations within ±20% are permitted under current regulations, falling below this threshold, as in the case of Inkai, requires the issuance of new permits. This introduces further administrative friction and raises the possibility of additional operational delays across multiple assets.

Despite these constraints, Kazatomprom reported strong financial performance in 2024, with consolidated revenue rising 26% year-on-year to KZT 1.81 trillion. This was driven by higher average realised prices, reflecting the strength in spot U_3O_8 markets, and supported by higher enriched uranium sales, notably from increased FA deliveries by Ulba-FA LLP. However, margins were pressured by a sharp 39% increase in the Group's cost of sales, driven by inflation, input cost increases, and rising prices for purchased uranium. Material and supply costs rose 42%, reflecting both elevated spot uranium pricing and inflationary pressure across inputs, particularly sulphuric acid, the core reagent in KAP's ISR operations.

C1 cash costs increased 25% in USD terms, while AISC rose 29%, underlining a fundamental shift in the uranium cost curve. Looking ahead, management has acknowledged that revenue and cost outcomes in 2025 may deviate from guidance due to continued KZT/USD exchange rate volatility, elevated spot pricing, and persistent supply chain issues. In this environment, the company remains open to purchasing material from the spot market to optimise inventory levels, a strategic posture that has direct implications for spot price dynamics.

At the heart of Kazatomprom's operational posture is its inventory strategy. The company has historically maintained six to seven months of attributable production in inventory as a buffer against operational volatility and delivery risk. However, as of the latest disclosures, inventory has fallen to just over five months of production, the lowest level since 2016, and below the stated strategic floor. While management asserts that contractual obligations for 2025 remain covered, the company's willingness to return to the spot market introduces potential volatility, particularly given the thinly traded nature of the uranium spot market. Should KAP act to rebuild depleted inventories amid constrained production, its presence alone could drive a material tightening in the market, a dynamic that would be supportive of uranium equities and sequesters such as SPUT.

Year	KAP Year End Inventories	KAP Inventory Change YoY (%)	Group Year End	Inventories Change YoY (%)	KAP Attributable Production (tU)	Attr. Prod. Change YoY (%)	Group Production (tU)	Group Prod. Change YoY (%)	KAP Inventories % of KAP Prod.	Group Inventories % of Group Prod.
Dec-24	5,431	-11.1%	6,334	-13%	12,286	10%	23,270	10%	44%	27%
Dec-23	6,108	-21.2%	7,242	-23%	11,169	-2%	21,112	-1%	55%	34%
Dec-22	7,749	0.3%	9,352	6%	11,373	-4%	21,227	-3%	68%	44%
Dec-21	7,724	14%	8,824	17%	11,858	10%	21,819	12%	65%	40%
Dec-20	6,761	-21%	7,537	-24%	10,736	-19%	19,477	-15%	63%	39%
Dec-19	8,571	17%	9,906	26%	13,291	16%	22,808	5%	64%	43%
Dec-18	7,353	-18%	7,892	-13%	11,476	-5%	21,705	-7%	64%	36%
Dec-17	8,999	64%	9,085	61%	12,093	-8%	23,321	-5%	74%	39%
Dec-16	5,498	83%	5,650	83%	13,095	3%	24,586	4%	42%	23%
Dec-15	3,001	-	3,080	-	12,766	-	23,607	-	24%	13%

Source: LSE Prospectus 2015-18

Source: Annual Reports 2018-2024

The geopolitical dimension cannot be overstated. China and Russia together accounted for 51% of Kazatomprom's revenue in 2024, with sales rising 27% and 18% respectively. The November 2024 extension of KAP's supply agreement with China's CNNC and CNUC was one of the largest in company history — with cumulative transaction values now exceeding half of KAP's total asset base.

Budenovskoye, which was expected to underpin long-term growth, remains delayed, with acid constraints and infrastructure buildout pushing timelines to the latter half of the decade. The first three years of its production have already been earmarked for Russian offtake, further limiting upside to Western buyers.

In parallel, Kazakhstan's parliament has proposed amendments to mineral laws that would grant KAP at least 90% ownership in new or expanding uranium projects and require foreign partners to either transfer sensitive enrichment and conversion technology or relinquish majority control.

For the uranium market, these pressures are unequivocally bullish. The withdrawal of Kazatomprom volumes from the spot or term market, whether due to underperformance, regulatory hurdles, or redirected flows to Eastern buyers, will amplify the structural supply deficit. Given current spot market dynamics, any indication that KAP will under-deliver in 2025 could drive an acceleration in both price and equity momentum.

Kazatomprom's guidance is intact on paper, but the operating environment suggests otherwise. Inventories are at decade lows, sulphuric acid constraints remain unresolved, and key assets are underperforming.

In 2023, 81% of Kazakhstan's uranium exports flowed eastward, primarily to Russia and China, leaving Western utilities to compete over a shrinking portion of Kazakh supply. While Kazatomprom maintains that geographic diversification remains a strategic priority, the practical reality suggests otherwise: China alone has the demand capacity to absorb the bulk of Kazatomprom's production. The transaction value of Kazatomprom's latest supply agreement with China, when combined with earlier deals with CNUC and CNNC Overseas, now represents 50% or more of the company's total book value—a concentration that underscores just how dominant China's role in the market has become.

Year	China (lbs)	Russia (lbs)	Total Exports (lbs)	China %	Russia %	Combined %
2015	31,331,037	13,823,410	63,327,375	49%	22%	71%
2016	29,145,144	8,989,721	64,602,272	45%	14%	59%
2017	42,249,471	7,234,551	61,911,146	68%	12%	80%
2018	25,719,003	10,046,996	53,436,805	48%	19%	67%
2019	17,477,142	15,264,234	59,296,338	29%	26%	55%
2020	27,352,731	15,332,744	61,325,206	45%	25%	70%
2021	16,261,035	13,991,243	52,959,614	31%	26%	57%
2022	15,828,973	18,943,053	57,404,847	28%	33%	61%
2023	22,673,722	24,994,345	59,155,713	38%	42%	81%

Source: World Integrated Trade Solution

UNITED STATES

Trump's re-election and return to the White House in January coincides with significant nuclear tailwinds. Under his second term it is likely that the US will rebuild capacity across the fuel chain, and revive its nuclear industry through plant restarts, new builds, and its SMR and AMR pipeline. While one of his first actions was to withdraw the US, once again, from the Paris Climate Agreement, the administration remains steadfast on its ambitions for nuclear. A subject which enjoys bi-partisan support. In May, Trump signed an historic series of executive orders aimed at revitalising the U.S. nuclear energy sector. These directives are designed to expedite the regulatory approval process for new reactors, bolster domestic nuclear fuel supply chains, and reduce reliance on enriched uranium imports from Russia and China.

The United States receives 20% of its entire electricity generation, and 55% of its clean electricity generation from nuclear power. It is also the world's largest consumer of nuclear fuel. It currently has 94 operating commercial nuclear reactors at 56 nuclear power plants in 28 states. Florida, for example, gets 90% of its clean energy from five nuclear reactors (Progress Energy's Crystal River, Florida Power & Light's St. Lucie 1 and St. Lucie 2 in Jensen Beach, and FPL's Turkey Point 3 and Turkey Point 4).

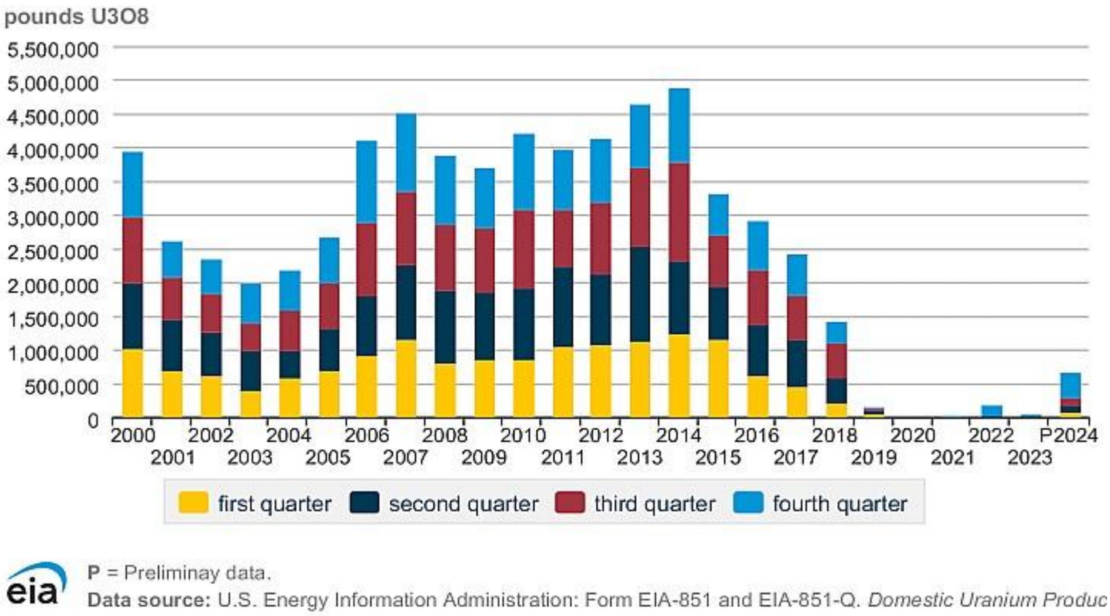
In August 2022, California lawmakers voted to keep Diablo Canyon nuclear plant open. The plant which supplies c.10% of the State's electricity needs was scheduled to close in 2025 but has now been extended to 2030, and potentially 2035.

The Palisades nuclear power plant in Michigan, previously shut down in 2022, is undergoing plans to be restarted—the first such case of a U.S. nuclear plant being revived after permanent closure. The project is led by Holtec International, with strong backing from the U.S. Department of Energy, which conditionally approved a loan to support the restart. Holtec has said it is on track to restart operations at Palisades in October.

50% of uranium into the US is from Kazakhstan, Uzbekistan, and Russia, meaning that 1/10 homes in the US are run on fuel from these countries.

The US government have also begun procurement for their domestic strategic uranium reserve. UEC, a US based uranium developer, was awarded a contract to supply the US government 300,000 lbs at a price of $59.50/lb, representing a 24% premium to the current spot price. The week after, enCore Energy, a Canadian based producer, was awarded a contract to supply the US government 100,000 lbs at $70.50/lb, representing a 48% premium to the current spot price.

As the US continues to add pounds to its reserves and source the fuel needed to feed its nuclear fleet, we expect pounds out the ground from Canadian and US miners to be purchased at a premium. Last year saw the highest US production of uranium concentrate since 2018, spurred by a sustained period of higher uranium prices. Total production for 2024 was 676,939 pounds U3O8, an increase of ~626,939 lbs from 2023. The increase, however, represents only 1% of total US demand for uranium.



Source: EIA, 2025

Since the Inflation Reduction Act's $700 million allocation to the DOE's HALEU Availability Program in August 2022, significant progress has been made to build a domestic supply chain for HALEU, the critical fuel for next-generation reactors. In late 2024, the DOE awarded up to $800 million in deconversion contracts and $2.7 billion in enrichment contracts to firms including Centrus, BWXT, Orano, and Urenco. By April 2025, the first DOE-supplied HALEU batches were delivered to U.S. reactor developers such as Kairos, TerraPower, and Westinghouse, marking the first domestic commercial use and reducing reliance on Russian supply.

President Trump Signs Executive Orders to Usher in a Nuclear Renaissance

In May, Trump signed executive orders aimed at accelerating nuclear technologies. Key components of the orders include directing federal agencies to identify suitable federal lands for new nuclear facilities, streamlining construction procedures, and expanding the use of loan guarantees through the Department of Energy.

The orders call for a fourfold increase in nuclear capacity by 2050, including the potential to deploy reactors on military bases and Department of Energy land. This could bypass many of the constraints imposed by traditional civilian oversight and position nuclear power as a foundational pillar of U.S. energy, defence, and AI policy. In this context, Trump's efforts may not only revive a dormant industry but also reclaim a legacy of technological ambition capable of meeting the twin challenges of AI and decarbonisation.

Inflation Reduction Act

The Inflation Reduction Act of 2022 was introduced to reduce the federal budget deficit, lower prescription drug prices, and invest in domestic energy production and clean energy. It was signed into law on August 16, 2022, and represents the largest investment in addressing climate change in US history.

It included production tax credits for existing nuclear power plants, helping to ensure their continued operation and financial viability as well as extending clean energy credits to nuclear power. The act directed investment in advanced nuclear technologies aimed at developing and deploying advanced nuclear technologies, such as small modular reactors (SMRs) and other innovative designs. Lastly it provided funding to support the domestic nuclear fuel supply chain, reducing reliance on foreign sources and enhancing energy security.

The act provides for improvements to the infrastructure that supports nuclear power, including upgrades to the electrical grid to better integrate nuclear power with other energy sources.

ADVANCED Act

President Biden signed the Fire Grants and Safety Act into law in 2023, which included a welcome boost for the nuclear power industry. The bill included the ADVANCE Act, which aims to expedite the deployment and licensing of new reactors and fuels, addressing the growing energy demand from data centres, electric vehicles, and industrial processes. The ADVANCE Act directed the US Nuclear Regulatory Commission (NRC) to reduce licensing fees and increase staffing for reviews. The act also focused on microreactor and fuel technologies, directing the NRC to develop licensing guidance and eliminate costs for pre-application activities. Additionally, the ADVANCED act supported the cleanup and reuse of brownfield sites, including retired coal plants, for nuclear power development, helping to maintain jobs and economic opportunities in these communities.

Infrastructure Investment and Jobs Act & CHIPS Act

The IIJ Act includes significant support for the nuclear sector. It funds the development and deployment of advanced nuclear reactors, supports the continued operation of existing nuclear power plants, and allocates resources for nuclear research and development. Additionally, it emphasises improving safety, efficiency, and waste management in nuclear technology, and supports workforce training for the nuclear industry.

Similarly, the CHIPS Act invests in university research reactors to provide hands-on experience for nuclear engineering students and addresses supply-chain issues for advanced nuclear reactors. The act includes funding for materials like specific isotopes and new fuel forms, which are crucial for scaling production and supporting the clean energy transition.

COP 29

At COP29 in November 2024, the U.S. unveiled a roadmap to triple its nuclear energy capacity by 2050, aiming to add 200 GW through new reactor builds, restarts, and upgrades, with a near-term goal of 35 GW by 2035. This followed its pledge at COP28 in Dubai, where over 20 nations committed to expanding nuclear energy. The U.S. plan, outlined in the "Framework for Action," includes reforms to licensing, investments in workforce development, supply chain expansion, and strategies for managing spent nuclear fuel, positioning nuclear power as a cornerstone of its clean energy transition.

RUSSIA

Putin's superpower is built on a foundation of oil, gas, and uranium and these assets are his weapons in the Colder War. He has embraced such diverse international pariahs as theocratic Iran, Assad's Syria, and socialist Venezuela. He has cut deals on all sides, everywhere from China to Israel, from Algeria to Brazil and it is always about energy. Putin is turning his country's newfound influence against a Western alliance that is unprepared for the geopolitics of energy. Before the war, Russia supplied ~50% of the EU's natural gas imports.

"While yellowcake [uranium] production is important for controlling the market, it's not the critical element…owning all the yellowcake on the planet won't help you one bit with the ability to turn it into something a nuclear reactor can use…The choke point in the whole process isn't in the mines but in the conversion and enrichment facilities that turn yellowcake into nuclear fuel. That's Putin's goal: to corner the conversion and enrichment markets…control those and you control the availability and pricing of a product whose demand will be rising for decades." – Marin Katusa, Author of The Colder War

Russia's dominance in uranium spans much further than their enrichment capacity. Rosatom estimates Russian uranium reserves amount to 1.2bn lbs, which would be the second largest in the world. Add in Russia's foreign projects in Kazakhstan, Ukraine, Uzbekistan, and Mongolia, and analysts estimate that Russia's sphere of influence could contribute 140m lbs of uranium per year, or 74% of current annual global demand.

With control of not only uranium production capabilities, but also enrichment and conversion operations in multiple countries, Katusa describes Russia's grip on uranium in one word: "*Stranglehold*".

In late 2024, Russia's state-owned Rosatom sold significant stakes in two Kazakh uranium projects to Chinese entities. Specifically, Rosatom's Uranium One divested its 49.979% share in the Zarechnoye mine to SNURDC Astana Mining, a subsidiary of China's State Nuclear Uranium Resources Development Company. Additionally, a 30% stake in the Khorasan-U joint venture was sold to China Uranium Development Company, affiliated with China General Nuclear Power Corporation.

In a draft plan released in September 2024, Russia's Unified Energy System proposed increasing the share of nuclear power in the country's electricity mix to 23.5% by 2042, supported by the construction of 34 new nuclear power units.

For a deep dive on Russia's involvement in the global nuclear industry please see our report from June 2023: '*A NUCLEAR STRANGLEHOLD: RUSSIA'S UNSANCTIONABLE POSITION IN THE NUCLEAR INDUSTRY'.*

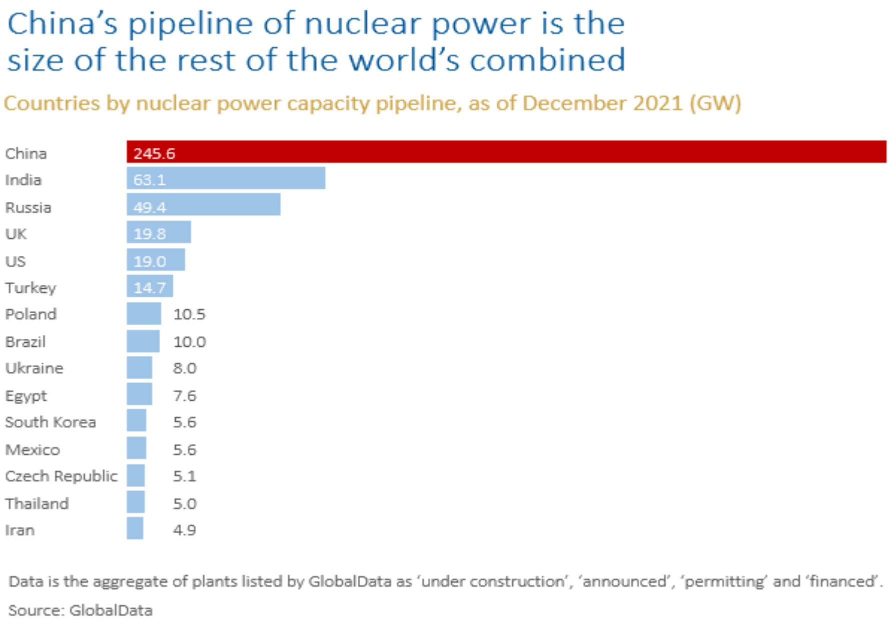
CHINA

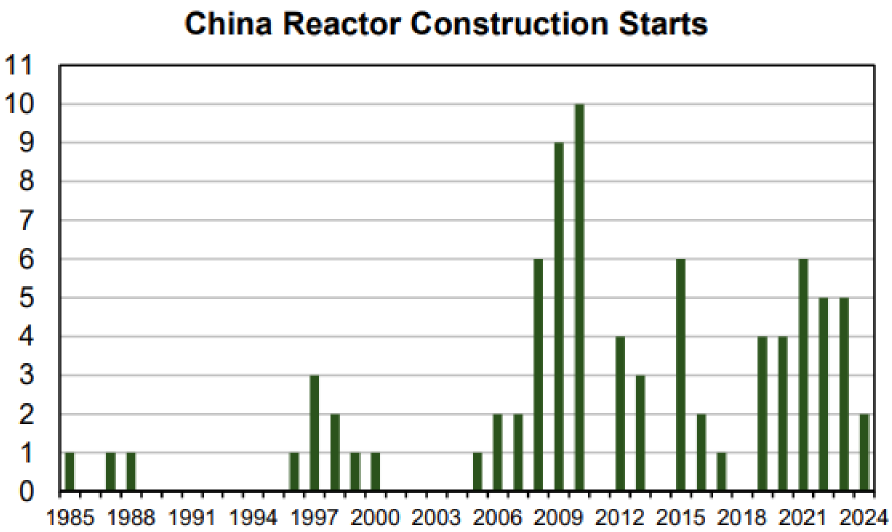
While China is currently the world's largest producer of carbon dioxide emissions, it will soon become the world's largest producer of nuclear power, and thus consumer of uranium. The scale of the Chinese nuclear growth story is something unseen before in the industry, with potential to see over 100 new nuclear reactor approvals in the next decade.

China's nuclear energy production grew by approximately 380% between 2011-24. Today, China has 58 reactors (53.2 GWe net) in full commercial operation plus 32 reactors (29.9 GWe net) under active construction.

China has more nuclear reactors under construction than any other nation in the world and approved 10 new reactors in each of the last two years. The country is expected to surpass France and the US to be the world's leading atomic power generator by 2030, according to BloombergNEF.

China's latest Five-Year Plan, issued in 2021, calls for 70 GWe gross to be in operation by the end of 2025. While this target may not be met, it appears that China will get very close to attaining its goal. Moreover, with 83 GWe already confirmed, China will clearly surpass the 70 GWe level later this decade. The next unofficial target for 2030 appears to be around 100 GWe.





Sources: GlobalData, UxC

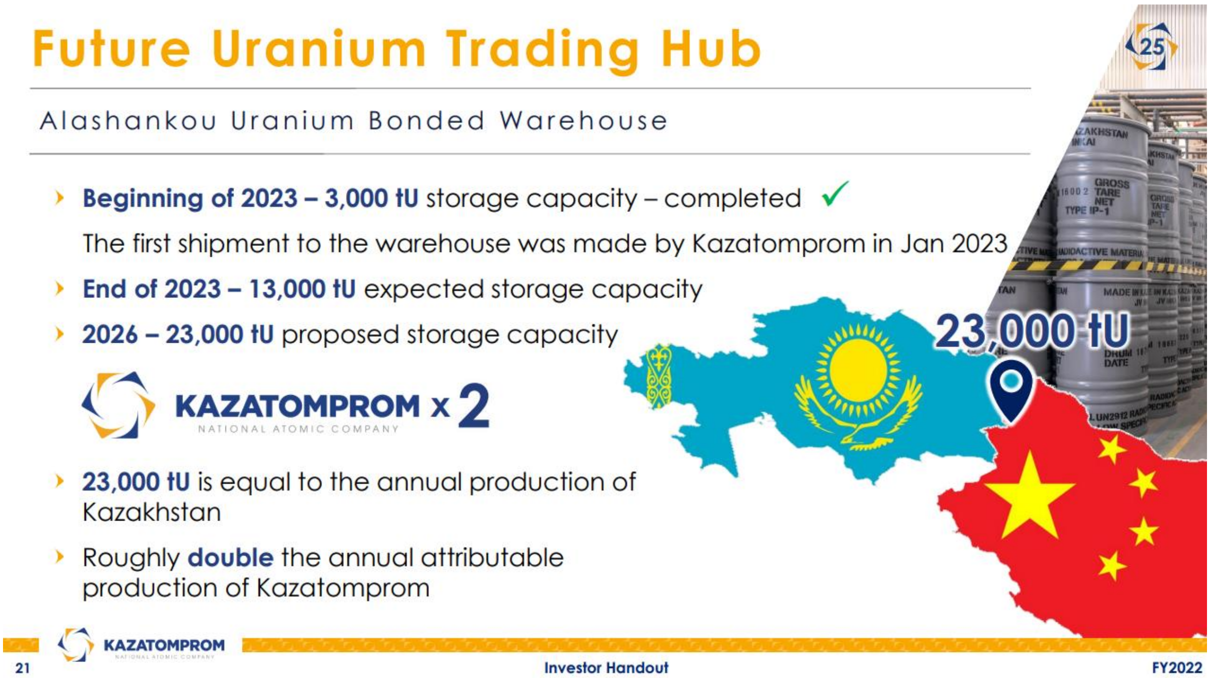
The current nuclear capacity in China is second only to the United States. In addition, given the rapid rollout of nuclear reactors over the past decade, China has a young nuclear fleet with an average age of only 10 years old, compared to 40 years in the United States. On a global scale, two-thirds of the world's operating plants are over 30 years old.

Given the scale of China's nuclear growth strategy, they are a key component for the demand side of the equation for uranium. Estimates show that at their current rate of procurement, China could procure up to one billion lbs of uranium, or five times the global annual demand.

"China's nuclear fuel requirements are set to become the largest in the world by the 2030s, which will drive further expansion into all fuel cycle sectors as supply security dictates future actions. Recently, China's political leaders have described their nuclear fuel supply strategy as a "four-legged stool," which is comprised of domestic production, domestically-held stockpiles, investments in foreign mines and facilities, as well as imports from foreign suppliers. Actions over the past few years have reflected an ongoing emphasis on the latter two legs of the stool as new international projects (e.g., CGN's new Ortalyk JV, which includes the Central Mynkuduk and Zhalpak mines, as well as CGN's new JV Ulba fuel fabrication project both with KAP) have moved forward while also signing multiple new large uranium supply contracts with a variety of major primary uranium producers. These trends are unlikely

to let up in the coming years, especially as China's utilities increasingly feel confident about their future reactor demand growth and fuel needs". - UxC

The 'Alashankou' warehouse on the Kazakh Chinese border is expected to hold an amount equal to around more than 25% of global primary supply, or the annual production of Kazakhstan.



Source: Kazatomprom Investor Handout 2023

At the current rate of Chinese procurement, we could see 1bn lbs of uranium sequestered from the market over the next 15 years, equivalent to 7.6x global annual production.

In April 2025, China's State Council approved the construction of 10 new nuclear reactors across five major projects, marking the fourth consecutive year of such approvals. The projects include expansions at the Fangchenggang, Haiyang, Sanmen, Taishan, and Xiapu nuclear power plants, with a combined investment exceeding $27 billion. Eight of the new reactors will utilize China's domestically developed Hualong One technology, while the remaining two will employ the CAP1000 design, a localized version of the US-designed AP1000.

In 2019, the EU and US accounted for over half of nuclear energy production, however, with such aggressive plans for expansion, forecasts show China will quickly overtake both in becoming the global nuclear powerhouse. Couple this with countries like Germany who have now closed their remaining three nuclear plants and it becomes quickly apparent how China will soon assert dominance on production and therefore consumption of nuclear fuel.

61% of the Chinese population support nuclear – that is the highest percentage support amongst the advanced economies.

EU

The EU Sustainable Taxonomy, the EU's ambitious labelling system for green investment, was passed on July 6th and came into force on 1st January 2023. It described the sustainable criteria for renewable energy, car manufacturing, shipping, forestry, and bioenergy and more, and included a "technology-neutral" benchmark at 100 grams of CO_2 per kilowatt-hour for any investments in energy production. It is worth noting that Western and Central Europe (including Great Britain) is responsible for almost one third of current global civilian uranium demand and is a growing electricity market.

The European Union has elected to classify some nuclear energy projects as 'green' in its Sustainable Taxonomy draft. Under the draft's terms, nuclear power plants would be classified as green provided the project has a plan, the required funds, and a site to safely dispose of radioactive waste. The development also needs to receive its construction permits before 2045.

The EU's Commissioner for the Internal Market, Thierry Breton, gave an interview with France's weekly Journal Du Dimanche saying that a "colossal" investment will be needed over the next 30 years to meet the EU's emission targets. Existing nuclear plants need EUR50bn of investment through to 2030, while the next generation will require EUR500bn between now and 2050. Breton said nuclear energy combined with investment in renewable sources will be crucial for meeting the EU's objective of net zero emissions by 2050.

In October 2024, EU countries agreed that they should call to accelerate "low-emissions technologies" in line with its nuclear commitments from COP28.

"The push for more recognition of nuclear energy symbolises a shift in attitudes towards the power source in Europe, which were hardened against it following Japan's Fukushima nuclear disaster in 2011." – Alice Hancock, FT

A number of European countries have notably shifted their stances on nuclear energy, reflecting a broader continental trend toward embracing nuclear power as a key component of energy security and decarbonisation strategies.

Germany: Under Chancellor Friedrich Merz, Germany has reversed its longstanding opposition to nuclear energy. The government now supports treating nuclear power on par with renewables in EU legislation and is investing in next-generation technologies like small modular reactors and nuclear fusion.

Belgium: In May 2025, Belgium's parliament repealed its 2003 nuclear phase-out law, officially reversing its commitment to eliminate nuclear power. This decision allows for the continued operation of existing reactors and opens the door to future nuclear developments.

Denmark: Denmark is reconsidering its 40-year ban on nuclear energy, originally imposed in 1985. The government is exploring the potential role of small modular reactors (SMRs) to complement its renewable energy sources, acknowledging the need for stable baseload power.

Greece: Prime Minister Kyriakos Mitsotakis has signalled a potential policy shift by opening discussions on developing nuclear energy for the first time, as part of the country's broader energy transition strategy.

Ireland: While historically opposed to nuclear power, Ireland is now engaging in serious discussions about its potential role in achieving energy security and climate goals, particularly considering modern nuclear technologies like SMRs.

Spain: Although Spain confirmed a policy in December 2023 to phase out nuclear power by 2035, the government indicated in April 2025 that it would consider proposals from nuclear plant operators to extend closure dates, reflecting a more flexible approach.

The union is also focused on reducing its dependence on Russian uranium. In 2024, the EU imported over €700 million worth of uranium products from Russia, accounting for a significant portion of its nuclear fuel supply. To address this, the European Commission has announced plans to restrict new supply contracts for uranium and other nuclear materials from Russia, aiming to phase out such imports by the 2030s.

The European Commission has proposed that member states coordinate backup supplies of essential goods—including nuclear fuel stockpiles—as part of a new EU-wide strategy to strengthen crisis preparedness amid rising geopolitical and climate-related threats.

FRANCE

After the oil shock of 1974, France created energy policies to rapidly expand the country's nuclear power capacity. As a result, France has achieved substantial energy independence and is the world's largest net exporter of electricity due to its very low cost of generation.

Over 70% of France's electricity is generated using nuclear power, the most by any nation globally. It comes as little surprise therefore to see French President Emmanuel Macron announcing in October 2021 that nuclear power must continue to play a significant role in the country's energy program. Additionally, in November 2021 he announced that France would build additional nuclear reactors to support energy independence and forecasting that construction of six new reactors would be announced shortly.

France is advancing a major nuclear expansion, with plans to build six new EPR2 reactors starting in 2027 and completing by 2038. To support this, the government has committed to subsidizing at least half of the €67 billion estimated cost through preferential loans to EDF, including a price ceiling on electricity contracts to shield consumers from market volatility.

To steer this ambitious agenda, EDF appointed Bernard Fontana as CEO in April 2025. Fontana is conducting a strategic review to divest non-core or underperforming assets, allowing the company to concentrate financial and operational resources on nuclear development in alignment with national priorities.

France is also enhancing its nuclear fuel cycle resilience. Orano secured a €400 million loan from the European Investment Bank to expand uranium enrichment at the Georges Besse II plant by 30%, part of a broader €1.7 billion initiative aimed at bolstering European energy independence and reducing reliance on foreign enrichment services.

A coup in Niger at the end of July 2023 put ~5% of global uranium supply in the balance. Niger currently accounts for 20% of the EU's uranium imports and 15% of French supply. As the country's second largest export, uranium is a pivotal source of GDP for Niger. Orano reported in October that it had to suspend operation in the country following the closure of the main supply and export corridor.

In spite of Orano's efforts to maintain dialogue with SOPAMIN, the shareholder representing the State of Niger, the government has not been cooperative and has not paid any of its debts to the mining company for the past 15 months. As of June 2025, Niger has escalated its dispute with French nuclear company Orano by nationalising the Somaïr uranium mine.

Niger has shifted its diplomatic and economic focus now from France to Russia. Its new government has sought Russian investment in its natural resources, revoking French company Orano's license to operate.

In an interview with Russia's Ria Novosti press agency, Mining Minister Ousmane Abarchi said: *"We have already met with Russian companies that are interested in coming to explore and exploit Niger's natural resources ... not only uranium."*

UK

The UK currently generates 15% of its electricity from approximately 6.5 GW of nuclear capacity, with plans to go to 25% by 2050. Current nuclear capacity is produced from nine operating reactors, with two reactors currently under construction: Hinkley Point C (estimated to start operation between 2029-2031) and Sizewell C (estimated to start operation in 2031).

As part of the Energy Security Strategy, there are proposals for eight large new reactors and SMRs by 2050. Part of this proposal was the formation of a new body called 'Great British Nuclear' who are responsible for driving delivery of new nuclear projects in the United Kingdom.

At the start of 2023, the UK government announced the creation of the 'Nuclear Fuel Fund', comprising £75 million in UK government funding to support the development of alternatives to Russian fuel supply and strengthen UK energy security. The fund will invest £50 million to stimulate a diverse and resilient nuclear fuel market, and support projects aiding the fuel requirements for both traditional but also advanced nuclear.

In January 2024, the UK government announced that it is investing £196 million to build a uranium enrichment facility at Urenco's Capenhurst site, aiming to produce 10 tonnes of high-assay low-enriched uranium (HALEU) annually by 2031. This facility aims to reduce reliance on Russia for HALEU.

2025 saw the UK launch a major nuclear energy revival, with Energy Secretary Ed Miliband announcing £14.2 billion in funding for two new reactors at Sizewell C in Suffolk—part of a broader £17.8 billion initiative to power six million homes. This investment secures stable, low-carbon baseload electricity to complement renewables and is central to the UK's long-term energy resilience strategy. It comes amid a wider £300 billion public spending plan covering healthcare, infrastructure, and clean energy expansion.

In parallel with large-scale projects, the UK is advancing future-ready technologies like SMRs and fusion energy. Rolls-Royce SMR has been selected as the preferred bidder in the national SMR programme and is moving to contract negotiations. The design, based on a pressurised water reactor, is already in Phase 2 of the general design assessment, with the government aiming for operational deployment in the early 2030s following permitting and investment decisions expected in 2026–2027.

This marks a historic return to nuclear power as a cornerstone of Britain's energy mix. With the current reactor fleet set to retire by the early 2030s, Sizewell C and the SMR rollout represent a generational leap, re-establishing the UK as a leader in clean energy.

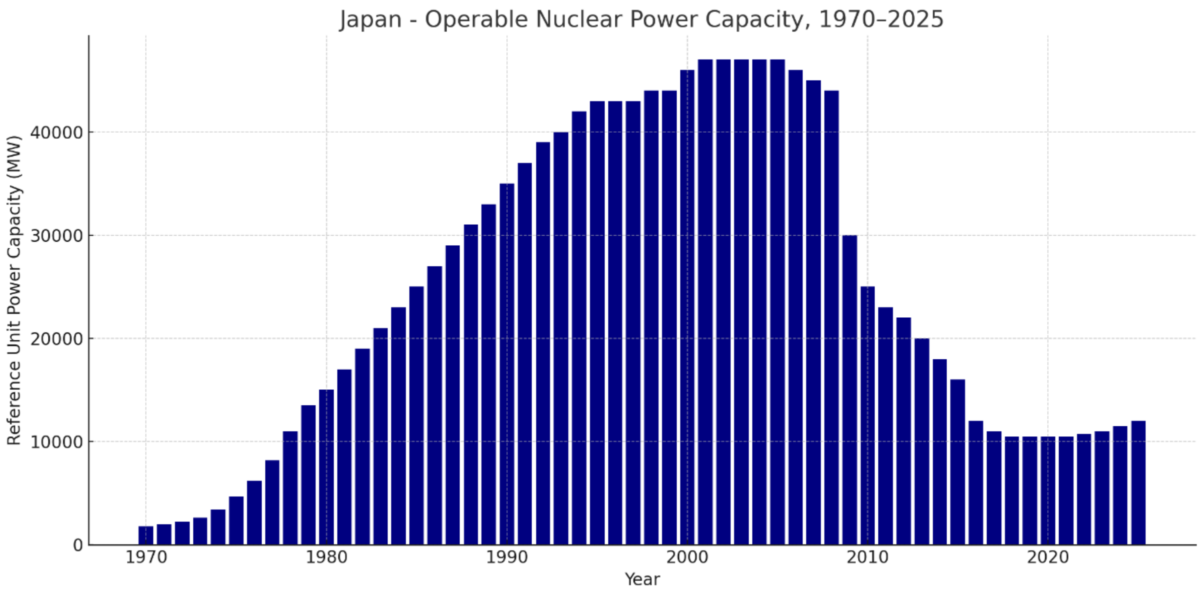
JAPAN

On 11 March 2011, a nuclear accident occurred at the Fukushima Daiichi Nuclear Power Plant, caused by the most powerful earthquake ever recorded in Japan. As a result, 14-metre-high waves damaged the plant's emergency diesel generators, leading to a loss of electric power. While the earthquake and tsunami took the lives of close to 20,000 people, none of these deaths are known to have been related to radiation exposure. The incident at Fukushima Daiichi Nuclear Power Plant had a significant impact on world uranium market as it led to lower public confidence in the safety of nuclear power, changes to energy policies, shift towards renewable energy and changes in the investment and development of nuclear projects.

Post-Fukushima, Japan shut down its entire fleet of 54 reactors and started to increase imports of fossil fuels, nuclear power provided approximately 30% of the electricity in Japan and this was expected to increase to at least 40% by 2017.

In December 2022, Japan approved a plan to revive the use of nuclear energy, following a softening of public opposition to restart reactors after repeated blackout scares and rising costs of electricity.

Today, Japan has a total of 33 operable reactors in the country and another two currently under construction. However, in 2013 the Nuclear Regulation Authority established new regulatory requirements, and just 10 reactors have since received clearance from the regulator to restart. The first two reactors to restart after the March 2011 accident at Fukushima Daiichi did so in August and October 2015. Since then, a further eight have restarted, and another 15 operable reactors are at various stages in the process of restart approval. Two under-construction reactors (Ohma and Shimane 3) have also applied.



Source: World Nuclear Association

According to Japan's administration, nuclear energy will be indispensable to the country due to its current dependency on imports for over 90% of its primary energy needs. Japan's previous Prime Minister Fumio Kishida announced in August 2022 that he has instructed officials to deliver a concrete plan to further include nuclear in the country's plans for carbon neutrality by 2050. This plan will look at extending the lives of current reactors, constructing new reactors, and integrating next-generation nuclear into the country's energy mix.

In February 2025, the Japanese Cabinet approved the Seventh Strategic Energy Plan, aiming to increase nuclear power's share to approximately 20% of the country's electricity generation by 2040, up from 8.5% in 2023. This plan signifies a departure from previous policies that sought to minimize nuclear reliance. The government intends to restart existing reactors, extend the operational life of aging units beyond 60 years, and develop next-generation reactors to meet this target.

Progress has been made in restarting nuclear reactors. Notably, in April 2025, the Tomari Nuclear Power Plant's Reactor 3 received clearance from the Nuclear Regulation Authority, with plans to resume operations in June 2027 after completing safety upgrades. Additionally, the Kashiwazaki-Kariwa Nuclear Power Plant has been preparing for the restart of its reactors, with fuel loading activities approved and underway, although full operations are contingent upon further safety assessments and local approvals.

INDIA

The Indian government is committed to growing its nuclear power capacity as part of its massive infrastructure development programme, however, procurement has not yet begun for this capacity increase.

India's largest power producer announced plans in August 2022 for the construction of two 700-megawatt reactors in Madhya Pradesh. This news follows the announcement earlier in the month from NTPC – India's largest energy conglomerate – that it is targeting its nuclear power debut with two reactors in the northern state of Haryana.

Indian PM, Narendra Modi, has been vocal in his support of nuclear, aiming to more than triple India's nuclear fleet over the next decade. India currently generates c.70% of its electricity from coal, and c.3% from nuclear.

India plans to import approximately 19.8 million pounds of uranium between 2025 and 2033—nearly quadrupling its imports from the previous five years—to fuel its expanding nuclear power program under the National Nuclear Energy Mission. This initiative aims to increase nuclear capacity from 8.88 GW to 22.48 GW by 2031–32, with a long-term goal of 100 GW by 2047.

MIDDLE EAST

The number of reactors currently under construction in the Middle East is at the highest point in the last two decades, with reactors being built or planned in new jurisdictions such as Egypt, Saudi Arabia, Turkey and the UAE. While all these countries are experiencing an increase in energy demand, the driving themes behind the announced build-out plans are energy security and desalination.

Egypt has considered establishing nuclear power since the 1960s. It began construction on a nuclear power plant comprising of four large Russian reactors with significant desalination capacity. A financing agreement with Russia was signed for US$25 billion and has been announced to cover 85% of the project's costs, with repayments on commissioning of the facilities.

Saudi Arabia currently has no operable reactors nor any reactors under construction. However, they do have plans to establish a civil nuclear power industry eventually. In January 2022, Saudi Arabia's energy minister indicated that the country was looking at producing '*pink hydrogen'*, which is hydrogen made using nuclear energy. The plans propose the construction of two reactors by 2030 and bring 17GW of nuclear capacity online by 2040. Alongside its nuclear industry, Prince Abdulaziz said the country would look to develop its own uranium reserves. Currently, all the country's electricity is generated by burning fossil fuels.

Nuclear power is a primary component of the United Arab Emirates' 'Net Zero 2050' initiative. The UAE's first nuclear power plant in Barakah went online in 2020, followed by units two in 2021 and three in October 2022. In June 2022, it was said that the four-unit plant was more than 97% complete. Construction for the project was completed on time and on budget—which makes it a unique project within an industry characterised by cost overruns and delays.

The nuclear project is based primarily around providing electricity for desalination for drinking water. Nuclear power was chosen as the “environmentally promising and commercially competitive option, which could make a significant base-load contribution to the UAE’s economy and future energy security”. The four reactors provide 25% of the UAE’s electricity, at approximately 25% of the estimated cost of alternate production from natural gas. The UAE’s clean energy production capacity (including solar and nuclear) is forecast to increase from 2.4 GW in 2020 to 14 GW by 2030.

Turkey currently has four nuclear reactors under construction at Akkuyu, which commenced in April 2018 and are planned to start up between 2025 and 2026. Construction is on-going and Unit 1 is expected to be operational in 2025. Start-up and commissioning work on this unit has already started in 2024, following the delivery of the first batch of nuclear fuel in April 2023. These four reactors are expected to generate approximately 10% of Turkey’s electricity when completed. As Turkey currently imports approximately 75% of its energy, energy security and efficiencies are priorities.

SOUTH KOREA

In South Korea, pro-nuclear President Yoon Suk-yeol has pledged to reignite the country’s nuclear industry. Currently, 26 reactors provide about one-third of South Korea’s electricity.

In the first quarter of 2025, nuclear power generation surpassed that of coal and natural gas, accounting for nearly 35% of the country's electricity. This shift has led to a 20% reduction in fossil fuel imports compared to the same period in 2024.

AUSTRALIA

Despite holding one-third of the world’s uranium reserves, Australia accounts for only c.8% of global supply and comprising 17% of all energy exports. There are three operating uranium mines in Australia: Ranger in Northern Territory, Olympic Dam in South Australia, and Beverley with Four Mile in South Australia. Four Mile has final processing through the Beverley plant.

In 2025, Australia exported roughly 11.2 million lbs of uranium, with expectations to surpass 13 million lbs by 2026 as global demand for nuclear fuel intensifies. Production is being led by Boss Energy’s Honeymoon mine, which began output in January and is on track to deliver 850,000 lbs in its first year. Major projects like Mulga Rock and Bigrlyi are also advancing. While domestic nuclear power remains banned, Australia’s vast reserves position it as a key player in the international uranium supply chain.

RESTARTS AND EXTENSIONS

Governments around the world are increasingly extending the lifespans of nuclear power plants and, in some cases, restarting previously closed facilities, marking a significant shift in energy policy. In the U.S., reactors like Oconee, V.C. Summer, and Palisades have received life extensions or are being recommissioned, while the UK extended operations at Heysham, Hartlepool, and potentially Sizewell B.

France is investing €6 billion to keep 20 of its 1,300 MW reactors running past their 40-year mark, and countries like Belgium and Finland have also reversed phase-out plans in favour of extensions. These actions, combined with Japan’s gradual reactor restarts, reflect growing reliance on nuclear power to ensure grid stability, energy security, and low-carbon generation.

This wave of extensions and restarts signals a clear global nuclear renaissance. Once seen as a sunset industry, nuclear is now being reembraced as a vital part of the energy transition—offering dependable, round-the-clock electricity alongside renewables. As new builds like SMRs progress, the extension of existing plants forms a critical bridge.

NUCLEAR SAFETY AND SMALL MODULAR REACTORS (SMRS)

Over the last four decades, the average time it has taken to build a new nuclear power plant has ranged from 58 to 120 months – or, in other words, up to a decade. This is a long-term commitment, meaning that some countries simply idled capacity rather than tear it down even when the industry suffered image issues following Fukushima.

Next-generation, SMRs are an emerging technology that will help with the current scalability issues around nuclear reactor construction and financing, while also having a significant impact on underlying uranium demand upon commercialisation.

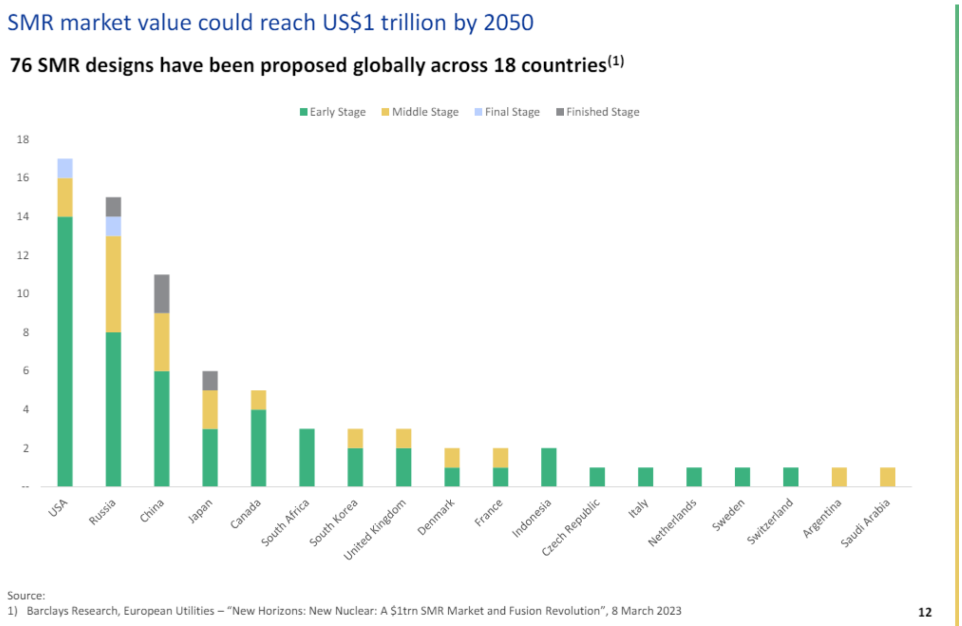
The benefits of SMRs are:

- Safety: Facility protection systems, including barriers that can withstand design basis aircraft crash scenarios and other specific threats, are part of the engineering process being applied to new SMR design.
- Modularity: the ability to be able to put major components of the reactor together in a factory, requiring limited onsite preparation.
- Cheaper: Reduced capital investment due to the lower plant capital cost, mainly associated with modularity. Location: SMRs can provide power for applications where large plants are not needed or sites lack the infrastructure to support a large unit, creating far better site flexibility.
- Efficiency: SMRs can be coupled with other renewable energies or fossil fuels to leverage resources and produce higher efficiencies and multiple energy end-products while increasing grid stability and security.
- Economic: deployment of a 100 MW SMR could create 7,000 jobs and generate more than US$1 billion in sales.

The Rolls-Royce SMR project, for example, targets a 500-day construction time on a 10-acre (4 ha) site. Overall build time is expected to be four years; two years for site preparation and two years for construction and commissioning. These SMRs will have power capacity of 470MW and could be capable of powering one million homes – equivalent to a city the size of Leeds, Austin or Lille. The Rolls-Royce SMR continues its generic design assessment under UK regulators and remains on track for a 500-day build per unit after around two years of site preparation. While the GDA progress is confirmed, final investment decisions are expected by the end of this decade, with commercial operations anticipated in the mid-2030s.

Ontario Power Generation (OPG) has received a construction licence from the Canadian Nuclear Safety Commission and is now moving forward with site preparation for a 300 MW BWRX-300 SMR at the Darlington site, adjacent to the existing nuclear station. The multi-unit project is part of a CA$21 billion ($15 billion) investment, aiming to build four reactors to power some 1.2 million homes by 2030. Early ground works are underway, with full construction expected later this year.

In January 2025, the Wyoming Industrial Siting Council approved construction of TerraPower's first 345 MWe Natrium reactor and accompanying molten-salt "energy island" at Kemmerer. Non-nuclear construction is underway, and the US NRC has granted initial project exemptions to allow early work.



Source: Yellow Cake Investor Presentation

SMRs are categorised into generations—Gen III, Gen III+, and Gen IV—based on their technological maturity and innovation. Each generation reflects a step forward in reactor design, with improvements in efficiency, safety, and fuel utilization.

Gen III SMRs are evolutionary designs based on traditional light water reactor (LWR) technology. They retain the core principles of large-scale nuclear plants but scale down in size for modularity and ease of deployment. With passive safety features (such as natural convection cooling), simpler designs, and established regulatory familiarity, Gen III SMRs like NuScale and SMART offer a practical and relatively low-risk path to expanding nuclear capacity. Their use of proven uranium fuel and conventional water cooling systems makes them suitable for near-term commercial deployment.

Gen III+ SMRs build upon the Gen III foundation with further enhancements in safety, efficiency, and operational flexibility. These designs integrate more robust passive safety systems, reduced reliance on active controls, and in some cases, improved load-following capability to support variable renewable energy sources. Examples like the BWRX-300 and Holtec SMR-300 also focus on lowering construction and maintenance costs through modular fabrication and simplified system architecture. Gen III+ reactors serve as a bridge between today's nuclear power and the advanced features of future technologies.

Gen IV SMRs represent a transformative leap, using non-traditional coolants—such as molten salt, helium, or liquid metal—and advanced fuels like TRISO to achieve higher efficiency, longer lifespans, and minimal waste. These designs are geared toward sustainability, with some capable of recycling spent fuel or using fast-spectrum neutrons to burn long-lived isotopes. Though still in the research or demonstration phase, Gen IV SMRs like TerraPower's Natrium and X-energy's Xe-100 hold promise for revolutionising nuclear energy by providing industrial heat, enabling hydrogen production, and significantly reducing the nuclear waste footprint.

THE GEN III+ RACE

Rolls Royce: The Rolls-Royce SMR is a Generation III+ PWR producing 470 MW of electricity, designed for modular factory construction to reduce costs and speed up deployment. It uses low-enriched uranium (LEU) fuel in the form of uranium dioxide, leveraging proven light water reactor technology for easier licensing and integration. Initial deployment is expected in the early 2030s, with potential sites including Trawsfynydd, Wylfa, Sellafield, and other existing nuclear locations across the UK.

Holtec: Holtec's SMR-300 is a Generation III+ PWR designed to produce 300 MWe of low-carbon electricity. The reactor uses low-enriched uranium fuel, similar to that employed in existing reactors, facilitating integration into current nuclear fuel supply chains. In the United States, Holtec has initiated "Mission 2030," aiming to deploy the first two SMR-300 units at the Palisades site in Michigan by 2030, co-located with the existing 800 MWe plant, which is being restarted after its 2022 shutdown.

GE Vernova: GE Vernova, in partnership with Hitachi and Ontario Power Generation (OPG), is building Canada’s first grid-scale SMR — the BWRX-300 — at the Darlington site in Ontario. This 300-megawatt unit will power around 300,000 homes and is the first of four planned reactors aiming to support Ontario’s growing clean energy needs. Construction began in 2025, with the first unit expected to be operational before 2030.

BIG TECH, ARTIFICAL INTELLIGENCE & DATA CENTRES

The rise of AI and its insatiable demand for energy could not have come at a better time for the nuclear industry. In the same way that coal fuelled the industrial revolution, nuclear will be pivotal for the success of the coming AI revolution.

Goldman Sachs estimate data centre power demand to grow 165% through 2030 from 2023 levels. Like us, they view today as the early stages of the nuclear renaissance both in the US and globally. Big Tech will continue to invest in low-carbon, baseload energy and are happy to pay a premium for it. Microsoft are reportedly paying Constellation Energy Corp. between $100-115 a megawatt-hour for power from Three Mile Island. That compares to about $60 a megawatt-hour for wind and solar energy readily available in the same region without any additional Capex requirement.

The rapid growth of AI has created a major energy challenge for tech companies committed to cutting carbon emissions. A single ChatGPT query consumes 0.0029 kilowatt-hours (kWh) of electricity—nearly ten times more than a typical Google search at 0.0003 kWh. With ChatGPT now handling around 1 billion queries daily from over 300 million weekly users, it consumes roughly 2.9 million kWh of electricity each day—100,000 times more than the daily consumption of an average U.S. household. additionally, image generation tasks are estimated to use over 60 times more power than simpler text-based queries, a gap that may be widening as AI models become more complex.

This surge in demand is part of a broader trend: global data centre electricity use reached 415 terawatt-hours (TWh) in 2024—1.5% of total global consumption—and is projected to more than double to 945 TWh by 2030, equivalent to Japan’s current national usage. With the IEA forecasting 150–200 new large-scale data centres to be built each year through 2026—many of them dedicated to AI workloads—the need for reliable, low-carbon baseload power is more pressing than ever. This helps explain why tech giants like Amazon, Google, and Microsoft are investing heavily and paying a premium to secure clean energy sources, including advanced nuclear.

At the 2025 CERAWeek conference in Houston, a landmark development marked Big Tech’s deepening commitment to nuclear energy. Leading corporations—including Amazon, Google, Meta, and Dow—signed the Large Energy Users Pledge, aligning themselves with the global objective of tripling nuclear energy capacity by 2050.

Five members of the so-called “Magnificent Seven”—Amazon, Google, Microsoft, Meta, and Nvidia—have already made significant moves into the nuclear energy sector. Their activities span a variety of strategies, including investments in small modular reactors (SMRs), long-term power purchase agreements (PPAs), the co-location of nuclear facilities with data centres, and the reactivation of dormant nuclear power plants.

Google:

- **Partnership with Kairos Power:** Google's collaboration with Kairos Power remains active, underpinned by a Master Plant Development Agreement signed in October 2024. The agreement aims to deploy 500 megawatts (MW) of advanced nuclear capacity by 2035.
- **Support for Elementl Power:** Google is also partnering with advanced nuclear developer Elementl Power, providing early-stage funding to support site development at three prospective locations in the United States. Each site is targeting a minimum capacity of 600 MW.

Microsoft:

- **AI Infrastructure Expansion**: Microsoft plans to invest $80 billion in artificial intelligence (AI) data centres during the 2025 financial year—an increase from $53 billion the previous year.
- **Three Mile Island Reactivation**: In September 2024, Microsoft signed a PPA with Constellation Energy for power from the Three Mile Island Unit 1 nuclear reactor. Since then, Constellation has made rapid progress on workforce recruitment, site preparation, regulatory approvals, and technical inspections, with the restart ahead of schedule.

Amazon:

- **Development of SMRs**:
    - Amazon has entered an agreement with Dominion Energy to explore the development of an SMR near the North Anna nuclear power station in Virginia.
    - It is also working with Energy Northwest to construct four advanced SMRs in the state of Washington.
    - Amazon has invested in X-energy to support the advancement of next-generation SMRs and nuclear fuel technologies.
- **Long-Term Power Agreement with Talen Energy**: Amazon Web Services (AWS) has signed a long-term agreement with Talen Energy to purchase up to 1,920 MW of electricity from the Susquehanna nuclear power plant in Pennsylvania. This deal forms part of Amazon's broader $20 billion investment in data infrastructure in the state and includes plans to investigate the deployment of SMRs and the potential expansion of the plant. Talen expects to earn approximately $18 billion over the duration of the contract, with energy deliveries scaling up to full capacity by 2032.

Meta:

- **Major PPA with Constellation**: Meta has signed a 20-year PPA for 1,121 MW of nuclear power from the Clinton Clean Energy Centre, commencing in June 2027. Based on an estimated annual output of 8.867 billion kilowatt-hours (kWh) at a rate of $0.07/kWh, the agreement is valued at approximately $620.7 million per year.
- **Future Nuclear Procurement**: Meta is also progressing with a nuclear request for proposals (RFP) to identify suitable developers. The company is targeting between 1 and 4 gigawatts (GW) of new nuclear capacity in the United States.

Fermi America:

Fermi America is building a groundbreaking energy and data centre complex located near Amarillo, Texas. This initiative aims to integrate multiple energy sources to support the growing demands of AI and data processing

- Scale: The campus will span approximately 5,800 acres and is designed to deliver up to 11 GW of power—enough to supply electricity to over 8 million homes.
- **Diverse Energy Sources:** The facility will combine the largest nuclear power complex in the US (AP1000 and SMRs), the nation's biggest combined-cycle natural gas project, utility grid power, solar power, and battery energy storage into a unified development.
- **AI Data Centre Capacity:** The campus will house 18 million square feet of AI data centre space, positioning it as the world's largest energy-driven AI complex.

- **Strategic Location**: Situated near the Pantex nuclear weapons facility and major gas pipelines, the site offers access to abundant energy resources.
- **Nuclear Power Plans**: Fermi America has submitted applications to construct four 1-GW Westinghouse AP1000 nuclear reactors, with the first phase targeting a 2032 launch date.

Other Big Tech:

- **Apple**: Partnership with TerraPower to develop advanced nuclear reactors to power its data centres.
- **Oracle**: Designing a data centre powered by three SMRs, providing over a gigawatt of electricity. Secured building permits for these three SMRs.
- **Nvidia:** Through NVIDIA's venture arm NVentures they participated in TerraPower's $650 million capital raise, supporting the build out of its first Natrium SMR in Wyoming

We expect to see more long-term power agreements like the one between **Meta and Constellation** as AI developers and hyperscalers seek firm, carbon-free energy at scale—and the capacity is clearly there. According to a report from the Department of Energy, 54 currently operating nuclear power plant sites across the U.S. have potential for additional units. Of these, 37 sites in 24 states have sufficient space and infrastructure to support at least one new large light-water reactor (LWR). Another 24 states also show potential to host smaller, advanced 600 MWe reactor technologies, such as SMRs, broadening the landscape for future deployment.

We believe that big tech's AI ambitions are creating a domino effect in terms of financing and could provide advanced nuclear the funding clarity it needs to get these units into commercial development. Over the past several years through our own work and collaboration with industry, we have heard the same two things are hindering SMR development: financing and fuel.

The *"chicken and egg"* scenario that has hindered advanced nuclear companies' commercialisation timelines has stemmed from a lack of demand certainty. In other words, there was not a customer lined up saying *"you build it, we will buy it".*

We are in a fundamentally different scenario today. The least price sensitive customers on the grid are lining up to provide billions in funding to these developers as their ESG ambitions collide with their AI ambitions. This, in turn, is bringing banks off the sideline as credit risk is mitigated given the associated balance sheet strength of customers, as the FT reported last month.

"Hyperscalers have the balance sheets and timelines that could afford them a higher risk appetite for investing in nuclear if these investments could create a differentiated advantage." – McKinsey

Fuelling these reactors, however, remains an issue. As we know, HALEU supply is a major concern for SMR developers, particularly those looking to diversify away from Russia. There is currently an insufficient domestic commercial capability to produce HALEU in the West. Two US companies currently have NRC licenses to produce HALEU, however only one is producing it. Centrus announced in June it had produced and delivered over 920 kg of HALEU under its DOE contract.

Kilogram quantities, however, fall far short of demand. HALEU demand is projected to be 215 metric tonnes in 2030. At which point US HALEU supply chain will likely still be in development as things stand.

We believe the world will view traditional centrifuge enrichment in much the same way they used to view gaseous diffusion, highly capital intensive, and inefficient. This is particularly relevant for higher enriched products like HALEU.

Despite its drawbacks, governments have focused their funding towards known-traditional centrifuge technology. Scaling up with traditional centrifuge technology will require significant time and investment that will likely delay SMR deployment and test public and private commitments to their respective climate pledges. Centrus, for example, will require 11,000 centrifuges to produce tonne quantities of HALEU, costing billions of dollars.

TerraPower and ASP Isotopes finalised definitive agreements in May 2025 including a conditional loan from TerraPower to support construction of a HALEU enrichment facility at Pelindaba, South Africa with initial production targeted for 2027 pending permits—

and committed to two HALEU supply deals: one to fuel the first core of TerraPower's Natrium reactor in Wyoming and a long-term 10-year contract delivering up to 150 MTU from 2028 through 2037; they also pledged to explore building additional enrichment capabilities in the U.S. ***"We are optimistic about ASP Isotopes' enrichment capabilities and planned timeline to help ensure advanced nuclear energy can achieve its necessary role in meeting climate energy targets."***

Characterised by its capital light, modular, high-margin, innovative technology ASPI-QLE has the potential to disrupt the uranium enrichment market and with views of commercialising HALEU production by 2027, it may be SMR developers and Big Tech best bet at deployment before 2030. In December 2024, ASP Isotopes announced in its annual shareholder letter:

"The Company is happy to share with investors that scientists from ASP Isotopes have already been active at Pelindaba and the construction of the first of two HALEU test facilities has been completed. We anticipate that we will complete the construction of the second test facility during 2025 and this will pave the way to start comprehensive testing of our technologies on the production of HALEU."

RISKS

AN ACCIDENT AT A NUCLEAR POWER PLANT (NPP)

The nuclear disasters most vivid in the human imagination are Chernobyl in the former Soviet Union, Three Mile Island in the US, and Fukushima in Japan. And it might surprise you to know that in Three Mile Island and Fukushima, the problem was not so much the accident, but the authorities' panicked response to it. According to the UN's World Health Organisation, the number of fatalities at Fukushima caused by direct radioactive exposure was zero. It was the tsunami, followed by the panicked evacuation, which killed 18,000 people and caused the damage.

The problems caused by the Three Mile Island accident were similar. When the reactor partially melted down, the container worked, and no radiation leaked into the surrounding area. The problem, again, was the panic.

Chernobyl was different. Radioactive material leaked and c.5,000 people died. Soviet political culture was not one of transparent accountability, but one of blame and avoidance. The slow response of the authorities also played a large part. The Chernobyl model was not even remotely like today's reactors, missing essential features like a container. As such, one should be careful with the comparison.

The probability today of an accident at a NPP is a complex and multifaceted issue that depends on various factors, including the design and safety features of the plant, the effectiveness of regulatory oversight, the competency of operators, and the overall safety culture.

Modern NPPs are designed with multiple safety systems and redundant features to prevent and mitigate accidents. These include passive safety systems that can operate without human intervention. Well-trained and qualified operators are crucial for the safe operation of NPPs. Strict operating procedures, training programs, and regular drills are implemented to ensure that operators can respond effectively to abnormal conditions.

Regulatory bodies in each country where NPPs operate play a vital role in ensuring safety. They establish and enforce safety standards, conduct inspections, and review plant operations to ensure compliance with safety regulations. NPPs have comprehensive emergency preparedness and response plans in place. These plans are regularly tested through drills and exercises to ensure a coordinated and effective response to any potential accidents. Newer reactor designs often incorporate enhanced safety features, such as passive cooling systems and simplified designs. Retrofitting and strengthening measures of older nuclear plants is subject to continuous and rigorous regulation by national and regional regulatory authorities.

A severe NPP accident is the worst outcome imaginable for the obvious reasons. The impact of a nuclear accident on the nuclear renaissance would depend on the nature and severity of the accident, as well as the responses of governments, the nuclear industry, and the public. In the event of a very significant nuclear accident such as a megadeath, we would have bigger and more meaningful things to think about than our uranium investment.

Nonetheless, the probability of a severe accident at a well-designed and well-operated NPP is considered extremely low. The IAEA has estimated the probability of a catastrophic accident in a NPP is very small in order of 1 in 1,000,000,000 each year. You are 4x more likely to be killed by a shark than in a NPP accident.

MOBILE INVENTORY

Bears point to the fact that utilities are not panicking and trying to secure as much uranium today as possible because there is an abundance of floating or mobile inventory.

Based on several estimates, total uranium inventories are c.1bn lbs globally, this is down from 2bn lbs historically (a lot of it was held by Russians). Details of uranium inventories may not always be publicly disclosed in real-time due to security and commercial considerations. Access to such information has always been restricted to protect national security interests and commercial sensitivities.

One billion lbs might seem like a very large figure, enough to cover many years of global consumption, but once we start to categorize the inventory it becomes clearer that this is not the correct interpretation of these figures:

- Around 250m lbs of inventory (14 months of global demand) are typically in the 'fuel building' / 'in-process category', meaning that these are inventories already under contract and being readied for fuel fabrication and future consumption. Some is held by enrichment and conversion facilities which is referred to as 'working inventory'.
- Strategic inventory: When Japan was operating 55 reactors consuming 20m lbs per year, they wanted a minimum of 4 years or 80m lbs of inventory in reserve. Similarly, most utilities today hold 2-3 years of consumption as a precautionary measure / margin of safety which equates to 400 - 500m+ lbs. This number could go up if utilities feel insecure about future supplies.
- Though incredibly opaque ~400m lbs of inventory reside in China. This may seem excessive in relation to China's current consumption, but not when you factor in the country's plans to build 150+ reactors over the next 15 years.

Also, important to note is that when new reactors come online, preparing the initial core requires 2-3x the reactor's annual fuel consumption. Some of the larger reactors coming online in China require 2m lbs upfront to load the initial core.

UxC reported in September 2022 that the era of excess inventories overhanging the nuclear fuel market is "emphatically behind us." There is very little mobile inventory left in the market and the majority is held by financials, utilities and other suppliers who have sequestered inventory for the long term.

"Post-Fukushima, we had high levels of inventory in the market which provided flexibility… that flexibility is now gone" - Laurent Odeh, CCO, Urenco

Utilities previously looking to buy short-term inventories from a flooded spot market are now unable to do so. Findings from the UxC 2022 Global Nuclear Fuel Inventories (GNFI) report concluded that the trend of inventory reduction that began in 2017 has continued over the last few years, and has been accelerated by several factors - primarily the emergence of financial entities such as the Sprott Physical Uranium Trust (SPUT) and Yellow Cake (YCA) who now own c.85m lbs between them, and neither party are sellers, only buyers. This buying spree resulted in financial entity inventories increasing 140% between 2020-22 while US, EU, Japanese and uranium trader inventories all declined significantly during the same period.

While there is uranium inventory globally, this inventory cannot be viewed as 'mobile' or 'excess' inventory that can be used to meet incremental uranium needs.

THE CHEAPNESS OF RENEWABLES

Much has been written about the growing cheapness of renewables and the unit cost of solar and wind have fallen sharply over the years. The issue is that those lower solar and wind unit costs have not translated into lower electricity prices for the countries that have used them. The problem is not related to the cost of the units but that they are fundamentally unreliable and require geographically specific locations.

For example, in 2016, Germany added 10% more wind capacity but only generated 1% more electricity from wind, because it was not very windy in those years. Solar, obviously, can only generate electricity when the sun shines. So, for most of the year during the morning and evenings, which is peak electricity demand, the supply of solar disappears. Battery storage and photovoltaic efficiency innovation is changing but nothing changes the fact that on very sunny days solar can overproduce to such an extent that prices go negative. Large-scale and cost-effective storage solutions remain in their nascent development stages.

These intermittency problems put grids under significant pressure and show up in the price end-consumers must pay. Compared to traditional fossil fuel or NPPs, the energy density of wind and solar installations is lower. This means that a larger area and more equipment may be needed to generate the same amount of power, potentially leading to higher infrastructure costs and land use.

Wind and solar are fundamentally ill equipped to be more than 10-15% of most grids. For baseload power, which needs to be available for the surges there are only three possibilities: coal, natural gas and nuclear. If you buy into the climate science the need for less polluting electricity generation is obvious. Nuclear is 100% carbon free, and completely clean.

ALTERNATIVES TO URANIUM

FUSION

Fusion is the process that takes place in the heart of stars, and provides the power that drives the universe. As opposed to traditional nuclear fission in which the nucleus of an atom splits into two or more smaller nuclei, fusion combines nuclei to form a heavier nucleus. The IAEA estimate that fusion could generate 4x more energy per kilogram of fuel than fission, and nearly 4,000,000x more energy than burning oil or coal.

The UKAEA is the national fusion research body funded primarily by the government with ~£350m annual budget in 2023 and is advancing various research projects to position the UK as a global leader in nuclear fusion.

Their flagship project is STEP, which stands for Spherical Tokamak for Energy Production. STEP is a UKAEA programme that aims to demonstrate the ability to generate net energy from fusion. It will also determine how the plant will be maintained through its operational life and prove the potential for the plant to produce its own fuel.

The first phase of the programme is to produce a concept design by 2024, with the construction of the prototype power plant targeting completion around 2040. STEP has received £250m of funding so far and should receive substantially larger government funding over the next five years.

In May 2024, the UK announced a competition for up to £600 million in contracts to build the world’s first commercially viable fusion power station prototype which it hopes to have connected to the power grid by 2040.

While there has undoubtably been progress in fusion over recent decades, commercialisation remains in its infancy, a view shared by the UKAEA who responded the following to the UK Government when asked to estimate when fusion power will supply electricity to the grid.

“The penetration of fusion into the market is almost impossible to predict when looking beyond the 2050 timescale .... If (historical technology roll out rates were used) fusion could reach 10% of global energy demand by 2100 – equivalent to supplying all of Europe.”

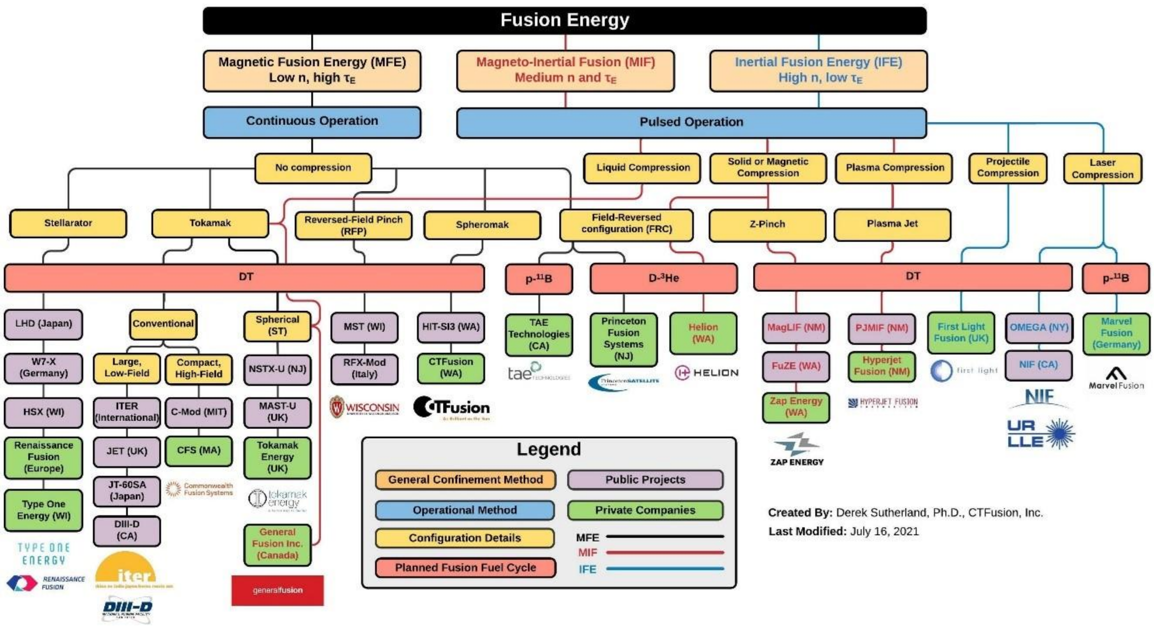
The most notable project globally is ITER (International Thermonuclear Experimental Reactor), in Southern France, which is an international collaboration of 35 nations that was launched in 1985 for nuclear fusion research and engineering aimed at creating energy through fusion.

The goal of ITER is to operate at 500 MW (for at least 400 seconds continuously) with 50 MW of plasma heating power input. An additional 300 MWe of electricity input may be required in operation, and no electricity will be generated. Construction began in 2010 and the original 2018 first plasma target date was put back to 2025 by the ITER council in 2016.

Whilst China are part of ITER, they also have the China Fusion Engineering Test Reactor (CFETR), which aims to further validate the ITER project. CFETR is aiming to demonstrate fusion energy production up to 200 MW initially and to eventually reach DEMO relevant power level which is over 1 GW. CEFTR is one of the most advanced projects aiming for construction to be completed in the 2040s with some (few 100 MWs) net electricity production as a demonstration of capability.

Beyond government programmes, the private sector has also seen a wave of interest in fusion, although this has started to slow over recent years. Private fusion has had over $5bn invested since 1992 with the majority coming between 2017-21. Investment into private fusion has tailed off in the last couple of years mainly due to the rising cost of capital.

Note that the graphic below is from 2021, but it gives a sense of the multitude of different fusion-related projects and their proposed applications.



Of the private companies focused on fusion, 93% are aiming to deliver a prototype during the 2030s. We view this as unlikely, and we will not see many of these companies reach prototype phases given both technological and financial constraints.

THORIUM-232

Thorium is far more abundant in nature than uranium, with the largest reserves held by India. Secondly, unlike uranium, it is not fissile on its own, meaning that the nuclear reaction can be stopped at any time. Thirdly and probably most importantly, the nuclear waste coming from thorium is far less radioactive than the nuclear waste from a uranium-fuelled power plant. Finally, the electricity output for every kg of fuel input is higher when using thorium.

Why then is thorium not being used? It comes down to the fact that uranium-based reactors have been in use for many decades, and the technology is well-established. Shifting to thorium would require significant investment in new reactor designs, fuel cycle technologies, and infrastructure.

Thorium-fuelled power plants do not produce any plutonium whereas uranium-fuelled power plants do, and you need plutonium to build nuclear warheads. Military considerations effectively have a huge role in the nuclear agenda.

While thorium has some potential advantages, the existing infrastructure and the prevalence of uranium-based reactor technologies have contributed to the continued use of uranium in most NPPs.

ALTERNATIVE EXTRACTION PROCESSES

There are other forms of uranium extraction such as seaweed extraction, solvent extraction, ion exchange and precipitation. There is no commercially viable method for extracting uranium from seaweed. While trace amounts of uranium can be found in seawater, the concentration is extremely low, making the extraction process challenging and costly (currently mooted at c.$200/lb). The chemical processes used for extracting uranium, such as solvent extraction, ion exchange, and precipitation, involve the use of specific reagents and the careful management of chemical reactions. These processes can be both technically challenging and expensive. None have yet commercialised.

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