OCEAN WALL

THE CASE ON URANIUM

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We have developed a proprietary live uranium tracker encompassing all uranium related equities and ETFs to analyse broad trends within the theme – this can be found on Bloomberg under the ticker .OWL.U U Index

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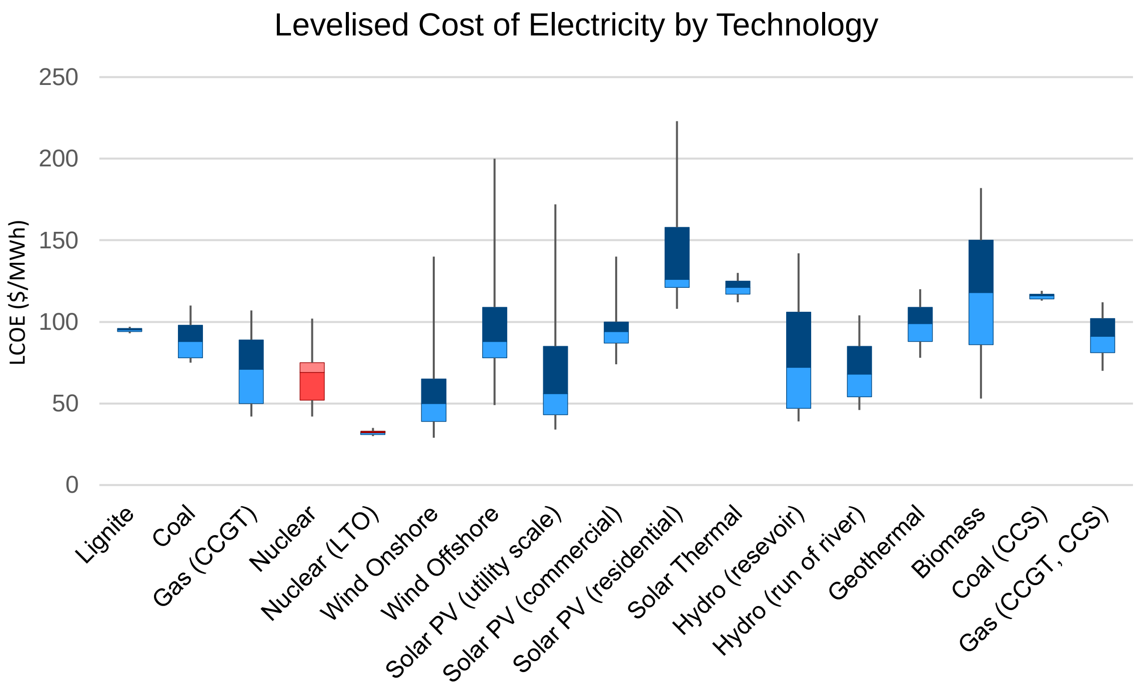
THE THESIS

"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.



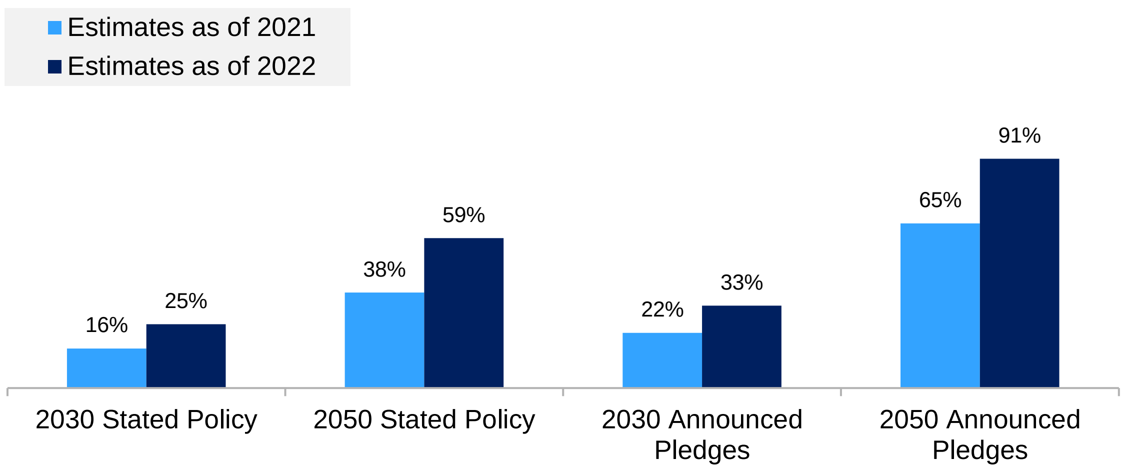
Source: IAEA

Currently c.10% of the world's electricity is delivered using nuclear. 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 COP27 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 (to name a few) have all pledged to carbon neutrality by 2050, with China committing to by 2060.

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 double by 2050.

Expected growth in nuclear power production vs 2020



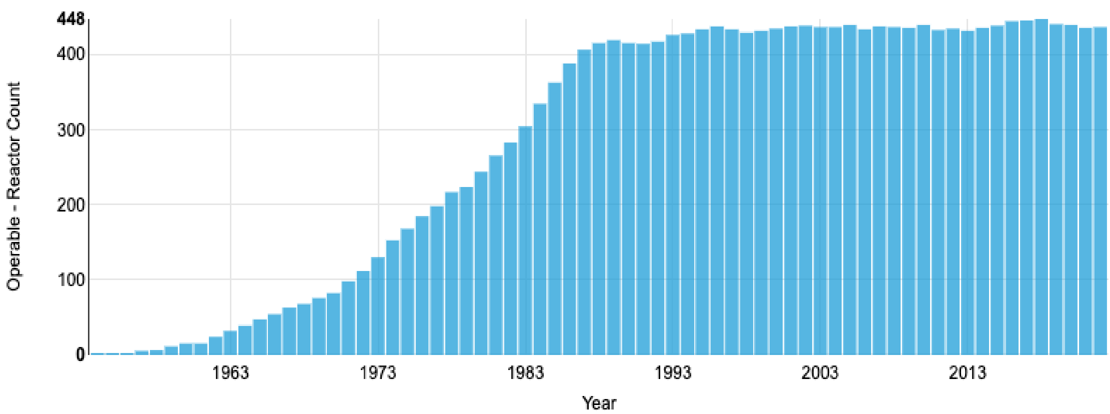
Source: World Energy Outlook

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 more than doubled in the past two 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 c.$143/lb in 2007, uranium hit lows of $19/lb post Fukushima. The uranium spot price has since tripled to c.$55-60/lb, reaching as high as c.$64/lb in March 2022 in reaction to Russia's invasion of Ukraine.

Source: Trading Economics

After Fukushima, the Japanese decommissioned their nuclear fleet and flooded the uranium spot market with inventory. As the chart shows, prices collapsed getting to distressed levels that saw most uranium mining operations become cost ineffective. Operating expenses 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 falling prices have the reverse and only recently has investor capital begun to return.

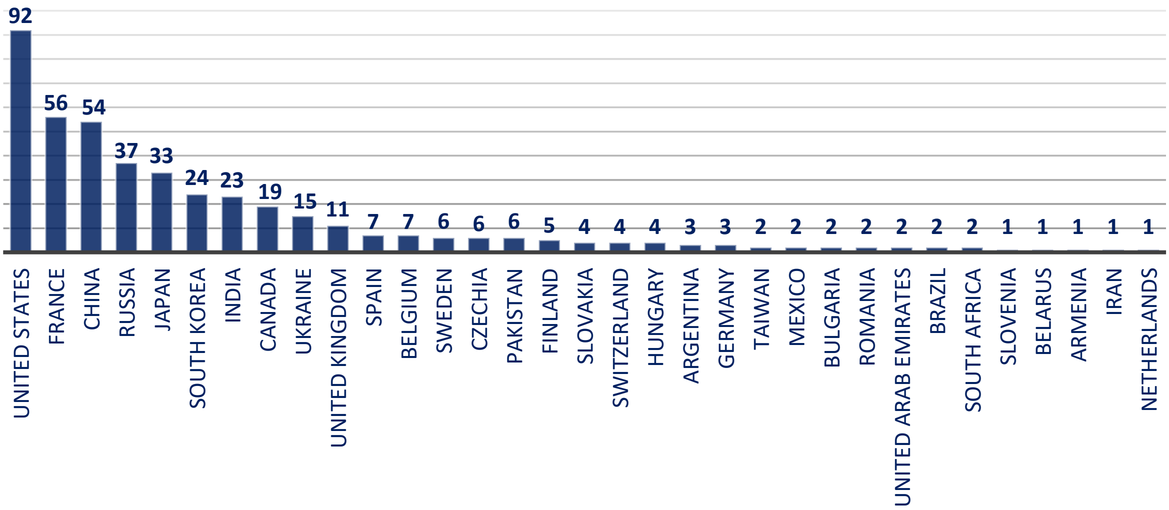
As of September 2023, there were 436 operable nuclear reactors worldwide, 60 reactors under construction, over 100 reactors planned, and over 300 proposed. While there are standard designs for reactors such as Light Water Reactors in the US, and VVER reactors out of Russia, the common theme among them is that many are starting to age, with a production ramp up flattening out in the late 1980s.



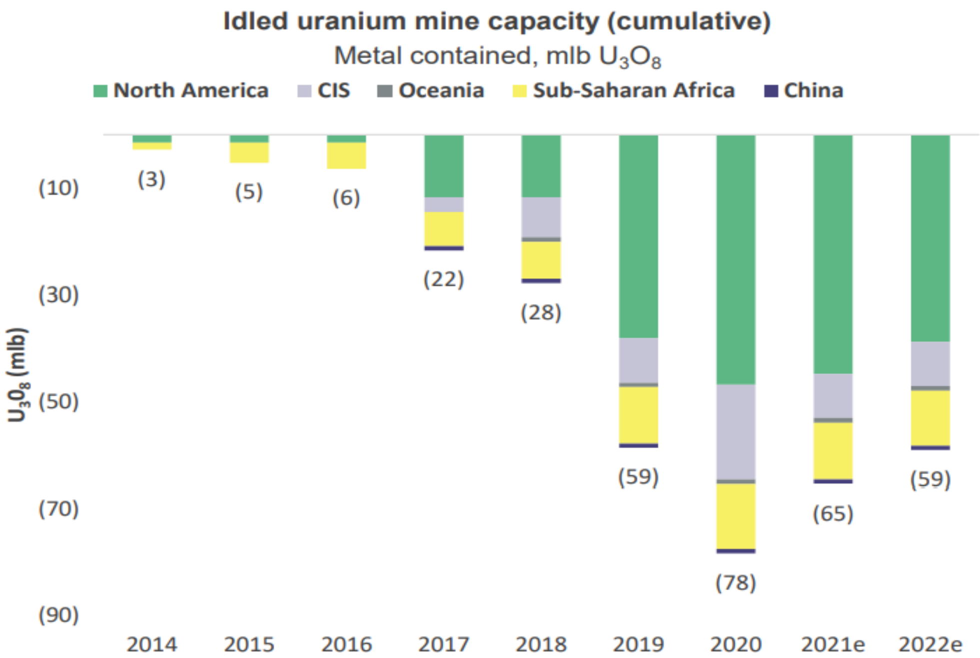
Source: World Nuclear Association

As less uranium was required post-Fukushima, exploration companies and miners curtailed their production, because even though capacity was there, demand was not. Uranium is now in a long-term structural supply deficit as idle mines wait for the spot price to reach the point where they can resume their operations. This was exacerbated by the pandemic which forced Cameco, the world's second largest producer, to close every one of its uranium mines in Canada.

Number of Operable Nuclear Power Reactors Worldwide, by Country (as of January 2023)



Source: Statista, Ocean Wall



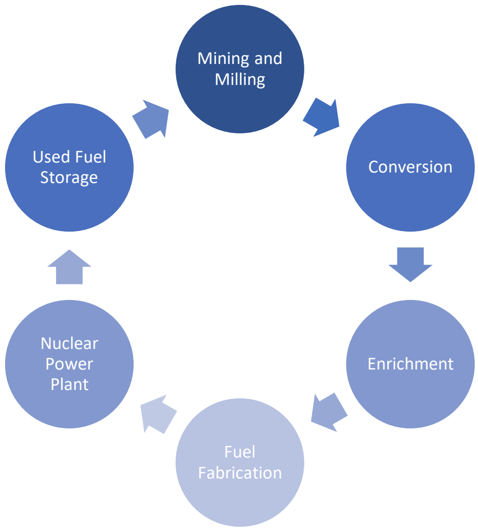
Source: MineSpans

We have developed a proprietary live uranium tracker encompassing all uranium related equities and ETFs to analyse broad trends within the theme – this can be found on Bloomberg under the ticker .OWL.U U Index

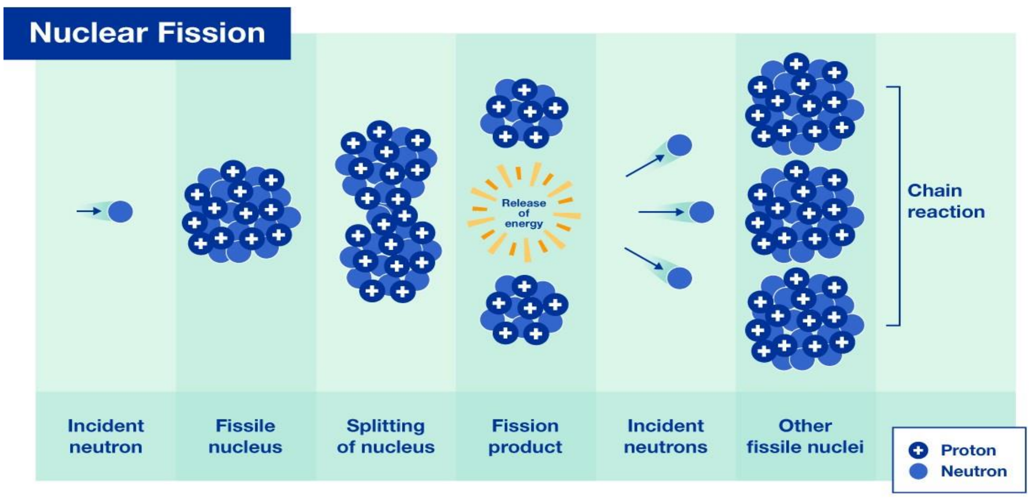
Primary supply will not reach previous levels even when the spot price exceeds incentive levels as idle mines take 12-18 months to restart due to government approvals, safety checks, capital, workers, and machinery all needs to be reengaged. In addition, exploring, permitting, developing, and putting into production a new mine can take as over ten years. Additionally, 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.



Source: IAEA

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 U3O8.

CONVERSION

Usually milled uranium oxide, U3O8 is then processed into either of two substances depending on the intended use. For use in most reactors, U3O8 is usually converted to uranium hexafluoride (UF6), 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, c.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).The are other very small conversion facilities, but most of the balance of the world's UF6 comes from Russia and China.

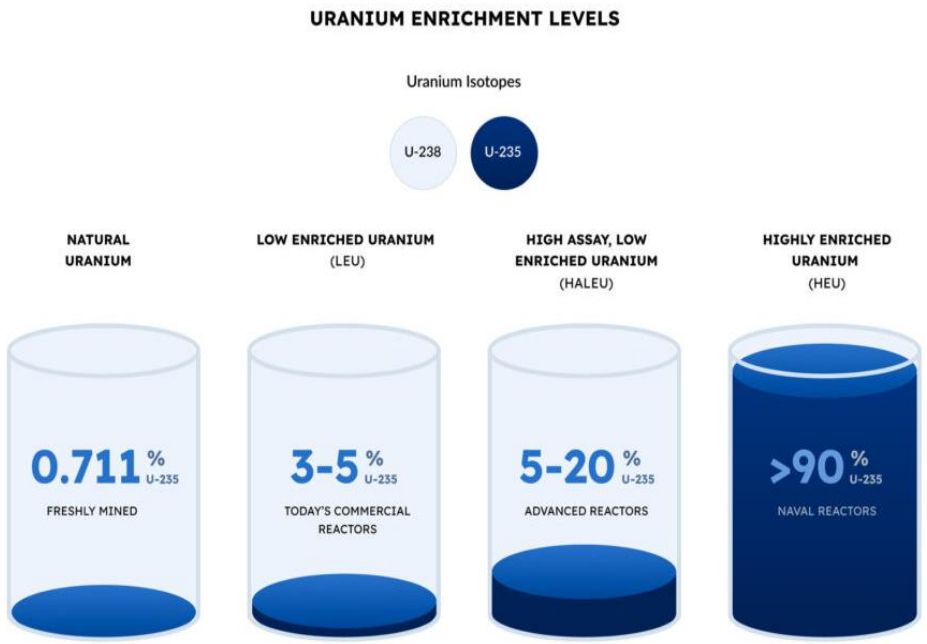
ENRICHMENT

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 GLE (global laser enrichment.) This process involves separating isotopes through laser excitation. Silex Systems are an ASX listed vehicle who are pioneering this technology and have been for over 30 years.

Cameco has a 49% interest in GLE, the exclusive licensee of the proprietary Separation of Isotopes by Laser Excitation (SILEX) technology. GLE is commercialising this third-generation uranium enrichment technology. Cameco is also the commercial lead for the project. See our report from March 2022 on Silex Systems here.

HALEU



Source: Centrus Energy

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%-20% 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.

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 such as Constellation Energy in the US, look to contract for fuel requirements six years ahead of time. This will affect market prices now as utilities scramble 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 utilities are at risk of running out.

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.

US inventories in 2022 held about 16 months of inventory, falling eight months short of the IAEA recommendation. In 2022, total US commercial inventories (including those owned by reactor operators, brokers, converters, enrichers, fabricators, producers and traders/financials in the US) were 140 million lbs U_3O_8 in 2022, which is down roughly 1% on 2021. US utility uranium inventories decreased 4% in 2022 compared to 2021, or approximately 19% off their peak in 2016.

In the European Union, uranium inventories (still including UK inventories) held by utilities averaged 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.

Uranium inventories held by EU and US utilities (tU)

Year	EU Utility Inventories	US Utility Inventories
2015	51892	46589
2016	51514	49217
2017	49004	47635
2018	45342	42759
2019	42912	43385
2020	42396	41024
2021	36810	41732

Source: NEA & 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. The World Nuclear Association estimate that as of January 2021, China had an accumulated inventory of over 129,000 tU, while India held an inventory of 9,600 tU.

Japanese owned materials have historically represented one of the largest sources of surplus inventories globally, and while current volumes are unknown, estimates show that pre-Fukushima, the Japanese had US$33 billion worth of nuclear fuel. Current Japanese inventories are unknown.

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.

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, 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.

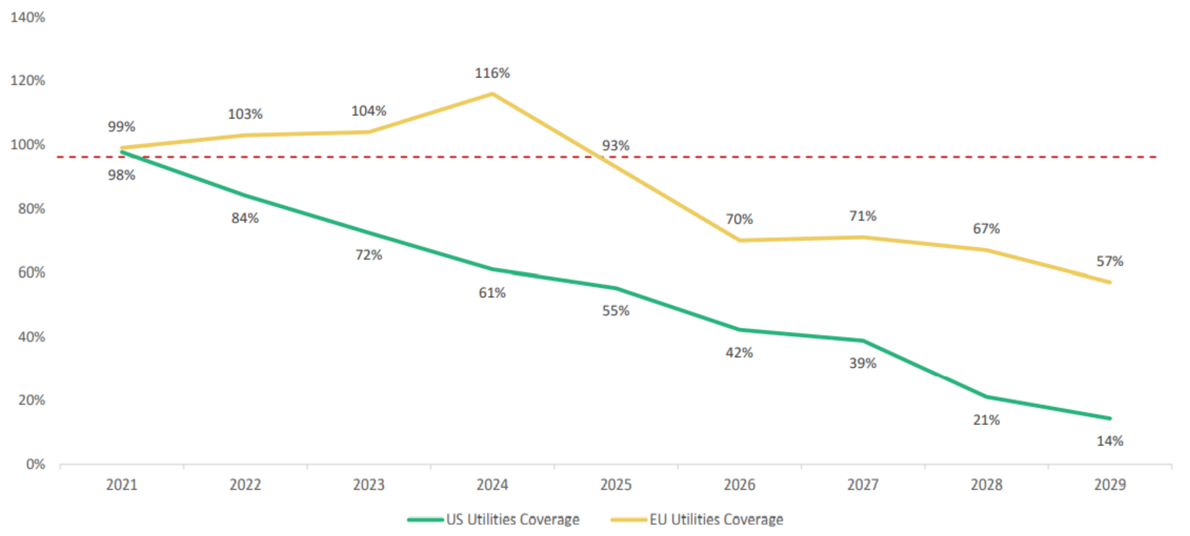
Except for China, all countries with nuclear stockpiles and alternative utilities have witnessed a decline since the 2018 report, while financial entities have seen an increase. Moreover, many holders who experienced inventory growth are expected to retain their stocks for the foreseeable future. As 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.

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. Some utilities have even begun 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.

Future contracted coverage rates of US and European utilities



Source: EIA

The term 'commodity super cycle' is synonymous with brand names such as oil, gas, gold, silver, copper and nickel. The chart below compares uranium's relative value to its peers. More specifically, we see uranium to be the cheapest valued asset relative to its all-time high when compared with other major commodities.

SUPPLY / DEMAND

'There is a risk that there may not be enough material to satisfy all existing global demand in the mid- to long-term.' – Askar Batyrbaev, Kazatomprom CCO, September 2021

The fuel buyer at the nuclear power plant will never 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 c.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 315% 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 $143/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. 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.

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.

There is an estimated multi-hundred million lb deficit through 2040, which does not factor in the influence of financial buyers, nor the emergence of next-generation SMRs. Both components have the potential to widen the supply deficit further.

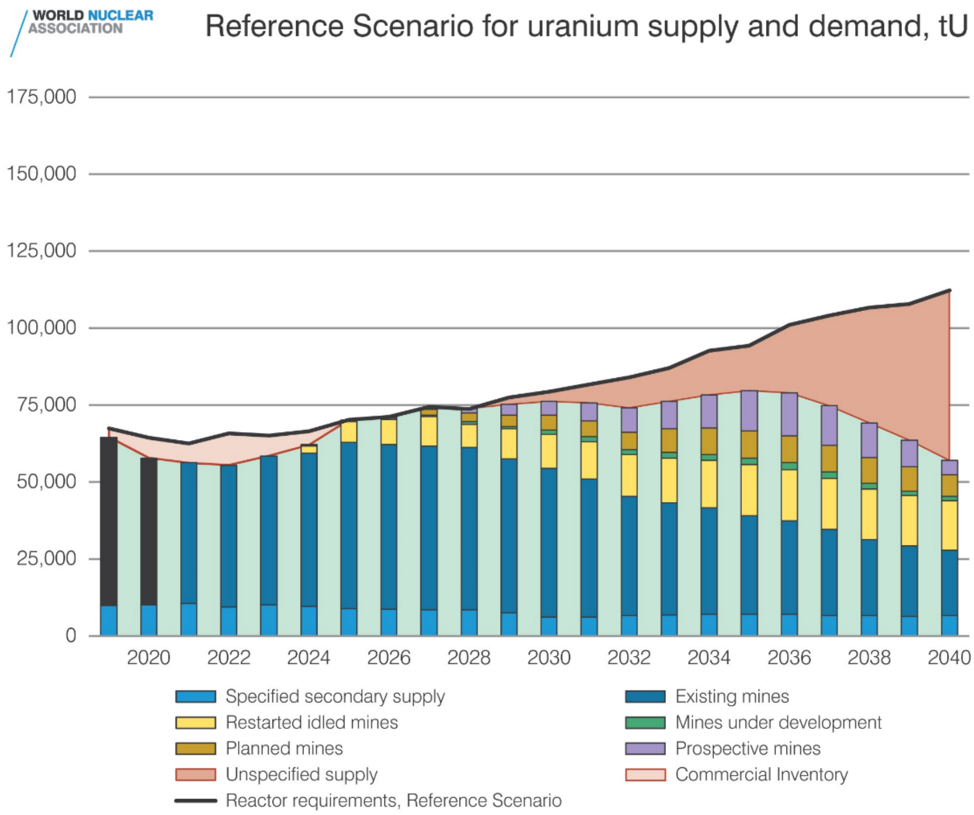
Broadly, supply gaps are expected to occur due to the gestation period associated with bringing online new production capacity. These projects can take over a decade from discovery to production and, as we have seen particularly in the West, incentive prices are not at financially viable levels for some 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 US$100. Given these fundamental constraints, a lack of financing has meant that new projects are rarely being commissioned.

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.

There was a cumulative 100m lb deficit between 2021-2022, and estimates for 2023 are 190m lbs of demand versus 140m lbs of supply. This deficit is expected to widen to multi-hundred million lbs over the next decade. The only way to supplement this deficit is higher pricing that will incentivise a return to Western primary production. 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.



Source: World Nuclear Association

URANIUM EQUITIES

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 over $3bn, holding close to 62m lbs of uranium (as of September 1st , 2023). 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.

In conjunction with this, we saw unprecedented levels of retail participation in uranium equities as the 'Reddit Crew' further drove the bull run, although this involvement contributed to a harsh correction at the end of 2022 reflecting that they were not long-term holders.

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 c.200% between IPO in December 2019 and September 2022 and saw net assets rise from $40m to over $1bn (currently $1.07bn as of September 1st 2023). 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 $55m.

The emergence of uranium sequesters like Sprott (SPUT), Yellow Cake (YCA), and ANU Energy (Kazakh uranium fund) 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. In addition, Goldman Sachs Investment Strategy Group have announced a 'tactical long position in spot uranium', although figures were not disclosed.

The fundamentals are now the tightest they have ever been. However, the number of uranium sector stocks has dropped from c.600 in 2007 to just 80 publicly traded names today. In fact, the total value of global uranium stocks is only c.$44bn (as of September 1st, 2023). Strip out the two main producers Kazatomprom and Cameco and the combined market cap is just $20bn. In 2007 the global market cap of uranium was over $150bn! We believe the fundamentals of the uranium market and supportive environment for nuclear today provide a significantly more bullish backdrop today than in 2007.

"We had the last bull market with half the world against us" – 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. Uranium equities are currently trading, on average, 60% off their all-time-highs, with most of the producers from the previous bull market having been unable to survive the 10-year bear market.

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 October 2022 where Cameco (2nd largest uranium producer in the world), and Brookfield Renewable Partners formed a strategic partnership to acquire Westinghouse in a deal valued at US$7.8bn. Cameco was a pure-play uranium name which is now investing downstream to become a more rounded nuclear play.

Uranium Energy Corp has also been very active in M&A particularly in 2022. In December 2021 they acquired Uranium One Americas. June 2022 bought UEX Corp for $192.7m in the largest M&A transaction in North American uranium sector history. October 2022 UEC bought Roughrider uranium project from Rio Tinto for $109m.

Other examples include:

- August 22 Deep Yellow and Vimy, two ASX listed uranium players completed a $658m merger to create one of the largest uranium mineral resource inventories globally (389m lbs).
- July 23 uranium developer Lotus Resources signed SID to merge with uranium exploration A-Cap Energy to create an Africa-focused uranium player. This deal is not yet concluded.

For those directly exposed to the spot price, what was worth 'Y' in 2021 is now worth 'Yx2', with prices more than doubling. There are undoubtably attractive M&A opportunities starting to resurface in the uranium sector, and we expect to see capital pour into these deals as uranium companies previously crippled asset values start to rise.

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 highly 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.

However, on March 17th 2022, four Senators introduced a bill to ban imports of Russian uranium. Russia's Rosatom accounts for ~40% of the world's enriched uranium supply, over 30% of conversion supply, by far the dominating producer. New investments in Russian conversion, enrichment fabrication and purchase are already banned. As Rosatom is directly involved in taking control of Ukrainian reactors it is highly likely Russian uranium will be sanctioned.

On March 9th 2023, US Senators introduced bipartisan legislation to ban imports of Russian uranium.

"Enriched uranium is key to unlocking the boundless potential for clean and reliable nuclear energy. Just as importantly, it's a pillar of American national security. Unfortunately, the U.S. lacks capacity to fully produce enriched uranium, and it has resulted in an unsafe reliance on Russia—a bad actor who could cut off uranium exports to us at any time…I am proud to work with Manchin and Barrasso on legislation to increase uranium production in the U.S., reduce dependence on Russia, and diminish Russian domination of the global nuclear fuel supply chain." – Senator Jim Risch

"Every dollar we give to Russia supports Putin's brutal war on Ukraine…America's nuclear industry is ready to transition away from Russian uranium…By banning Russian uranium imports we can further defund Russia's war machine, help revive American uranium production, and increase our national security." – Senator John Barrasso

"Russia invaded Ukraine one year ago, and Putin's energy war still shows no signs of slowing down. Russia's invasion completely changed the way natural gas and oil are bought and sold around the world, and the potential for even more supply disruptions — this time to our nuclear energy supply chain — is only increasing. This bill would help ensure that American nuclear energy companies aren't reliant on Russian imported uranium fuel and send a strong message to the world that the United States doesn't need to rely on Putin for the materials we need to power our country." – Senator Joe Manchin

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.

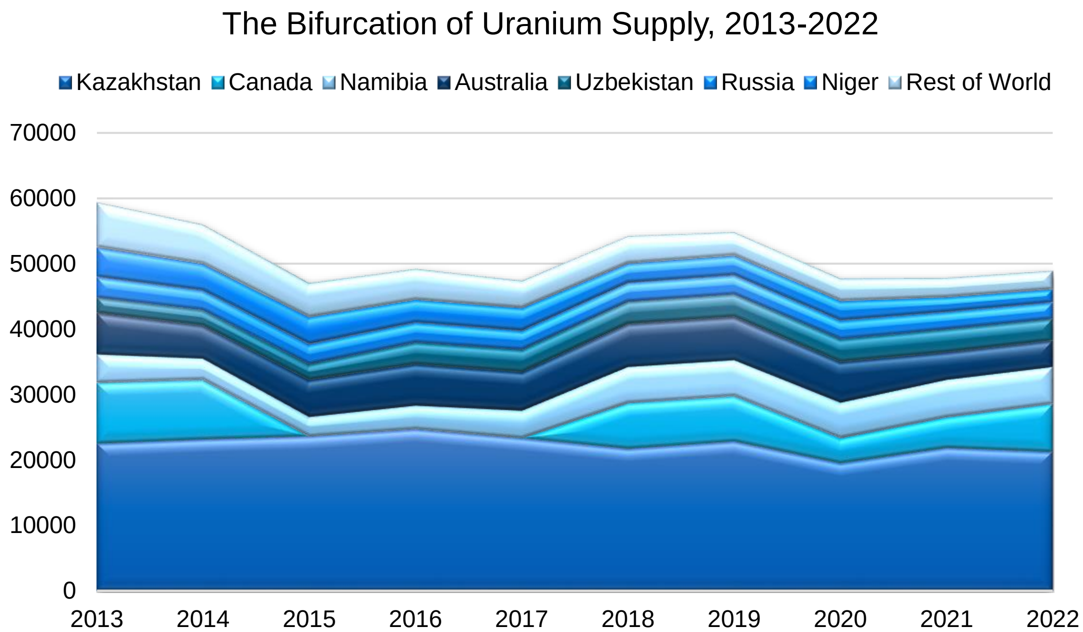
While these announcements show positive steps towards ultimately banning Russian involvement in the nuclear fuel cycle, until dates are confirmed we will likely not see material impact on either equities of the underlying price of the commodity.

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 also had uranium investors anxious over the resulting response of Kazakhstan, the world's largest producer of uranium.

As 40% of the world's uranium supply, Kazakhstan sits at the epicentre of uranium discussions. For context, Kazakhstan's dominance in uranium is four times that of Saudi Arabia's contribution to global oil production. State-owned Kazatomprom (KAP) is the largest uranium producer in the world, with a c.25% free float for international participation on the London Stock Exchange.



Source: World Nuclear Association

The events of January 2022 in Kazakhstan saw major protests over rising fuel price inflation. Rising prices have caused major political and investor unrest in Kazakhstan. Inflation is both unpopular and potentially destabilising and has caused the price of fuel to skyrocket. As one would imagine, this had major implications for uranium equities globally.

The events serve as a reminder for utilities that over-reliance on any one source of supply is risky. It also reinforces the shift in risk from suppliers to utilities that has occurred in this market.

In November 2021, KAP announced that they will become the key supplier to a new, Kazakh-based uranium fund, ANU Energy. The fund, similar to YCA and SPUT, will raise capital and purchase uranium for long-term sequester at their Western storage facility, Port Hope. The fund has raised $74m to date.

In an August 2022 earnings call, KAP's management noted that the company will look to increase its usage of a trans-Caspian supply route which will avoid Russian territory. Considering 50% of their deliveries travel through the Port of St. Petersburg (Russia), KAP is at high risk of delivery delays as their primary export option becomes increasingly difficult to use and Western shipping companies refuse to run the route. While the trans-Caspian route did complete one successful delivery in 2022, KAP's aim of implementing a transport network via Shanghai to the West is not feasible in our view. We have written an internal report titled: *'Chasing the Dragon: Can Uranium Go East?'.*

We have also examined potential pinch points in the KAP transport network given intensifying geopolitical risk in their international supply chain. We have compiled a detailed report which is publicly available titled: '*Uranium and its New Silk Road – Further Problems for Western Buyers'.*

UNITED STATES

Under the Biden administration, the US officially re-joined the Paris Agreement, and in November 2021 set out its plan to distribute a $1 trillion infrastructure package, of which $2.5 billion has been allocated towards the development of SMRs. The US is also set to construct a $4 billion advanced power plant backed by Bill Gates and Warren Buffet in Wyoming.

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).

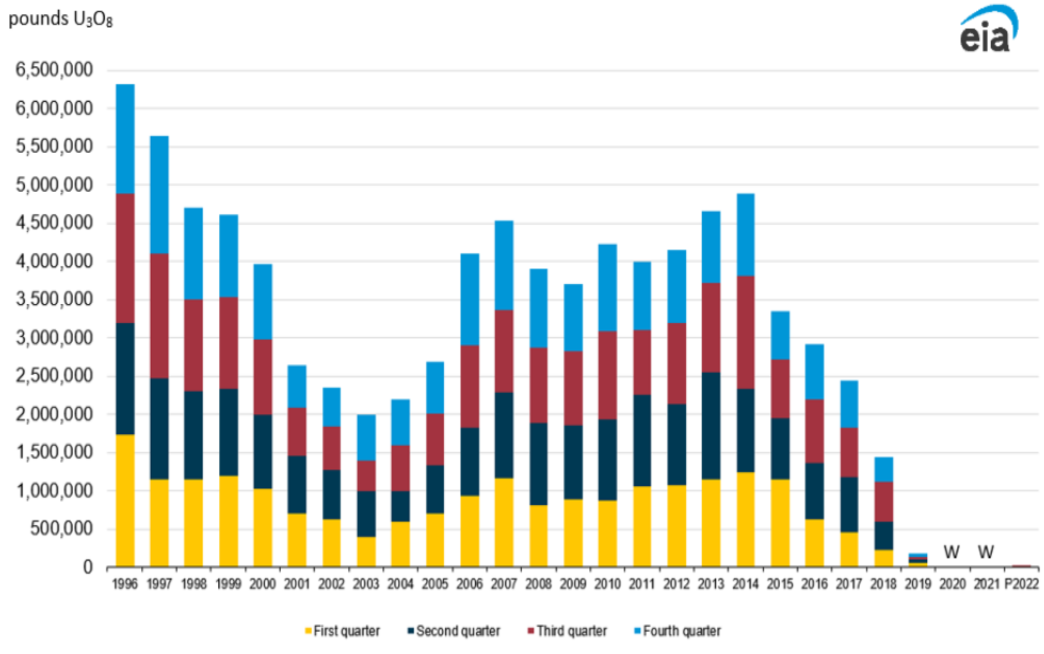
In August 2022, California lawmakers voted to keep Diablo Canyon nuclear plant open. The plant which supplies c.10% of the State's electricity needs was scheduled to close in 2025 but has now been extended to 2030, and potentially 2035.

For context, 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. Today, uranium production in the United States has stagnated, with the US only producing 190,000 lbs of uranium in 2022 – equivalent to approximately $10m worth.

Figure 1. Uranium concentrate production in the United States, 1996 to third-quarter 2022



Source: EIA

The political stance on nuclear is changing too, with Joe Manchin, the powerful Senator for coal and natural gas-rich West Virginia, wanting to implement a tax credit to keep nuclear plants operating. Under the version passed by the House, a credit of as much as $15 per megawatt-hour could be claimed for the next six years. Manchin, whose support is necessary for Senate Democrats to pass the legislation on a party-line vote, wants the tax credit to last 10 years instead.

In what was the largest ever federal investment in saving financially distressed nuclear reactors, the DOE announced plans in April 2022 of a $6bn program to support uneconomical plants that are due for closure. In August 2022, the passing of the Inflation Reduction Act (IRA) included a $700m funding package to support the ongoing HALEU Availability Programme which is being conducted over the next four years by the DOE.

As the fuel needed for the majority of next-generation reactor designs, HALEU availability has been a hot topic on the minds of those we have spoken to in the enrichment space. Currently, the only commercial supply of HALEU comes from Rosatom subsidiary, TENEX.

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 c.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*".

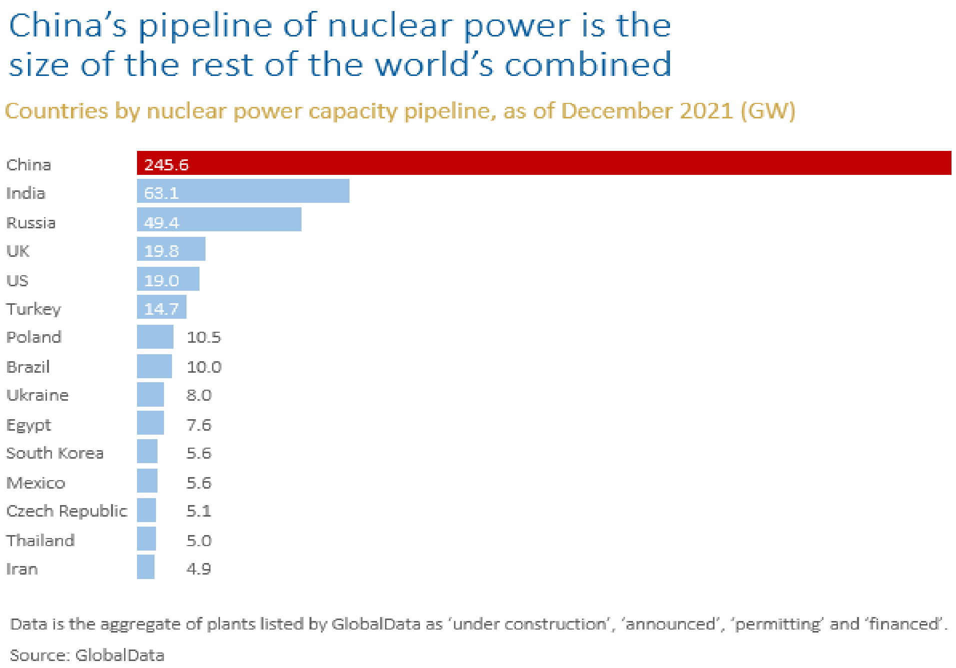
CHINA

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 plans to build at least 150 new reactors in the next 15 years, which is more than what has been built by the rest of the world in the past 35 years.

China's nuclear energy production has grown by approximately 300% since 2011 and their domestic nuclear capacity pipeline alone will increase global nuclear capacity by approximately 60% compared to 2022.

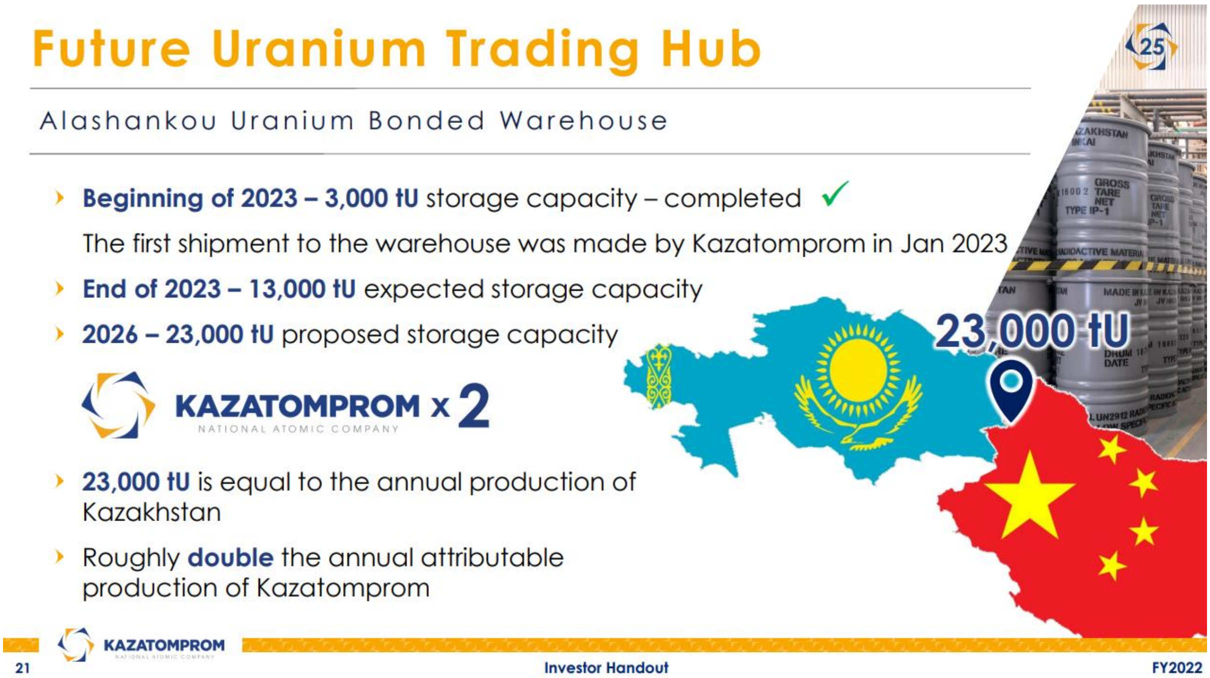
The current nuclear capacity in China is second only to the United States. In addition, given the rapid rollout of nuclear reactors over the past decade, China has a young nuclear fleet with an average age of only 10 years old, compared to 40 years in the United States. On a global scale, two-thirds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



Source: GlobalData

Kazakhstan. The 'Alashankou' warehouse is expected to hold an amount equal to around 40m lbs, 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 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 close their remaining three nuclear plants and it becomes quickly apparent how China will soon assert dominance on production.

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. Honeymoon was shut down in 2013 pending improved uranium prices, and the main Beverley (and North Beverley) wellfields were also shut down soon after that. There are plans to bring Honeymoon back into production.

Australia, which has bans on nuclear power stations in every state and territory due to environmental and safety concerns, has never had an operating nuclear power station. However, in October 2021, the national secretary of the Australian Workers Union (AWU) called for these bans to be revisited and proposed the introduction of Small Modular Reactors (SMRs) into Australia's climate change discussions.

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.

A coup in Niger at the end of July 2023 put c.5% of global uranium supply in the balance. According to the Euratom Supply Agency, EU utilities purchased 2905 tU of Niger-produced uranium in 2021. This represented just over 24% of EU uranium imports, putting Niger slightly ahead of Kazakhstan as the EU's leading source of uranium. As the country's second largest export, uranium is a pivotal source of GDP for Niger, so the expectation is that the country's uranium industry will remain unaffected, but this is by no means a guarantee.

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.

In 2022, however, due to maintenance work, planned outages and industrial action, France's reactor fleet produced 282 TWh, well below the ten-year average of 395 TWh. EDF estimates output for 2023 will be 300-330 TWh, 315-345 TWh for 2024, and 335-365 TWh for 2025. In February 2022 France announced plans to build six new reactors and to consider building a further eight.

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 in 2027) and Sizewell C (estimated to start operation in the early 2030s).

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.

The UK also continues to display its willingness to host SMRs on home soil, as Rolls Royce have come to surface as the front runners in the race to build these reactors in the UK. In addition, US based Last Energy is in advanced talks with the UK government to build a fleet of these advanced reactors across England and Wales, aiming to build its first "mini-nuclear" power plant by 2025. Reports in March 2023 suggested that Last Energy has agreed to sell 24 SMRs to the UK at a cost of £100 million per unit.

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.

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.

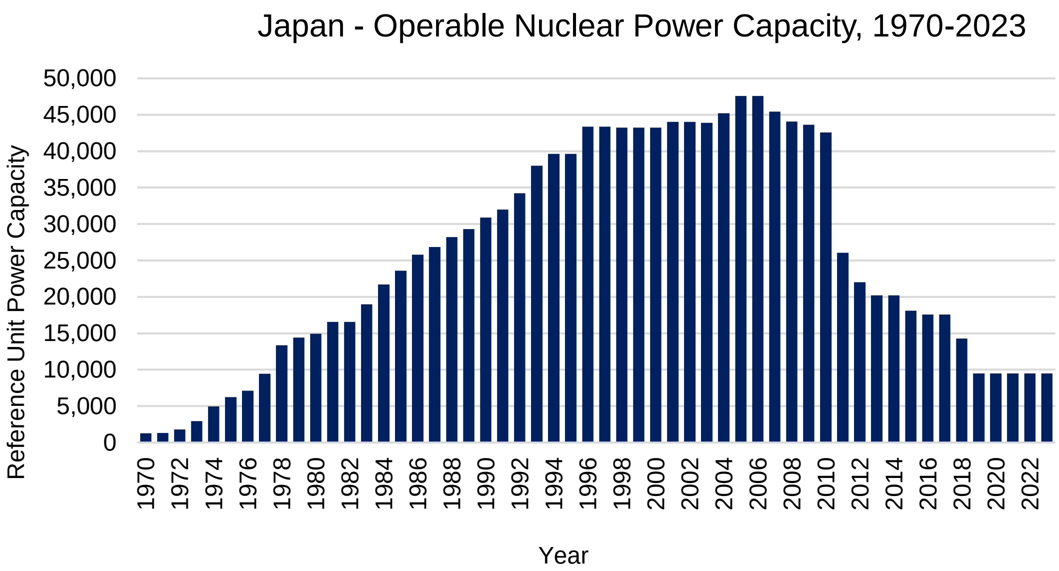
Post-Fukushima, Japan shut down its entire fleet of 54 reactors and started to increase imports of fossil fuels, nuclear power provided approximately 30% of the electricity in Japan and this was expected to increase to at least 40% by 2017.

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.

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. Pro-nuclear 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 2023, a survey conducted by one of the largest newspapers in the country found that 51% of the respondents in Japan were in favour of restarting nuclear plant operations with 42% opposed.



Source: World Nuclear Association

INDIA

India has a largely indigenous nuclear power programme. The Indian government is committed to growing its nuclear power capacity as part of its massive infrastructure development programme.

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.

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. 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 are set to 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 2023 and 2026. 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.

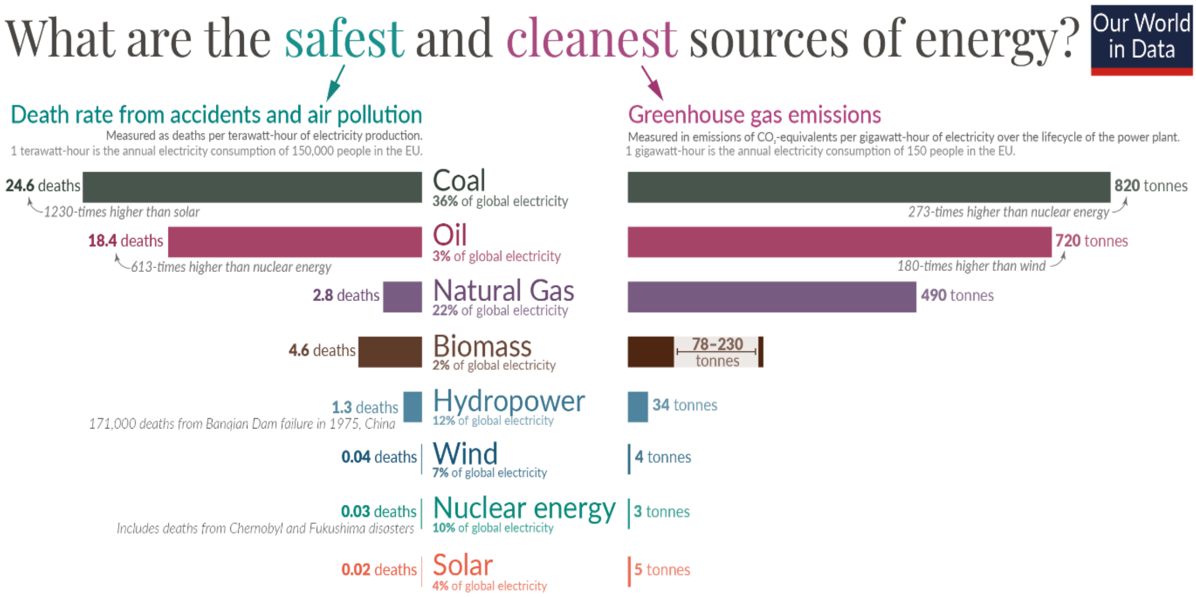
SOUTH KOREA

In South Korea, pro-nuclear President Yoon Suk-yeol has pledged to reignite the country's nuclear industry. Currently, 25 reactors provide about one-third of South Korea's electricity.

Industry analysts and officials have made it clear that SMR technology will be core to this revamp, something that is unsurprising given Korea's track record of producing quality technology for nuclear plants. Among these companies is Doosan Heavy Industries, who are likely to pioneer Korean SMR production given their current involvement with numerous SMR design firms. South Korea is currently involved in building the UAE's first nuclear power plant under $20bn contract.

NUCLEAR SAFETY AND SMALL MODULAR REACTORS (SMRS)

Nuclear accounts for only 0.07 deaths per terawatt-hour of energy production compared to 18.43 for oil and 32.72 for brown coal. However, there remains backlash surrounding the safety of nuclear as an energy source. The advent of Small Modular Reactors is changing this.



Source: Our World in Data

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.

In 2017, the UK government provided funding of up to £56 million over three years to support SMR research and development. In 2019 the government committed a further £18 million to the development from its Industrial Strategy Challenge Fund. In November 2021, the UK government provided funding of £210 million to further develop the design, partly matched by £195 million of investment by Rolls Royce. They expect the first unit will be completed in the early 2030s.

In the US in 2020, the DOE awarded US$160 million to X-energy and TerraPower through their 'Advanced Reactor Demonstration Program'. There is the potential for billions more in further funding, and projects completion dates are expected to be around 2027. The DOE intends to invest about US$3.2 billion over the next seven years into advanced nuclear.

NuScale is the first and only publicly traded pure play on next generation nuclear reactors. It currently has the only NRC approval for an SMR. NuScale aims to deliver its first SMR in the US by 2029.

RISKS

The greatest edge-risk for the uranium sector remains another major accident like Chernobyl or Fukushima. An event of this kind would undoubtedly set the nuclear agenda back years. As we have discussed, the advent of SMRs is significantly improving safety concerns around nuclear.

Additionally, there is always the possibility of an alternative fuel to uranium. Thorium is a potential competitor, and while there are currently no operating thorium reactors, there are several in production. Notably, uranium reactors cannot be converted to thorium reactors, so the friction in transitioning from one metal to another will likely be sufficient to deter utilities.

As part of the European Commission Taxonomy, the first nuclear related activity that is mentioned is R&D of advanced technologies that minimise waste and improve safety standards. The main environmental concern associated with nuclear energy is radioactive waste. There are several companies exploring depleted uranium as a fuel source, which would significantly reduce the demand for the original metal.

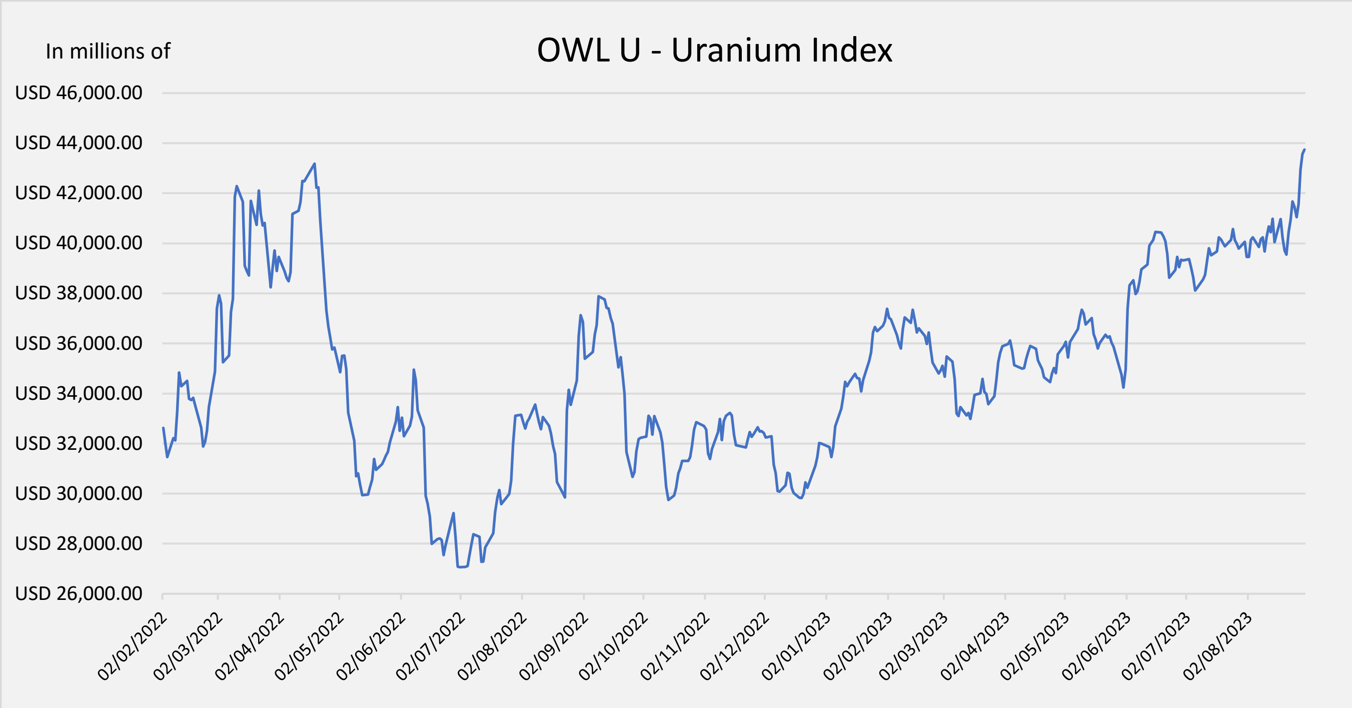
Furthermore, advancements in energy storage will reduce the significance of non-intermittency, as the grid would have backup power stored to meet demand. Hydrogen is one possible threat as it can be easily stored due to its lightweight and high energy density.

Current nuclear reactors use fission technology which heats uranium atoms to incredibly high temperatures to create a nuclear reaction. Nuclear fusion slams two atoms together to create energy, the output is 3-4x more powerful than fission. Notably, the most advanced fusion project is in California, with estimates that the first nuclear fusion power will be delivered to the grid in 10-15 years.

A more recent demand side risk is associated with Russia's invasion of the Ukraine. Currently, 18% of the 439 operating nuclear reactors globally were made in Russia. This has implications for care and maintenance as component parts need to be sourced from the OEM. In something as high risk as nuclear technology, trying to design and manufacture component parts from alternative sources to the OEM is highly dangerous. Should these reactors be unable to source component parts from Russia due to embargoes/sanctions, then they run the risk of closure. The market for Russian sourced component parts is estimated to be ~$4.3bn annually, not an insignificant source of capital for Putin's war machine.

OCEAN WALL URANIUM INDEX

We have developed a proprietary live uranium tracker encompassing all uranium related equities to analyse broad trends within the theme – this can be found on **Bloomberg under the ticker .OWL.U U Index**



We publish weekly updates on the uranium sector, should you wish to be added to the mailing list please contact ben@oceanwall.com - *Note this is available for institutional investors only.*

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