Uranium: How Much Risk and How Much Reward?

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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

INTRODUCTION

There are two questions we are now being continually asked:

- What can derail the uranium thesis?
- How much more upside does uranium have?

So far uranium has been a staccato series of events - German and Japanese political backtracking on nuclear, an African coup, two wars, a demoralised Central Asian corporate dealing with its recalcitrant master, US sanction bills, punitive Russian threats, logistical issues, panicked European statesmen and a backdrop of frenzied hungry hippo sequestration. All this with the apex-predatory hedge funds yet to enter.

Despite this chaotic backdrop, the interwoven nature of these events has exacerbated the already asymmetrical economic narrative of soaring demand and insufficient supply. The bifurcation of the uranium market is widening. The biggest implication of this is the reduction of, already limited, supply options for Western utilities.

The true political significance of uranium remains yet to be fully revealed. Next year it will be utilities and governments fretting as *force majeure* becomes part of the nuclear lexicon.

As to the risks of the trade, we look at the likelihood of nuclear accidents, the quantum of mobile inventory, the threat of renewables, alternatives to uranium, the alternative extraction processes as well as the threat to the roll out of SMRs.

RISKS TO THE TRADE – 2024 AND BEYOND

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 c.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 their fundamental unreliability and their geographical dependence. 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

Nuclear fusion is a reverse nuclear process where you make atomic particles collide instead of splitting them as you do in nuclear fission. Fusion has the potential to produce energy with near-zero carbon emissions, without creating the dangerous radioactive waste associated with today's nuclear fission reactors.

Predicting the exact timeline for when nuclear fusion will become commercially viable is challenging. Fusion has been a promising but elusive goal for many years, and progress has been slower than initially anticipated. Several international projects are working on developing practical and sustainable fusion energy, with ITER (International Thermonuclear Experimental Reactor) being one of the most prominent collaborations.

ITER's timeline involves achieving a sustained fusion reaction and producing more energy from fusion reactions than is supplied to the system (positive net energy) during the later stages of its experimental program. ITER is expected to reach full operation in the 2030s, with subsequent developments and commercialisation efforts following.

Experts agree that we are unlikely to be able to generate large-scale energy from nuclear fusion before around 2050 (the cautious add on another decade).

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.

COULD THE ROLLOUT OF SMALL MODULAR REACTORS (SMRS) BE DERAILED?

SMRs are nuclear reactors that are smaller in size, and capacity compared to traditional large-scale NPPs. The premise is that they will be a lot cheaper than big nuclear reactors because of their modularity.

The likelihood of the successful deployment and widespread adoption of SMRs will depend on whether they will pass the 'feasibility and investability' phase that the UK SMR project is currently going through. Advocates see it as a low-cost source of energy for other parts of the decarbonisation scene such as hydrogen and synthetic fuel.

Despite the potential for cost savings, the economic viability of SMRs is still uncertain. The upfront costs associated with research, development, and regulatory approval can be significant. Only last month, we saw US-based NuScale cancel its flagship SMR project due to a lack of interest arising from increased costs and delays. NuScale said in January the target price for power from the plant was $89 per megawatt hour, up 53% from the previous estimate of $58 per MWh, raising concerns about customers' willingness to pay.

However, Rolls Royce completed the feasibility stage of its SMR in May and are now looking to secure investment. This will be the test as each SMR will cost £1.8bn (CAPEX) and £40-60MWh over 60 years. This now puts it in the territory of getting access from private equity to build and run a reactor. So far, SMR development is loss leading or a state funded enterprise. If the cost of capital of Rolls Royce's reactor works, then SMRs have the potential to change the paradigm of nuclear reactor roll out.

The glowing promise of SMRs will be a key determinant for future uranium demand. These projects must prove they can be commercially viable and do so quickly. A large part of this will require a more concrete regulatory framework that can be replicated globally to accelerate project development timelines.

PRICES ARE UP, BUT URANIUM HAS A LONG WAY TO GO YET

Prices not only need to go higher, but they need to stay there. Whilst $80/lb uranium will incentivise some production to come online, there will be no Western projects coming online in 2024 that will have a significant impact on the supply deficit.

For example, the likes of UEC and enCore Energy in the US could bring online 1m lbs of production each in 2024 which would account for only 1.8% of the current supply deficit respectively. Global annual demand for uranium is 180m lbs versus 135m lbs primary supply - demand is expected to climb by 28% by 2030 and nearly double by 2040 as governments ramp up nuclear power capacity to meet zero-carbon targets.

"All the easy stuff will come back online by the end of next year, after that you are getting into the more challenging greenfield development which doesn't take one or two years to come back online, it will take five, six, seven, eight years…that's really the challenge in the next five years is whether we can actually build some new mines and bring online new, meaningful production…I don't mean one or two million lbs per year but bigger mines" – John Ciampaglia, CEO, Sprott Asset Management

To see the investment required for bringing online new uranium mines, there will need to be certainty that prices will not only go higher but also stay there. These projects take over a decade to come into production in the Western world, prices will therefore need to stay higher for the lifecycle of project development. Over the next few years, greenfield capacity could add approximately 30-35m lbs to primary supply, which would total 160-165m lbs and still be short of even today's demand.

"Whether these price signals accelerate investment decisions in new mines remains to be seen, but even if they do, we are sceptical that any large new mine supply outside of Kazakhstan can be realized before 2030." – UxC Weekly

Part of the lag in bringing new mines online is access to relevant expertise. There has been an exodus of talent from the sector during a 10-year bear market, where other energy transition commodities such as lithium and copper have attracted mining-related labour. This is making it more difficult for uranium producers to bring back online mothballed assets, or for new producers to bring nascent assets online. This was part of the reason for a production miss at Cameco alongside equipment reliability issues.

Kazakhstan, currently 43% of global supply, is the key producer in the global uranium market. Kazatomprom (KAP) have issues in material sourcing for production, transport and logistics, and management retention. We estimate that these issues are compounding and the future of Kazakh supply is at risk – particularly to Western customers. It is becoming clear that Kazakhstan's main customers going forward will be in Asia, not in the West, given the appetite for uranium in the likes of China and India, but also the ease of transport both logistically and financially.

China is a demand outlier, continuing to procure uranium at unprecedented levels and is, to date, estimated to have procured over 400m lbs of uranium. This leaves less lbs available for the West, highlighting the necessity for more Western production which will only come online with sustained higher prices. India is second in the world, after China, in terms of the number of reactors being constructed, and will ramp up their domestic procurement strategy over the next several years.

The US remains the largest nuclear powerhouse globally, accounting for close to 25% of global annual uranium demand. However, since the start of 2022, the US has mined just 185,000 lbs of uranium domestically, or 0.4% of their domestic annual consumption. This has forced the government to reassess how it plans to get the uranium it requires for its nuclear fleet – responsible for 20% of all US electricity. The US Congress in 2020 allocated $75m to set up the US Strategic Uranium Reserve with the initial goal of buying just 1m lbs of US jurisdiction uranium, which allocated funds to various US uranium companies in 2022. The contracts paid between 10-20% higher than the spot price at the time, reflective of not only the scarcity of material then but the premium that should be applied to US jurisdiction uranium.

The uranium market is still in the early innings of the contracting cycle. Utilities presently have 1.5bn lbs of cumulative uranium requirements through 2040 that are not covered by long-term contracts. After a decade of purchasing only 40% of their annual consumption, utilities will likely acquire uranium at levels exceeding the replacement rate in the years ahead. Activity in the term market is at decade highs, with estimates that 180-190m lbs of uranium will be contracted in the term market in 2023 which would meet the annual replacement rate for the first time in a decade.

While institutional capital has played a more prominent role in the uranium sector in 2023, involvement is still limited. We see a snowball effect taking place over the next couple of years where rising spot prices will bring online some new projects, real cash flows will return to the sector, and the current $55bn market cap of uranium equities will increase significantly. This will see liquidity improve and open the sector to larger institutions. The role nuclear energy will play in the war on climate change will also open the uranium trade to ESG funds looking to deploy capital into the energy transition space.

Finally, the presence of financial speculators in the uranium market is increasing - it is estimated that 40-50 hedge funds have licenses to buy and hold physical uranium, couple this with the likes of SPUT, YCA, PFYN, Zuri Invest and it starts to become apparent that it is not only utilities, traders and producers competing for material. Alternative investment and institutional asset managers are, barring a handful of names, uninvolved in this trade. This is in large part due to the size of the sector and the lack of meaningful cashflows. As the uranium sector evolves, we see competition between financials and traditional purchasers intensifying, with the concomitant impact of forcing prices higher.

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