

Sujet traité : L'uranium : un renouveau nucléaire / Uranium : A Nuclear Revival?

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# Uranium: A Nuclear Revival?

## A Word From Chen Zhao

Today's *Special Report "Uranium: A Nuclear Revival?"* is written by my colleague Noah Ramos, our Global Strategist, and the newest addition to our research team. Before joining Alpine Macro, Noah spent five years with 13D Research & Strategy as an analyst covering disruptive technologies. Going forward, Noah's research and coverage will continue to focus on this area, with an aim of discovering some exciting and "out of the box" investment ideas for clients.

In this report, Noah argues that a "super-cycle" bull market in uranium prices is unfolding. He notes that approximately 48 GWe of nuclear capacity was shuttered globally following the 2011 Fukushima nuclear disaster as nations shunned nuclear energy. Yet, global urgency to decarbonize has led to a nuclear revival, resulting in uranium demand vastly outstripping supply following a decade of underinvestment. This supply crunch is worsening with no end in sight. I trust you will find this *Special Report* interesting, well-argued, and convincing.

Best Regards,  
Chen Zhao

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This *Special Report* covers our increasing conviction that uranium has entered a super-cycle bull market. We first covered uranium's bull run in a February *Research Note*.<sup>1</sup> Below, we take a closer look at the drivers behind, and how to profit from, the unfolding nuclear power renaissance.

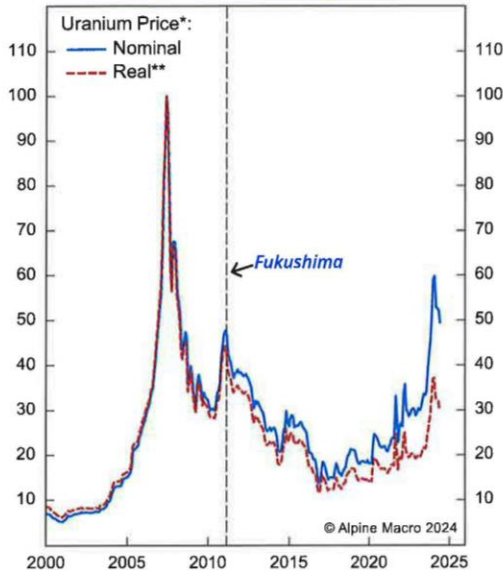
## A Radioactive Comeback

Post Fukushima, spiking global pessimism towards nuclear energy and reactor shutdowns dropped uranium prices to \$19.60/lb – a level at which at least 75% of the world's uranium production is

<sup>1</sup> Alpine Macro 2022 *Global Strategy Research Note* "The Uranium Bull Has Legs" (February 7, 2024).

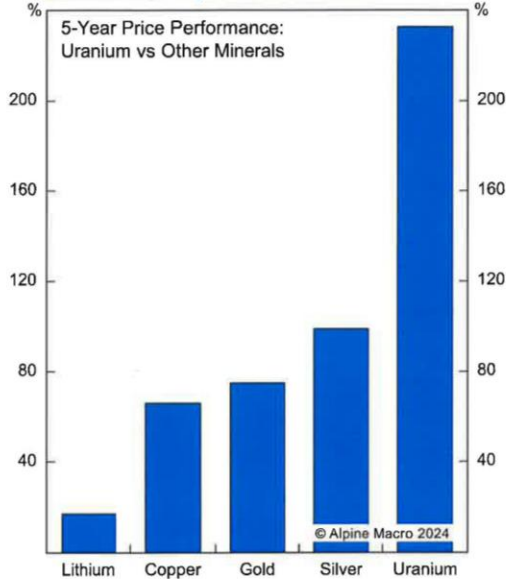
↳ Notre investissement dans ce secteur date de Juin 2021. Rendement cumulé de +68% depuis. (3ans)

**Chart 1** Uranium's Price Remains Below Historic Highs



\*Average contracted prices of U<sub>3</sub>O<sub>8</sub>/yellowcake with estimates for latest December and January values  
 \*\*Deflated by OECD CPI  
 Note: Both series are rebased to June 2007=100; source: IMF, Bloomberg Finance L.P., Alpine Macro

**Chart 2** Uranium's Rally Has Outpaced Other Metals



Source: Bloomberg Finance L.P.

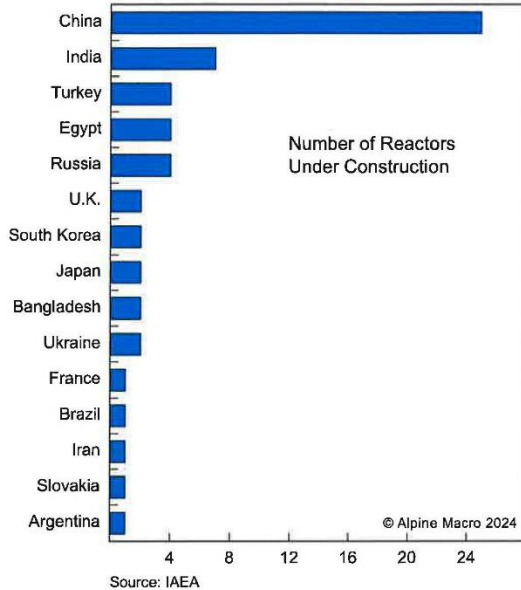
unprofitable (Chart 1). This led to key mine closures and chronic underinvestment across the entire uranium value chain. As a result, the radioactive metal became the worst performing and most hated commodity in the world. Approximately 48 GWe of nuclear capacity was shuttered globally following Fukushima as nations shunned nuclear energy.

Fast forward to the present, uranium has emerged from an 11-year bear market. This unprecedented shift to "re-embrace" nuclear energy is fueled by the lackluster green energy rollout and global urgency to decarbonize, improve energy security, and satisfy growing energy demand. Consequently, at the turn

of the decade, uranium demand began to vastly outstrip supply, leading to the current structural supply deficit that has no end in sight. Over the past five years, the metal has climbed over 230% – more than triple the gains in gold and copper even after declining a bit in 2024 (Chart 2). Yet, uranium's rally remains in its early stages as the metal's price sits well below its previous nominal and inflation-adjusted peaks (Chart 1).

Uranium's meteoric rise is most directly attributed to two key factors: (1) the need for a proven, low carbon, "always on" energy source that can easily scale to satisfy insatiable energy demand and (2) nuclear energy's superior characteristics and high energy density compared to its peers.

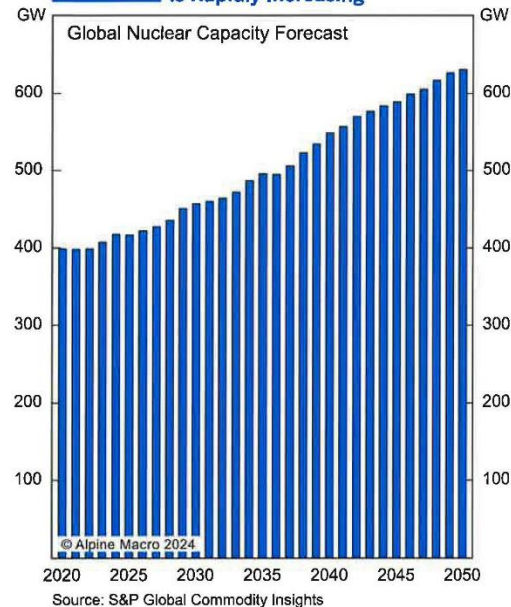


**Chart 3** China Is Leading The Reactor Buildout


Nuclear's advantages include zero emission, 24/7 availability, a small land footprint, low-operating costs, and the ability to decarbonize industrial processes. Uranium's energy density is approximately 2 million times higher than that of fossil fuels and, contrary to popular belief, nuclear is one of the safest energy forms on earth, resulting in just .03 deaths/terawatt-hour, compared to 18.4 for oil and 24.6 for coal.

### Perfect Demand Setup

Currently, there are 440 nuclear reactors operating worldwide requiring 180 Mlbs of uranium yearly. This fleet has a combined energy output of just under 400 GWe (approx. 10% of the global electricity

**Chart 4** Global Nuclear Capacity Is Rapidly Increasing


generation). Yet, five key factors are converging to turbocharge uranium demand.

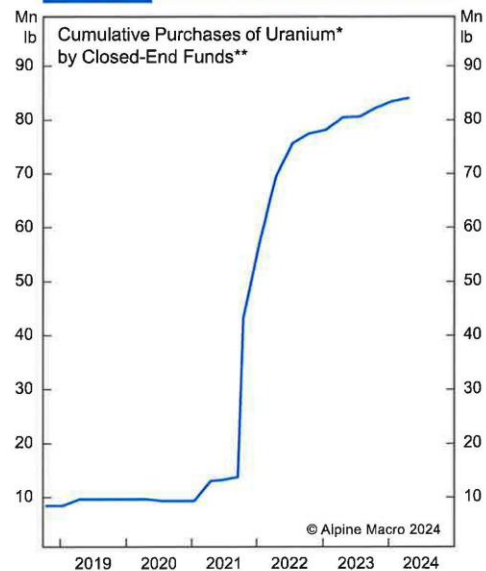
- The global reactor fleet is rapidly scaling. Over 61 reactors are actively under construction and over 300 are in the planning/proposal phase (Chart 3). China alone is investing \$440 billion to construct 150 new reactors which will add an additional 100 Mlbs of yearly uranium demand by 2040.
- Recently, 22 countries have pledged to triple nuclear power capacity by mid-century (an increase from 400 GW to 1,200 GW). Chart 4 shows that prior to the tripling commitment, nuclear power generation capacity was expected to top 600 GW by 2050. As a result of the pledge,

yearly uranium demand could top 600 Mlbs by 2050. An increase of just 200 GW of nuclear capacity by 2035 alone would result in an additional ~100Mlb of annual uranium demand.

3. Reactor life extensions and idled reactor restarts are occurring worldwide. The World Nuclear Association (WNA) predicts that over 140 reactors could see life extensions through 2040, adding up to 70 Mlbs of annual demand. Japan, a nation that once abandoned nuclear, restarted four idled reactors in 2023 and is aiming to restart an additional 13.
4. The stockpiling of uranium by financial buyers is a new demand driver. Financial buyers did not play a role in previous bull markets (Chart 5). Financial buyers, including the Sprott Physical Uranium Trust, also keep upward pressure on prices by acquiring virtually all available uranium in the spot market at the margin.
5. The nascent small modular reactor (SMR) roll-out will boost demand in the 2030s. SMRs are miniature versions of their GW reactor cousins, yet use a more energy-dense fuel known as High-Assay Low Enriched Uranium (HALEU). HALEU fabrication requires more raw uranium than standard fuel.
6. Public opinion has rebounded to embrace atomic energy once again. For example, 77% of Americans now support nuclear energy, a record high, according to the latest National Nuclear Energy Public Opinion Survey.

It is also essential for investors to note that uranium demand is inelastic. The fissionable metal is irreplaceable for nuclear plant operators and represents

Chart 5 Stockpiling By Financial Buyers



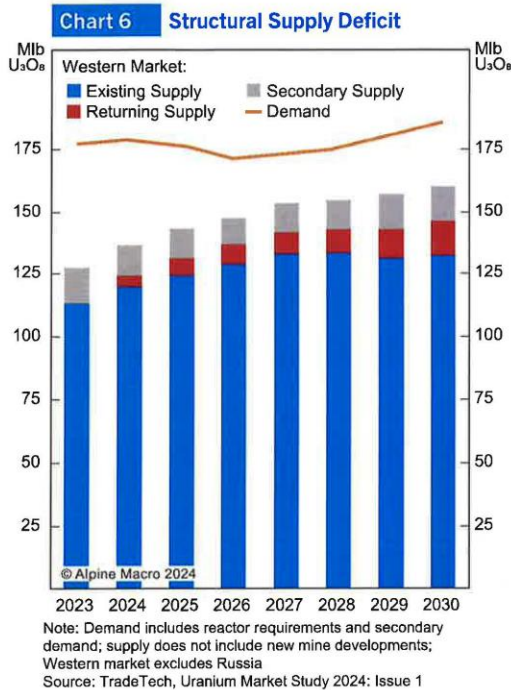
\*U<sub>3</sub>O<sub>8</sub>/yellowcake  
 \*\*Includes Sprott Physical Uranium Trust and Yellow Cake PLC  
 Source: Sprott, Yellow Cake PLC  
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a mere 4-8% of a reactor's operating costs versus 80-90% for oil and gas plants. This means utility operators prioritize having sufficient fissionable material on hand over short-term price sensitivity.

### Persistent Structural Supply Deficit

Today, global primary mining output is 135-140 Mlbs (close to its 12-year low of approx. 123 Mlbs in 2021). Demand from the existing global reactor fleet is over 180 Mlbs.

As illustrated in Chart 6, even when factoring in expected idled mine restarts, greenfield mine openings and secondary supply, the annual supply deficit will still range between 20-45 Mlbs in the short term and is slated to expand.



Importantly, this 20-45 Mlbs supply deficit only factors in demand from the current reactor fleet and none of the additional demand drivers listed above. To meet expected demand in 2030, when new reactor capacity begins to further strain supply, estimates predict up to 23% of uranium will come from uncompleted mines, with an additional 8% coming from projects that remain not fully permitted, financed, or constructed.

There is no “silver bullet” solution to increase the uranium supply rapidly. As a result, we believe it is essentially impossible that new capacity will be able to adequately fill this gap. Increasing supply faces several key challenges, including:

**1. An era of historically low exploration expenditures and lack of interest to increase mining capacity.**

Exploration budgets plummeted from nearly \$1.2 billion in 2008 to around \$200 million in 2022. Adjusted for inflation, the real investment is almost negligible. This is now haunting miners who are seeking to boost output.

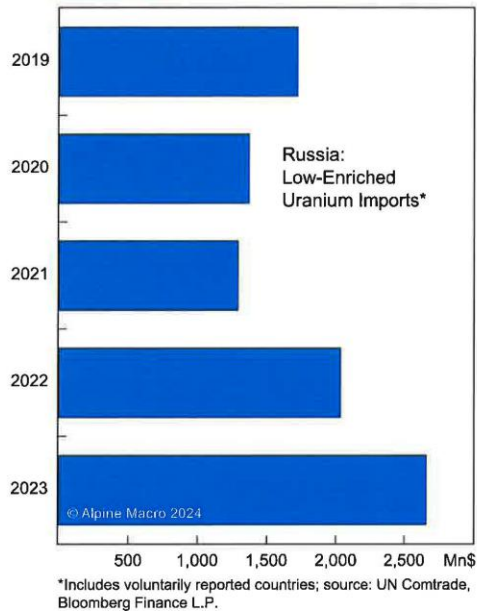
**2. Persistent production expectation downgrades at key mining assets due to restart challenges after a decade of reduced/zero output.**

**3. A lack of any sizeable greenfield mines that could bring on new supply in a reasonable timeframe.** No greenfield mine has entered production during the unfolding bull market. Furthermore, no greenfield mine capable of adding enough supply to bridge the supply-demand gap is expected to open soon. This is clear evidence that miners simply cannot “turn on” new supply although prices have rebounded to make mining profitable again.

**4. It takes between eight to fifteen years to open a new uranium mine, even in a mining-friendly jurisdiction.**

**5. Geopolitical rifts continue to muddy supply.** Recently, the U.S. passed legislation that blocks imported Russian uranium starting in mid-August. While the impact of the ban remains challenging to quantify due to the possibility of waivers granted for “essential” importation, it compounds uranium supply uncertainty for the West. While the legislation allocates \$2.72 billion to expand the U.S. uranium industry, we believe this investment is a drop in the bucket. Russia controls nearly half of the world’s supply of

**Chart 7** Russia Dominates The Uranium Market



enriched uranium and currently provides about one quarter of the U.S.'s enriched uranium. As shown in **Chart 7**, 2023 was a record year for Russian uranium exports.

### A Seller's Market Is Forming

We believe uranium's spot price is set to continue its upward trend, although investors should expect high volatility. At the conclusion of 2023, the metal's spot price hit \$91/lb, a 15-year high and up 90% from early 2022 levels. This year, the spot price topped \$107/lb in early February. During the last uranium bull market in the early to mid-2000s, the spot price topped out at \$135/lb. This is direct evidence that the spot price has ample room to increase off

February 2024 highs. Importantly, we believe this bull market offers further upside potential due to the unprecedented demand/supply dynamics.

### Watch Long-Term Volumes Over Spot

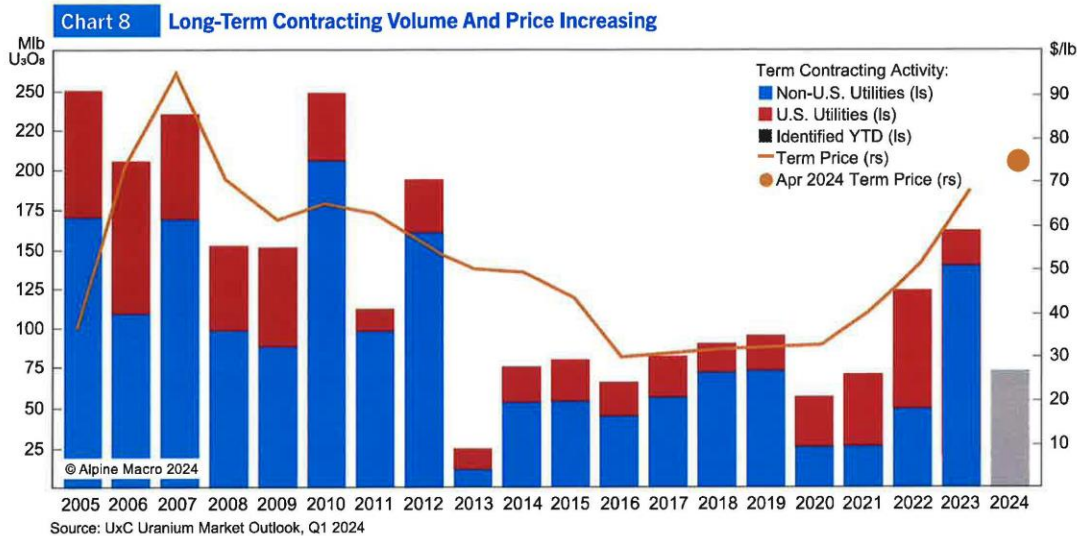
Although the spot market is a key indicator of sector momentum, we prefer to track the opaque long-term market, where over 80% of uranium is contracted.

Last year, cumulative long-term volumes exceeded 160 Mlbs, the highest level since 2012 (**Chart 8**). This year, we anticipate contracting volumes to top the annual replacement rate of the global reactor fleet of 180 Mlbs. Already, the long-term price has risen ~18% and is sitting at ~\$80/lb, the highest level in 15 years.

For comparison, during the 2005-2011 bull market, utilities contracted about 110% of annual consumption. Industry consultant UxC forecasts that utilities have ~2.3 billion pounds of uncovered requirements through 2040 for the existing reactor fleet. Historically, the largest uranium price spikes have occurred when total utility contracting is at or above the annual rate of consumption. This is significant, as our analysis indicates that term prices have never been this high so early in a contracting cycle. Sustained increases in term pricing directly expand margins and cash flow for uranium miners.

### Multifaceted And Misunderstood Supply Bottleneck

Reactors cannot simply run off raw uranium. Raw uranium ( $U_3O_8$ ) must first be converted to U235 and then enriched to a higher fissionable percentage

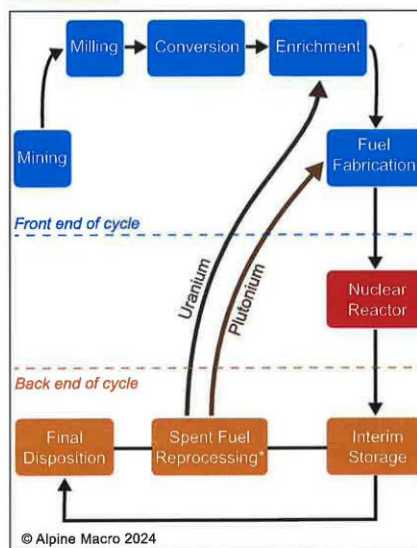


(3.5-5%). **Chart 9** shows a diagram of the nuclear fuel cycle.

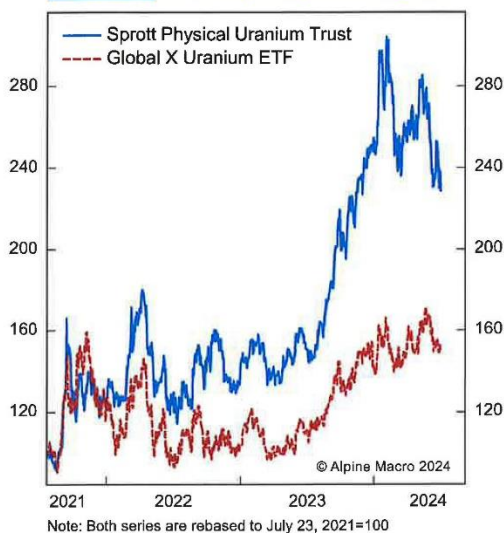
Our research shows that both the conversion and enrichment services market are experiencing record tightness. Tightness in the enrichment cycle specifically is emerging as a nascent uranium supply strain. This is because enrichers are being forced to transition from “underfeeding” to “overfeeding” their enrichment centrifuges. As a result, enrichers are using more raw uranium than necessary to produce the contracted amount of fissionable output to speed up the cycle. We believe this enrichment bottleneck is not priced in by the market, thus adding further upside potential to the uranium price.

**Bottom line:** the uranium sector is entrenched in a structural supply deficit that is poised to increase in severity as demand increases while supply remains stagnated.

**Chart 9 Nuclear Fuel Cycle**



\*Spent fuel reprocessing is omitted from the cycle in most countries, including the U.S.  
Source: Pennsylvania State University Radiation Science and Engineering Center

**Chart 10 Pure Plays Outperforming ETFs**


### Investment Considerations

Investors seeking exposure to uranium should accumulate positions through pure play vehicles, such as financial buyers, uranium mining equities, and manufacturers of nuclear reactor components. While ETFs, like URA, do provide broad exposure to uranium, our research indicates that pure play vehicles have outperformed (Chart 10).

For mining equities specifically, we believe Tier-1 miners located in Western-aligned jurisdictions, like Canada or Australia, are primed to outperform their peers. Additionally, risk-tolerant investors should consider adding exposure to SMRs *via* pure play equities. We stress that SMRs remain highly nascent but are positioned to play a key role as modular, highly energy-dense providers for application areas including data centers and manufacturing.

### Risks

In our view, there are two main risks to our uranium bull market thesis. The first and largest is the potential of a nuclear accident at an operational reactor or at the Zaporizhzhia nuclear plant in southeastern Ukraine. Any nuclear accident could revive apprehension towards nuclear energy and result in a downturn in uranium prices. It is important to note that the risk of a nuclear accident is declining. This is because modern reactor technology boasts a swath of improved safety features including passive cooling, that reduces the chance of accidents at newly built power plants.

Another risk is a breakthrough in nuclear fusion that could negatively impact long-term nuclear fission viability. We view a breakthrough in nuclear fusion as highly unlikely during the uranium bull market timeframe, yet it is something investors should bear in mind.

**Noah Ramos**

*Global Strategist*

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