

KOPERNIK PERSPECTIVE ARE URANIUM STOCKS RADIOACTIVE?

*Well, I don't know, but I've been told
Uranium ore's worth more than gold
Sold my Cad', I bought me a Jeep
I've got that bug and I can't sleep
Uranium fever has done and got me down
Uranium fever is spreadin' all around*

--Elton Britt, Uranium Fever, 1955

Public opinion of uranium is cyclical. Sometimes, it symbolizes the promise of a clean energy future; at other times, it represents destruction. The heaviest (primordially occurring) element on the periodic table, uranium first showed up as an unwanted byproduct in the silver mines of the Czech Republic. Silver miners in the 1500s called it *pechblende* (German for “tar mineral”) and its presence signified the end of the productivity of a particular vein of silver in the mine. It was a waste product.

Eventually, a sample of the *pechblende* made its way to Martin Klaproth, a German chemist who isolated a grayish residue which he called “a new element which I see as a strange kind of half-metal.”¹ He named this element uranium (after the ancient Greek god Uranus). It continued to be viewed as a worthless byproduct of silver mining until it was discovered that its radioactive properties could be useful. The medical community began to use radiation to shrink cancerous tumors in the early 1900s. And the energy potential of uranium was quickly realized for both wartime and peaceful purposes. After the development and use of atomic bombs in World War II, the international scientific community called for the peaceful use of nuclear power, primarily to provide for increasing energy and electricity needs.

“Uranium fever” didn’t just permeate the scientific community, though: it became a part of pop culture, particularly in the United States. Artists such as Elton Britt and Warren Smith recorded songs about adventuring off to mine uranium. A series of “Miss Atomic” pageants was held in Las Vegas between 1952-1957. A cartoon rabbit gained superpowers after eating a carrot from a carrot patch containing uranium and became “Atomic Bunny,” using his powers for good in comic books that ran from 1955-1958. And in 1958, Lucille Ball poked around in the Nevada desert with a Geiger counter in an episode of *The Lucy-Desi Comedy Hour* entitled “Lucy Hunts Uranium.” The promise of uranium was everywhere.

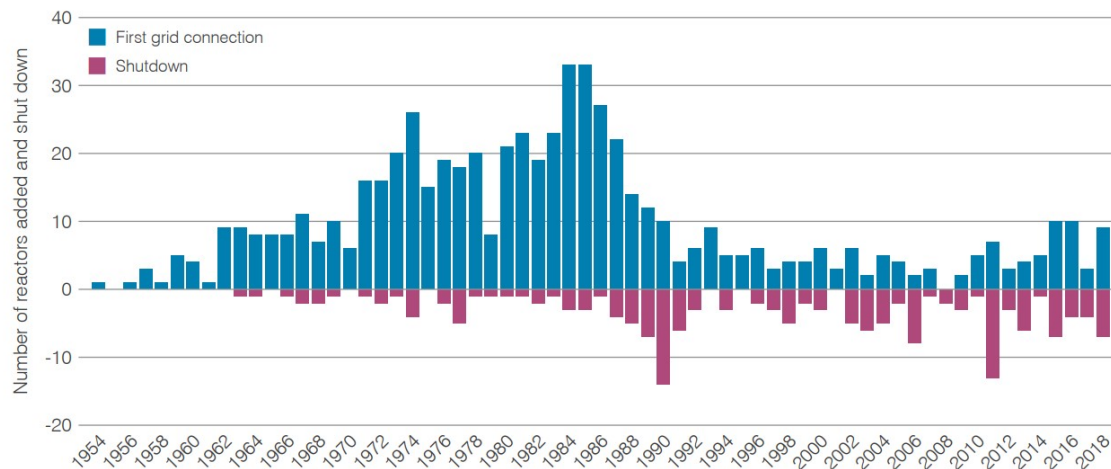
Public opinion started to wane after the Three Mile Island and Chernobyl accidents, and, unsurprisingly, so did the pace of nuclear reactor builds. As shown in the chart on page 2, nuclear reactor construction outpaced shutdowns in the 1970s and 1980s. This was driven by new nuclear development in the United States, where 95 gigawatts of nuclear operating capacity came online between 1970-1990.² However, nuclear construction began to slow in developed countries after 1990.

¹ Tom Zoellner, *Uranium: War, Energy, and the Rock that Shaped the World*, p. 17.

² U.S. Energy Information Administration, “Most U.S. Nuclear Power Plants Were Built Between 1970 and 1990,” April 27, 2017.
<https://www.eia.gov/todayinenergy/detail.php?id=30972>



Figure 13. Reactor first grid connection and shutdown 1954-2018



Source: World Nuclear Association, IAEA PRIS

Today, nuclear power currently supplies about 4.4% of the world's energy needs.³ However, this market share understates how important nuclear power is in countries where it is a significant part of the mix. In 2018, nuclear power made up 72% of electricity generation in France, 51% in Hungary, 40% in Sweden, 39% in Belgium, 19% in the U.S. and 15-25% in countries such as Spain, Canada, the United Kingdom, Korea and Russia. What's more, it is usually the cheapest source of energy in these nations. Nuclear generators operate in 30 countries, although six countries account for about 75% of the world's operable generators (the U.S., France, Russia, China, Korea and Japan, when the latter fully returns to the market). There are currently 440 operable nuclear reactors in the world, another 59 under construction and about 160 in various planning stages.

This much growth in the pipeline should bode well for uranium demand. However, we also need to consider retirements as most nuclear plants are over 30 years old. Some will be retired, as plant operators choose not to spend money to extend the plants' lives for another 20-30 years; others will be retired due to negative public opinion. Germany, for example, decided after the 2011 Fukushima tsunami to sunset their entire nuclear fleet by 2022, a move up from the previous date of 2036.⁴

As mentioned above, public opinion is cyclical, and the 2011 Fukushima tsunami has clearly had an impact on the industry. After the tsunami, Japan, which at the time operated 10% of global reactors, shut down all its reactors pending further inspections and safety improvements. So far only 9 out of 54 have returned to work, 21 have been decommissioned, and 24 remain shut. Of these 24, half are unlikely to restart. Despite many of Japan's reactors having long-term contracts, this event clearly had a negative impact on uranium demand.

The residual distrust from the Fukushima accident has made it difficult to build new plants in developed markets; however, we are seeing new reactors under construction in emerging markets. Even with retirements in developed markets and the majority of Japan's reactors remaining offline, overall nuclear power and demand for uranium globally is likely to grow about 15% over the next ten years. While this only amounts to 1.5% per year growth, we find it hard,

³ BP Statistical Review of World Energy, 2019.

⁴ Scott Carpenter, "As the Costs of Germany's Nuclear Phase Out Mount, Little Appetite for a Rethink," *Forbes.com*, January 11, 2020.



absent another Fukushima type incident, to define a plausible scenario in which demand declines over that time frame. Our research indicates it will likely remain the lowest cost source of electricity for at least the next ten years and increasingly attractive as a zero-carbon emitting technology.

Could fears over another Fukushima cause more nuclear power plants to close early? It's possible, although it looks like most of the damage is done on this front. The momentum on this seems to be shifting as several countries that initially looked like they might follow Germany's lead have decided to let their reactors operate at least through the end of their permitted lives. There is also a decent chance that shutdowns might not happen as fast, even in Germany, as they are just starting to realize the high costs of doing so and are struggling to replace the power with low cost, low carbon energy sources. Even environmental organizations like the Sierra Club have, at times, softened their resistance to nuclear power, and some groups, like the Clean Air Task Force, promote nuclear energy as a partial solution to climate change.⁵

This is not to say that there will not continue to be pushback on the use of nuclear energy. Nuclear accidents, waste and radiation poisoning have held a particularly terrifying place in the imaginations of doomsayers for many years now. For example, the Three Mile Island accident in 1979 launched the "No Nukes" concerts and massive protest marches. More recently, the HBO series "Chernobyl" introduced a new generation to the dangers of nuclear power.

Nuclear accidents account for much of the public conversation about nuclear energy. However, despite its reputation, nuclear power has proven to be quite safe, especially compared to most of the other sources. Below is a table of mortality estimates for different electricity sources.⁶ These are subject to quite a bit of uncertainty as they incorporate estimates of deaths from pollution as well as accidents. However, these would have to be off by orders of magnitude to suggest that nuclear power is unsafe.

Source of Energy	Mortality Rate Deaths/Trillion kWhr
Nuclear – Global Average (including Chernobyl & Fukushima)	90
<i>Nuclear – U.S.</i>	<i>0.01</i>
Wind	150
Solar – Rooftop	440
Hydroelectric – Global Average	1,400
<i>Hydroelectric – U.S.</i>	<i>5</i>
Natural Gas	4,000
Biofuel/Biomass	24,000
Oil	36,000
Coal – Global Average	100,000
<i>Coal – U.S.</i>	<i>10,000</i>
<i>Coal – China</i>	<i>170,000</i>

We don't think this kind of data will change the minds of regulators in Europe or the U.S. to encourage more nuclear power construction. However, governments in emerging markets are once again moving forward. China and India have

⁵ Amy Harder, "Environmental Groups Change Tune on Nuclear Power," *Wall Street Journal*, June 16, 2016; www.catf.us/work/advanced-nuclear-energy/; Clean Air Task Force, www.catf.us

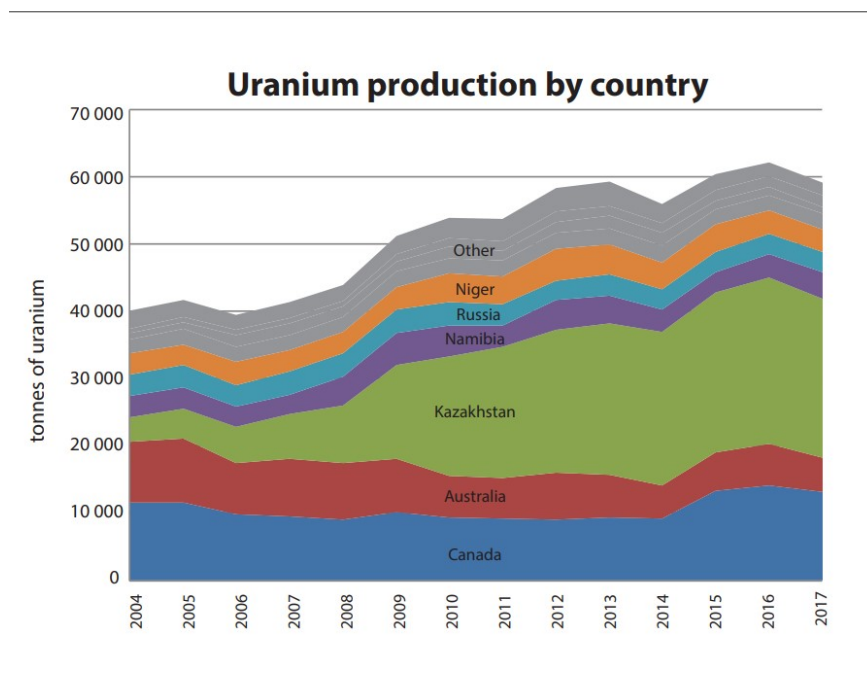
⁶ James Conca, "How Deadly Is Your Kilowatt? We Rank the Killer Energy Sources," *Forbes.com*, June 10, 2012.



very aggressive nuclear growth plans and smaller countries from Bangladesh to Belarus are anxious to get their first plants. If new technologies such as low cost Small Modular Reactors ever become feasible, emerging market growth could be even higher.

Uranium Supply Dynamics

If the demand outlook for uranium doesn't look too bad, maybe we just have so much of it available at very low cost that supply will forever keep prices low? On this front we would also disagree. Uranium prices have been depressed for a dozen years as the uranium market was in serious oversupply. During the last major up cycle in 2006-2007, uranium averaged over \$100 and peaked at \$137. Subsequently, global production increased by nearly 40%, driven mostly by Kazakhstan where supply increased 5-fold.

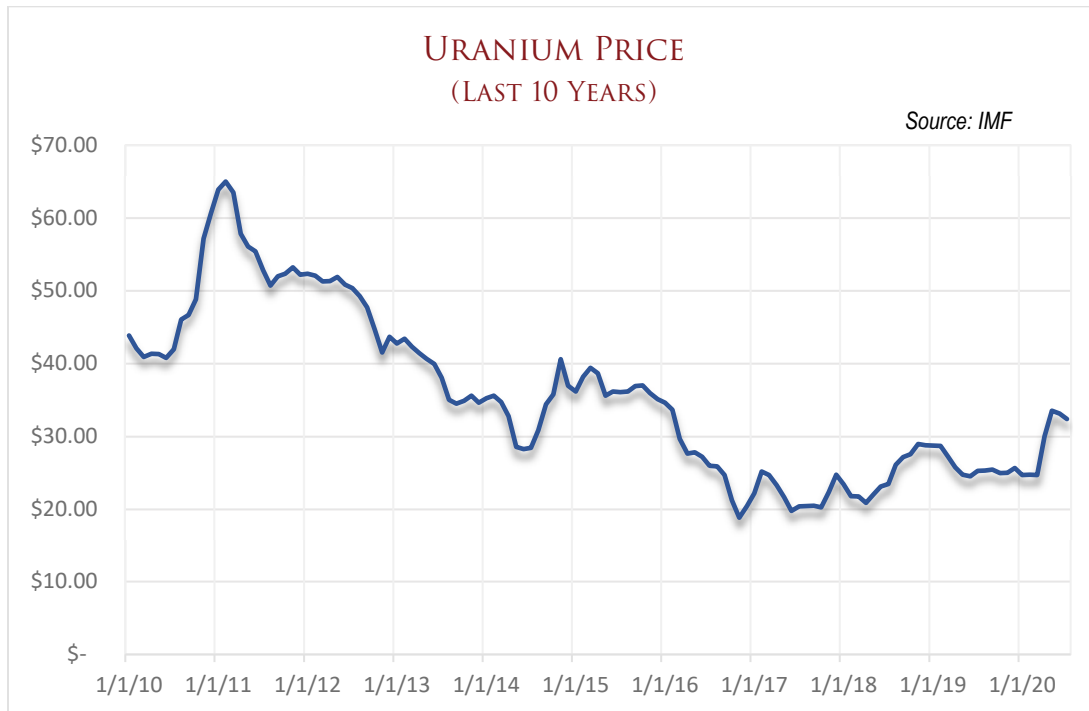


Source: IAEA Bulletin, June 2018, p. 28.

The market has spent the last dozen years running down excess inventories. As a result of prolonged low uranium prices, mine supply has been reduced. In January 2018, Cameco Corp. ("Cameco"), the largest Canadian uranium producer, suspended production at its McArthur River mine, the world's largest high-grade mine (production has yet to resume as of June 2020); Cameco also briefly suspended production at the Cigar Lake mine in March 2020. Both McArthur River and Cigar Lake were producing at a rate of roughly 18.0 million pounds per year. In 2017, the last year that both mines were actively producing, this made up roughly 20% of the global total. Kazatomprom JSC ("Kazatomprom") also announced production cuts equaling 20% through 2021.⁷ While some of these production cuts would have happened without the coronavirus pandemic, Covid-19 certainly sped up this process. All told, companies are shuttering mines at current prices, and nuclear reactors will eventually have to go idle for lack of fuel unless prices rise materially.⁸

⁷ "Kazatomprom prolongs uranium production cuts," World Nuclear News, August 20, 2019. <https://world-nuclear-news.org/Articles/Kazatomprom-extends-uranium-production-cuts>

⁸ Kopernik has positions in Cameco and Kazatomprom.



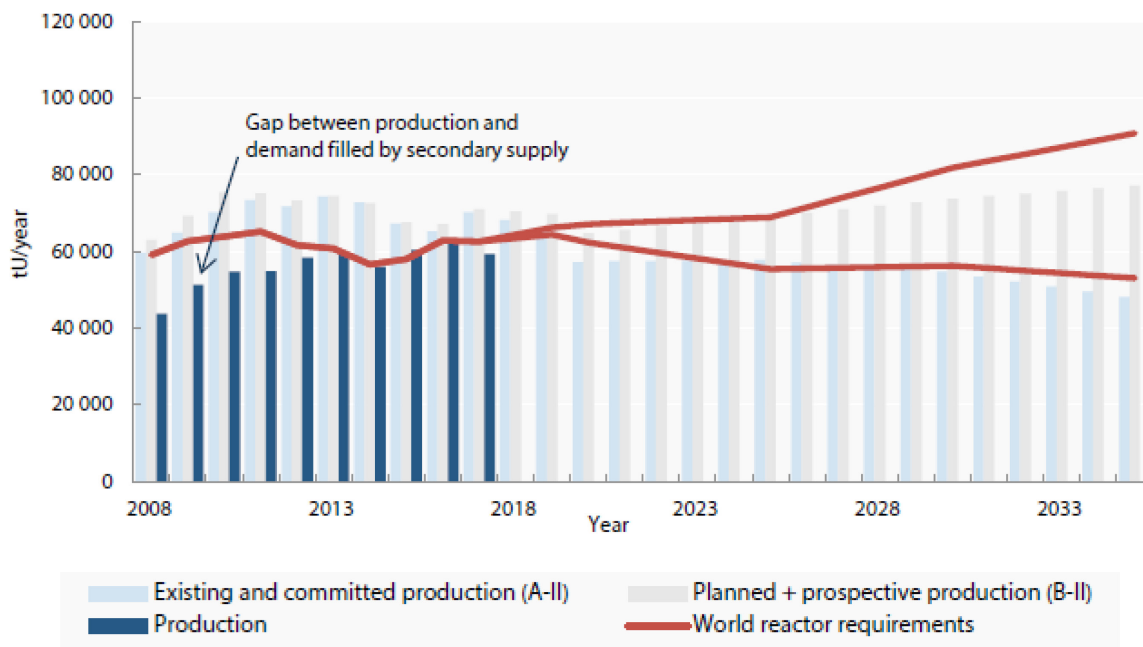
In addition to mine supply, the uranium market is supplied by secondary sources. These are a combination of sales out of inventories (government and commercial), re-enrichment, and recycled uranium. Most of these are complex and introduce quite a bit of uncertainty to the supply analysis, especially with respect to timing as data from many governments and enrichment plants is scant.

Supply from secondary sources has been declining. Through the end of 2013, much of the world's secondary supply was from the "megatons to megawatts" program which converted Russian nuclear weapons fuel to low enriched uranium usable for power generation. More recently much of it is probably from underfeeding enrichment plants. In the enrichment process, U_3O_8 (uranium oxide) is enriched to roughly 4.0% U-235 before it is sold to a commercial reactor. The byproducts of uranium enrichment are called "tails assays." These have a lower concentration of U-235 and can be stored, disposed of, or re-enriched to 4.0% U-235. When they are re-enriched, this is known as "underfeeding." According to the World Nuclear Association, underfeeding enrichment plants could contribute 7,000-8,000 tU/year to world markets between 2015-2025.⁹ As the supply demand dynamic tightens, however, this counter-cyclical underfeeding is likely to reverse, although the timing of this is uncertain as enrichment capacity remains very high. Even under the most bearish scenario, production is unlikely to be able to meet demand over the next 15 years.

⁹ World Nuclear Association, *Uranium Enrichment*, May 2020.



Projected world uranium production capability to 2035 (supported by identified resources at a cost of <USD 50/lb U3O8) compared with reactor requirements (85% of total production capacity)



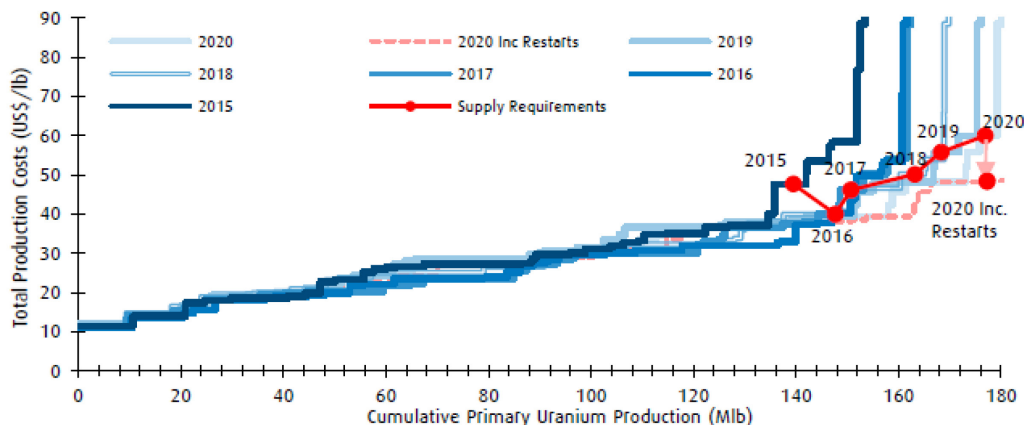
Source: IAEA, *Uranium 2018: Production, Resources, and Demand*

One of the reasons that uranium spot prices have fallen so far, despite less than disastrous fundamentals, is that buyers can be price agnostic. Generally, most supply is bought by utilities on long-term contracts as security of supply is very important to them. Demand for uranium is also inelastic as its cost is a minor part of the total cost of generating electricity – about 4-5%. So unlike in natural gas or gasoline where demand rises as the cost goes down, helping to equalize the market, uranium buyers do not go out and buy more when it gets cheap. This also suggests that a rising price will not slow demand growth on the upside of the cycle either.

The uncertainties with respect to secondary supply, and slow changes in this market, makes the timing of any uranium price recovery uncertain. However, we believe that over the long term the price will need to get to the incentive cost of bringing on new capacity unless we are way off in our demand outlook. This incentive cost is probably in the range of \$60-90 per pound of U3O8 and we would not quibble with any estimate within this range. With spot prices in the \$30s, this suggests that there is way more upside than downside in the commodity.



Exhibit 47: BMO Research's Total Cash Cost and Supply Requirements (Mlb U₃O₈)



Source: BMO Capital Markets.

The final piece to consider here is whether the uranium stocks are already discounting an eventual return to higher prices. The answer to this is most likely no. The cleanest uranium bet in the stock market is Uranium Participation Corporation ("UPC") which is a vehicle for buying and storing uranium.¹⁰ This currently trades at a discount to the spot market (about 10%). The uranium miners seem to be discounting long-term prices in the \$30-40/lb. range, which is a premium to spot but about in line with where long-term contracts are likely to get signed near term, and well below the previously mentioned \$60-90/lb. price needed to incentivize new production. At this incentive price there is still quite a bit of upside to the uranium stocks.

If timing is our biggest uncertainty here, it is a risk we don't mind taking. The solution to low prices is low prices, and if it takes ten years for the price to recover, our returns will be more than adequate. If it happens sooner, our returns would be quite high. And perhaps just as important, the downside from here seems very limited. We are not saying that nuclear power is the answer to the world's energy needs, only that it is likely to remain an important part of the equation, and acknowledge that existing plants are very cost-effective and environmentally friendly, more plants are being built, and existing mines are being shut at current prices. Very expensive nuclear reactors will sit idle unless prices rise substantially, to a point that will incentivize supply. If it takes a while for the price to double, it will be worth the wait.

Steve Rosenthal, CFA
Kopernik Global Investors, LLC
February 2017
Updated August 2020

¹⁰ Kopernik also has a position in UPC.

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