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September 20, 2023

80-20 Industry Primer: Uranium

A Pareto Approach to Industry Analysis …

Uranium is a relatively small industry compared to other commodity markets like gold, silver, or copper.

There are only a few producers on the supply side and an even smaller number of potential supply sources in the pipeline at current prices.

The demand side is equally concentrated between major utility producers, fuel traders, and financial buyers like hedge funds and ETFs.

Our goal with this 80-20 Industry Primer is to create a simple but robust global supply and demand model. From this, we can answer the most critical questions surrounding the Uranium Thesis:

1) **Supply:** How much supply is there currently, where will new supply come from, and how much will there be in 1-2 years?
2) **Demand:** Who's currently buying the supply, how much are they buying, and how will their buying habits change over time?
3) **Price:** How do all of these changes affect the price of uranium?

We develop deep conviction by doing our own work, stress-testing it against industry experts, and continually updating our models in the face of new evidence.

And it's this conviction that will allow us to hold our position during the inevitable drawdowns along the super cycle.

Let's get after it.

The Supply Side: Primary & Secondary Deep Dive

To understand the future of any commodity industry, it is vital to understand its past. Let's look at historical uranium production.

History of Uranium Production

Fifteen countries dominated global uranium production from 1945 to 2022:

	Cumulative production (tU)
Canada	554,475
United States	378,038
USSR*	377,613
Kazakhstan	349,789
Australia	240,579
Germany	219,685
South Africa	165,692
Namibia	158,856
Niger	156,797
Czech Republic	112,055
Russia	90,725
Uzbekistan	76,808
France	76,021
China	53,712
Ukraine	24,670
Others	149,299
Total	3,184,812

* Until 1991 USSR comprised the uranium produced in Russia, Kazakhstan, Uzbekistan, Ukraine and other former Soviet Union republics.

We can further split uranium's production history into four distinct periods (via the WNA website).

Period 1: 1945 to mid-1960s

Nuclear fuel spurred production growth during this military era. Production rose in the 50s to satisfy utility/power generation demand. However, by the mid-60s, demand fell sharply and prompted a production cut of ~50%

Period 2: Mid-1960s to mid-1980s

Rapidly expanding civil nuclear energy triggered a massive increase in nuclear reactor orders. New uranium mines came online to meet this increased demand, backstopped by long-term offtake agreements from utility companies in the US, Japan, and Western Europe.

However, the added new mine production peaked supply in the 1980s and remained above reactor requirements through 1985.

Period 3: Mid-1980s to ~2002

This period marked a reduction in nuclear reactor construction programs. The problem was that many utility companies had long-term offtake agreements anticipating new reactor builds. So, utility companies used their stockpiles instead of getting supply from mine production.

At the same time, a new mine supply came online from Russia (former Soviet Union) in 2003, which exacerbated the supply overhang.

Period 4: Early 2000s to Today

In the early 2000s, many assumed we'd need more primary production to meet nuclear reactor fuel requirements. This sparked a 13x increase in uranium prices from 2003-2007. However, the Fukushima meltdown in 2011 prompted massive demand destruction. Uranium prices have just now started to recover.

That brings us to today's supply outlook.

Current Supply: Global & Country-Specific

There are two ways to view supply: Global Production and Company-Specific. Let's start with Global Production.

Eight countries supply nearly 100% of the world's Uranium (data as of 2022):

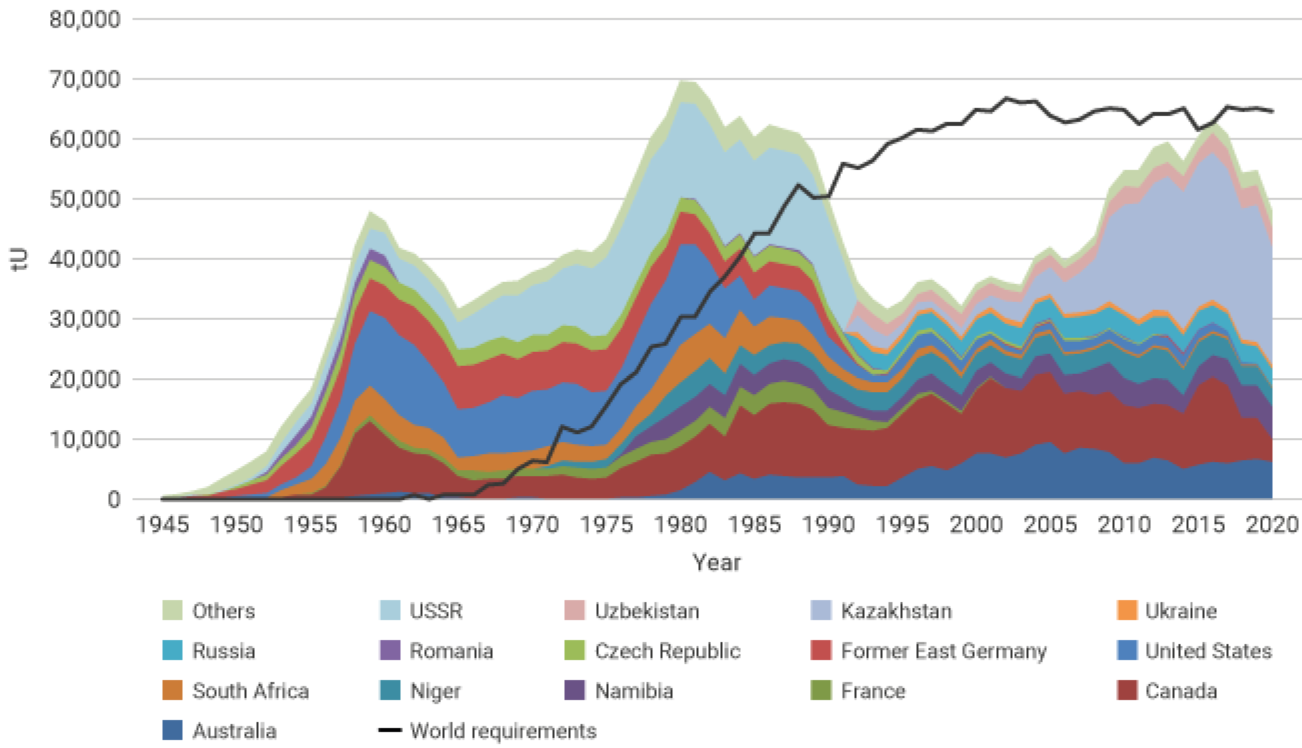
- Kazakhstan (44%)
- Canada (15%)
- Namibia (12%)
- Australia (9%)
- Uzbekistan (7%)
- Russia (5%)
- Niger (4%)
- China (4%)

The sheet below shows the production volumes of each country from 2013-2022.

Country	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	% of 2022 Production
Kazakhstan	22,451	23,127	23,607	24,689	23,321	21,705	22,808	19,477	21,819	21,227	43.97%
Canada	9331	9124	13,325	14,039	13,116	7001	6938	3885	4693	7351	15.23%
Namibia	4323	3255	2993	3654	4224	5525	5476	5413	5753	5613	11.63%
Australia	6350	5001	5654	6315	5882	6517	6613	6203	4192	4553	9.43%
Uzbekistan (es	2400	2400	2385	3325	3400	3450	3500	3500	3520	3300	6.84%
Russia	3135	2990	3055	3004	2917	2904	2911	2846	2635	2508	5.20%
Niger	4518	4057	4116	3479	3449	2911	2983	2991	2248	2020	4.18%
China (est.)	1500	1500	1616	1616	1692	1885	1885	1885	1600	1700	3.52%
									Total	48,272	

Each ton of extracted uranium produces ~1.18 tons of U3O8, which is the type of uranium used by global utility companies to power their plants.

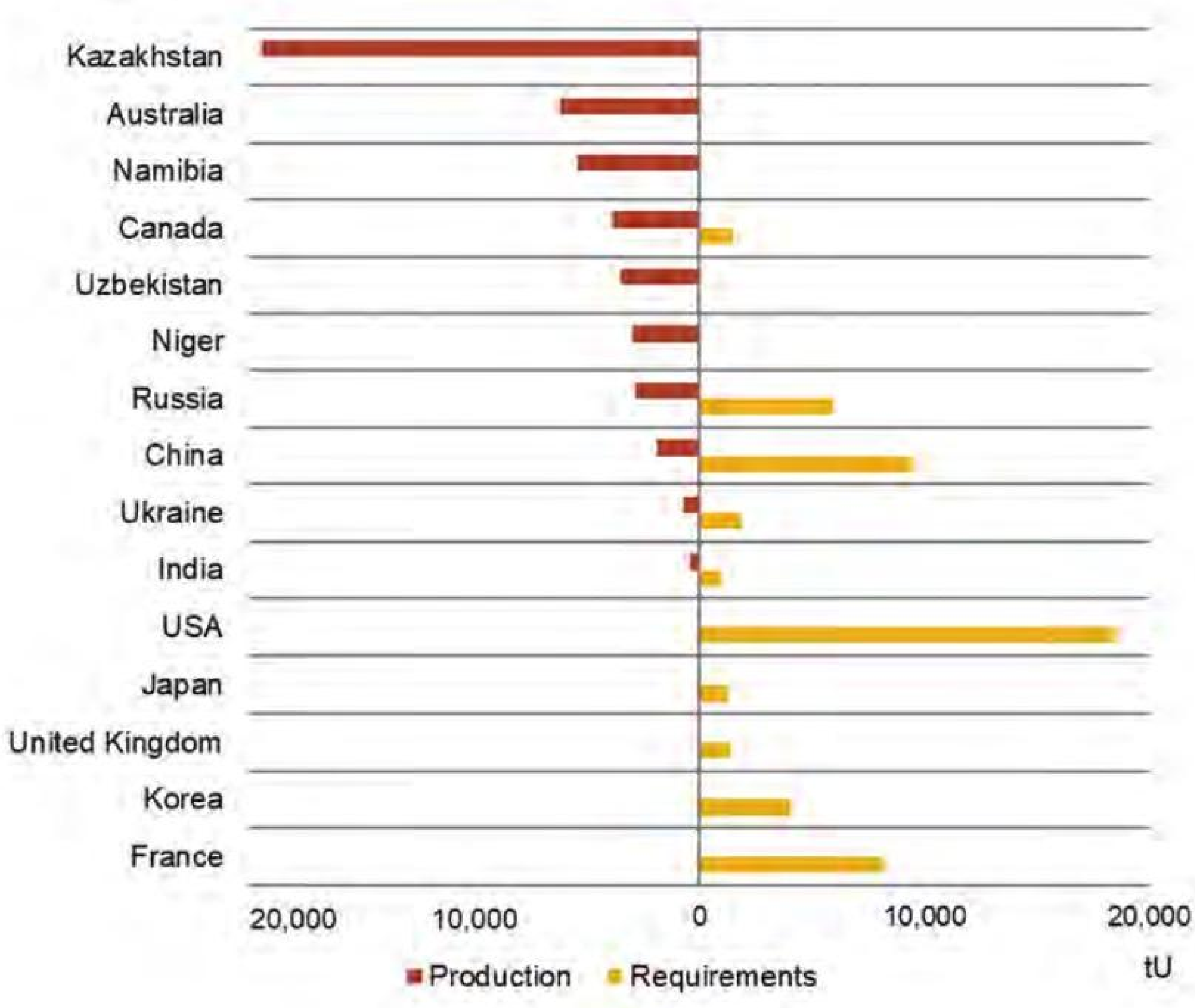
By 2022, the top eight countries produced ~57Kt of U3O8, roughly 72% of global demand.



Here's another graph showing the country-specific production versus fuel requirements.

Figure 6: Uranium production and reactor requirements for major producing and consuming countries in 2020, tU

(Source: OECD-NEA, IAEA, World Nuclear Association)



Extracting Uranium

There are two ways to extract uranium: Underground or open pit mining or In situ leach (ISL).

Open-pit mines are just giant holes in the ground. Underground mines are more complicated and involve complex operations to ensure the mine doesn't collapse.

In situ leaching is slightly different and involves artificially dissolving minerals (like uranium) using sulfuric/nitric acid or carbonate. Check out the diagram of the ISL process below.

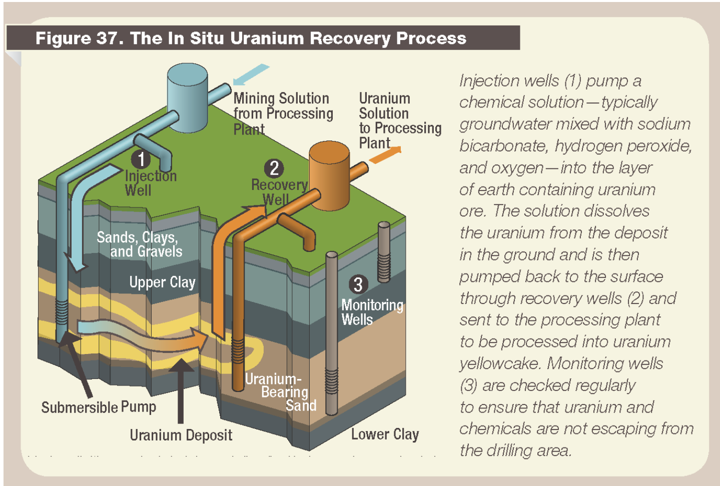


Figure 37. The In Situ Uranium Recovery Process

Injection wells (1) pump a chemical solution—typically groundwater mixed with sodium bicarbonate, hydrogen peroxide, and oxygen—into the layer of earth containing uranium ore. The solution dissolves the uranium from the deposit in the ground and is then pumped back to the surface through recovery wells (2) and sent to the processing plant to be processed into uranium yellowcake. Monitoring wells (3) are checked regularly to ensure that uranium and chemicals are not escaping from the drilling area.

In the early 1990s, most uranium miners used open pits or underground mines. However, by 2022, 55% of uranium production came from ISL methods (see below).

Method	tonnes U	%
In situ leach (ISL)	27,773	56%
Underground & open pit (except Olympic Dam)	18,569	38%
By-product	3013	6%

Company and Mine Concentration

As we mentioned above, uranium production is highly concentrated in eight countries. But within those eight countries, things get *even more* concentrated.

The top nine largest producers account for **96% of the global output.**

Company	tons	% of Global Production
Kazatomprom	11,373	23.04%
Cameco	5,675	11.50%
Orano	5,519	11.18%
CGN	4,627	9.37%
Uranium One	4,454	9.02%
Navoi Mining	3,300	6.69%
CNNC	3,247	6.58%
BHP	2,813	5.70%
ARMZ	2,508	5.08%
General Atomics/Quasar	1,740	3.53%
Other	4,098	8.30%
Total	**49,355**	**100**

The three largest producers (Kazatomprom, Cameco, and Orano) account for 46% of global production. There are only four publicly traded companies from that list:

- ➢ **Kazatomprom (KAP.LSE)**
- ➢ **Cameco (CCJ)**
- ➢ **CNNC International (2302.HK)**
- ➢ **BHP (BHP)**

Over 50% of these companies are State-Owned Enterprises (or SOEs).

Uranium production is like a Russian doll of increasing concentration. So far, we've learned that:

- ➢ **~100% of global supply comes from eight countries**
- ➢ **96% of global production comes from nine producers**

➢ **Of that 96% of production, 46% comes from the three largest producers**

There's one last bit of production concentration to discuss: single-mine locations.

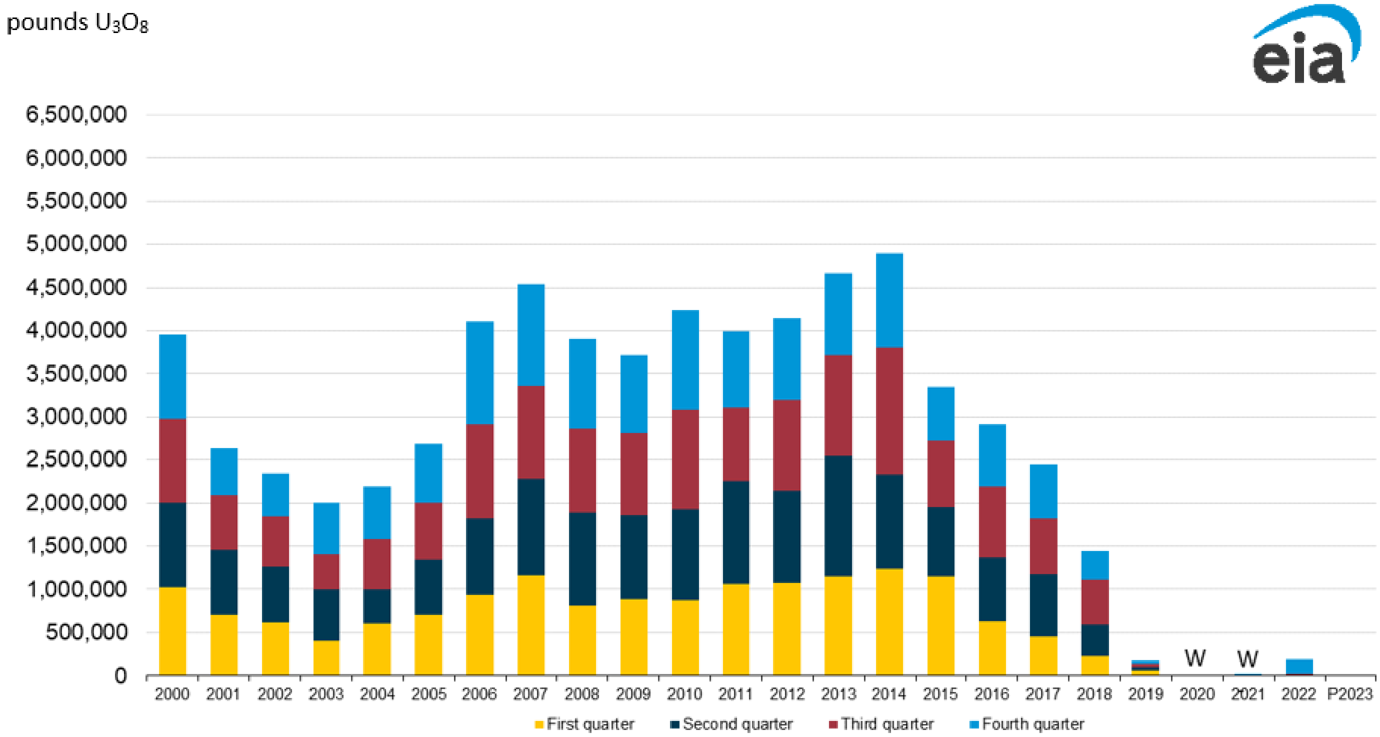
57% of the world's uranium supply comes from 10 mines (see below).

Mine	Country	Main owner	Type	Production (tons U)	% of world
Cigar Lake	Canada	Cameco/Orano	underground	6,928	14
Husab	Namibia	Swakop Uranium (CGN)	open pit	3,358	7
Inkai, sites 1-3	Kazakhstan	Kazatomprom/Cameco	ISL	3,201	7
Olympic Dam	Australia	BHP Billiton	by-product/underground	2,813	6
Karatau (Budenovskoye 2)	Kazakhstan	Uranium One/Kazatomprom	ISL	2,560	5
Rössing	Namibia	CNNC	open pit	2,255	5
SOMAIR	Niger	Orano	open pit	2,020	4
Four Mile	Australia	Quasar	ISL	1,740	3
Central Mynkuduk	Kazakhstan	Ortalyk	ISL	1,650	3
South Inkai 4	Kazakhstan	Uranium One/Kazatomprom	ISL	1,600	3
Top 10 total				**28,125**	**57%**

The top five mines represent 40% of global production.

You're probably wondering … where's the US production in this? The answer is that it doesn't exist. From 2000-2014, the US produced ~3-4Mlbs of uranium annually. However, domestic production fell sharply post-2014; as of 2022, the US produced less than 500Klbs of yellow cake (see below).

Figure 1. Uranium concentrate production in the United States, 2000 to second-quarter 2023



P = Preliminary data

Data source: U.S. Energy Information Administration, Form EIA-851A, *Domestic Uranium Production Report (Annual)*, and Form EIA-851Q, *Domestic Uranium Production Report (Quarterly)*

Capacity Utilization: A Declining Lever

Capacity Utilization is a fancy way of saying **how much of something we can squeeze from what's available to capture.** The higher the capacity utilization, the more stuff you're squeezing.

Here's how this relates to primary supply. There are ~10 mines that contribute 57% of the global uranium supply. The higher capacity utilization from those mines, the more uranium they can produce, which increases supply.

However, the lower the capacity utilization from those mines, the fewer tons of uranium they extract, which reduces supply.

There are five drivers of capacity utilization:

- ➢ Capital/Financing
- ➢ Labor

➢ Resource reserves
➢ Transportation/fuel costs
➢ Ore quality

Each driver is under attack.

Capital is scarce: Exploration spending on uranium fell from $2.12B in 2014 to $280M in 2021).

Labor is more expensive: Nobody wants to work in the mining industry.

Grades are declining: All the easily accessible uranium has already been mined.

Transportation and fuel costs are rising: Lower grades require more fuel to go deeper into a mine.

The result is a global decline in capacity utilization rates from 83% in 2016 to 69% in 2020. Uranium mines aren't living up to their potential. It's like your dad telling you he's not mad, just disappointed.

	Production					Nameplate capacity					Capacity utilization				
	2016	2017	2018	2019	2020	2016	2017	2018	2019	2020	2016	2017	2018	2019	2020
Kazakhstan	24,689	23,321	21,705	22,808	19,477	25,714	29,764	29,764	29,764	29,063	96%	78%	73%	77%	67%
Australia	6,315	5,882	6,517	6,613	6,203	7,497	10,655	10,655	6,807	6,807	84%	55%	61%	97%	91%
Namibia	3,654	4,224	5,524	5,476	5,413	5,654	11,232	9,232	9,328	9,328	65%	38%	60%	59%	58%
Canada*	14,039	13,116	7,001	6,938	3,885	16,282	16,538	6,922	6,924	6,924	86%	79%	100%	100%	56%
Uzbekistan**	3,325	3,400	3,450	3,500	3,500	3,500	3,500	3,500	3,500	3,500	95%	97%	99%	100%	100%
Niger	3,479	3,448	2,911	2,983	2,991	3,600	3,600	3,600	3,400	3,400	97%	96%	81%	88%	88%
Russia	3,005	2,917	2,904	2,911	2,846	4,885	4,600	4,600	4,900	4,900	62%	63%	63%	59%	58%
China***	1,616	1,692	1,885	1,885	1,885	1,808	1,808	1,923	1,923	1,923	89%	94%	98%	98%	98%
Ukraine	808	707	790	800	744	1,650	1,650	1,650	1,650	1,650	49%	43%	48%	48%	45%
India***	385	423	423	308	400	610	610	610	610	610	63%	69%	69%	50%	66%
South Africa	490	308	346	346	250	1,269	769	769	769	769	39%	40%	45%	45%	33%
USA	1,125	960	582	58	6	2,780	3,596	1,673	1,404	385	40%	27%	35%	4%	2%
Others	277	116	116	116	131	812	116	116	116	336	34%	100%	100%	100%	39%
Total	**63,207**	**60,514**	**54,154**	**54,742**	**47,731**	**76,061**	**88,438**	**75,014**	**71,095**	**69,594**	**83%**	**68%**	**72%**	**77%**	**69%**

** McArthur River produced 77 tU in 2018, but its capacity is not included in Canada's nameplate capacity in 2018. Other idled mines are treated likewise.*
*** Estimated numbers for Uzbekistan uranium production in 2020.*
**** Estimated uranium production for China and India.*

Low capacity utilization rates wouldn't be as significant of a problem if we lived in a high uranium price environment. But we don't. So, there's zero incentive for new mines to come online or brownfield expansion from existing mines. It's uneconomical.

Consistently low (or declining) utilization rates put downward pressure on primary and **Secondary Supply** production, which we'll discuss next.

Secondary Supply: What It Is & Where It Comes From

As mentioned, primary global supply only accounts for ~72% of global demand. So how does the world get its remaining 28% of supply? Secondary Sources.

There are four main types of secondary supply:

- ➢ **Civil stockpiles held by utility companies and governments**
- ➢ **Nuclear weapons stockpiles**
- ➢ **Recycled plutonium and uranium**
- ➢ **Re-enriched depleted tails**

Secondary supply sources are nearly impossible to predict with any certainty. Our best bet is to create ranges of potential supply in each secondary source based on off-hand information or a collection of state-owned reports.

However, the *2021 Nuclear Fuel Report Summary* has an excellent chart dissecting the various Secondary Sources into their originating states, economic roles, owners, and marketable forms (see below).

Originating stage	Economic role	Owners	Type of initial secondary source	Marketable forms of secondary material
Pre-irradiation in nuclear reactors (front end)	Targeted (desired) products	Commercial entities (producers, traders, utilities)	Commercial inventories	• Natural U_3O_8, UF_6; • LEU as UF_6, UO_2, fabricated fuel and its feed/SWU components
		Governments and their contractors	Military-related materials and depleted uranium	• LEU from surplus weapons-grade HEU
		International fuel banks	Comparable to commercial inventories in terms of specification	• LEU as UF_6 stocks
	By-products (including underfeeding)	Commercial entities (enrichers) or governments and their contractors	Legacy tails and underfeeding	• Natural uranium equivalent as UF_6 from tails
		Commercial entities (enrichers)		• LEU from tails or underfeeding as UF_6
Post-irradiation in nuclear reactors (back end)	Reusable products	Commercial entities or governments and their contractors	Recycled material	• Reprocessed uranium • Enriched reprocessed uranium (ERU) mostly as UO_2 • MOX fuel containing plutonium from spent fuel or defence • Unprocessed spent fuel (potential source)
	By-products of recycled material	Commercial entities (enrichers)		• LEU from slightly irradiated uranium (DSIU) • Depleted RepU as UF_6 or UO_2

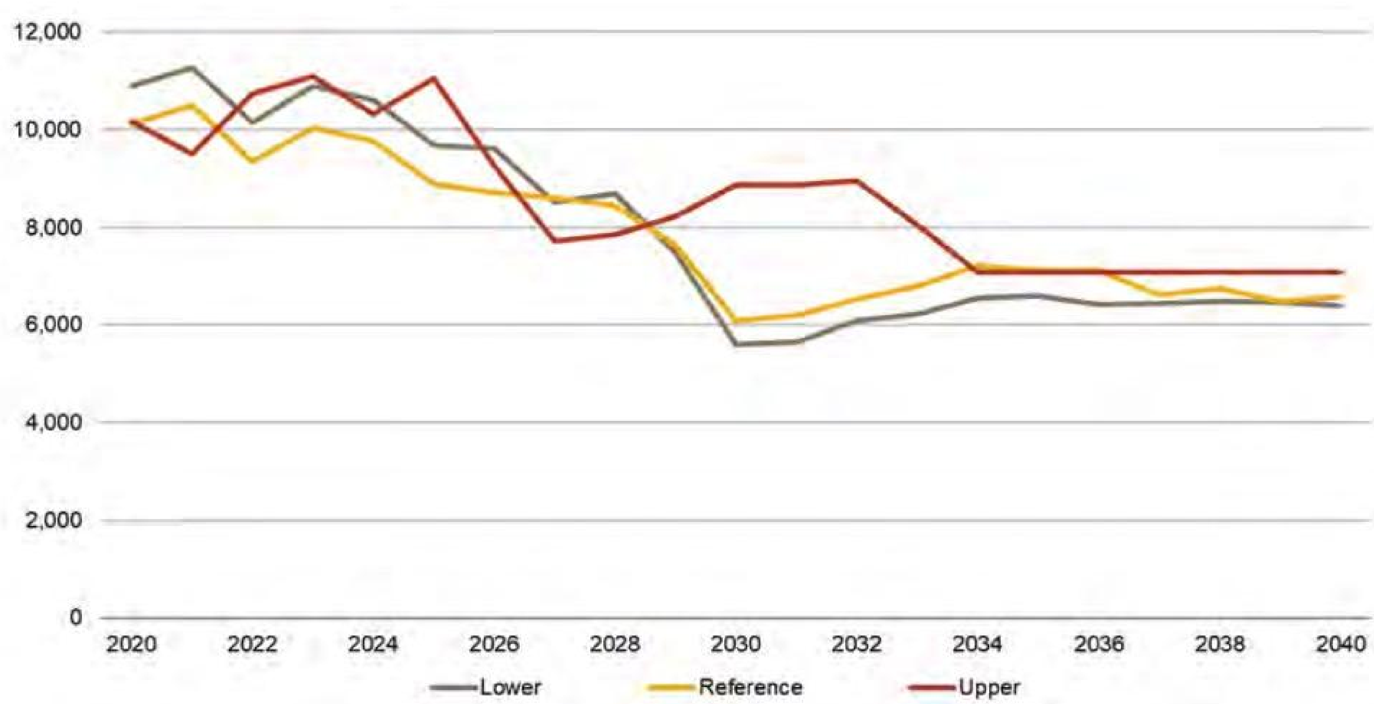
The WNA has rough secondary supply predictions:

- ➢ Civil / government stockpiles: **~282Kt** for utilities
- ➢ Military weapons: **15% of world's reactor requirements**
- ➢ Recycled uranium and plutonium: Saves **2Kt** from primary production with another **26Kt** in Reprocessed Uranium between UK, Belgium, Germany, Switzerland, and France
- ➢ Underfeeding: **3,500-7,000t/year**

Remember, the above available tons show how much is available *should* utility companies draw down on those reserves annually (see civil/gov't stockpiles).

The 2021 Nuclear Fuel Report Summary provides a good chart outlining this idea of available annual supply (see below).

Figure 5: Secondary supply scenarios for uranium, tU_{eq}



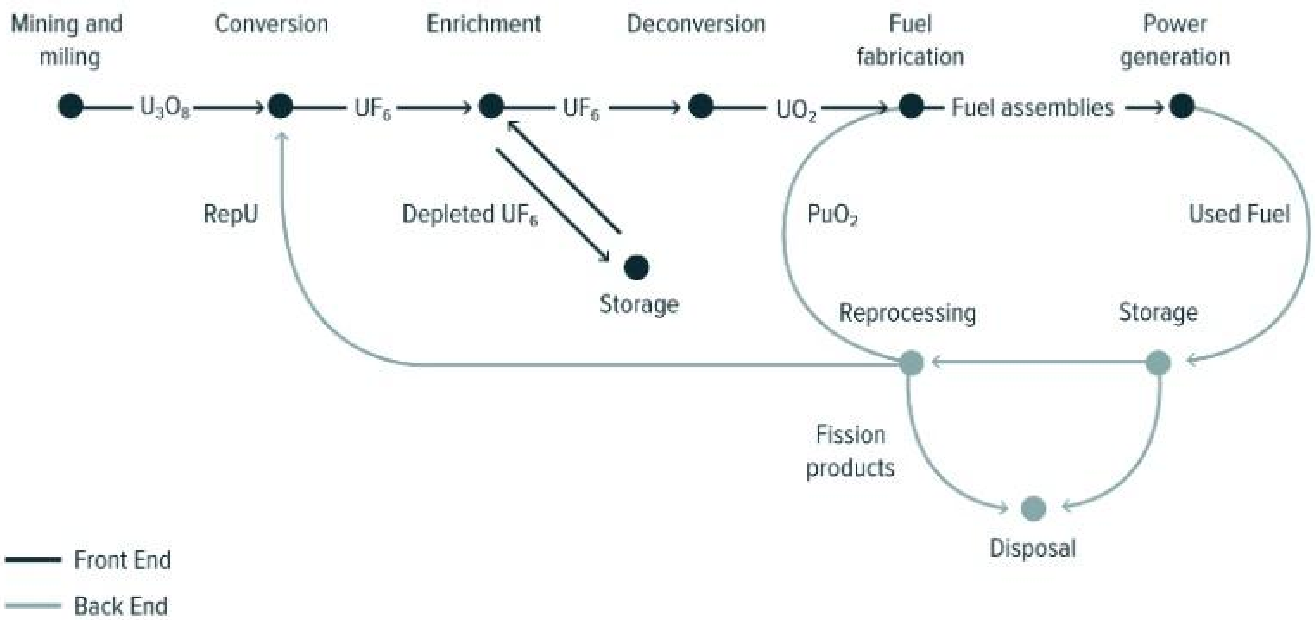
<u>Overfeeding, Underfeeding, Tail Assays, & Enrichment</u>

I want to emphasize "Underfeeding/Overfeeding" in Secondary Supply because it's a confusing topic for most generalists (it sounded like a foreign language when I first heard it).

Let's start with the basics of the nuclear fuel cycle (great chart below).

THE NUCLEAR FUEL CYCLE

Sources: Global X ETFs with information derived from: World Nuclear Association. (2022, April). *The Nuclear Fuel Report: Global Scenarios for Demand and Supply Availability 2021-2040, Report No. 2022/001.*



Global-X ETFs explain this fuel cycle well (emphasis added):

> *To generate nuclear energy, the utilities that buy uranium from the mines need a certain quantity of enriched uranium. Uranium consists of two main isotopes, U-235 and U-238, chemically identical but different in mass.*
>
> *Their difference in mass allows the isotopes to be separated and makes it possible to increase, or "enrich," the percentage of U-235.*
>
> *The fission of the U-235 atoms generates nuclear energy. Lower levels of enriched uranium, such as uranium with 5% U-235, are commonly used for nuclear reactor fuel.*
>
> *Historically, the* ***uranium enrichment process has a good degree of inertia.*** *Even when enriched uranium demand declined following the Fukushima accident, enrichment plants continued operating because it was costly to shut down and re-start centrifuges.*
>
> *Primary and secondary supplies are the two basic divisions of uranium supply.* ***Mined and processed uranium is referred to as the primary supply****, while*

> ***reprocessed uranium that is added back into the fuel cycle** is the secondary supply."*

Here's how they explain underfeeding and overfeeding (emphasis mine):

> *"The ability to redirect excess enrichment supply to uranium production by underfeeding (operating at low tails assay) affects the secondary uranium supply. **Enrichment facilities are underfeeding because of the worldwide oversupply of enrichment capacity.**"*

Clear as mud? Let me explain.

Underfeeding and overfeeding refer to the amount of uranium used in the enrichment process. The enrichment process turns yellow cake (U3O8 … the stuff *we* care about) into usable uranium for utility powerplants.

Here's why it matters to supply. Underfeeding means excess uranium is in the enrichment process because the mine doesn't need as much to produce an equivalent amount of enriched uranium.

So what does the mine do? They keep the excess under-fed uranium and sell it on the market to utility companies. This **increases** the uranium supply.

Overfeeding is the opposite process. It means you need **more** uranium to generate the same amount of enriched uranium at the end of the fuel cycle.

Think about it like baking a cake. Suppose you substitute all-purpose flour for almond flour. The recipe calls for 3 cups of all-purpose flour **or** 4 cups of almond flour.

By switching to almond flour, you're **overfeeding** the batter because you add more **flour** to make the same cake. Whereas if you used all-purpose flour, you'd **underfeed** the batter relative to almond flour.

Who's hungry?

One of the reasons why uranium prices have stayed low over the past three years is because the industry has been constantly underfeeding. It needed less uranium to make enriched products than it produced.

<u>That trend is reversing, and it's incredibly bullish for uranium's supply/demand deficit.</u>

Here's why.

The West relied heavily on Russia/the East for uranium enrichment capacity. I discussed this topic with Daren Heitman of Azarias Capital on our podcast.

He mentioned that Russia has ~43% of the global enrichment capacity (see breakdown below), and the US relies on Russia for 17% of its imported uranium and 23% of its enriched uranium.

WORLD ENRICHMENT CAPACITY – OPERATIONAL AND PLANNED (THOUSAND SEPARATIVE WORK UNIT/YR)

Sources: Global X ETFs with information derived from: World Nuclear Association. (2022, October). *Uranium enrichment*.

Country	Company and plant	2013	2015	2020
France	Areva, Georges Besse I & II	5500	7000	7500
Germany-Netherlands-UK	Urenco: Gronau, Germany; Almelo, Netherlands; Capenhurst, UK.	14,200	14,400	14,900
Japan	JNFL, Rokkaasho	75	75	75
USA	Urenco, New Mexico	3500	4700	4700
Russia	Tenex: Angarsk, Novouralsk, Zelenogorsk, Seversk	26,000	26,578	28,663
China	CNNC, Hanzhun & Lanzhou	2200	5760	10,700
Other	Various: Argentina, Brazil, India, Pakistan, Iran	75	100	170
	Total SWU/yr approx	51,550	58,600	66,700

However, the Russia/Ukraine war disrupted the entire enrichment supply chain. The US is still reliant on Russia's enrichment capacity. But it doesn't want to be.

How does the US/West fix that?

They overfeed their enrichment facilities so they aren't *as* dependent on Russian-enriched uranium.

Now, a significant part of the secondary supply chain moves from a net producer to a net consumer. In other words, overfeeding will put an even greater strain on the uranium supply and widen the deficit.

At this point, we know how much uranium is produced globally, who makes it, and what mines represent the bulk of production.

But an important question is, "How much uranium is in the ground? And what are the odds that we can extract it to increase production?"

Let's answer these questions.

Global Uranium Availability

According to the World Nuclear Association, *"Uranium is a relatively common element in the crust of the Earth (very much more than in the mantle). It is a metal approximately as common as tin or zinc, and it is a constituent of most rocks and even of the sea."*

Like any other mineral, uranium has varying quality (low-to-high) grades. Anything over 200,000 parts per million (or ppm) is considered high-grade ore.

Anything below 100 ppm is considered very low-grade ore.

For reference, seawater has 0.003 ppm of uranium (which is disturbing when I think about all the seawater I accidentally drank while swimming at the beach last weekend).

Very high-grade ore (Canada) – 20% U	200,000 ppm U
High-grade ore – 2% U	20,000 ppm U
Low-grade ore – 0.1% U	1000 ppm U
Very low-grade ore* (Namibia) – 0.01% U	100 ppm U
Granite	3-5 ppm U
Sedimentary rock	2-3 ppm U
Earth's continental crust (av)	2.8 ppm U
Seawater	0.003 ppm U

ppm = parts per million

* Where uranium is at low levels in rock or sands (certainly less than 1000 ppm) it needs to be in a form which is easily separated for those concentrations to be called 'ore' – that is, implying that the uranium can be recovered economically. This means that it needs to be in a mineral form that can easily be dissolved by sulfuric acid or sodium carbonate leaching.

It's impossible to determine the total amount of available uranium. Our best guess is the **known reserves** in the ground **capable** of being mined.

Known reserves capable of being mined are a function of uranium prices and the economics of extracting uranium. That's why you always hear the term, "the cure for high prices is high prices."

For example, at a high enough price, it becomes economical to extract uranium out of seawater (according to the US DOE, we'd need $277/lb uranium to make seawater extraction economically feasible).

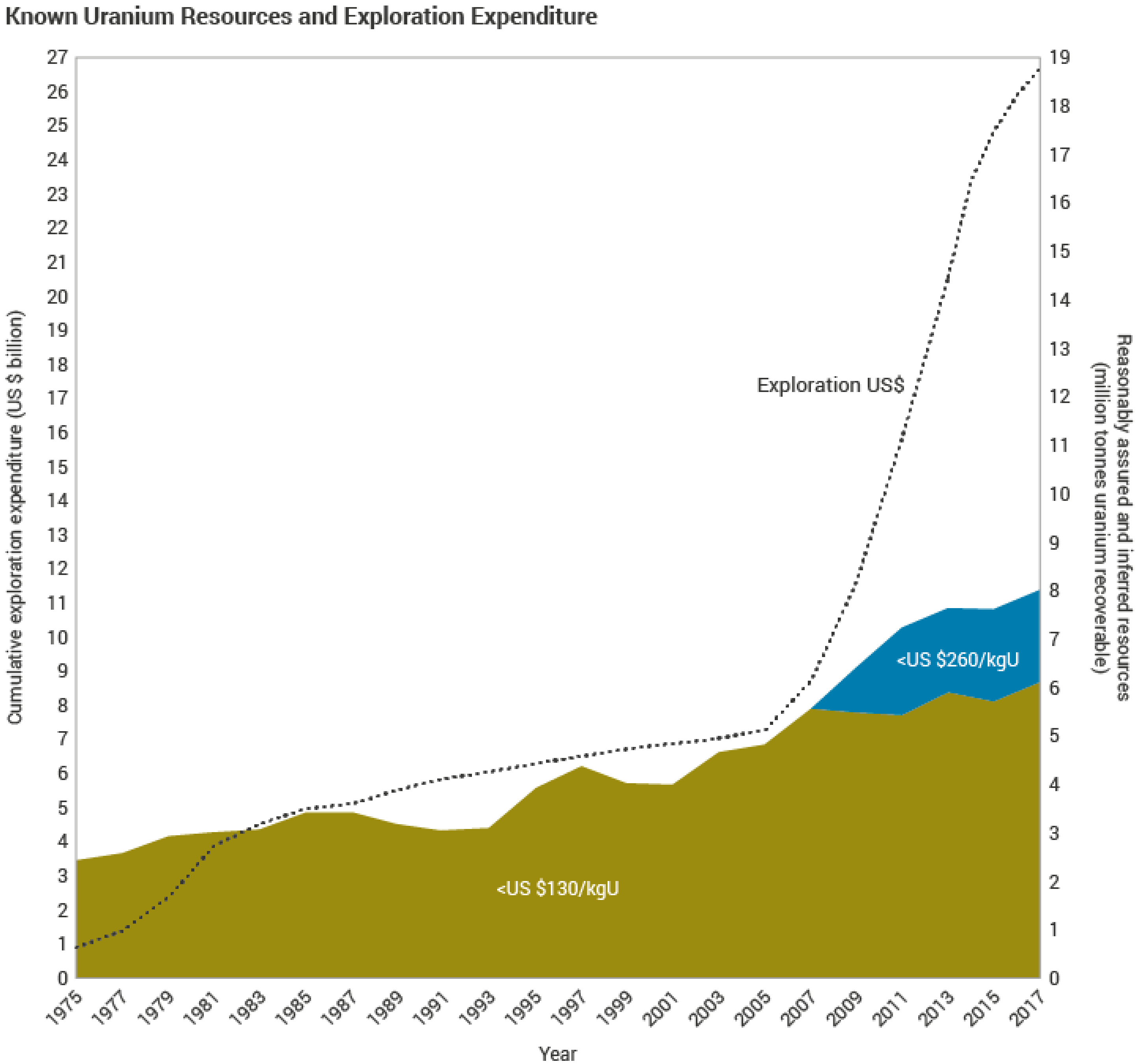
My point is that the lower the price, the fewer tons of uranium available worldwide. The higher the price, the more availability.

What does the available uranium supply look like today?

Our most recent analysis is from the 2021 OECD NEA & IAEA report, which shows **~6.08Mt available globally** (see below).

Country	tons U	% of world
Australia	1,684,100	28%
Kazakhstan	815,200	13%
Canada	588,500	10%
Russia	480,900	8%
Namibia	470,100	8%
South Africa	320,900	5%
Niger	311,100	5%
Brazil	276,800	5%
China	223,900	4%
Mongolia	144,600	2%
Uzbekistan	131,300	2%
Ukraine	107,200	2%
Botswana	87,200	1%
USA	59,400	1%
Tanzania	58,200	1%
Jordan	52,500	1%
Other	266,600	4%
World total	**6,078,500**	**100%**

The above report assumed a **$59/lb uranium price.** The report also noted that recoverable available resources grew to 7.918Mt if uranium prices reached $118/lb (see graph below from OECD).



The last step in our supply-side analysis is understanding all the possible uranium deposits and future mines coming online over the next few years.

Remember, all else equal, a significant increase in new uranium mine production reduces the supply/demand deficit and the risk/reward in the thesis.

So, we must know where new supply might come from, how much might come online, and the probability of that supply entering the market.

Future Uranium Projects

The uranium industry separates future uranium projects into three buckets:

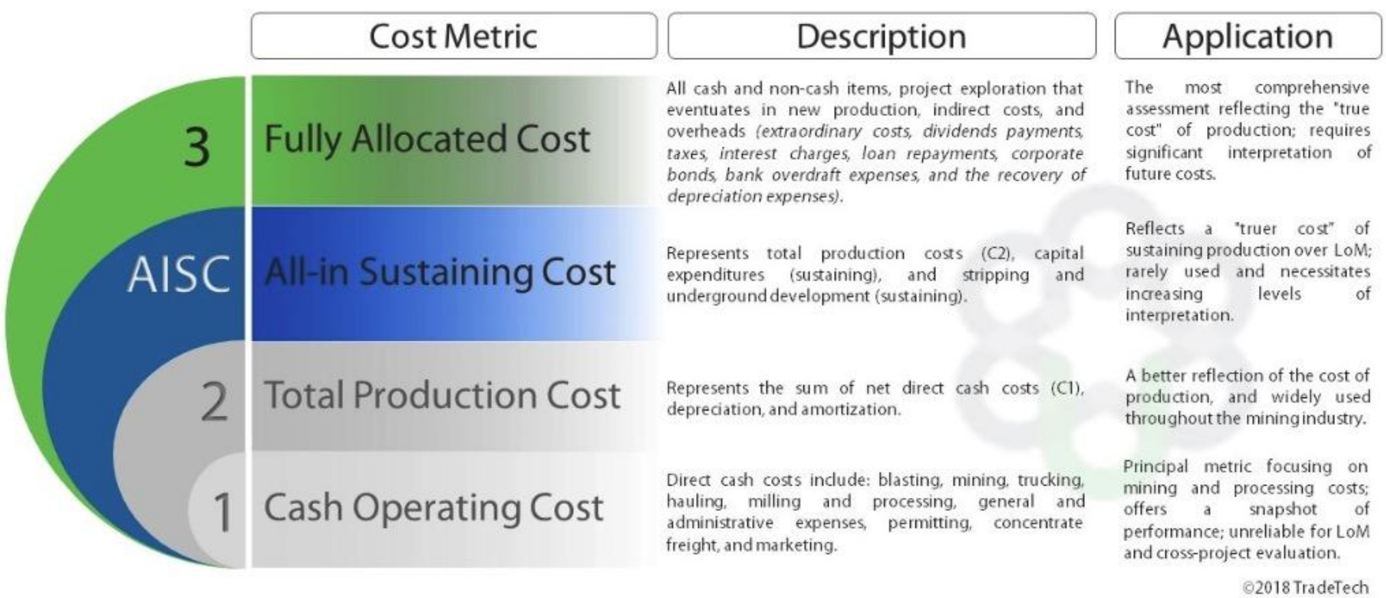
- ➢ **Viable Projects**
- ➢ **Potentially viable projects**
- ➢ **Non-viable projects**

Think of it like how we analyze oil reserves for upstream companies: PDP, PDNP, and PUD.

Wikipedia has a great resource on all potential uranium projects (see here), which we'll use for our analysis. You can also check out the *IAEA/INFCIS* website, which documents the world distribution of uranium and thorium deposits.

Before diving into each category, it's important to note that mines can (and do) move in and out of these buckets. A mine can be viable at one price, potentially viable at another, and non-viable at a third price.

How do we determine where a mine falls? The incremental cost of production curve (see below).



Source: TradeTech

The AISC number determines what mines are viable, potentially viable, and non-viable.

Let's start with Viable Projects. We exclude the top ten producing mines from this category (since Wikipedia doesn't bifurcate them).

As of 2020, there are 44 viable uranium projects across 20 countries. The estimated annual production from these projects is 36.8Kt.

Then there's Potentially Viable Projects. As of 2020, 32 potentially viable projects from eight countries (mainly Kazakhstan) are available. Only three of the projects have estimated annual production rates:

- ➢ Argentina (Hatai): 680t
- ➢ Australia (Jabiluka): 2,290t
- ➢ Australia (Honeymoon): 1,500t

There are 107 Non-Viable projects spanning nine countries (primarily Canada). I couldn't find annual production estimates for these projects.

Finally, there are the Prospective and Decommissioned projects. As of 2020, there were 103 such projects spanning 11 countries (the majority split between Canada and Germany).

I created an Excel Spreadsheet to track Viable, Non-Viable, and Prospective / Decommissioned projects (see here).

By this point, you have a firm understanding of:

- ➢ The history of uranium production
- ➢ Current primary supply concentration within countries, companies, and single mines
- ➢ How capacity utilization rates affect primary production
- ➢ The importance of Secondary Supply as an incremental source of production for utility companies.

We now have the tools to build the supply side of our supply/demand model. We've done all the hard work. The only thing left is 2nd-grade math to create our 80-20 Uranium Supply Side model.

Making The Supply Side Of Our Model

Our first step is to start with Primary Supply. We assume a 5% production increase in primary and secondary supply between 2023-2024.

Supply Source	**2023E Tons U**	**2024E Tons U**
Primary Supply		
Kazatomprom	12,510	13,136
Cameco	6,243	6,555
Orano	6,071	6,374
CGN	5,090	5,344
Uranium One	4,899	5,144
Navoi Mining	3,630	3,812
CNNC	3,572	3,750
BHP	3,094	3,249
ARMZ	2,759	2,897
General Atomics/Quasar	1,914	2,010
Other	4,508	4,733

From here, we add our Secondary Supply estimates (which we got from the 2021 Nuclear Report Summary and our own percentage estimates).

Secondary Supply		
Comercial Stockpiles	3,000	3,150
Nuclear weapons stockpiles	1,800	1,890
Recycled Plutonium and uranium	3,000	3,150
Re-enriched depleted tails	4,200	4,410

Finally, we combine both Primary and Secondary Supplies to get a Total Supply Estimate (in tons).

From there, we'll convert our Total Supply Estimate into Total U308 by multiplying Total Supply by 1.18 (from our conversion above).

Finally, we convert tons to pounds by multiplying by 2,000.

Supply Source	**2023E Tons U**	**2024E Tons U**
Primary Supply		
Kazatomprom	12,510	13,136
Cameco	6,243	6,555
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Other	4,508	4,733
Secondary Supply		
Comercial Stockpiles	3,000	3,150
Nuclear weapons stockpiles	1,800	1,890
Recycled Plutonium and uranium	3,000	3,150
Re-enriched depleted tails	4,200	4,410
Total Supply Estimate	**66,289**	**69,604**
Total U3O8 Supply Estimate	**78,221**	**82,133**
Total Lbs Supply Estimate	**156,442,984**	**164,265,133**

Our end result is **~156Mlbs of uranium supply in 2023** and **164Mlbs in 2024.**

For reference, Praetorian Capital's Harris Kupperman has [2024 Uranium Supply of ~160Mlbs](#) (150Mlbs in primary supply + 10Mbls in secondary supply).

This brings me to the most crucial point when modeling supply and demand. Our goal isn't to be the most precise with our estimates. Instead, we want to be **directionally correct**.

Investors lose a ton of money obsessing over decimals in their models.

The point is that we are directionally accurate in our model's supply estimates. We get the 80-20.

How To Update Our Supply Side Model

Take a breath and relax. You've done all the heavy lifting in building the supply-side model. Now, all that's left is continuously monitoring and updating the model to reflect news and supply-side developments.

Here's how to do that.

First, create a watchlist for every publicly traded uranium-related company. We've partnered with Koyfin at MO, and they make this step easy.

All you do is run a screener that captures every company with "uranium" in its security description. You can then save that list of stocks as a watchlist. Here's a screenshot of my watchlist.

My Watchlists

News | Shared | Download

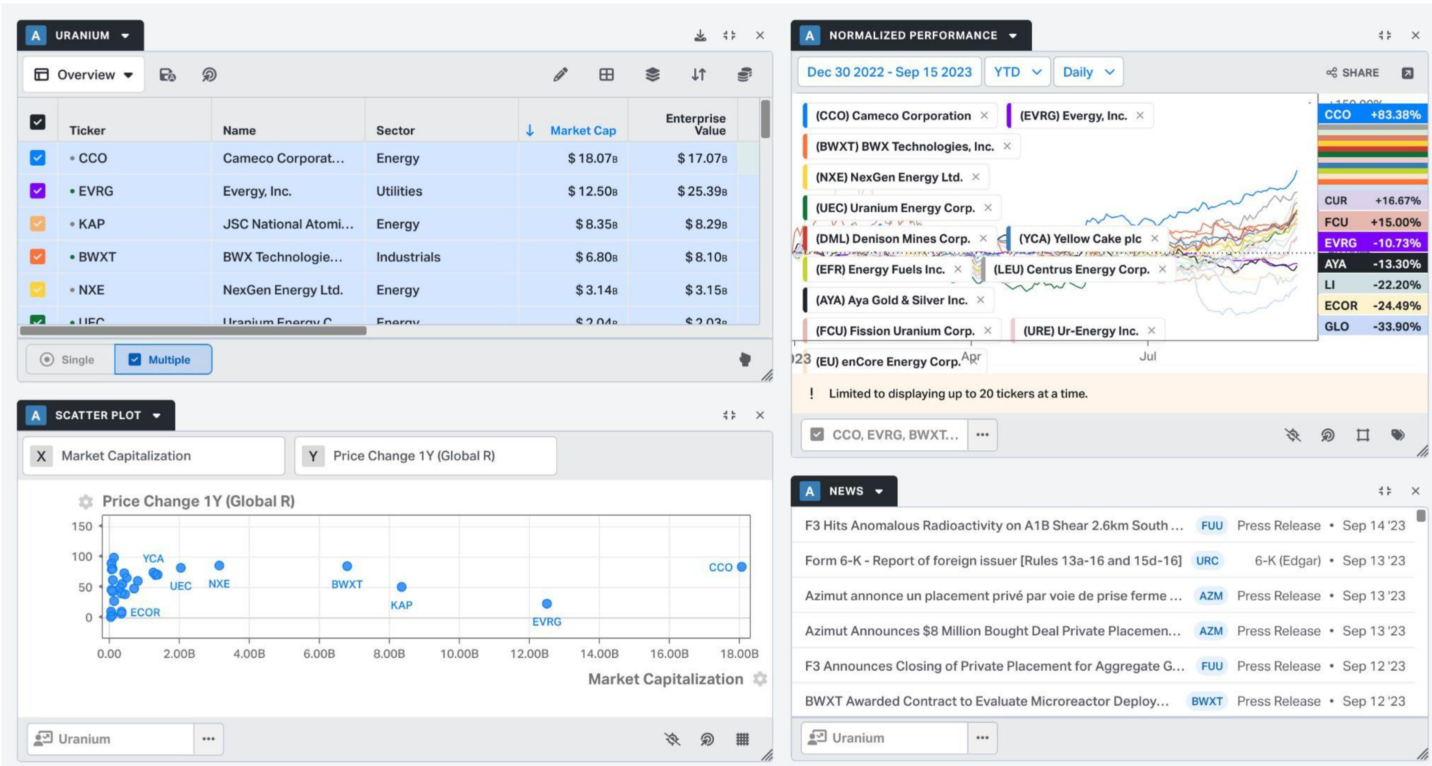
Macro Ops Portfolio | Uranium

Overview | Auto | Columns | Summary | Group | Sort | USD

Ticker	Name	Sector	Market Cap	Enterprise Value	Last Price	1-Day %	Sparkline Graphs (1Y)	Total Return (1M)	Total Return (3M)	Total Return (YTD)
CCO	Cameco Corporat…	Energy	$ 18.04B	$ 17.04B	56.21	4.29%		22.89%	34.41%	83.15%
EVRG	Evergy, Inc.	Utilities	$ 12.52B	$ 25.41B	54.49	0.09%		-2.83%	-7.59%	-10.63%
KAP	JSC National Atomi…	Energy	$ 8.35B	$ 8.29B	34.10	3.96%		19.65%	32.33%	29.32%
BWXT	BWX Technologie…	Industrials	$ 6.80B	$ 8.10B	74.30	-0.05%		1.59%	10.05%	29.25%
NXE	NexGen Energy Ltd.	Energy	$ 3.14B	$ 3.15B	8.58	2.75%		33.44%	40.89%	43.24%
UEC	Uranium Energy C…	Energy	$ 2.05B	$ 2.03B	5.43	0.28%		48.09%	67.23%	40.08%
DML	Denison Mines Co…	Energy	$ 1.38B	$ 1.34B	2.22	4.23%		24.02%	34.55%	43.23%
EFR	Energy Fuels Inc.	Energy	$ 1.32B	$ 1.23B	11.29	3.77%		33.29%	32.05%	34.73%
YCA	Yellow Cake plc	Industrials	$ 1.26B	$ 1.18B	5.13	3.74%		20.76%	19.80%	36.81%
LEU	Centrus Energy C…	Energy	$ 815.10M	$ 785.30M	52.50	0.69%		28.99%	48.89%	61.64%
AYA	Aya Gold & Silver I…	Materials	$ 707.78M	$ 664.32M	7.82	5.25%		8.31%	-10.32%	-13.30%
FCU	Fission Uranium C…	Energy	$ 497.78M	$ 463.07M	0.92	3.37%		46.03%	41.54%	15.00%
EU	enCore Energy Co…	Energy	$ 450.07M	$ 503.83M	4.19	4.49%		35.16%	23.60%	30.94%
URE	Ur-Energy Inc.	Energy	$ 427.24M	$ 369.30M	2.18	3.32%		45.33%	55.71%	38.85%
ISO	IsoEnergy Ltd.	Energy	$ 372.84M	$ 378.28M	4.53	2.49%		64.13%	51.00%	55.67%
ECOR	Ecora Resources …	Materials	$ 349.39M	$ 392.03M	1.09	1.87%		0.00%	-10.78%	-24.49%
LI	American Lithium …	Materials	$ 347.79M	$ 322.44M	2.19	2.34%		27.33%	-20.07%	-22.20%

Once you have your watchlist, click the “News” tab and see the latest developments in the uranium industry.

You can also create a Dashboard to show latest news, price action, valuations, and SEC filings (see below).



We’re trying to find:

- ➢ Existing mine production figures
- ➢ Mine production cuts or raises
- ➢ New mine development progress (feasibility studies, etc.)
- ➢ General commentary on uranium market from largest suppliers (CCJ and KAP)

At the *least,* we must know when the largest producers report quarterly earnings so we can listen, read, and compare transcripts over time to spot new trends that may affect our supply estimates.

For example, CCJ recently reported production cuts from their largest mine, Cigar Lake. Now, that’s just one data point. But it’s important because that type of news could materially affect future supply.

We must adjust our primary supply estimate downward if Cigar Lake shuts down or production comes in at 20% lower than expected. The same applies if new mines come online or CCJ/KAP experience supply increases.

How often should you monitor the Uranium dashboard/news? Weekly should be OK. In fact, it's a great weekend exercise if you have a full-time job.

Concluding Supply

There you have it. A full soup-to-nuts supply-side model of the uranium industry and tools/processes on how to update the model over time.

Next, we'll cover the demand side of our model.

Grab another coffee, and let's dive back into the model!

The Demand Side: Primary & Secondary Deep Dive

Like supply, there are only a few critical drivers for our uranium demand equation:

- **Global electric utilities**
- **Fuel traders**
- **Financial buyers**

We'll spend most of our time on the utility companies since they drive 80-90% of uranium demand in both the spot and forward (long-term contract) markets.

Financial buyers are increasingly grabbing spot market supply, further tightening the market.

Global Utility Companies: The 80-20 of Demand

The basics … Utility companies use uranium as a feedstock in nuclear reactors to generate electricity from power plants.

Utility companies show this electricity as **Terawatt hours** or "TWh." TWh expresses the amount of produced energy, electricity, and heat from a reaction. It's the largest of the three most common expressions: **Gigawatt (GWh), Megawatt (MWh), and Kilowatt (kWh).**

For reference, one TWh is equivalent to:

- 1,000 GWh
- 1,000,000 MWh

➢ 1,000,000,000 kWh

It's a lot of energy. The acronyms are essential because we'll use them later to forecast demand.

Global utility companies are the most significant driver of uranium demand. As of January 2021, global utilities accounted for **60,114t** or **120Mlbs** in demand. That's 83% of the available supply.

As of 2020, there are **~440 reactors globally** with a combined capacity of **~390GWe**, which requires around 62,500t of uranium annually. In other words, **each reactor requires ~142t of uranium** annually to generate roughly **0.88GWe in electricity.**

Table 2.1. **Nuclear data summary**
(as of 1 January 2021)

Country	Operational reactors in 2021	Generating capacity (GWe net)	Reactors under construction	Reactor grid connections in 2019-2020	Reactor shutdowns in 2019-2020	Reactors using MOX[b]	2020 uranium requirements (tU)*
Argentina	3	1.8	1	0	0		219
Armenia	1	0.4	0	0	0		64
Bangladesh	0	0.0	2	0	0		0
Belarus	1	1.1	1	1	0		176
Belgium	7	5.9	0	0	0		944
Brazil	2	1.9	1	0	0		400
Bulgaria	2	2.0	0	0	0		320
Canada	19	13.6	0	0	0		1 715
China[a]	50	47.5	13	4	0		8 352
Czech Republic	6	3.9	0	0	0		594
Finland	4	2.8	1	0	0		720
France	56	61.4	1	0	2	23	6 034
Germany	6	8.1	0	0	0		1 012
Hungary	4	1.9	0	0	0		348
India	22	6.8	7	0	0	1	1 350
Iran	1	0.9	1	0	0		160
Japan	33	31.7	2	0	5		3 168
Korea	24	23.1	4	1	1		3 904
Mexico	2	1.6	0	0	0		430
Netherlands	1	0.5	0	0	0	1	80
Pakistan	5	1.3	2	0	0		211
Romania	2	1.3	0	0	0		208
Russia	38	28.6	3	4	1		5 100
Slovak Republic	4	1.8	2	0	0		483
Slovenia	1	0.7	0	0	0		149
South Africa	2	1.8	0	0	0		294
Spain	7	7.1	0	0	0		946
Sweden	6	6.9	0	0	1		1 104
Switzerland	4	3.0	0	0	1		480
Türkiye	0	0.0	2	0	0		0
Ukraine	15	13.1	2	0	0		2 480
United Arab Emirates	1	1.4	3	1	0		224
United Kingdom	15	8.9	2	0	0		944
United States	94	96.6	2	0	2		16 886
Total World	442	393.2	52	11	14	25	60 114
Total OECD	293	279.5	16	1	12	24	39 941
Total Non-OECD	149	113.7	36	10	2	1	20 173

* NEA/IAEA estimate. MOX is not included in uranium requirement figures.

(a) The following data for Chinese Taipei are included in the world total but not in the total for China: four reactors in operation, 3.8 GWe net; 615 tU as 2020 uranium requirements; no reactor under construction, none started up and one shut down during 2019 and 2020.

We can also think about utility demand as a function of TWh generated. For example, in 2020, global reactors generated 2,556TWh of electricity. At 60,114t of uranium, **~24t of uranium is needed per TWh of electricity generated** (see below, via IAEA).

Table 2.2. **Electricity generated at nuclear power plants**

(TWh)

Country	2015	2016	2018	2019	2020
Argentina	7	8	7	8	10
Armenia	3	2	2	2	3
Belarus	0	0	0	0	0.3
Belgium	25	41	27	41	33
Brazil	14	15	15	15	13
Bulgaria	15	15	15	16	16
Canada	96	95	94	95	92
China[(a)]	161	198	277	330	345
Czech Republic	25	23	28	29	28
Finland	22	22	22	23	22
France	417	384	396	382	339
Germany	87	80	72	71	61
Hungary	15	15	15	15	15
India	35	35	35	41	40
Iran	3	6	6	6	6
Japan	9	18	49	66	43
Korea	165	154	127	139	153
Mexico	12	10	13	11	11
Netherlands	4	4	3	4	4
Pakistan	4	5	9	9	10
Romania	11	10	11	10	11
Russia	182	183	191	196	202
Slovak Republic	14	15	14	14	14
Slovenia	6	5	6	6	6
South Africa	11	15	11	14	12
Spain	55	56	53	56	56
Sweden	54	61	66	64	47
Switzerland	22	20	25	25	23
United Arab Emirates	0	0	0	0	2
Ukraine	82	76	80	78	72
United Kingdom	64	65	59	51	46
United States	797	806	808	809	790
Total World	2 452	2 473	2 563	2 657	2 556
Total OECD	1 889	1 874	1 878	1 902	1 783
Total Non-OECD	563.1	598.5	684.7	755.1	772.6

(a) The following data for Chinese Taipei are included in the world total, but not in the total for China: 35.1 TWh in 2015; 30.5 in 2016; 26.7 TWh in 2018; 31.1 in 2019 and 30.3 in 2020.

Source: i) Government-supplied responses to a questionnaire; ii) NEA Nuclear Energy Data 2021 for OECD countries and iii) IAEA Energy, Electricity and Nuclear Power Estimated for the period up to 2050 (IAEA, 2021a) for non-OECD countries.

As mentioned above, uranium is an early feedstock for utility power plants. Consider it a small COG in a large, primarily fixed-cost operating model.

The WNA explains the relationship between uranium input costs and a power plant's overall cost structure (emphasis added):

> *“Because of the cost structure of nuclear power generation, **with high capital and low fuel costs**, the **demand for uranium fuel is much more predictable than with probably any other mineral commodity.***
>
> *Once reactors are built, **it is very cost-effective to keep them running at high capacity** and for utilities to make any adjustments to load trends by cutting back on fossil fuel use. **Demand forecasts for uranium thus depend largely on installed and operable capacity, regardless of economic fluctuations.**”*

Notice the key points above … *“high capital and low fuel costs”* … *“demand is much more predictable”* … *“very cost-effective to keep them running”* … *“demand forecasts depend on installed and operable capacity regardless of economic fluctuations.”*

These points are what make uranium the most exciting commodity investment out there. It’s a low-cost input to a mission-critical business (keeping the lights on) whose demand is a function of long-term, easily identifiable, hard-to-reverse drivers.

Think about it like a car and gasoline. If gasoline prices increase by 10%, you’re not rushing to the dealership to buy a brand-new, more fuel-efficient vehicle. You’ll take the price hike and fill ‘er up. In fact, you’ll probably do that for a 20%, 30% or 40% increase in fuel prices. Why? Because the relative cost of paying the higher gas price is still ***much lower*** than the cost of buying a new car.

Utility companies will pay higher uranium prices because the **cost** of **not** utilizing the power plant at optimal capacity trumps the relative increase in feedstock prices.

Back to demand … We can view reactor demand on a short-term and long-term basis.

The OECD explains short-term reactor demand (emphasis added):

> *“Reactor-related requirements for uranium over the **short term are fundamentally determined by installed nuclear capacity.***
>
> *Since **near-term capacity is made up of reactors that are either already in operation or under construction**, short-term requirements can be **projected with greater certainty.**”*

This makes sense since we know the number of reactors globally, roughly how much TWh/GWe each reactor produces, and the required uranium tons to generate each TWh/GWe.

Those three inputs alone put us >50% of the way towards completing our demand-side model.

But it's not *that* simple. We must understand long-term demand drivers if we want to correctly model demand in the future.

Long-Term Uranium Demand Drivers

There are four primary long-term demand drivers within the global reactor space:

- ➢ **Capacity (or load factor)**
- ➢ **Tails assays**
- ➢ **Burn-up**
- ➢ **Fuel cycle length**

Let's start with Capacity (or load factor).

Capacity measures how efficiently a utility runs its power plant.

We discussed capacity as a producer earlier, where greater capacity equaled higher production volumes. The same concept applies to utility companies.

The higher the capacity (load factor), the **more uranium** required to run the plant. Here's the WNA on capacity and its effect on uranium requirements (emphasis mine):

> *"Energy availability and capacity (or load) factors also play an important role in determining uranium requirements. Load factors have increased to over 80% in the period 2000-2010 (IAEA, 2020).*
>
> ***Increased load factors tend to increase uranium requirements.*** *The world average load factor declined to 77.4% in 2011 and further to 73.1% in the period 2012-2015 (IAEA, 2020b) following the Fukushima Daiichi Nuclear Power Plant accident.*
>
> *In the period 2019-2021,* ***the average energy availability factor calculated for 446 reactors in the world increased instead again to 79.5%*** *(IAEA, 2020b)."*

Increasing capacity rates over time makes sense as global utilities invest in innovation and technology to squeeze every drop out of their reactors.

Here's how that affects long-term demand. The WNA estimates that a 5% increase in Capacity Rates leads to a 6% increase in uranium requirements (the opposite is true for a 5% decline).

Then there are tail assays. We discussed tail assays above, but to refresh your memory … Underfeeding and overfeeding refer to the amount of uranium used in the enrichment process. The enrichment process turns yellow cake (U3O8 … the stuff we care about) into usable uranium for utility powerplants.

WNA explains how tail assays/underfeeding/overfeeding impact demand (emphasis added):

> *After the Fukushima Daiichi Nuclear Power Plant accident, overcapacity in the enrichment market incentivised operators to "underfeed" enrichment facilities by extracting more 235U from the uranium feedstock.*
>
> ***This reduces the amount of uranium required to produce contracted quantities of enriched uranium and, in turn, creates a stockpile of uranium.***
>
> *In recognition of these recent market trends, and since the 2012 edition of the Red Book,* ***uranium requirements for the operational lifetime of projected new reactors in this publication have been reduced from 175 tU/GWe/yr, the original assumption being a tails assay of 0.30%, to 160 tU/GWe/yr,*** *under the new assumption of a* ***tails assay of 0.25% over the lifetime of the reactor.***

What does that mean? It means that enrichers have spent the past decade-plus using ***less uranium*** to generate the equivalent amount of enriched uranium for utility power plants. Hence, the drawdown from 0.30% to 0.25% tail assay values.

But that's changed since the Russia/Ukraine war, as the US had historically depended on Russia for 25% of its enriched uranium.

So now utility companies will require more uranium to produce the same amount of enriched uranium for their plants, increasing the tail assay value to something higher than 0.25%.

How does this impact demand? For every 0.03% increase in tail assay percentages, uranium demand requirements increase by 6%. In other words, tail assay percentages have a **20x multiplier on its required uranium demand base**.

Next, let's discuss Burn-Up Rates.

Burn-up is what it sounds like … it measures how much uranium is burned in the reactor. Another way to think about burn-up is the **amount of energy the uranium produces**.

According to the [US Nuclear Regulatory Commission](#) *(US NRC)*, Burn-up is measured in gigawatt-days per metric ton of uranium (or GWd/MTU). Reactors have used ~35 GWd/MTU in Burn-up over the past two decades. Today, however, reactors generate 45 GWd/MTU in burn-up.

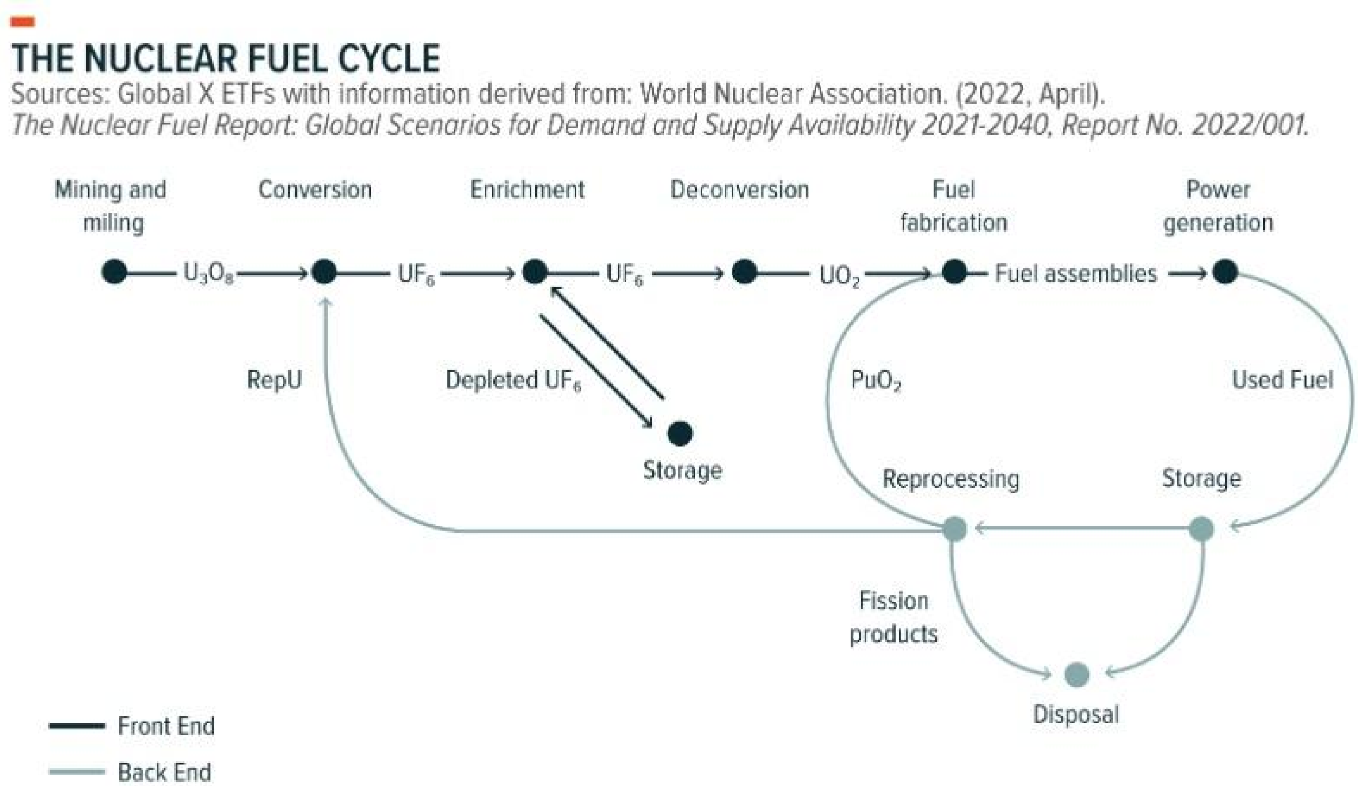
Here's how that impacts uranium demand (via US NRC, emphasis added):

> ***"Utilities now are able to get more power out of their fuel before replacing it.*** *This means* ***they can operate longer between refueling outages.*** *It also means* ***they use less fuel****."*

Burn-up reduces uranium demand. According to the WNA, a **5 GWd/MTU increase** in Burn-up results in a **3% reduction in uranium required.** A **10 GWd/MTU increase** leads to a **4-5% reduction in uranium needed**.

Finally, there's Cycle Length and its impact on uranium demand.

Cycle Length refers to the Nuclear Fuel Cycle (see diagram below).



Longer fuel cycles mean that each ton of uranium generates more fuel, allowing the utility to use that uranium for a longer time (all else equal).

This **increases** the long-term demand for uranium as reactors must generate *more electricity* from their uranium tons.

The WNA estimates a base value of 12 months for the fuel cycle. **A 6-month increase** in the base value fuel cycle generates a **7% increase in uranium requirements.** A **12-month increase** in fuel cycle length requires an **18% increase in uranium demand.**

Check out the demand-driver sensitivity chart below (via WNA).

Table 2.3. **Uranium demand sensitivity to some parameters**

Factor	Base value	Change	Impact on uranium requirements
Capacity (or load factor)	80%	+5% -5%	+6% -6%
Tails assays	0.25%	+0.03% -0.03%	+6% -6%
Burn-up	40 GWd/tU	+5 GWd/tU +10 GWd/tU	-3% -4-5%
Cycle length	12 months	+6 months +12 months	+7% +18%

Source: WNA, 2019; NEA/IAEA estimate.

Of the four demand drivers above, I have high conviction in two increasing demand: **Capacity (load factor)** and **(Tail assays)**.

Over the next few years, enrichment facilities will flip from underfeeding to overfeeding, thus increasing tail assay base values.

Technology and innovation will also increase capacity load factors, allowing power plants to use more uranium to generate more electricity.

We covered the most essential demand drivers in utility companies and power plants. Next, let's discuss financial buyers as the "cherry on top" for removing incremental supply from the market**.**

Secondary Demand Sources: Financial Buyers

I want to briefly discuss financial buyers. Yes, they are a legitimate demand source. But they pale in comparison to global reactor demand.

There are two main camps of financial buyers:

➢ Close-end funds
➢ Hedge funds/PE/Family Offices

Close-end funds like Sprott Physical Uranium Trust (U.UN, disclosure: we own U.UN) and Yellow Cake PLC (YCA) represent a "cherry on top" for increased demand.

U.UN has purchased ~30,000t of uranium since 2018 (~6,000t annually). YCA has bought ~8,600t of uranium since its inception in 2012.

As a group, close-end funds/hedge funds like U.UN and YCA represent **~10,000-20,000t in uranium demand.**

To conclude, Financial Buyers represent ~20,000t in uranium demand annually. However, this number will likely increase as uranium sentiment and prices improve. Higher prices will flood the market with other closed-end funds and hedge funds dying to get in on the action.

For example, a PE firm raised a $125M physical uranium fund earlier this month. If that fund successfully buys its allotted uranium, that would **add another 1,000t (or 2Mlbs) in demand.**

Building The Demand Side Of Our Model

Okay, we now have all the information we need to develop the demand side of our model.

First, let's estimate the total uranium ton demand for 2024. We're assuming a ~7% increase in annual uranium ton demand from global reactors. We also assume ~1 reactor addition per year to the existing 442 (as of 2020).

Finally, we're holding Ut/GWe and Ut/TWh constant.

Check out the table below.

Year	Reactors	Total GWe Capacity	Total TWh Generated	Uranium Requirements (t)
2020	442	393	2,556	**60,114**
2021	443	421	2,735	**64,322**
2022	444	450	2,926	**68,825**
2023	445	481	3,131	**73,642**
2024	446	515	3,350	**78,797**

By 2024, global reactor demand will reach ~79,000t (158Mlbs) or ~177t per operational reactor. This represents a ~7.5% increase in uranium requirements per reactor, which is a function of our estimate of **higher capacity utilization (load factor)** and **tail assay base rate increases**.

Next, we add our demand estimates from Secondary Demand (financial buyers).

Financial Buyer	2022 Tons	2023E Tons	2024E Tons
U.UN	5,200	5,460	5,733
YCA	4,600	4,830	5,072
Other funds	15,000	15,750	16,538
Total	**24,800**	**26,040**	**27,342**
Total (lbs)	**49,600,000**	**52,080,000**	**54,684,000**

We assumed a ~5% increase in tons purchased annually from 2022 to 2024. This gives us ~55Mlbs in annual uranium demand from financial buyers.

The final step is combining primary and secondary demand estimates.

Combining Primary & Secondary Demand Estimates

Here is our combined demand estimate model, given the above assumptions.

Year	**2022**	**2023**	**2024**
Primary Demand	68,825	73,642	78,797
Secondary Demand	24,800	26,040	27,342
Total Demand (t)	93,625	99,682	106,139
Total Demand (lbs)	**187,249,037**	**199,364,470**	**212,278,383**

By 2024, global demand from primary and secondary sources will reach **~106,000t (or 212Mlbs).** We can cross-check our estimates with the existing data that show that primary demand via global reactors represents ~75% of total demand.

Like our supply-side model, we're not looking for absolute precision. We care about being directionally correct.

How To Update Our Demand Side Model

This is a living, breathing model. So, updating it in the face of new evidence is essential. We do that by focusing on our demand-side drivers and refining our forecasts as those drivers change.

For instance, if tail assays decline from their 0.25% base, we'd reduce our demand model. If capacity loads increase, we increase our demand estimates.

Finally, we monitor new reactor developments, shutdowns, and restarts. New developments and restarts require ~15Mlbs of uranium to jump-start, which increases our demand model. More shutdown reduces demand.

There are a few great sources for updating the demand model:

➢ *World Nuclear Association (WNA)*
➢ *US Nuclear Regulatory Agency (US NRA)*
➢ *International Atomic Energy Agency (IAEA)*

Bringing It Together: Estimating Uranium Deficits

The final step in this process is combining our supply and demand estimates to determine if there's a supply deficit or oversupply.

We subtract the total estimated supply (from primary and secondary) from the total estimated demand (from primary and secondary). See below.

Year	**2023**	**2024**
Total Uranium Supply	78,221	82,133
Total Uranium Demand	99,682	106,139
(Deficit)/Oversupply (t)	-21,461	-24,007
(Deficit)/Oversupply (lbs)	**-42,921,486**	**-48,013,249**

Uranium will experience a **~43-50Mlb supply deficit over the next two years.**

The deficit will widen as **supply struggles to come online** due to increasing **demand from global reactors**, financial buyers, and increased nuclear adoption. What is the cure for such deficits? **Higher prices**.

How To Play The Deficit In Financial Markets

We made the model, estimated supply and demand, and concluded that uranium will experience a 50Mlb deficit in two years.

We want to profit from that hypothesis.

What's the best way to do that?

There are three ways to express our bullish bet on uranium deficits:

1) **Close-end funds like Sprott (U.UN) or Yellowcake (YCA)**
2) **Large uranium producers like Cameco (CCJ) or Kazatamprom (KAP)**
3) **Small junior explorer companies like Alligator Energy (AGE.ASX)**

Here's how we're betting on uranium.

Most of our uranium exposure is in U.UN. It's the most straightforward way to go long uranium because you're betting on *increasing physical uranium prices*.

I like this approach because you're not incurring any single stock or single mine risk with large or small producers. Not to mention the cost inflation eating away at producer profits, ESG red tape, and the 1,000,000 things that can go wrong mining for minerals.

Large producers like CCJ or KAP are another way to play the theme. Cathy Wood of ARK owns quite a bit of CCJ. And Druckenmiller has traded in/out of CCJ over the past year.

CCJ and KAP will be the go-to producer investments for large funds/institutions that want exposure outside the physical spot market. These companies are the largest and most liquid in the space and should attract the most capital.

Finally, there are the junior explorers. We own one, AGE.ASX, and it's in small size. Junior explorers are the highest-risk, highest-reward side of the uranium barbell.

You're exposed to everything I mentioned above: mining risks, labor force risks, cost inflation, single mine exposure, awful management teams, and the 1,000,000 other things that can go wrong at a mine.

Choose your vehicle and get ready for a ride …