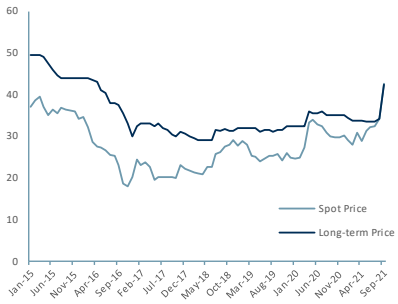
EXPLAINS NOTE

Extractives



Sources: TradeTech; UxC

Thursday, 14 October 2021

Commodity Prices	**USD**
Uranium	
Current Price	40.20/lb
Brent Crude Oil	
Current Price	83.18/bbl.
WTI Crude Oil	
Current Oil	81.08/bbl.
Metal Prices	
Copper	
Current Price	445.50/lb
Gold 100oz	
Current Price	1,794.90 t/oz

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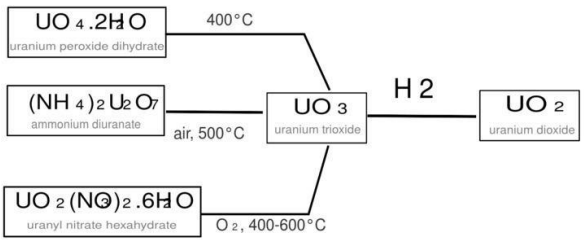
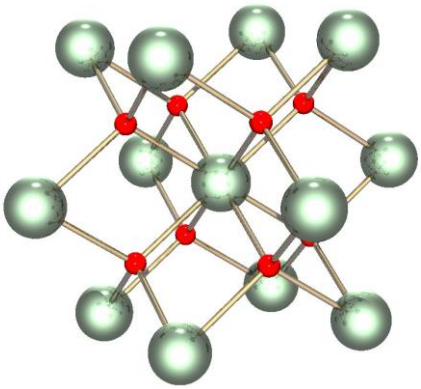
Uranium Market

Market Mechanism and Drivers U_3O_8

Uranium's (U-235) main use is as a fuel in the production of electricity by nuclear power stations. Though uranium is around 100x more common than silver, U-235 makes up only approximately 0.7% of natural uranium. The uranium market is complex, illiquid (thinly traded) and opaque. Directly or indirectly state-controlled producers account for up to 68% of global production based upon YE18A data (NEA, IAEA), down 2% vs. our 2019 analysis. The top 10 mines produce 55% of all Uranium, up 4% vs. 2019. State control of production means the majority of players do not have to follow economic logic. The primary trading instrument is yellow cake (U_3O_8).

- No traditional spot or forward market;
- Conversion market is a leading indicator for the production market;
- Top 10 uranium mines account for 55% of production, up 4%;
- Majority of the world's 458 nuclear reactors are in 5 countries;
- 68% of supply - companies state-owned and in different countries with radically different politics to the majority of reactors;
- Utility companies hold unknown or unknowable uranium reserves.





Above: Uranium dioxide (UO_2) or urania, is a black crystalline powder used in nuclear fuel rods in nuclear reactors.

How the Uranium Market Functions

Triuranium octoxide (U_3O_8) or yellow cake (refined uranium ore) is the standard traded oxide of uranium. The standard traded contract unit is 250 lbs of U_3O_8.

The price to convert U_3O_8 to uranium hexaflouride (UF_6), which is a step towards making uranium fuels, is implied through the pricing of UF_6.

Enriched uranium (EUP), which is nuclear fuel, is priced via the cost to enrich UF_6 to EUP. The cost to enrich is quoted in SWU. From the inferred UF_6 spot price and the SWU spot price it is possible to infer an EUP spot price.

Unfortunately, published U_3O_8 spot prices, which feed into the above pricing mechanisms are established using few public trades and considerable inference, in our view.

Uranium pricing behavior describes an amplified cobweb model.

Exhibit 1: **Uranium pricing mechanism**

Uranium	Units	Description
U_3O_8 price	$/lb	Spot price for yellow cake (refined uranium ore)
Convert to UF_6	$/KgU	Price to convert yellow cake to UF_6 - step in enrichment
UF_6 price	$/KgU	U308 spot price + conversion cost = UF_6 spot price
SWU price	$/SWU	'Separative Work Unit' – enrichment cost
EUP price	$/KgU	SWU + UF_6 price = Enriched Uranium Price = fuel price

Sources: ACF Equity Research, industry pricing platforms.

These characteristics make the market susceptible to marginal pricing, dumping and panic selling.

Unlike most commodities, uranium (U) is not traded on the open market, nor is it governed by the typical supply and demand pricing mechanism. The uranium market is comprised of a few key players, and there's no real single market price.

Illiquid market for uranium trading

The uranium market is highly illiquid since trades are few and often carried out in secrecy. Trade reporting is late and may in fact be largely inaccurate.

Trades in the market are commonly of three types - spot prices (buying on the day) mid-term contacts and long-term contracts that determine price, volume and production levels for a buyer and seller.

Market for uranium is not transparent

Uranium trades once or twice per day, which is in direct contrast to commodities like oil and gold, which trade several million times a day.

Because of its close ties to politics, buyers and sellers negotiate deals privately. This lack of transparency means that there is no global market price, instead prices are published by independent market consultants; UxC LLC (UxC) and TradeTech.

Spot price is the price for the immediate purchase of a pound of U_3O_8 or a kg of UF_6.

Prices in the uranium industry are not set in the same way as other commodities. Instead, TradeTech and UxC infer a spot price by analysing various uranium transactions from around the world and the general state of the global market.

UxC and TradeTech also publish longer-term prices.

As such, the spot price is very unlikely to be the price paid. The same is true to a lesser degree of mid and long-term contract rates.

Spot market is not a real market.

Industry standard uranium pricing may well be in large part informed by expert inference and judgement rather than records of trades.

The data for spot pricing appears to be a function of the spot prices of large volume trades made during the week, and as such it may not be possible to achieve a trade particularly close to the spot prices that are published on a daily, weekly or monthly basis.

Essentially, the published spot prices are formulated from a mixture of pricing sources and inferences. The constituents of the published spot prices are data related to completed transactions; transactions the market expects to complete; transactions that are as much a matter of expressed intent as they are real and; offers to borrow and lend.

Note that there are also a range of concentrates with their own spot pricing indicators and a range of 'for delivery date' prices within those concentrate prices.

First nuclear power station was turned on in 1960.

10% or 2,500 TWh p.a. of the world's electricity is produced from "burning" U_{235} and U_{238}.

In 1960 the total global electricity generation from all sources was 2,500 TWh p.a., the same as today's contribution from nuclear power.

Price trends for uranium are decoupled

In general, basic materials follow the pricing patterns of energy, the exception being precious metals such as Gold (Au), which have more complex demand drivers.

Mined commodities broadly follow the price of energy because energy is required as the key system input to change something dug out of the ground into something we want.

The dominant use of uranium is as an energy source in the production of heat to create steam to drive turbines to generate 10% of global electricity. Uranium's pricing should also therefore be reflected in the price of other hard commodities, but it is not.

The spot, mid and long-term uranium (U_3O_8) prices are decoupled from other markets. In our view, the UF_6 (conversion market) is a forward indicator for the milled and leached U_3O_8 market.

The UF_6 market forward indicator characteristic is further evidence of an extreme asymmetrical information flow and so a distorted or even dysfunctional pricing market.

Uranium pricing is cyclical over the long run

The majority of consumption (power stations) are far from the majority of production (mines). Consumption growth requires decades-long investment cycles whereas supply (uranium) is relatively volatile.

As a result of the above dynamics, uranium pricing is best described by an amplified cobweb model.

The cobweb model is used to describe cyclical markets. The uranium market is cyclical over the long run.

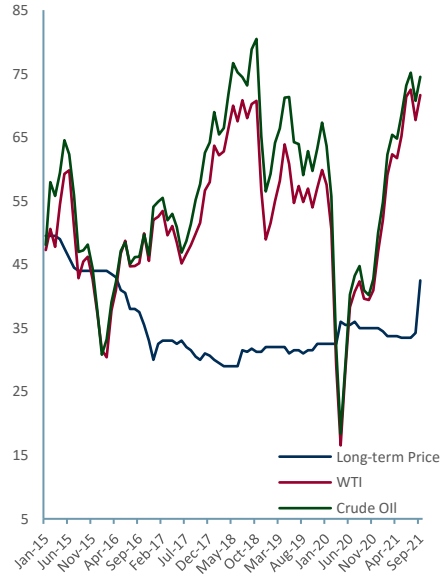
The uranium market exhibits lead times for demand for uranium that run into decades with high barriers to entry (approving, planning and building nuclear power stations).

Supply (mining and milling uranium ores), in contrast, is much more volatile.

Exhibit 2: Uranium spot prices vs. oil

Sources: TradeTech; UxC; EIA

Exhibit 3: Uranium long-term prices vs. oil



Sources: TradeTech; UxC; EIA

UxC and TradeTech also publish longer-term prices.

Exhibit 4: Top 10 uranium producers YE19A

Company	T/U	%	Exchange	Ticker	MCAP
Kazatomprom	12,229	22	LSE	KAP	3,064
Orano Group	5,809	11	Private	-	-
Cameco	4,754	9	TOR	CCO	5,050
Uranium One	4,624	8	Private	-	-
CNNC	3,961	7	Private		
CGN	3,871	7	Private	-	-
Navoi Mining	3,500	6	Private	-	-
BHP	3,364	6	LSE	BHP	37,924
ARMZ	2,904	5	Private	-	-
Energy Asia	2,122	4	Private	-	-
*General AQ	1,764	3	Private	-	-
Sopamin	1,032	2	Private	-	-
Rio Tinto	1,016	2	LSE	RIO.L	53,537
VostGok	801	1	Private	-	-
Other	3,001	5	-	-	-
Total	**54,752**	**100%**			

Source: World Nuclear Association
***General Atomics/Quasar**

80% of global uranium production was accounted for by the top 10 producers YE19A. 55% of uranium production was accounted for by the top 10 mines YE20A.

Producing Countries and Mines

Around 68% of all uranium mine production is from state-owned mining companies.

Australia holds around 32% of the global RAR uranium resource, according to the Minerals Council of Australia, making it number one globally. Kazakhstan, in contrast, holds 12% of the total currently identified global uranium resource, according to world-nuclear.org.

Kazakhstan is the largest uranium mine producer delivering 43% of global supply from its mines in YE19A, up from 41% in YE18A in our previous note.

Kazakhstan production is followed in a distant second place by Canada at 13% and Australia at 12% of global uranium production.

Exhibit 5: **Top 10 uranium producers by country (tonnes U)**

Country U/t	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Kazakhstan	14,020	17,803	19,451	21,317	22,451	23,127	23,607	24,586	23,321	21,705	22,808
Canada	10,173	9,783	9,145	8,999	9,331	9,134	13,325	14,039	13,116	7,001	6,938
Australia	7,982	5,900	5,983	6,991	6,350	5,001	5,654	6,315	5,882	6,517	6,613
Namibia	4,626	4,496	3,258	4,495	4,323	3,255	2,993	3,654	4,224	5,525	5,476
Uzbekistan (est.)	2,429	2,400	2,500	2,400	2,400	2,400	2,385	2,404	2,404	2,404	3,500
Niger	3,243	4,198	4,351	4,667	4,518	4,057	4,116	3,479	3,449	2,911	2,983
Russia	3,564	3,562	2,993	2,872	3,135	2,990	3,055	3,004	2,917	2,904	2,911
China (est.)	750	827	885	1,500	1,500	1,500	1,616	1,616	1,885	1,885	1,885
Ukraine (est.)	840	850	890	960	922	926	1,200	1,005	550	1,180	801
USA	1,453	1,660	1,537	1,596	1,792	1,919	1,256	1,125	940	582	67
Total (U/t)	49,080	51,479	50,993	55,797	56,722	54,309	59,207	61,227	58,688	52,614	53,982

Source: World Nuclear Association

Exhibit 6: **The largest producing uranium mines in YE19A.**

Mine	Country	Main owner	Type	Production (tonnes U)	% of world
Cigar Lake	Canada	Cameco/Orano	underground	6,924	13
Husab	Namibia	Swakop Uranium (CGN)	open pit	3,400	6
Olympic Dam	Australia	BHP Billiton	by-pro/Undg*	3,364	6
Moinjum & Tortkuduk	Kazakhstan	Orano/Kazatomprom	ISL	3,252	6
Inkai, sites 1-3	Kazakhstan	Kazaktomprom/Cameco	ISL	3,209	6
Budenovskoye 2	Kazakhstan	Uranium 1/Kazatomprom	ISL	2,600	5
Rössing	Namibia	Rio Tinto	open pit	2,076	4
SOMAIR	Niger	Orano	open pit	1,912	4
Central Mynkuduk	Kazakhstan	Kazatomprom	ISL	1,964	3
South Inkai (Block 4)	Kazakhstan	Uranium One/Kazatomprom	ISL	1,601	3
Top 10 total				**30,032**	**55%**

Source: World Nuclear Association
**by-product / underground*

Demand Drivers

Market dependency upon finite non-productive capacity.

Nuclear power demand

Uranium market demand is dominated by nuclear power stations requiring uranium rod bundles, which means there are in fact two markets – the U_3O_8 production market and the UF_6 (gaseous phase for enrichment) conversion market.

Demand for nuclear power in electricity generation is the biggest driver of global uranium demand. As countries around the world seek cleaner alternatives to fossil fuels, nuclear power use in electricity generation has regained traction.

We assume 443 nuclear power stations operate globally.

We assume 50 more are in construction.

Nuclear power stations currently account for 10% or 390 GW of global electricity generation. 10% of global electricity generation today is equivalent to nearly the entire global electricity production in 1960.

We assume 100 more are in the planning phase.

About 5.5 GW or new nuclear power came online since 1Q19A but this replaces the amount that was permanently taken off-line (IEA). However, in our view these statistics belie the true demand, which is masked by highly extended planning cycles.

Nuclear electricity generation was down around 2.5% in 2020 vs. 2019, according to the IEA and at the date or our last analysis. The IEA attributes the reduction to lower electricity demand during the Covid pandemic.

Zero emissions electricity.

Climate change policy makers support nuclear energy as an alternative to fossil fuels.

Underlying demand is rising – completion pricing is above production costs for the first time in 10-11 years.

We have assumed that there are 450 nuclear power reactors in operation, based upon IAEA data and a further 55 in the build phase and we assume there are another 109 reactors in the planning phase.

Together, the nuclear reactor build, and planning phases represent around an additional 180 GW of nuclear power generation. We assume around a further 330 nuclear power reactors are at the proposal stage.

We have also assumed that electricity demand growth is underpinned by population growth, emission free electricity, and green and strategic energy government policy. These factors have brought nuclear power back into vogue after Three Mile Island.

The readvancement of nuclear power after Three Mile Island faced setbacks after Chernobyl and Fukushima, each of which halted nuclear power generation's progression for long periods.

Environmental factors

As more countries are implementing emission reducing policies, companies are turning to nuclear power as a greener or zero emissions electricity alternative to burning fossil fuels. We expect nuclear energy to provide a 40-year role in cutting emissions.

Macroeconomic factors

The demand for uranium grows in direct proportion with global economic growth. As economies become more reliant on nuclear electricity to power their growth, the demand for uranium will continue to rise.

Supply Drivers

Uranium prices are under pressure due to over-supply in the short run.

Global supply sources
Relative to demand (building new nuclear power stations), supply (uranium mining) is highly volatile and is subject to non-commercial decisions from panic sellers and state-controlled enterprises.

Lack of discipline in production from state backed entities, distressed selling and opaque inventories held by utility companies.

Marginal pricing (the ability to price to every customer individually) is possible due to the illiquidity and opaqueness of the market and because a small number of producers in the industry can exert a significant influence on global supply and thus prices.

In addition, the top three producing countries - Kazakhstan, Canada and Australia – provide about two-thirds of global annual supply of uranium. Therefore, events in these countries can have market moving effects.

Complacency about long-run future supply driven by untested, unproven, unlicensed and unpermitted new production claims.

Kazakhstan dominates supply from a country perspective and the US dominates consumption – they are geographically and politically far apart. Note that we expect China and India to dominate consumption in the long term.

Global inventories

Production has reduced though the closing of mines and processing mills.

Many utilities hold unknown or unknowable inventories creating an unknown level of supply overhang in the market, leading to pricing uncertainty due to asymmetric information – i.e. the utilities (buyers) know far more about the total global supply than the producers (sellers)

Capital investment has been cut and new projects have come offline.

Many producers hold inventories of uranium to buffer against the effect of lower prices. However, holding a buffer has the opposite effect of that which is intended.

Holding a buffer, signals that uranium supply is ubiquitous and causes prices to fall, much like the effect of warrants or options issued by a company.

Warrants create a stock overhang causing a fall in the company share price because of the anticipated dilution when the warrants are converted to new shares. Similarly, once dug out of the ground the market expects the uranium to come into play at some point.

However, the underlying demand cycle is in an upturn as evidenced by conversion pricing.

Closing mines and milling facilities does act as a signal to the market that supply is dropping. However, due to illiquidity, lack of transparency, panic sales and uncommercial selling by state-controlled entities below the cost of production, closing mines and facilities does not guarantee that prices in the uranium market will rise.

Uranium Price Squeeze Characteristics

Post-pandemic, uranium prices have begun to regain momentum, however this was not due to a surge in demand. As a result of Covid-19 lockdown restrictions, mines closed unexpectedly (which is different to planned closures due to lower prices) resulting in a squeeze on the supply of uranium.

Because of the opacity of the uranium trading mechanism the market is constantly vulnerable to stock overhangs and squeezes. Below we describe the current squeeze, its mechanism and potential longer-term implications.

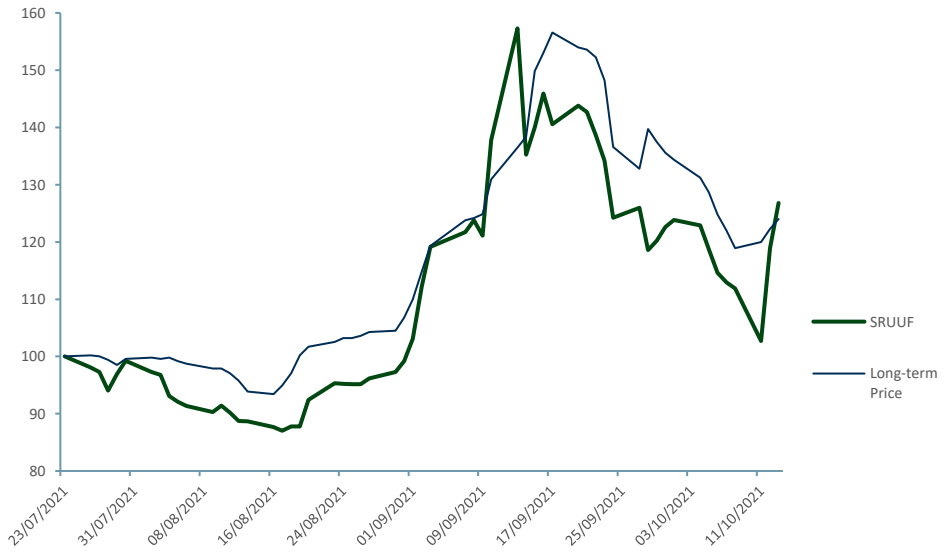
The current squeeze suggests a supply-demand imbalance of ~50m lbs. Prices are expected to increase to $60/lb up from ~$40/lb.

As of 30 Sep 2021, the long-term price of uranium had increased more than 25%, up to $42.5/lb from $33.6/lb on 26 Aug 2021.

The spot price 30 Sep 2021 was $42.6/lb. This is on the back of Sprott Physical Uranium Trust Fund's (OTCPK : SRUUF) accumulation of the metal in order to boost prices.

Our research suggests that trades have occurred at prices in the range of $50/lb during September and that buyers and sellers by the end of Sep 2021 were accepting bargains in the $44/lb range.

Exhibit 7: **Price rel SRUUF share price vs. U_3O_8 long term prices**



Sources: ACF Equity Research; Refinitiv; Trading Economics; Markets Insider

On 31 Aug 2021, Sprott Physical Uranium Trust Fund (SRUUF, U-UN.TO), a 'revised' uranium trading vehicle was launched to purchase and store physical uranium.

Since the launch of the SRUUF trust fund, and in less than two weeks it acquired 14m lbs of uranium – the annual demand is 180m lbs. Another way of visualising SRUUF's buying behaviour is as an annual run rate of ~364m lbs, or over 100% of the current annual global demand.

Utility companies don't want another squeeze where prices rose to $140/lb up from $8/lb in 2007 when China initiated its nuclear reactor construction programme.

Utility companies need uranium, but utility companies also stockpile uranium and they have the most knowledge about the true supply and demand schedule.

It is possible that utility companies or government-controlled uranium producers could flood the market with uranium to put a stop to SRUUF's current behaviour. If this happens, it will cause further market volatility and no doubt dissuade many investors from investing in uranium proxies.

Speculators suggest that the SRUUF is playing a long game. Currently it only trades in Canada, but the expectation is that it will list on a main index in the US in 1Q22E.

The squeeze also comes at a time when the US is essentially uncovered for uranium mining post 2024. In 2019 the US only produced 0.3% (173,875 lbs) of uranium fuel requirements for its nuclear power plants. This was 88% lower than 2018's production levels.

In 2020 US nuclear power reactors bought around 49m lbs of uranium, of which approximately 98% was bought from outside the US (EIA, 2021).

US domestic uranium concentrate (UO_2) supply has fallen from around 44m lbs in 1980 to 0.17m lbs in 2020 (EIA, 2021).

There is little doubt that nuclear power is a transition technology in the global economy's search for alternatives to fossil fuel power generation. In our view, uranium is likely to be seen as an alternative 'green' fuel for another four decades.

Even though the market for uranium remains opaque and so inefficient and the general public remain wary of the risks associated with the catastrophic failure of large scale nuclear power plants, uranium is a commodity market that is here to stay for the foreseeable future. With increased demand and supply the market may even become more efficient.

For now at least, the demand drivers for uranium only point to higher prices over the mid-term.

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