

NUCLEAR INTELLIGENCE WEEKLY[®]

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Market Points

Ukrainian leadership may be putting pressure on the US to sanction Russia's nuclear fuel trade, but US Democrats in Congress are resisting a \$1.5 billion request to create a domestic nuclear fuel reserve.

Wider-economic signals pressured the price lower again this week, with Energy Intelligence's Uranium Price Panel delivering an average spot price of \$49.82 per pound on Sep. 22, down from \$50.03/lb. on Sep. 15.

GoviEx says its Madaouela project in Niger could produce 51 million lbs. U3O8 over 19 years, with \$343 million in initial capital expenditures and operating costs estimated at \$31/lb. U3O8.

UPP: \$49.82/LB U3O8



WEEKLY ROUNDUP

More Shelling as Support Grows for a ZNPP Security Zone

- Even with “detailed talks” underway aimed at establishing a nuclear safety and security zone around Ukraine’s Zaporizhzhia nuclear power plant (ZNPP), there was more shelling this week at the plant — and a near-miss at the South Ukraine nuclear power plant. The idea of a safety zone around Zaporizhzhia gained momentum with high-level talks Sep. 22 in New York convened by French President Emmanuel Macron. This was bolstered by a statement from nine countries after the meeting supporting a continued International Atomic Energy Agency (IAEA) presence at the plant, the IAEA’s seven nuclear safety and security pillars outlined earlier in the conflict, and the establishment of a zone. While in New York, IAEA Director General Rafael Grossi, who co-chaired the meeting with Macron, also met separately with the Russian and Ukrainian foreign ministers, Sergei Lavrov and Dmytro Kuleba, as part of an effort to reach an agreement soon on establishing the proposed zone. On Sep. 19 Ukraine said that an explosion had occurred that morning “around 300 meters” from the South Ukraine NPP, impacting three power lines and damaging windows, according to an IAEA statement. Renewed shelling at ZNPP Sep. 21 damaged electrical cables and temporarily forced one of the six reactor units to rely on emergency diesel generators, the IAEA reported.
- Japan’s outgoing Nuclear Regulation Authority (NRA) Chairman Toyoshi Fuketa warned Sep. 21 that “the nuclear safety myth” that accidents cannot happen could revive if post-Fukushima safety standards are softened. Fuketa will be replaced Sep. 26 by NRA Commissioner Shinsuke Yamanaka, a professor of nuclear engineering and ex-Osaka University vice president, who joined the NRA in September 2017 and is seen as more nuclear-friendly than his predecessor. Fuketa is the last of the original NRA commissioners appointed when the NRA was set up in the wake of the March 2011 Fukushima Daiichi disaster. The handover follows conservative Prime Minister Fumio Kishida’s announced drive to step up restarts of reactors idled by the triple meltdown. During his retirement news conference, Fuketa said he approached each restart application from the standpoint that “nuclear accidents can happen again” and advised his successor to “decide based on your convictions without fear of flipping over the table even at the final stage.”
- South Korea on Sep. 20 officially incorporated nuclear energy into its green taxonomy, despite opposition from environmental groups. The “K-taxonomy” of sustainable investments was first introduced late last year by the previous Moon Jae-in government, excluding nuclear. But the May inauguration of pro-nuclear President Yoon Suk-yeol came with an aggressive promise to achieve by 2030 a 30% share for domestic nuclear output and 10 reactor exports — and the nuclear exclusion was reversed. Meanwhile, in the EU, Greenpeace has formally requested the EU Commission conduct an internal review of the inclusion of nuclear and gas in its taxonomy, saying in a Sep. 19 statement the “European Parliament failed to object in a vote in July, despite widespread opposition from EU citizens, climate scientists, financial institutions and environmental organizations.” The EU Commission has until February to review the request and reply.

NUCLEAR FUEL MARKET

Price Stagnates on Lack of Regulatory Clarity

The uranium spot market is struggling to recover from wider market-related losses, even following Duke Energy's large request for quotations (RFQs), other prospective RFQs and the possibility that Ukrainian leadership is pressuring the US to sanction Russia's nuclear fuel trade.

The market slipped again this week with Energy Intelligence's Uranium Price Panel delivering an average spot price of \$49.82/lb. on Sep. 22, down from \$50.03/lb. on Sep. 15.

Ukrainian Energy Minister German Galushchenko this week withdrew a statement saying he had "discussed the possibility of sanctions on Russia's nuclear power supplier Rosatom with U.S. Energy Secretary Jennifer Granholm," Reuters reported on Sep. 22. The Energy Ministry did not explain why the statement was withdrawn, but the sentiment echoes a comment by Ukrainian President Volodymyr Zelensky in a Aug. 29 speech to the 2022 Offshore Northern Seas Conference: "It is not normal when there are still no blocking sanctions against Rosatom for radiation blackmail at the Zaporizhzhia [nuclear power plant], for which specific Rosatom employees at the plant are also responsible."

It's unclear whether the US would or could impose sanctions on Rosatom. One major complication involves Rosatom's role as the world's largest and, in some cases, sole supplier of medical isotopes, which are used in a number of life-saving medical procedures and tests. The Euratom Supply Agency has been working to advocate for the preservation of medical isotope supply chains, including prescriptive language in any proposed sanctions to protect medical isotope deliveries.

An outright ban on nuclear fuel supplies from Russia, depending on the timing, could limit fuel supply security at a number of nuclear power plants, in the US and Europe, for at least a few years. Currently, Russia supplies roughly 20% of US nuclear fuel demand and nearly 30% in Europe. The only two western enrichers, Urenco and Orano told Energy Intelligence they don't reasonably foresee being able to add capacity until 2027 at the earliest, limiting their ability to replace Russian supply until then. Urenco

and Orano's joint-venture gas centrifuge manufacturing company Enrichment Technology Co. has been operating at reduced levels after years of a moribund enrichment market.

Energy Intelligence understands that the US Department of Energy's (DOE) Office of Nuclear Energy has been coordinating with the agency's quasi-independent National Nuclear Security Administration to incentivize new domestic nuclear fuel capacity by restarting a procurement program to help the US fleet and potentially operators in allied nations divert from Russian supply.

But the agency's recent request for \$1.5 billion to begin procuring nuclear fuel for existing reactors and high-assay low-enriched uranium (Haleu) for advanced reactors has met with resistance from Congressional Democrats in both House and Senate appropriations committees over the high price tag, according to a Sep. 15 report from Bloomberg. The request was included in the White House's proposed continuing resolution — to keep the government operating beyond Sep. 30 — and is understood by Energy Intelligence to be part of a larger unofficial request for \$5.2 billion over ten years to revive the American Assured Fuel Supply program.

In the first step to revitalize the program, DOE has already been allocated \$500 million for Haleu production, a solicitation for which is expected soon. Urenco, with its enrichment plant in New Mexico, has said it is ready to respond to the request. And Orano USA this week appointed Casey Bough as vice president of business development in Bethesda, Maryland, outside of Washington, DC, to leverage Orano's conversion and enrichment capabilities in support of US development of the advanced reactor fuel supply chain.

Meanwhile, in Niger, GoviEx released the results of its feasibility study for the Madaouela project suggesting production of 51 million lbs. U3O8 total over 19 years, with initial capital expenditures of \$343 million and operating costs estimated at \$31/lb., up from \$29/lb. in the pre-feasibility study. Energy Intelligence understands the junior is in talks with utilities for long-term offtakes.

Jessica Sondgeroth, Washington

URANIUM PRICE PANEL

For the week ended September 22, 2022

| | Weekly Spot Market Prices | | | | | | | | | | | | | |
|--------------------|---------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| | Chg. | Sep | | | | Aug | | | | Jul | | | | June |
| | | 22 | 15 | 8 | 1 | 25 | 18 | 11 | 4 | 28 | 21 | 14 | 7 | 30 |
| Price (\$/lb U3O8) | -0.21 | 49.82 | 50.03 | 51.83 | 52.50 | 48.38 | 47.75 | 47.63 | 47.84 | 48.85 | 46.03 | 46.04 | 47.53 | 50.00 |
| Total Assessments | 0.00 | 10.00 | 10.00 | 8.00 | 8.00 | 9.00 | 10.00 | 9.00 | 8.00 | 9.00 | 10.00 | 9.00 | 10.00 | 10.00 |
| % within 1 StDev | -10.00 | 60.00 | 70.00 | 75.00 | 62.50 | 77.78 | 80.00 | 77.78 | 75.00 | 55.56 | 80.00 | 55.56 | 70.00 | 60.00 |
| Low (\$/lb U3O8) | 0.00 | 49.00 | 49.00 | 51.25 | 52.00 | 48.00 | 47.50 | 47.25 | 47.50 | 48.50 | 45.75 | 45.50 | 47.00 | 49.25 |
| High (\$/lb U3O8) | 0.00 | 51.00 | 51.00 | 52.00 | 53.50 | 49.00 | 48.25 | 48.00 | 48.25 | 49.25 | 46.25 | 46.75 | 48.50 | 50.75 |
| Variability* | 0.62 | 1.00 | 0.38 | 0.19 | 0.39 | 0.38 | 0.25 | 0.04 | 0.00 | 0.00 | 0.00 | 0.31 | 0.50 | 0.16 |

*This represents the value of the potential range of conceivable final averages that might result when random elimination is used to balance market positions within the panel.

CHINA

Accelerating Newbuild to Meet Security, Climate Goals

China is visibly accelerating its nuclear power program as the threat to energy security intensifies amid persistently high fuel prices and increasingly frequent power crunches precipitated by extreme weather. This acceleration could see China become the world's leading nuclear power producer as early as 2030 — a feat requiring it to roughly double its currently installed capacity.

The urgency to move forward with its nuclear newbuild approval process parallels efforts elsewhere to either build new nuclear or extend the lifetimes of existing reactors as power producers grapple with power shortages from heat waves and other extreme weather events. But the extent to which China delivers on nuclear depends on both accelerated newbuild approvals and timely construction starts. So far this year, China has seen construction starts on four reactors, a pace which while impressive needs to be increased in order to achieve 100 gigawatts of capacity by the end of the decade, according to Francois Morin, China Director of the World Nuclear Association (WNA).

Beijing has called for “proactive and orderly” development of nuclear power — targeting a total installed capacity of 70 GW by end-2025 — as part of its effort to peak carbon emissions by 2030. As of July, the country's installed nuclear capacity was 56 gigawatts — roughly parallel to France's fleet, half of which is struggling to come back online — and it looks set to fall short of its 2025 target. However newbuild approvals are clearly accelerating after slowing to a halt in the years following the 2011 Fukushima disaster.

Chinese Premier Li Keqiang presided over a Sep. 13 State Council session during which four nuclear newbuilds were green-lighted; this followed the Apr. 20 approvals for six newbuilds. This brings the tally of newbuild approvals to 10 so far this year — the most in a single year in 14 years. China's pace of newbuild approvals last peaked in 2008, when a record 14 reactors were approved. After Fukushima Beijing suspended approvals in 2011, 2013–14 and 2016–18. For the years 2012, 2015 and 2019–21, the number of newbuilds greenlighted each year ranged from two in 2012 to eight in 2015.

The latest round of approvals followed an unusually dry spell which resulted in a 50% plunge in hydro availability in China's top hydro province Sichuan, which produces nearly 30% of China's hydroelectricity and exports a third of its output to other parts of the country. This coincided with record-breaking summer temperatures which caused air-conditioning demand to spike. The ensuing power crisis forced local authorities to impose an 11-day power rationing, during which many energy-intensive industrial users were ordered to halt production so that electricity could be diverted to residential users.

For several years nuclear authorities in China have publicly said the country needs to achieve a construction rate of six reactors annually until 2030 and ratchet up to eight per year after 2030 in order to attain energy security and decarbonization goals, observes the WNA's Morin. He believes two further first concrete pour dates (FCDs) are possible this year in addition to the four FCDs achieved so far at Sanmen-3, Xudapu-4, Haiyang-3 and Lufeng-5. He mentioned as possibilities Sanmen-4 and Haiyang-4 but also didn't rule out Zhangzhou-3 or Lianjiang-1.

If China can attain a rate of six to eight FCDs a year, this would take its installed nuclear capacity to around 100–110 GW in 2030 and 130 GW in 2035, “which is reasonable,” says Morin, and that would make China the world's top nuclear power producer.

China is also looking to increase the use of nuclear energy for winter district heating in its northern regions under Beijing's push for “clean heating.” In its latest five-year energy plan for 2021–25, Beijing has set targets of sourcing 20% of total primary energy needs by end-2025 from “non-fossil sources,” which include nuclear. As China's hydro sector matures and stagnates — not helped by increasing frequency of droughts due to climate change — Beijing would need to increase reliance on other “non-fossil” energy sources like solar, wind and nuclear to deliver on its climate promises.

Latest Approvals

The Sep. 13 newbuild approvals were for China National Nuclear Corp's (CNNC's) Zhangzhou-3 and -4, which are planned twin Hualong-One reactors in Fujian, as well as for State Power Investment Corp's (SPIC's) twin CAP1000 reactors Lianjiang-1 and -2 in Guangdong. These followed six newbuilds approved earlier on Apr. 20 — for CNNC's Sanmen-3 and -4 in Zhejiang and SPIC's Haiyang-3 and -4 in Shandong, as well as for China General Nuclear's (CGN's) twin Hualong-One reactors Lufeng-5 and -6 in Guangdong.

CNNC's Zhangzhou-3 and -4 are each designed as 1.2 GW Hualong-Ones. Unit 3's planned FCD is on Jun. 30, 2023. The company is targeting a construction period of 58 months, with commercial operations planned in April 2028, according to the project's environmental impact study. Unit 4 is scheduled for FCD 10 months after Unit 3, targeting commercial operations in February 2029.

The full Zhangzhou project was originally proposed as a 6-unit nuclear station with all reactors planned as AP1000s. But in 2016, CNNC applied to change the technology to Hualong-Ones and received approval in 2018 to do so for the first four reactors under the first phase. CNNC didn't provide an updated status report for Zhangzhou-1 and -2, which have been respectively under construction since 2019 and 2020. Neither did the company mention its plans for Zhangzhou-5 and -6.

Lianjiang and Shidao Bay

The first two Lianjiang units that received approval on Sep. 13 are to be 1.25 GW CAP1000s. Unit 1's FCD is planned for Jun. 30, 2023, said Lin Tian, director of planning and development at the Shanghai Nuclear Engineering Research and Design Institute (Snerdi), who spoke at an IFNEC (International Framework for Nuclear Energy Cooperation) webinar on Sep. 15. SPIC is targeting a 56-month construction period each for Lianjiang-1 and -2, with their FCDs to be spaced 10 months apart.

The full Lianjiang project is planned for six reactors and for subsequent Lianjiang units "maybe CAP1400 will be an option," said Tian.

SPIC is now building the first-of-a-kind CAP1400 twin reactors at Shidao Bay in Shandong province. First safety concrete for Unit 1 was poured in early 2019. According to the State Nuclear Power Demonstration Plant (SNPDP) website, Shidao Bay CAP1400 Unit 1 is targeted for completion in end-December 2023.

"At the end of this year (2022), we will come to the point of hydraulic test. We hope at the end of next year CAP1400 will come to commission," said Tian. The second CAP1400 reactor is scheduled for completion in end-June 2024.

Kim Feng Wong, Singapore

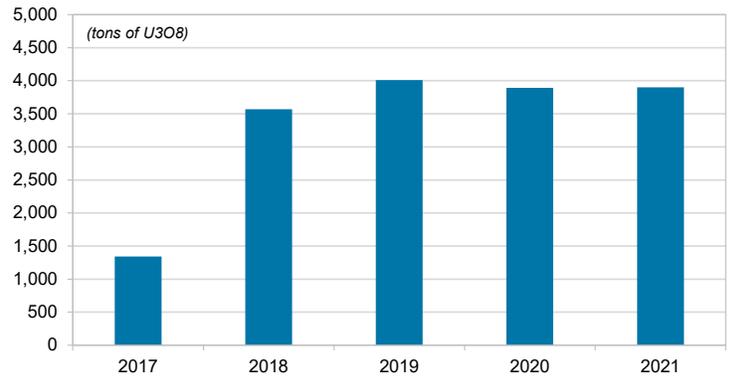
NAMIBIA

CGN's Husab Mine Misses Targets, Blames Water Supply

China General Nuclear (CGN) subsidiary Swakop Uranium revealed that "milling and processing operations" at its enormous Husab uranium mine in Namibia "continued to be hampered by the inconsistent supply of water," underlying its call for a second water desalination plant to compete with Orano Mining's Erango plant. If sustained, Husab's production woes could mean that China has to find new sources of uranium to meet its growing nuclear fleet requirements.

Mining is a water-intensive business and in the Namib desert that makes it an extra costly one. France's Orano owns the desalination plant responsible for supplying Husab and the nearby Rossing mine, owned by state-owned China National Nuclear Corp. (CNNC) subsidiary China National Uranium Corp. Orano's desalination plant was built in 2010 at a cost of \$2.5 billion Namibian dollars (US\$140 million) to supply Orano's mothballed Trekkopje mine, which never entered production. Even with recent upgrades to the desalination plant, Swakop claims its capacity is insufficient to meet Husab's requirements and those of the region. Swakop says Husab alone uses about 70% of the freshwater supplied by Orano's

HUSAB U3O8 PRODUCTION



Source: Swakop Uranium Sustainability Reports

plant. But Husab is also struggling against high operating costs and reducing the cost of water might be one way to improve the mine's economics.

For its part, the Namibian government, through state-owned water utility NamWater, is currently in the process of procuring a public-private partnership to help construct a second desalination plant on the Namibian coast and press reports indicate at least four mining companies are involved in negotiations. Currently, NamWater contracts Orano's Erango desalination plant to support fresh water supply to coastal communities and mines. According to Swakop, the "capacity of the desalination plant" is insufficient to meet the "full needs of all water users in the region, and is often faced with maintenance-related issues" attributed to occasionally high sulfur levels in the seawater that force the plant to shut down or risk damage. Swakop estimates that by 2025 water supplied from this plant will be in a deficit of about 20 million cubic meters.

But for Husab, sources say the issue may be less about the desalination plant's capacity — which they say Orano can readily increase — and more about prices, as Orano-supplied freshwater is frequently characterized as "expensive." Bannerman Resources estimated in its August 2021 pre-feasibility study for its Etango project, southwest of Husab and Rossing, that it would pay a water tariff of US\$3.5 per cubic meter based on discussions with NamWater and including the estimated cost of desalination. Sources have suggested that Orano's costs are about half its prices.

Orano, meanwhile, has increased capacity at the desalination plant, setting "a new record by producing 12.7 million cubic meters of fresh water" in 2021, according to an Aug. 14 post from the Namibian Chamber of Mines. Prior to 2021, the plant produced an average of 8.8 million cubic meters annually since 2013, Energy Intelligence estimates. Orano said it has been "gradually upgrading the reverse osmosis system's capacity" to more than 2,000 cubic meters per hour. And Orano expects to source an additional 5 megawatts of power from a new solar plant to be completed by InnoSun Energy Holdings at the end of 2023.

Husab's milled tons for 2021 fell 8% below target, according to Swakop's latest sustainability report, "and as a result, saleable U₃O₈ production was 11% below budget" at 3,902 tons U₃O₈ (8.6 million lbs. U₃O₈). Swakop says over the past five years the water issue has contributed to an average production loss of around 400 tons of U₃O₈ per year. Swakop reported a loss of \$3.14 billion Namibian dollars, up by 33% from its 2020 loss, and operating costs appear to be near \$55/per pound U₃O₈. But Swakop's struggles to achieve breakeven costs aren't just about water supply. The miner also cites the impact of the Covid-19 pandemic on staff and supplies, not to mention production system challenges involving conveyors, power and pumping control system faults, and "equipment failures resulting in low throughput rate and runtime."

So long as Husab continues to struggle with production and operating costs, CGN's parent and sister companies may find it more economical to buy uranium elsewhere — beyond Kazakhstan and Uzbekistan — to meet the growing Chinese fleet's requirements. But CGN also has a huge uranium inventory, so Husab would have to continue to miss its production targets, at high operating costs, for a bit longer to really impact uranium market prices and China's buying decisions, one source told Energy Intelligence.

Rossing Increases Output

Just a few dozen kilometers away, CNNC's Rossing mine has been able to increase output, producing 2,882 tons of U₃O₈, up by nearly 400 tons from 2020 production, according to its latest sustainability report. To deal with water supply issues, Rossing relies on reservoirs and more recently, newly built water storage capacity.

Three NamWater reservoirs supply fresh water to the Rossing mine and the nearby town of Arandis, providing "buffer capacity when there are sulphur sea outbreaks in the ocean and the Orano desalination plant is unable to operate," Rossing said. But that doesn't mean Rossing isn't still vulnerable. When NamWater is unable to supply fresh water and when reservoir levels drop, "buffer capacity is reserved for Arandis" and Rossing "has to cease operations, until such time that reservoir levels have recovered sufficiently to safely resume operations."

Because of this, Rossing in 2021 also added its own water storage capacity to minimize "production outages because of the unavailability of fresh water." Today Rossing has 60,000 cubic meters of storage capacity in three water tanks that have already "supplied the mine with fresh water during a planned plant shutdown at the desalination plant when NamWater water supply to the mine was interrupted."

Mining Juniors

Mining juniors with assets in Namibia have also begun securing water rights with NamWater. Paladin Energy announced in July plans to restart its mothballed Langer Heinrich mine with first production by March 2024. This was followed by an Aug. 26 annual report to shareholders that it has "entered into a contract with

NamWater" to access water via pipeline connection, which was funded by Langer Heinrich but remains under NamWater's ownership. The total cost to restart Langer Heinrich increased to US\$118 million from US\$87 million driven primarily "by recent inflationary pressures across the project supply chain, brought forward power and water infrastructure works and increased owners team costs," according to the company's latest guidance.

Other mining juniors in Namibia have not yet announced timelines for developing their greenfield operations, which can stretch out years longer to first production than a mothballed site like Langer Heinrich.

Deep Yellow, which is pushing forward with its Tumas project in Namibia, reiterated in a February 2022 announcement the findings of its 2021 pre-feasibility study "that water supply" will "be sourced from a combination of available local groundwater and water supplied by" NamWater. However, Deep Yellow said it is also exploring a "strategy to reduce the supply cost." It also plans to use water storage tanks and a process plant to minimize demand "for high-quality and expensive desalinated water from NamWater." And Bannerman Resources plans to source desalinated water from NamWater using a planned pipeline and pumping system from NamWater's base reservoir in Swakopmund, the mining junior said in an August 2020 presentation.

Jessica Sondgeroth, Washington

INTERVIEW

Orano's Peythieu on Navigating Market in 'Fog of War'

The drive to replace Russian-supplied front-end nuclear fuel products in the wake of the Ukraine war has prompted speculation about possible enrichment and conversion capacity expansions in Europe and the US. France's Orano is a key producer in both spheres, and pre-war had already invested considerably in new facilities: the Georges Besse II (GBII) enrichment plant in Pierrelatte, France, and the Comurhex II conversion complex split between the Malvesi UF₄ plant, in southwest France, and the Philippe Coste UF₆ plant, also in Pierrelatte. At the recent World Nuclear Association general symposium Energy Intelligence's Phil Chaffee talked with Jacques Peythieu, who heads Orano's conversion and enrichment business unit, about Orano's market views.

Q: Since Russia's invasion of Ukraine in February we've seen huge changes in the uranium conversion and enrichment markets, prompting many market players to express supply concerns. Is this situation temporary? Where do you see the market going from here?

A: We are still in the fog of war. We don't know whether there will be an embargo from Russia similar to what they've done for

gas. The other question mark is [Western] state policies. There are strong statements, both from the US and the European Union, saying that we need to reduce dependency on Russia. In the US they already have an EUP [enriched uranium product] quota that maybe they will reinforce, but we have not seen any decision. And in Europe its also unclear. So for utilities there's not much visibility.

But what is more definitive is that there is a change of mind in at least some of the utilities, maybe not all of them. Some utilities clearly now understand that price is not the only factor in selecting a supplier, but there's also security of supply.

Q: Are you seeing this shift in concrete contractual terms?

A: I won't give any details but what's clear is that there is momentum from some of the utilities. Maybe because their share of Russian imports is quite large, or because they were not completely covered, or they want to build additional inventories to have a backup. I think it's true for Orano and for our competitors. There is also the reaction of the utilities to use all the [contractual volume] flexibilities.

Q: Specifically in Eastern Europe, we've seen multiple operators be very public about wanting to shift away from Rosatom subsidiary Tvel for their VVER fuel supply. Are you seeing evidence that these operators are also shifting away from Rosatom for the underlying EUP in that fuel? Is that a market a potential prospect for you?

A: Yes. For sure. Maybe it will be more gradual.

Q: In terms additional capacity, you're obviously still ramping Comurhex II, but that should be done by 2024, and I think GBII is at capacity. These were massive investments for Orano and for its predecessor Areva. What would it take for you to decide you need more capacity in either conversion or enrichment than you've brought on?

A: For us there are different considerations for conversion and enrichment.

For conversion we have big facilities, and we have done our part of the job to secure the industry. We have the newest facility. So for us the priority is not to expand capacity, it is to achieve the ramp-up of our conversion facility. And for the time being, we don't have strong signals from the customer for conversion, which is a surprise. But that's the case. They are more worried about enrichment than conversion.

For enrichment we are a smaller producer, and it's true that there is the momentum we discussed. We can envision extending capacities, but it will be subject to long-term customer commitments. Because for us to get the investment approved by our board, we must have a normal return on investment. We are ready to investigate the expansion of capacity, but we need commercial support from our customers. And I think what is important for

customers is clear visibility from governments about what they want to do about the level of Russian supplies.

Q: So any future sanctions against Rosatom might very quickly ramp up customer commitments?

A: Yes. As mentioned, the conversion market is very tight. Due to our transition from Comurhex I to Philippe Coste, and the fact that ConverDyn [marketer of output from the US Metropolis UF6 plant, which] was suspended, I'm not sure that there are enough inventories in the market for utilities too reliant on Russian supplies.

Q: Although it sounds like enrichment is where you're open to building new capacities. In terms of that, what would it take to add enrichment capacity? Assuming you got firm customer commitments, built out an order book for additional enrichment capacity, and your board approved additional investment, what would the lag be between that decision and bringing on the new capacity? Because you have to put in an order at ETC [the centrifuge-manufacturing joint-venture with Urenco], and ETC has not been producing centrifuges for several years. Are we talking two or three years? How long would it take to really get that new capacity in place?

A: We are working with our partner Urenco to help ETC to ramp up...

Q: Already you're doing this?

A: To prepare — just in case there are some decisions to add capacities. And after, as far as we are concerned, there will be a regulatory process, and we think that we can have additional capacities by the end of the decade. It will take five or six years to build.

Q: Quite a while.

A: That's why we need to rely on inventories and existing production for the years to come.

Q: I know Urenco was underfeeding [UF6 into the centrifuges] at its enrichment facilities. Were you also doing a lot of underfeeding at GBII, and is that done now? Are you switching to overfeeding?

A: No, we cannot switch so easily. And I think it's the same for Urenco. Because the conversion market is so tight, there is not enough physical UF6 to do overfeeding today. So for me switching from underfeeding to overfeeding is more for the second part of the decade than the first part of the decade.

Q: On that issue of UF6, I've been talking to market sources this week and I've heard that as you've ramped it there have been quality issues with some of the output at Philippe Coste, and getting it qualified at Urenco. True?

A: No. There have been no quality issues. Our UF6 was qualified by Urenco, and we have already sent UF6 to Urenco facilities and I guess they have processed it. For us there is no quality issue.

Q: Not even a year ago?

A: No.

Q: Given how low your production was, my understanding is that you've been borrowing material to supply customer contracts. As Philippe Coste reaches nameplate production capacity of 15,000 tons UF6, is a lot of that output not actually going to customers, but simply going to repay loans of UF6?

A: We're not giving any details on this. But you are right: if there are loans, you have to reimburse the loans.

Q: Moving into enrichment, you're obviously not talking about new capacity in the short term. But next year you are talking about producing low-enriched uranium up to 6% U-235. Who is the final customer for that higher-enriched LEU?

A: Today, clearly, the momentum is coming from the US. We'll be ready to supply uranium of higher enrichment maybe by the end of 2023, or 2024, if there is the commercial demand.

Q: Why do you think the commercial demand is coming from US utilities and not operators in Europe or Asia?

A: I think that in terms of increased burnup it was always the US that took the lead. And European utilities are waiting for the lessons-learned coming from the US.

Q: We're certainly seeing momentum on even greater enrichment levels, for High-Assay LEU (Haleu), up to 20% U-235. Do you think US enrichers will own this market? I know you've expressed willingness to supply Haleu in France, but given that the US government is talking about spending massive amounts of money on securing domestic Haleu production, will the Haleu market naturally be an American one?

A: For the time being, you are right. It's more driven by the US, and we welcome the DOE [US Department of Energy] initiative to allocate a significant budget to develop a supply chain solution.

When you mention Haleu, people think about enrichment. But in our view the deconversion is maybe more tricky...

Q: For the deconversion of the Haleu product?

A: Right. Because you have deconversion in oxide, but you have also deconversion in metal. For example, the TerraPower initiative is with a metallic fuel. And I don't know a lot of companies able to produce metal from UF6. We are one of them, but there are not so many. And so we give an alert: Haleu is not only an issue of enrichment, but it's also an issue of deconversion.

Q: I'd also like to talk about depleted uranium. Historically Orano sent depleted uranium to Russia for re-enrichment. Has this continued?

A: That was 20 years ago. We have not recently sent depleted uranium to Russia. We deconvert our depleted uranium into a stable U3O8 form, and we are waiting for a better time to re-enrich it. But today, with the price of enrichment and the price of uranium, it's not very competitive to re-enrich depleted uranium.

Q: Meanwhile EDF has an arrangement with Rosatom for processing reprocessed uranium (RepU) from Orano's back-end recycling plant at La Hague into EUP for commercial use in EDF reactors. I think that this arrangement continues, but obviously geopolitics may change things. Have you seen any interest in France for a non-Russian source of usable commercial RepU?

A: We have the technical capabilities to do it. We did it in the past. These facilities do not currently exist; we'll have to build new facilities to convert RepU into UF6. We are fully supportive of a European supply chain to do that. But EDF, which is the owner of the RepU, will be the one who will decide the strategy. We are just a supplier; they are the customer.

Q: What would these new facilities be?

A: First you have to convert it.

Q: But you can't do that with Comurhex II facilities?

A: No, because Philippe Coste plant is not licensed for RepU, and we don't want to mix RepU with natural UF6. You also need a dedicated line in the enrichment facilities. We'd need dedicated facilities. It will be based on the same process of conversion from U3O8 to UF6, and afterward you have to enrich reprocessed UF6.

Q: Finally, the facility to convert depleted uranium into UO2 is under construction at Malvesi. Output from that facility will then be blended with plutonium at Orano's Melox facility to create mixed-oxide (Mox) fuel. What's the status of the UO2 plant construction project?

A: The project is finished and we are currently commissioning [the plant]. We expect commercial production in the first quarter of next year.

Q: And how long will the ramp-up be to nameplate capacity?

A: Maybe one or two years. Melox needs 120 tons UO2 [annually], and Malvesi's capacity is higher.

Q: So you won't necessarily produce at maximal capacity—just what is needed by Melox?

A: Yes. We follow our customers' needs.

Phil Chaffee, London

INTERVIEW

Urenco's Odeh on Expanding Enrichment Capacity

European enricher Urenco is responding to a new market imbalance created by the Ukraine invasion by shifting from underfeeding to overfeeding, although it faces constraints. On the sidelines of the World Nuclear Symposium in London earlier this month, Urenco Chief Commercial Officer Laurent Odeh spoke with Energy Intelligence's Jessica Sondgeroth about that shift and prospects for capacity expansion.

Q: The big question on everybody's mind is capacity expansion. We've heard different estimates for when your centrifuge manufacturing joint venture with Orano, ETC, could produce new centrifuges. Assuming you had the contracts to justify increasing capacity, at what point could ETC be ready to provide the necessary additional centrifuges?

A: So, I'll speak for Urenco of course. We are making the necessary preparations to ramp up ETC's centrifuge building. As you know, we have not had the capacity for quite some time, but we've kept the technology alive. We need to ramp up and I would say, if we have all the right conditions — and I've insisted on that previously, meaning stable policy frameworks and clear political guidance, as well as contract commitments from our utility customers — we think we can add capacity towards the back end of the decade — 2027, 2028.

Q: Given German political resistance to nuclear, would expanding there pose a problem?

A: It's fair to say that Germany is not the most welcoming country right now with regard to nuclear generation. Our site in Germany is critical to the nuclear fuel cycle and it is not precluded from consideration for expansion. When we have to assess the list of options, we're going to assess them on their own merits with regard to location and economics, across all of our sites.

Q: It has been suggested that as Urenco's newest plant, the Eunice, New Mexico plant (also known as LES) would be the easiest location to expand. Is that fair?

A: When we built LES we did add several modules, but after Fukushima and the subsequent market downturn, we did not fully populate some of the some of those modules that we have there because the market didn't need it. So yes, there is potential in New Mexico as we already have some of the infrastructure we need to expand.

Q: In the panel discussion on Sep. 8, US Department of Energy (DOE) Office of Nuclear Energy Assistant Secretary Katy Huff mentioned the agency would soon issue a request for quotations (RFQ) for \$500 million for high-assay low-enriched ura-

ni-235 (Haleu) procurement. She mentioned specifically the potential for a deconversion facility attached to existing infrastructure and "an international consortium" that might be willing to work with the agency. We've heard Urenco talk about adding a deconversion facility to the LES plant to produce Haleu. Is that something that you're seriously considering?

A: Yes. We welcome that move from the US DOE. When we talk about high-assay LEU, the dynamic is different than for LEU because the market is nascent; we don't really have commercially viable demand to underpin investment yet. For us, unless we've got a mature Haleu market, it's very difficult to make an investment decision. Therefore this move from the US DOE is welcome by us and we are making ourselves ready to respond to the RFQ.

Q: Energy Intelligence has learned that DOE is planning to request Congressional appropriations of up to \$5.2 billion over 10 years to revive the decade-old American Assured Fuel Supply program to procure long-term contracts for not just Haleu but the entire front-end fuel cycle: enrichment, conversion services and with a lesser priority, uranium. How does Urenco feel about a US government customer?

A: LEU is a mature market and we're expecting operators to act in their own best interest, but if they want to obtain investment in the enrichment space, they will need to underpin that investment and therefore commit to long-term contracts. The market is already tight so you're going to have a new player that doesn't ultimately have a need for LEU coming into the market and making it tighter. The question I would have for the DOE is: how are they going to allocate [the LEU] to the utilities that need it?

That's why I really distinguish what the intent is for high-assay LEU and what it is for LEU. I think the market is operating for LEU and operators can make their own decision and not have to rely on government intervention. And if people want to commit, we're standing ready, if there's a requirement for additional capacity. I would say, yes I understand the high-assay LEU component, but I struggle with the LEU.

Q: Of course, DOE I'm sure would figure out itself how it's going to implement such a program, but it sounds as though there would be a premium paid to suppliers to procure material, with a priority for new capacity.

A: New capacity will be added when we have certainty about the requirements. We at Urenco, and the industry hopefully, have learned from past experience where we were somehow ahead of the demand and therefore created that additional capacity when Fukushima happened, and then suddenly we found ourselves in an extremely oversupplied market. We had to write down quite significant investments in the US because the market conditions changed quite dramatically. We intend to learn from that experience.

Q: And on underfeeding, I think you saw our estimates. We have heard from sources that Urenco has been underfeeding to the tune of about 2,000 tU in the past. We know that there's been some switch to overfeeding. Can you give us any idea of how much?

A: What I can tell you is we have made changes to operation parameters across the sites to release more enrichment capacity, at the expense of consuming more uranium, or UF6 for that matter. We are also the recipient of the decision that the customers made on their tails assay, so we're working with them, but it's fair to say that the more uranium you put in, the more SWU you get at the end. And then there's the question of the economics and the efficiency because the more uranium you put in, the more tails you generate, and so on. So I would say we've started to make those decisions. We're seeing the tails assay increasing, I can't give you a number.

But if we want to continue on that path, we will need more uranium, more natural UF6. That's why yesterday [on the panel] I was asked: "Where is the pinch point at the moment?" Conversion is one of them. We've seen that in the price rise in conversion, but we have to be very mindful that one pinch point doesn't become a pinch point elsewhere. We know enrichment capacity is under strain, and we believe that we have a role to play. We've got a duty to try to release it. So we're optimizing our footprint. But I can't give you numbers.

Q: Well this is another numbers question, but we had heard earlier this year that Urenco was looking to procure up to 10,000 tU as UF6, but that it wasn't able to find all of that material, which goes back to your mention of the pinch point...

A: It's commercially sensitive. What I can say generally speaking is when an enricher does underfeeding it generates uranium and that uranium is then contracted, therefore commitments are made to customers to deliver not only EUP but also to deliver uranium as natural UF6. If you change your operating parameters, then suddenly you no longer generate uranium, but you generate SWU and you need to replace that uranium. I won't get into numbers, but we've been looking at securing some UF6 and we are, as I said, optimizing our footprint as much as we can.

Q: So I guess in roundabout way, it's fair to say that the existing contracts you have to deliver UF6 might be restraining your ability to optimize.

A: And we are looking at the options. We have to move things around, but for the last 10 years, on the backdrop of Fukushima, inventories were rising — they were quite high and there was overcapacity in the enrichment market. So that gave enrichers quite a lot of flexibility to play with. Unfortunately, that has changed now. So we've been working through our inventory. We are back into a much more balanced position. And the shock at the beginning of the year is, once again, creating an imbalance that we're working through.

Q: I feel like this is a good place to jump to your order book, which you recently reported was up 30% in value from 2021. Could you explain why?

A: So we do tend to enter into long-term contracts where deliveries take place later on. But the other thing I can say is that the bulk of our portfolio is in a certain currency and that currency in the US has been increasing quite a lot. So there's an element of the exchange rate as well that has played quite a role. But yes, we've seen an increase in our order book, which we haven't seen for quite some time. But we have some legacy contracts, so there's always a lag between the order book and what you see in the financials.

Q: That goes to my next question regarding the lower average realized price per delivery. When do these older contracts start to fall off the cliff?

A: Some of those legacy contracts with high prices were fading away and had been replaced with lower-priced contracts; in 2018 we delivered record revenue, but the spot price for enrichment fell to \$34. Those lower-priced contracts we are now working through. And we are adding additional contracts into the portfolio. So there's no clear answer, but as a reputable partner and reliable supplier, we are honoring our contracts, across the board. But it's fair to say that because we've been contracting at a lower price, we have the legacy of some of those contracts for some time to come.

Q: And you also reported higher inventories, up by more than half. What's that about?

A: This is mainly for us to try to position material so that we've got the right material to feed our centrifuges.

Q: How is the Ukraine situation affecting demand and your own prospects for long-term contracting?

A: We're seeing different dynamics in different countries and even within countries between operators. There are three types of operators at the moment. You've got one type who came to us early on and said: "We want to emancipate from Russian supply, what can you do for us?" Then you've got the bulk of the utilities in the wait-and-see category and they are asking: "Should we act now, and in the event we want to act, can you be there for us?" And then you've got the third camp who are saying: "Well, we understand, but we've got procurement rules, and the prices remain lower for Russian supply."

I would say we are seeing gradually more people wanting to emancipate from Russian supply. And we will make the required investment decisions when we have enough of a sustainable contract portfolio to justify them. We've been able to execute a couple of those long-term contracts.

We are being very clear with our customers that we need their long-term commitments to reinvest in our capacity. We're not an

insurance company. We can't step in and suddenly solve the problem for the next two years, for people that hope maybe in two years' time there will be a different dynamic in the market and they can go back to Russian supply.

We really welcome fair competition and competition keeps us on our toes. However, we do not have access to certain domestic markets, whilst those that do can come in and dump material into the accessible markets where we and others operate.

Q: To jump to depleted UF6, your tails processing plant in the UK, TMF, has encountered some delays. Can you give us an update?

A: There have been some delays, I won't dispute that. It's a big chemical plant and we're seeing that in other parts of the business when you start a large chemical plant, it doesn't come without hiccups. But now it's online, it's starting to ramp up gradually. I believe that strategically, it remains the right thing for Urenco to do, to be able to deconvert UF6 and show good leadership in nuclear stewardship. At TMF, two kilns have been started and have deconverted UF6 to U308, but we're still in the ramp-up phase. We're hoping that soon we'll be able to achieve nameplate capacity.

Q: After canceling your contract for shipping depleted UF6 to Russia for tails re-enrichment, what is the current plan for that depleted UF6?

A: Depending on the market conditions, we can always re-enrich it. We have our own deconversion capacity. I would say if the conditions are right, then we can refeed that material, or eventually, we'll deconvert it.

Q: So that's another market signal decision. And then for ultimate disposal, what are the options on the table?

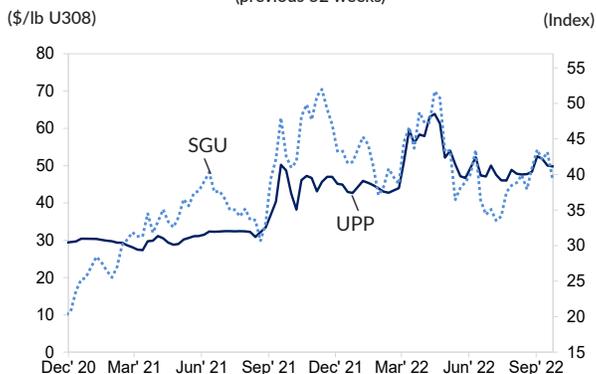
A: It looks like geological disposal is the route to go for depleted U308. Again options are being looked at, but at the moment, with TMF, we've got an oxide store that gives us a license to store it for a hundred years. We know government and other players are looking at options across the globe. We are helping them through that discussion. We've got a route to store depleted U308 for quite some time, but we're also mindful of the fact that tails are the largest weight on our balance sheet, and therefore we are very mindful of finding the right solution.

Jessica Sondgeroth, London

URANIUM MARKET UPDATE

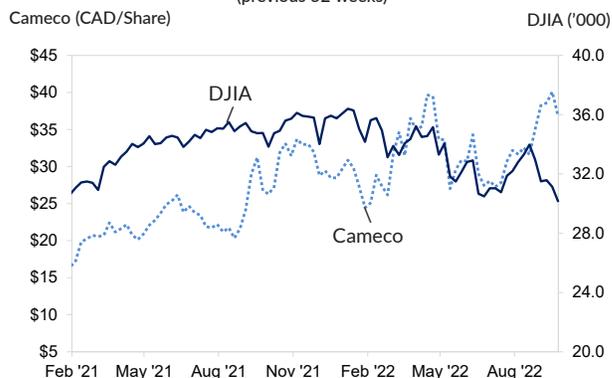
All prices as of Thursday, September 22, 2022

UPP VS. SOLACTIVE GLOBAL URANIUM INDEX
(previous 52 weeks)



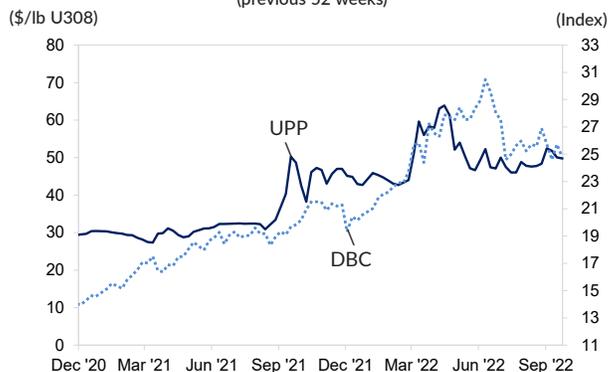
The Solactive Global Uranium Total Return Index, created by Structured Solutions AG, tracks the price movements in shares of companies active in the uranium mining industry. Calculated as a total return index and published in US\$, its composition is ordinarily adjusted twice a year.

CAMECO VS. DOW JONES INDUSTRIAL AVERAGE
(previous 52 weeks)



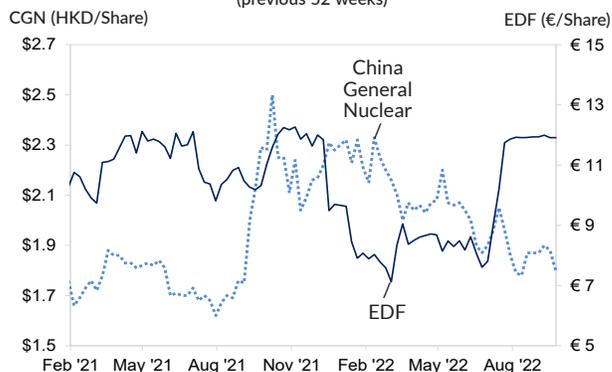
Canadian uranium miner Cameco's stock is valued in Canadian dollars compared with the US dollar on the Dow Jones Industrial Average (DJIA). Roughly two-thirds of DJIA's 30 component companies are manufacturers of industrial and consumer goods. The others represent industries ranging from financial services to entertainment.

UPP VS. POWERSHARES DB COMMODITY INDEX
(previous 52 weeks)



The PowerShares DB Commodity Index Tracking Fund is designed to provide investors with a broadly diversified exposure to the returns on the commodities markets. It is based on the Deutsche Bank Liquid Commodity Index, which is composed of futures contracts on 14 of the most heavily traded and important physical commodities.

EDF VS. CHINA GENERAL NUCLEAR
(previous 52 weeks)



The stock valuation of France's Electricite de France (EDF), largely owned by the French state, is in euros compared to state-owned China General Nuclear (CGN) Power Co., valued in Chinese yuan renminbi. Both companies build nuclear power facilities, design and service reactors, operate nuclear reactors and supply nuclear components and technology.

MONTHLY SPOT MARKET PRICES

| | Chg. | 2022 | | | | | | | | 2021 | | | |
|-----------------------------|-------|-------|-------|--------|--------|--------|--------|-------|-------|-------|-------|-------|-------|
| | | Aug | Jul | Jun | May | Apr | Mar | Feb | Jan | Dec | Nov | Oct | Sep |
| Uranium (\$/lb U3O8) | | | | | | | | | | | | | |
| Low | +2.00 | 47.50 | 45.50 | 45.50 | 46.00 | 52.50 | 51.00 | 42.50 | 43.00 | 42.00 | 43.00 | 36.00 | 36.00 |
| High | +3.00 | 53.50 | 50.50 | 52.50 | 54.00 | 64.00 | 60.00 | 44.50 | 46.50 | 47.00 | 47.50 | 48.00 | 51.00 |
| Conversion (\$/kgU) | | | | | | | | | | | | | |
| Low | +4.00 | 36.00 | 32.00 | 30.00 | 30.00 | 28.00 | 26.00 | 16.00 | 16.00 | 16.00 | 15.00 | 16.00 | 19.00 |
| High | +2.00 | 39.00 | 37.00 | 33.00 | 33.00 | 30.00 | 28.00 | 17.00 | 17.00 | 17.00 | 18.00 | 19.00 | 21.00 |
| Enrichment (\$/SWU) | | | | | | | | | | | | | |
| Low | +0.50 | 90.00 | 89.50 | 84.00 | 84.00 | 82.00 | 100.00 | 59.00 | 57.00 | 56.00 | 56.00 | 55.50 | 55.50 |
| High | -3.00 | 92.00 | 95.00 | 150.00 | 150.00 | 150.00 | 150.00 | 61.00 | 59.00 | 57.00 | 57.00 | 57.50 | 57.50 |

NIW monthly UF₆, SWU and U3O₈ prices rely on the general consensus of direct market participants and is informed by actual market transactions. This section was previously known as the Nukem Weekly Report and the Nukem Price Bulletin. The methodology for NIW's weekly UPP price is different - more information about the methodology behind that price is available on page two.

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