

NUCLEAR INTELLIGENCE WEEKLY[®]

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CONTENTS

- 2** PURE-PLAY INVESTORS DITCH CAMECO
- 3** CAMECO'S BIG BET ON NUCLEAR
- 4** GUANGDONG GREENLIT FOR MORE NUCLEAR
- 5** JAPAN WEIGHS REACTOR LIFE EXTENSIONS
- 6** GE-HITACHI'S WILEMAN ON SMRS
- 11** URANIUM MARKET UPDATE

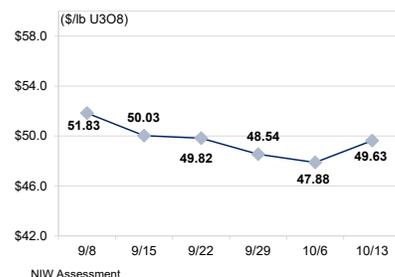
Market Points

Cameco's acquisition of Westinghouse may expand its role in nuclear fuel and reactor services, but the news appears to have driven many "pure-play" uranium investors to other market players.

Increased activity among traders and funds sent the average spot price delivered by Energy Intelligence's Uranium Price Panel higher to \$49.63 per pound U3O8 on Oct. 13, up by \$1.75/lb. from Oct. 6.

French nuclear fuel powerhouse Orano is paving the way to an increase of enrichment capacity, from 7.5 million to 11 million SWU per year, at its Georges Besse II plant in southeastern France.

UPP: \$49.63/LB U3O8



WEEKLY ROUNDUP

Brookfield Flips Westinghouse to Cameco and... Brookfield

- Brookfield Business Partners will sell Westinghouse, the storied reactor vendor and provider of nuclear fuel and services, to Canadian uranium miner Cameco and Brookfield Renewable and its institutional partners for \$7.875 billion. In what one industry source called "financial origami" and another "just Brookfield juggling the asset", Brookfield Renewable and its unnamed institutional partners will retain 51% control of Westinghouse. The \$7.875 billion purchase price includes some \$3.35 billion of Westinghouse debt, meaning the new buyers will pay an equity cost of \$4.5 billion, almost in line with the \$4.6 billion spent by Brookfield private equity vehicle Brookfield Business Partners acquiring Westinghouse out of bankruptcy in 2018. The new purchase will see Brookfield Renewable and its partners pay \$2.3 billion and Cameco pay \$2.2 billion. The Brookfield-led portion of this will be financed via Brookfield Global Transition Fund I, led by former central banker Mark Carney. In September Carney told investors that "there is no transition that works without nuclear, full stop," and said he was looking at ways "to participate" in nuclear.
- "Moving closer to the establishment of a protection zone" for the Zaporizhzhia nuclear power plant, Rafael Grossi, director general of the International Atomic Energy Agency (IAEA), said in an Oct. 12 tweet after a week of consultations in Kyiv and Moscow. The situation at Zaporizhzhia, which with its six VVER-1000s is Europe's largest nuclear plant, is "untenable and we need immediate action to protect it." Grossi's trip was the first since Russia's expropriation of the plant following its illegal annexation of four Ukrainian regions including Zaporizhzhia. It also came as continued fighting at the plant twice this week disconnected it from any connection to the outside grid, though both times it was reconnected. IAEA experts at Zaporizhzhia said that connection was restored the second time at 1:40 pm local time on Oct. 12, "enabling the plant to switch off the diesel generators that had been providing the reactors with electricity after the off-site power was lost in the morning," according to an agency update.
- The first of Georgia Power's twin-unit AP1000 newbuild project began fuel loading this week after receiving approval in August from the US Nuclear Regulatory Commission. Nuclear technicians and operators "are scheduled to safely transfer 157 fuel assemblies one-by-one from the Unit 3 spent fuel pool to the Unit 3 reactor core in the coming days," Southern Co. subsidiary Georgia Power said in an Oct. 14 statement. Fuel loading will be followed by several months of startup testing "to demonstrate the integrated operation of the primary coolant system and steam supply system at design temperature and pressure with fuel inside the reactor." Vogtle-3 is now expected to enter service in Q1 2023. Work on the newbuild project began in 2009 with operations originally forecast by 2017. Total project costs are projected in excess of \$30 billion, more than double their original estimates. Technical and design issues and the 2017 bankruptcy of primary contractor Westinghouse plagued the project, but unlike a parallel AP1000 project in neighboring South Carolina, Vogtle's owners have persevered.

NUCLEAR FUEL MARKET

Pure-Play Investors Drive Uranium Price Higher

The uranium spot price bounced back from recent declines with a deal by Sprott Asset Management’s physical uranium trust (Sput) exceeding \$50 per pound U3O8. The fund appeared to benefit from equity investors unhappy with Cameco’s partial acquisition of fuel fabricator and nuclear reactor vendor Westinghouse Electric Company.

Cameco’s share price dipped following the Canadian uranium miner’s announcement of the purchase, while almost simultaneously the share prices of Sput, Kazakh uranium producer Kazatomprom and the London-based Yellow Cake uranium fund all shot up. Uranium investors appear to have shifted their investments from Cameco to these “pure-play” uranium stocks. For Sput, the new interest brought in \$10 million in cash, helping the fund on Oct. 13 contract 100,000 lbs. U3O8 near \$50.25/lb.

With increased buyer activity leading up to the Sput transaction, the uranium spot price gained nearly \$2 per pound this week. Energy Intelligence’s Uranium Price Panel delivered an average spot price of \$49.63/lb. U3O8 on Oct. 13, up by nearly 4% from Oct. 6.

After announcing its 49% acquisition of Westinghouse, Cameco provided preliminary operating results for the recent quarter ending Sep. 30, highlighting the addition of 5 million lbs. U3O8 to its long-term contract portfolio. This brings the total Cameco sales portfolio to 50 million lbs. U3O8, while its conversion order book stands at 7 million kgU of UF6.

Additional Bull Market Signals

Meanwhile Texas-based Uranium Energy Company (UEC) is purchasing the Canadian Roughrider project in the Athabasca Basin from Rio Tinto for \$150 million, comprised of \$80 million in cash and \$70 million in UEC stock, UEC announced on Oct. 12. “Development-stage Roughrider Project has a non-current, historic resource of 58 million lbs. at an average grade of 4.73% U3O8” and is within 100 kilometers from two uranium mills “providing excellent infrastructure for future development,” UEC said.

Back in 2011, just as the uranium market started to feel the impact of the Fukushima disaster, Rio Tinto won a bidding war with Cameco to buy the promising Roughrider for \$650 million. But in 2017 Rio Tinto ceased further expenditure on the project, and its sale all but ends the legacy miner’s decades of participation in the uranium world.

More bullishly French fuel cycle giant Orano is laying the groundwork to increase enrichment capacity at its Georges Besse II (GBII) plant in southeastern France. The expansion from 7.5 million to 11 million SWU per year capacity, at a cost of €1.3 billion–1.7 billion, could be commissioned by 2028 if a decision to greenlight the project is made early next year.

Orano’s European competitor Urenco is also considering expanding enrichment capacity but both companies are still short of a final decision to order new centrifuges from their joint-venture Enrichment Technology (ETC). Energy Intelligence understands both partners have committed €200 million (\$195 million) each this year to hire about 850 engineers and technicians, and as of late September, ETC had hired about 100 individuals. ETC’s hiring process can be time-consuming because new hires have to be screened for security clearances before training, which is itself very technical.

Orano spokesperson Samira Taguine told Energy Intelligence that Orano’s decision to expand is subject to customers’ long-term contracts and approval by Orano’s board of directors. Since March 2022, Orano has been working through different scenarios involving enrichment capacity and demand. “Even if the quickest scenario is the extension to the current GBII plant, the options which will be retained will be subject to drivers in terms of schedule, costs,” Taguine said. “Building new capacity will take at least [five] years from the time of its decision.”

Orano is also studying the possibility of building enrichment capacity in the US, “if it makes sense in terms of planning and cost.” Its US subsidiary Orano USA had planned to commission, by 2014, the Eagle Rock enrichment facility in Idaho with production estimated at 3.3 million SWU by 2017. But market doldrums stalled the project, and in May 2018 Orano USA terminated the facility’s license with the US Nuclear Regulatory Commission, so any plans to revive the project would involve relicensing.

Jessica Sondgeroth, Washington

URANIUM PRICE PANEL

For the week ended October 13, 2022

	Weekly Spot Market Prices													
	Chg.	Oct		Sep				Aug				Jul		
		13	6	29	22	15	8	1	25	18	11	4	28	21
Price (\$/lb U3O8)	1.75	49.63	47.88	48.54	49.82	50.03	51.83	52.50	48.38	47.75	47.63	47.84	48.85	46.03
Total Assessments	3.00	12.00	9.00	8.00	10.00	10.00	8.00	8.00	9.00	10.00	9.00	8.00	9.00	10.00
% within 1 StDev	5.56	83.33	77.78	87.50	60.00	70.00	75.00	62.50	77.78	80.00	77.78	75.00	55.56	80.00
Low (\$/lb U3O8)	1.50	49.00	47.50	48.25	49.00	49.00	51.25	52.00	48.00	47.50	47.25	47.50	48.50	45.75
High (\$/lb U3O8)	2.25	50.50	48.25	49.00	51.00	51.00	52.00	53.50	49.00	48.25	48.00	48.25	49.25	46.25
Variability*	0.68	0.75	0.07	0.08	1.00	0.38	0.19	0.39	0.38	0.25	0.04	0.00	0.00	0.00

*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.

CORPORATE

Cameco Ups the Ante With Westinghouse Stake

Cameco's move this week to invest some \$2.2 billion for a minority stake in Westinghouse risks the company's credit ratings in favor of an ambitious bet on a global nuclear expansion. The acquisition by Canada's front-end nuclear fuel supplier may help it expand market share in an increasingly geopolitically bifurcated market, and analysts and industry sources believe it could be a profitable long-term play. But the Saskatoon-based company risks over-leveraging itself both directly through the debt it may use to fund the \$2.2 billion purchase, and indirectly through Westinghouse's significant debt load. And Cameco would be particularly exposed should the global nuclear industry face a downturn comparable to the years after the 2011 Fukushima disaster.

"Now countries are looking to sustain and build out their nuclear reactor fleet while asking themselves where those nuclear fuel supplies are coming from," Cameco CEO Tim Gitzel said in an Oct. 11 call announcing the acquisition. "This is highlighted by the Russian invasion of Ukraine." Calling the Westinghouse acquisition an "extraordinary platform for growth," Gitzel said he expects this to "expand Cameco's participation in the nuclear fuel value chain," to be "accretive to Cameco's cash flow after acquisition closing and prior to considering new revenue opportunities," and to "create new revenue opportunities" for Cameco.

Over the past several years, Cameco has attracted bullish uranium investors for its role as a "pure-play" uranium producer, along with improving public sentiment around nuclear energy and efforts by Western utilities to cease procuring any new contracts for Russian nuclear fuel supply. The partial acquisition of Westinghouse, a legacy nuclear fuel manufacturer, services provider, and reactor vendor, may therefore be seen as a dilution of Cameco's value as a uranium play. But for industry veterans and some market analysts, Cameco's move is a bet on nuclear energy, and Cameco could benefit from Westinghouse's progress as a fuel fabrication supplier to Eastern Europe, as nuclear operators there seek to replace Russian supplies of VVER fuel assemblies and the enriched uranium within them.

Cameco is no stranger to acquisitions, mergers, and partnerships beyond its uranium wheelhouse. From 2002-14, for example, Cameco held a minority stake in Canadian nuclear power producer Bruce Power. Cameco was even briefly part of the LES consortium led by European enrichment company Urenco — and including Westinghouse — which eventually built an enrichment plant in New Mexico in 2010. That's after Cameco exited the consortium in 2003 and Westinghouse in 2006. Cameco then reentered the enrichment business in 2008 by acquiring a stake in Global Laser Enrichment (GLE), a company then controlled by GE-Hitachi, which aims to commercialize laser enrichment technology licensed from Australia's Silex Systems.

The Westinghouse Deal

Now Cameco is buying 49% of Westinghouse from Canada's Brookfield Business Partners (BBP), four years after BBP bought Westinghouse out of bankruptcy. BBP will sell the remaining 51% stake in Westinghouse to its sister company Brookfield Renewable Partners, which has never previously owned or managed a nuclear company. While the strategic partnership would provide \$4.5 billion in equity and assume \$3.4 billion of Westinghouse's debt, for a total valuation of nearly \$8 billion, BofA Securities called the deal "strategically sound and complementary" to Cameco's operations, with some "risk" that it "would substantially increase financial leverage."

That risk is real. Cameco said it will be "pursuing a permanent financing mix of capital sources (cash, debt, and equity)" to fund its \$2.2 billion purchase, and that this will be "designed to preserve the company's balance sheet and ratings strength while maintaining its liquidity, prior to closing." But simultaneous to the purchase announcement Cameco closed a \$650 million share offering, and the combined news helped push down Cameco's share price. Meanwhile with Westinghouse's roughly \$3.5 billion of debt likely to be included in Cameco forecasts on a consolidated basis, and Cameco likely to incur higher debt, Moody's warned that the acquisition "will lead to weaker credit measures to an extent that could pressure Cameco ratings."

Once the purchase is closed, which is expected in the second half of next year, voting ownership of Westinghouse will be split among six directors: three appointed by Brookfield Renewable and three appointed by Cameco, Cameco spokesperson Victoria Brown told Energy Intelligence. "Directors will vote in accordance with the percentage ownership of the partner they represent," said Brown. "Even though Brookfield Renewable holds a majority ownership interest, our governance arrangement provides for joint control over significant strategic and operational matters."

Depending on how the two consortium partners ultimately define "significant strategic and operational matters", Cameco may have a lucrative opportunity to expand its customer base to Eastern Europe. "Cameco sees up to US\$50 million in new revenue opportunities," Toronto-based Eight Capital investor analyst Ralph Profitti said in an Oct. 12 note. In the year ahead, Profitti anticipates additional revenue potential from new customers in Eastern Europe such as Bulgaria and Slovakia, and existing customers in the Czech Republic, Ukraine, and Finland.

Leaders of several Eastern European nations where Rosatom is a fuel supplier — including Bulgaria, the Czech Republic, Finland, Slovakia, Slovenia, and perhaps more surprisingly Hungary — have spoken out against the Russian invasion, but the degree to which they are diversifying away from Russian varies. Most notably, Westinghouse was awarded ten years of new business post-2024 alongside France's Framatome at the Cez's twin VVER-1000 reactors at Temelin in the Czech Republic. And while Framatome is another Western competitor eager to supply VVER-1000 fuel

assemblies, Westinghouse has made greater inroads in breaking into the VVER-440 market. There are currently 10 VVER-440 reactors operating across Eastern Europe, each of which is currently reliant exclusively on Rosatom's Tvel.

As it breaks into this market, Westinghouse is keen to offer bundled fuel supply services, involving procurement throughout the entire front end of the supply chain. As a provider of uranium and conversion services, Cameco is likely eager to secure a role for itself in these kinds of supply agreements. And if GLE pays off, Cameco could eventually offer enrichment services, though this is unlikely before 2030.

Cameco could also benefit from Westinghouse's moribund conversion capacity at the Springfields site in the UK if indeed Russian nuclear fuel supply is wholly cut off from the west. Limited capacity in Western conversion services could constrain the ability of Western enrichers to offset Russian supply. Cameco had a toll-processing agreement for conversion services from the plant from 2005-14, but when the agreement ended, the facility closed in 2016. "With regards to Springfields Fuels Limited, it hasn't been active in conversion for nearly a decade, so the facility would need to be operationally capable of producing," Brown said. "As with our own operations, we would need to have contracts in place prior to making any production decision."

Jessica Sondgeroth, Washington

CHINA

Expanding Nuclear's Role in the Decarbonization of Guangdong

Beijing's recent acceleration of China's nuclear newbuild program will be particularly felt in southeastern province of Guangdong, the economic powerhouse that is in dire need of additional power generation capacity. Guangdong is China's largest electricity consumer, and is already the country's top nuclear power producer: the coastal province's nuclear fleet generated some 120 Terawatt hours in 2021, roughly 30% of China's total nuclear generation of over 400 TWh last year. Now Guangdong will also be home to the lion's share of newbuilds greenlit by Beijing so far this year over two rounds of approvals: four of the 10 new reactors across four provinces that were given the go-ahead to commence construction were in Guangdong.

Guangdong is in urgent need of more energy to avoid the kinds of "seasonal and periodical energy supply shortages" that it experienced during the previous five-year period (2016-20), the provincial government said in its latest energy plan released in April. Already it anticipates such power crunches would "continue or even worsen" during the current five years period ending 2025. The province expects its energy demand to remain in "fast

growth" mode during 2021-25, with electricity consumption rising by an average of 4.9% annually.

Much of that demand is slated to be met by nuclear power, which has been a key pillar of Guangdong's energy strategy since former Chinese Premier Li Peng pushed forward the French-supplied reactors at Daya Bay in the late 1980s. Li simultaneously launched a new Western-inspired nuclear operator, now known as China General Nuclear (CGN), which remains based in Guangdong. But where nuclear plants elsewhere in China, such as the provinces of Zhejiang, Shandong and Liaoning, are expanding beyond power output into markets such as district heating, the focus in Guangdong — which doesn't have the freezing winters of those more northerly provinces — appears to remain on ramping up power output.

Economically-booming Guangdong, which is home to the Pearl River Delta industrial hub sometimes known as "China's Silicon Valley", consumed nearly 790 TWh of electricity last year, according to data from the National Bureau of Statistics. For comparison that's considerably more than total annual German power consumption, and represents some 9% of China's national 2021 consumption of over 8,300 TWh. Nuclear reactors, with 16 GW of capacity at the end of 2021, provided 14% of Guangdong's 2021 electricity supply, second only to coal-fired generation's 43% share, CGN data showed. Natural gas has the third-largest share of 12% in Guangdong's electricity market.

Guangdong is China's top GDP contributor, accounting for nearly 11% of the national total during the first half of 2022. It also has a high energy import dependence of 74%: fossil fuels supplied some 70% of its total energy needs in 2020, and the proportion of supplied coal toward those needs was "higher than the world average of 27%." The share of cleaner-burning natural gas is also "lower than the global average of 24%," said the provincial government.

The Need for Faster Decarbonization

Recognizing that Guangdong's current pace of decarbonization "is not entirely compatible" with China's carbon peaking and carbon neutral goals, the provincial government wants to raise the share of non-fossil fuels — which include nuclear and renewables — from 30% in 2020 to 32% by 2025, all while boosting total provincial generation capacity from 142 GW at the end of 2020 to 238 GW by 2025. To achieve that goal, Guangdong plans to "strongly boost" development in nuclear, offshore wind and solar energy. By 2025 provincial leaders hope to add 36 GW of gas-fired capacity, 7 GW of offshore wind, 3 GW of onshore wind, 20 GW of solar capacity and 2.4 GW of new nuclear capacity, which is under construction at CGN's green-field Taipingling (also known as Huizhou) nuclear plant.

The first nuclear-safety concrete was poured for Taipingling-1 and -2 on December 2019 and October 2020, respectively. They are among China's first-of-a-kind reactors using the 1.2 GW integrated Hualong-One reactor, designed by the Hualong-One joint venture of CGN and CNNC, and had been slated for commissioning by the end of 2025.

But while Guangdong is banking on that target being met, this is increasingly doubtful. In its latest quarterly report released this week, CGN's Hong Kong-listed subsidiary CGN Power put the expected operational dates at 2025 for Unit 1 and 2026 for Unit 2. The later start date for Taipingling-2 means Guangdong might see only 1.2 GW of new nuclear capacity coming online by end-2025, instead of 2.4 GW. The reactor dome for Taipingling-2 was hoisted on Sep. 25, marking its progress into the "equipment installation phase," said CGN.

Post-2025: Lufeng and Lianjiang

The nuclear newbuilds greenlit this year, of course, are slated to come online in the next five-year plan. These projects include CGN's twin Hualong-One reactors, Lufeng-5 and -6, approved in April, and State Power Investment Corp's (SPIC's) twin CAP1000 reactors, Lianjiang-1 and -2, approved in September. When commissioned in the post-2025 timeframe, these four newbuilds will add a total of 4.9 gigawatts (GW) to Guangdong's power generation capacity.

Of these four newly-approved newbuilds only Lufeng-5 has commenced construction, with first concrete poured on Sep. 8, and there is no announced target to reach that milestone for Lufeng-6. CGN is targeting a 58-month construction period each of the twin Hualong-One reactors at Lufeng, which means Lufeng-5 would start operations only in the second half of 2027 at the earliest. CGN made no mention in its Oct. 11 report about the status of its other planned reactors Lufeng 1-4 in Guangdong, which have yet to receive construction approvals.

The other two newbuilds approved in Guangdong are SPIC's Lianjiang-1 and 2, which are to be 1.25 GW CAP1000s. First concrete pour for Unit 1 is planned for Jun. 30, 2023. SPIC is targeting a 56-month construction period each for Lianjiang-1 and 2, with their construction starts to be spaced 10 months apart. This suggests the earliest operational date for Lianjiang-1 would be in March 2028, followed by Lianjiang-2 in early 2029.

Kim Feng Wong, Singapore

JAPAN

Paving the Way for Operating Lives Beyond 60 Years

The new head of Japan's nuclear safety regulator has opened the door for the government to revise the 60-year ceiling on the operation of commercial nuclear power plants, a change long advocated by the nation's nuclear industry.

Shinsuke Yamanaka, the new chairman of the Nuclear Regulation Authority (NRA), said Oct. 5 that the question of how long nuclear

power plants should be operated in principle "is a matter for the utilization policy side," evidently referring to the Ministry of Economy, Trade and Industry (Meti). This was followed by Meti Minister Yasutoshi Nishimura's confirmation in a post-cabinet Oct. 7 news conference that changes to the so-called "40-year rule" in place since 2012, including possible legal revisions, were "under study" by Meti's Agency for Natural Resources and Energy (Anre). Nishimura declined to elaborate on the content of any revisions, and instead stated that "no decision has yet been made" and that Anre will submit proposals by the end of the year.

That "40-year rule" was codified in June 2012 in parallel with the NRA's formation under the then center-left Democratic Party of Japan administration in the wake of the March 2011 Fukushima Daiichi disaster. A new amendment to the Reactor Regulation Act granted operators a 40-year period of operation in principle — from the date of first electricity generation — that can be extended once for a period of 20 years with the NRA's permission. Meanwhile the NRA was established as an independent agency, nominally under the Ministry of the Environment, to replace the Nuclear and Industrial Safety Agency (Nisa) that had reported to Meti, Japan's prime bureaucratic promoter of nuclear power.

Yamanaka's Oct. 5 comments actually followed an Anre briefing (requested by Yamanaka) of the five NRA commissioners on the government's nuclear power development policy. The drive to review the 60-year ceiling is in line with the policies of the Liberal Democratic Party (LDP) administration of Prime Minister Fumio Kishida, who announced on Aug. 24 a new push to promote the restart and construction of nuclear power plants, and who directed the advisory "Green Transformation" executive committee to submit by year's end concrete proposals for "political decisions" to overcome obstacles to this push.

Japanese business journal *Nikkei* reported Oct. 5 that Anre electricity and gas division chief Yasuhiro Matsuyama had stated that his agency "will deepen discussions" on issues such as "excluding the period during which nuclear power plants are not in operation" from their official lifetime calculations, as some other countries do, "re-examining the 60-year ceiling," and "if necessary" making relevant changes to the law. Matsuyama said lifting the 60-year ceiling was necessary to promote restart of idled reactors and reduce barriers to the stable provision of electricity.

Debating Long-Term Operations

That ceiling has been intensely opposed by the nuclear power industry, even if no reactors are close to bumping up against it within even the next decade. A senior industry specialist based in Tokyo told Energy Intelligence that "it is basically ridiculous to decide plant age by law," as the "limit of plant age" should come "when the utility decides that replacement of components is no longer economically practical."

Former Atomic Energy Commission deputy chairman Tatsujiro Suzuki told Energy Intelligence that he agreed setting a 40- or

JAPANESE REACTORS TO REACH 40 BEFORE 2030

Operator	Reactor	Prefecture	Current Age	Status
Chubu EPC	Hamaoka-3	Shizuoka	35	Under NRA review
Chugoku EPC	Shimane-2	Shimane	33	Restart expected 2023
Hokkaido EPC	Tomari-1	Hokkaido	33	NRA review stalled
JAPC	Tsuruga-2	Fukui	35	NRA review stalled
Kansai EPC	Takahama-3	Fukui	37	Restarted
	Takahama-4	Fukui	37	Restarted
Kyushu EPC	Sendai-1	Kagoshima	38	Restarted
	Sendai-2	Kagoshima	36	Restarted
Tokyo EPC	Kashiwazaki Kariwa-1	Niigata	37	Not applied for restart
	Kashiwazaki Kariwa-2	Niigata	32	Not applied for restart
	Kashiwazaki Kariwa-5	Niigata	32	Not applied for restart

Key: Electric Power Co. (EPC); Nuclear Regulation Authority (NRA). Age is reported in years. Source: Agency for Natural Resources and Energy

60-year operational limit “is a policy decision that allows regulators to making planning easier.” Regulators “may have to formulate their own criteria for inspection periods to evaluate the safety of aging nuclear power plants, but that does not necessarily mean that the NRA regulators will be compromising safety regulations’ as they may actually formulate stricter inspection rules.”

But nuclear opponents now worry that Yamanaka’s openness to reactor operations beyond 60 years signals a reversion to Nisa’s alignment with nuclear promotion goals, and is a step away from regulatory independence. Multiple environmental organizations signed an Oct. 10 “emergency declaration” drafted by Friends of Earth Japan urging the NRA not to bow to industry and political pressure and affirmed that “there are technical and physical limitations to the safety of nuclear power plants and setting a ceiling on the operating period is an extremely appropriate method of regulation.”

Yamanaka rebutted such concerns in an Oct. 12 news conference, stating that he was reflecting an agency position from July 2020 that reactor operating periods should be decided by the organization setting utilization policy, and that the NRA should not express an opinion. Yamanaka also insisted that the NRA’s responsibility for ensuring nuclear safety will remain “great.” In its July 2022 submission to the Convention on Nuclear Safety the NRA explained that reactors operating beyond 30 years are evaluated for “ageing degradation of structures, systems and components” every 10 years, and must input the results of these evaluations in operational safety programs.

The NRA has yet to turn down a request for a reactor lifetime extension beyond 40 years. Four reactors have received approval for 20-year extensions: Kansai Electric’s Takahama-1 (47 years old), Takahama-2 (46) and Mihama-3 (45), as well as Japan Atomic Power Company’s Tokai-2 BWR (43). At present, only Mihama-3 is actually operating. Ten other reactors are scheduled to reach their 40-year limits in the late 2020s or early 2030s. On

Oct. 12, Kyushu Electric announced that it had submitted applications for 20-year life extensions for Sendai-1 and Sendai-2 based on the results of special inspections conducted of the two PWRs in October 2021 and February 2022.

Anre is already clear that it wants to enable operations beyond 40 years across the Japanese nuclear fleet. In a report presented to the NRA Oct. 5, Anre estimated that 37.22 gigawatts of nuclear power could be available in 2030 from 36 reactors assuming 60-year-life spans, but only 27 reactors (representing 27.31 GW) could be in operation if the 40-year limit is retained. The greater impact would be in 2040, as only 8 reactors (representing 9.56 GW) could be operating if limited to 40 years, compared to 32 (33.65 GW) if 60-year extensions were universally granted.

Dropping the 60-year ceiling would have a major impact even further out than that. But whether Kishida will have the clout to secure parliamentary approval required for such revisions remains somewhat uncertain, despite the solid majority held by the conservative LDP-Komeito coalition in both houses of the National Diet. In the wake of a scandal over the revelations of the conservative LDP’s deep links with the far-right former “Unification Church,” Kishida’s approval ratings slid to 38% positive and 43% negative in the NHK’s benchmark opinion polls.

Nevertheless, a Tokyo-based political analyst told Energy Intelligence that, if proposed, draft revisions are likely to be approved by the Diet “not because of Kishida, but because big business is pushing this and there isn’t really a strong anti-nuclear lobby anymore.”

Dennis Engbarth, Taipei City

INTERVIEW

GE-Hitachi CEO Jay Wileman on New SMR Focus

Under CEO Jay Wileman, GE-Hitachi Nuclear Energy has seen enormous success marketing its BWRX-300 small modular reactor (SMR) and the Sodium advanced reactor, the latter of which is a sodium fast reactor developed with TerraPower. Last month Energy Intelligence’s Phil Chaffee sat down with Wileman on the sidelines of the World Nuclear Association’s annual symposium in London to discuss GE-Hitachi’s outlook on the nuclear world. Below is an edited and shortened transcript of that interview.

Q: GE-Hitachi strikes me as the one legacy reactor vendor that has almost entirely switched over to the SMR market. Is that fair?

A: I would characterize it a little bit differently. We are still focused on our installed base and our existing market.

Q: But in the newbuild market ...

A: In the recent newbuild market we started with our ESBWR, and had the North Anna-3 project with Dominion. After they suspended it, and we stepped back and looked at what was going on in the world with newbuilds and power, and said: “OK, what do customers really want? What’s it going to take for them to rebuild the fleet?” This was just before everybody was talking about Net Zero by 2050.

Our team went out and really listened to the customer, and they want a few things: something that wasn’t going to potentially destroy the company’s balance sheet, so it couldn’t be a multibillion-dollar build.

Q: ... à la Vogtle and VC Summer.

A: You said it. They want certainty on cost and schedule. They want reliability — a lot of technologies back in the 60s and 70s, when they started up if they hit a 60% capacity factor, you were happy. Now you’ve got to blow past 90%.

So our engineers got together in 2017, we slid pizza and Red Bull under the door, and they came up with some innovations. We took the ESBWR, which is a very elegant type of design, and its passive safety, and we really simplified it down through innovation. That’s how BWRX-300 was born. Now the BWRX-300 has that technology base [the ESBWR] that was a licensed design by the NRC [US Nuclear Regulatory Commission] with a couple breakthrough propositions.

One is integral isolation valves; if you’re a nuclear engineer, you know that you have the reactor pressure vessel with some pipe — an MSIV (main steam isolation valve), another MSIV — and then you go off to a steam turbine. When you do that, regulators make you assume that the pipe is going to have a double guillotine break, and you’re going to release all that coolant into a containment. To mitigate this you need systems to put the water back in, and to deal with temperature, pressure, and all of that. Our patented innovation is an integral isolation valve. So it’s now our pressure vessel and the integral isolation valve, which is the same code classification as the pressure vessel, before any piping. Now, if a pipe break occurs, the integral isolation valves close to stop the loss of coolant. This simplifies everything.

The second thing is construction. If you’re building a traditional nuclear plant you’re going to scoop out about a million cubic meters of dirt, and then you’re going to build your building, and then you’re going to backfill it with expensive engineered backfill. What we’re going to do is build a vertical shaft, and come in with an innovation — in the nuclear industry — called steel bricks, which is a steel-concrete composite. So you bore down and then those can be built modularly, so you save a lot of time and a lot of money.

Q: And that’s for the foundation?

A: That’s for the reactor building. The containment, and the reactor building.

Critical for me are three pillars: Design to cost — carefully manage the nuclear creep, and have a standard plant. Next, there is certainty on outcome, on schedule and on cost. We’ve got great experience with our partners in Hitachi-GE Nuclear Energy, building ABWRs in Japan on budget and on time, and they did a great job modularizing. And the last thing is reliability. When you start up you can’t afford to be on a learning curve. This is a boiling water reactor; we know how to operate it.

I’m excited about the technology. OPG [Ontario Power Generation] is our launch customer. SaskPower has done their evaluation and selected us a month or two ago. TVA. Synthos Green Energy is in a joint venture in Poland with PKN Orlen. We’re excited about this real interest: not just MOUs [memorandums of understanding] to explore.

Q: In terms of creating a product that can be identical and sold anywhere, increased regulatory harmonization can of course enable this. But I was in Paris when you were on the stage with OPG Chief Strategy Officer Dominique Minière and Rumina Velshi, head of the Canadian Nuclear Safety Commission. But while Velshi talked about harmonizing regulatory approval with other regulators — particularly the NRC — Minière argued that “if we try” to harmonize regulations “too much,” then “we will slow down the speed of the SMR” deployment in Canada. How do you negotiate this understandable customer desire to just get going on their specific project with the broader but perhaps slower goal of harmonization of approvals across multiple regulators?

A: We’ve been working on this for quite some time. If you think about WNA’s Cordex (a harmonization initiative), which I’m a mentor for as a board member; if you think about what the NEA [the Paris-based Nuclear Energy Agency] is doing; about what NEI [the US Nuclear Energy Institute] is doing; about MDEP [the Multilateral Design Evaluation Programme] and about the fact the IAEA just came out looking for the same kind of harmonization. That’s great. We’ve had people doing this at the lower level, and the IAEA is going to bring a lot of attention and tailwind, and they’ll be the harmonizer of the harmonizers.

But one of the tenets that we’ve built in is that we can’t slow down the existing project. The first project will be under Canadian [regulation], and nobody will lose their sovereignty of licensing. The trick is going to be for us, as the design owner, to think about “I’ve got all these different regulatory areas in a Venn diagram. How do I find that regulatory sweet spot? And can some of those Venn diagrams move a little bit? Can we squish them together to get more overlap?” So this will be easier the further we go, but we have to be mindful of the right here, right now. We are looking for a license to construct [at Darlington] to be submitted by OPG later this year.

We’re working to develop a CPA [a construction permit application to the NRC], and our approach is not Part 52 [of the Code of

Federal Regulations] but Part 50. We're going to take the foundation of the ESBWR, which the NRC knows well and approved in November 2015. And where things are different, like this integral isolation valve, we're going to do a licensing topical report. We've already submitted five, and they've been approved.

So the NRC side, we're going in the direction they need, so we can have a good regulatory process. CNSC, same thing. In the UK, we will put in our application for a generic design decision in the next few months. I love this collaboration because the BWRX-300 is playing in all three of these markets. So we're the perfect test case.

Q: What sort of schedule do you envision for the CNSC?

A: I don't want to speak on OPG's behalf, or on the CNSC's behalf.

Q: Zooming in on the Darlington SMR, when I interviewed OPG's Miniere in November, he talked about a model for the SMR project that sounds a lot like the one they developed for the ongoing refurbishment of the existing Darlington Candu reactors. A model that isn't customer-client but much more collaborative. This is something new for GE-Hitachi. How do you envision that model working, particularly with your owner? Is GE comfortable with this collaborative model?

A: It's a great model. It's been demonstrated to be successful for the refurb project. The typical OEM-EPC-AE [original equipment manufacturer-engineering procurement construction-architect/engineer] model has everyone doing their scope, assuming their risk, and the owner has some risk as well.

[This involves] a traditional EPC contract, where when you have an issue you stop, you figure out whose problem it is, who's going to pay for it, and who will be responsible for the stop — which is an important point because the costs are going up all the time — and then you fight about it and you're in commercial negotiations for almost a year.

This [Darlington] model, everybody recognizes there's risk out there: the structure is an integrated project delivery model where we all share the risk. And you keep going, and you don't have to fight about where issues are coming from. It's a lot more complicated than that. Conceptually you've got a risk pool and you've got a benefit pool. Everybody's motivated; you're not set up for commercial arguments. That's the worst thing that can happen: stopping work just to argue.

Q: One of the reasons the ESBWR was so hard to sell, as far as I understand, was that GE and potentially Hitachi as well did not want to take on the construction risk that would have been necessary to sell these things. It does sound like you will take on some construction risk at the Darlington SMR. Are your owners OK with this?

A: What I would say at a high level is that for North Anna-3 we were going to take on risk that we could best control, where it was

us controlling it. And others would manage their risk. So we were willing to do that.

Now, with this shared risk, it still gets us to the same general concept, but it is more collaborative. We are being supported by both of our parents. Both GE and Hitachi are excited about this project. We fit well within the energy transition — helping to solve the energy trilemma — within GE Vernova [the GE renewables and power company spinoff that is the GE-Hitachi parent company]. Scott Strazik, the CEO of GE Vernova, is excited about the BWRX-300, and about the excitement he's hearing in the industry. So there's a lot of internal support.

Q: GE's nuclear joint ventures with Hitachi have occasionally over the years been floated on the market. Prospective buyers have looked at them. Is it safe to say they're off the market now?

A: There have always been rumors that there are discussions going on. Of course, we don't comment on rumors. However, Scott [Strazik] has made it very clear to the industry that nuclear has a spot within GE's overall portfolio.

Q: Returning to the BWRX-300, we have this first-of-a-kind. To what extent will these other prospective builds — in Estonia, Poland, Saskatchewan and TVA in Tennessee — wait for your Darlington first-of-a-kind to be operational? Will some move faster than that, and just wait till construction starts at Darlington?

A: First let me push back on that "first-of-a-kind." If you look at the BWRX-300 design, everything has been proven by either extensive tests or operations, except for the integral isolation valves, which by the way have been proven in the oil and gas industry at much higher pressures and temperatures. It's a very low technical risk, and we've cleared the major licensing risks. So I would say, and one of my innovation engineers has said, that this is really no different than taking Lego blocks and putting them together in a much simpler way. That's just a little push-back, but it is the first BWRX-300 specific design. I will give you that. But it's not like everything is new.

You'll have to go to them, but it's been stated in the press that they have a timeline to hit the early 2030s ...

Q: They being ...

A: They being all the customers you just mentioned. And if you do the math on that — the timing on that — I believe they will do their own early works. TVA has said publicly they're starting with us to do their construction permit. So people are doing things.

Now when will the FIDs [final investment decisions] line up? We'll see. But to be there by 2032 ...

Q: ... the FIDs may have to come before Darlington starts operation.

A: Yeah, or just after.

Q: And which of those prospective customers might be the next one after Darlington? Do you have any sense?

A: Good question. I think TVA has laid out their timeline to some degree, submitting their CPA, then it's going to be the standard time for NRC review. SaskPower has come out. There seems to be a big target between 2030 and 2032. Synthos Green Energy and PKN Orlen say they want to be next. Right after that is OPG themselves.

Q: Outside TVA and OPG, none of these are legacy nuclear operators.

A: Cez [the state-owned Czech utility] is.

Q: And we haven't talked about them. But they haven't narrowed their SMR plans down to you yet. And I supposed Estonia hasn't either.

A: That's correct.

Q: But certainly SaskPower, TVA and Synthos have narrowed it down to you.

A: That's correct. But think about the synergies of a North American play, and then a Canadian play with OPG and SaskPower. There's a synergy that you've got in that region. We're looking to recreate that [the Darlington model] with partners, and bring the whole solution. Instead of saying "Nope, I'm the NSSS [nuclear steam supply system] supplier, and here it is," we're trying to build this coalition to really be able to make it easier.

Because if you think about it these are not traditional nuclear companies anymore. I've got a whole new market segment. SaskPower, PKN Orlen and Synthos Green Energy — they understand the challenges of getting to net zero, and yet they're not historically a nuclear operator. We've got to help them along the way.

Q: Are you talking with TVA and OPG about going with them to third countries and customers?

A: Certainly there will be synergies between SaskPower and OPG.

Q: But for Estonia, there's nothing there.

A: What I can say right now is that TVA doesn't have that model. Nor does OPG — yet. They may choose to do that, but I'll leave that to them.

Q: For all of these foreign export projects — excluding TVA — how much firepower are you getting from Washington, in terms of Ex-Im Bank or the Development Finance Corp. (DFC) support?

A: We're getting support from the US government. There's a lot going on. I have always said, when people would say "We're in danger of losing our nuclear leadership," I'd say "No, we have lost our nuclear leadership." I think the US government understands

that. Both sides of the aisle are very supportive of nuclear, which is fantastic. We are getting great support from the DOE [Department of Energy] as we go to different places. So the model now with DFC can come in and play. Everything's starting to synchronize now and come together. I haven't seen that before in my career.

Q: Will this newly passed "Inflation Reduction Act" for climate and infrastructure have an impact on the nuclear industry?

A: I believe so. Both for the operating fleet, and now for any kind of a newbuild that we're going to need for net-zero carbon. It certainly will help with investments.

Q: In Wyoming, you're involved with TerraPower on Natrium. Could you explain GE-Hitachi's role there?

A: Sure. I'm very excited to be in partnership with TerraPower. It was an interesting marriage. We have had the Prism [fast reactor] technology in our portfolio since the 80s, post-EBR-II [the sodium-cooled experimental breeder reactor in Idaho].

We were looking at ways to commercialize it. We talked about a stand-alone plant. Even yesterday I had to correct someone when they used the word waste. It's not waste, it's slightly used fuel. But we came here to the UK and talked about plutonium disposition with the NDA [the UK Nuclear Decommissioning Authority], and we never really got traction.

Looking at what TerraPower was going through with their traveling wave reactor, we thought "What might we be able to do together?" Then ARDP [the US Advanced Reactor Demonstration Program], and we thought this is a good opportunity to do something. I talked with Chris Levesque and I said "How can we do something that takes the best from both companies?"

We are jointly developing the Natrium technology. The ARDP project in Wyoming is TerraPower.

Q: So you have no formal role in that demonstration project?

A: Just supporting the technology development under that. They are the project leader, and we are working with them at a technical level.

The important thing here [with the Natrium design] is this ability to go up to 500 megawatts in 5.5 hours to help with some grids that will be heavily into intermittent [generation]. That's a big deal.

Q: So is the Prism off the table? On your website you mention the NDA. I follow UK nuclear policymaking very carefully, and they're not close to a decision on plutonium disposition. Are there any other opportunities for Prism, or should we basically just think about Natrium when thinking about your fast reactor offerings?

A: Prism is not out of the portfolio. It's still there. However, I'm excited about the Natrium and this effort with TerraPower, for what seems to be where this industry is going.

Q: There's obviously a lot of attention — particularly in the US — in new types of nuclear fuel, including high-assay low-enriched uranium, but also on recycled fuels. You were just talking about reprocessing and recycling. Do you foresee the US or Canada building reprocessing facilities?

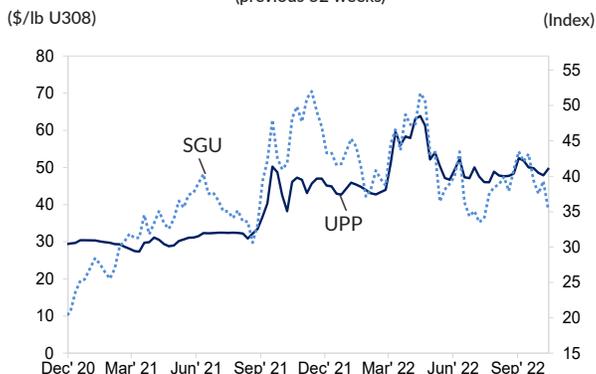
A: Well the technology is certainly there. Whether the policy and political will are [there] remains to be seen. There's a lot of discussion around this whole area that is not a technical discussion. Could it happen? I don't see any movement in that direction at this point.

Phil Chaffee, London.

URANIUM MARKET UPDATE

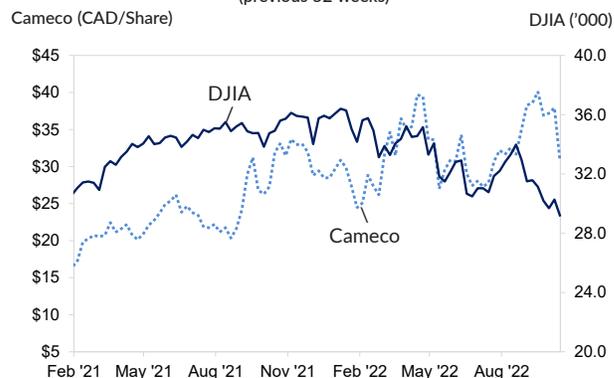
All prices as of Thursday, October 13, 2022

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



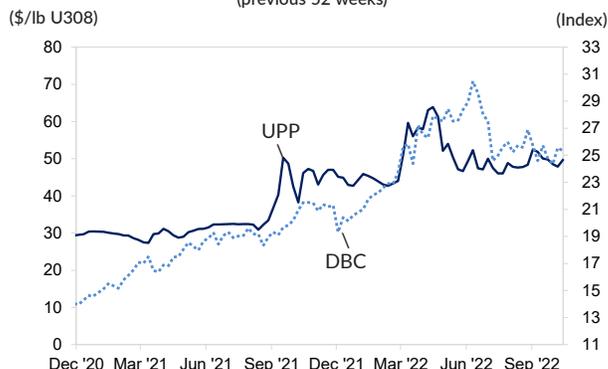
The Solactive Global Uranium Total Return Index, created by Structured Solutions AG, tracks the price movements in shares of companies active in the uranium mining industry. Calculated as a total return index and published in US\$, its composition is ordinarily adjusted twice a year.

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



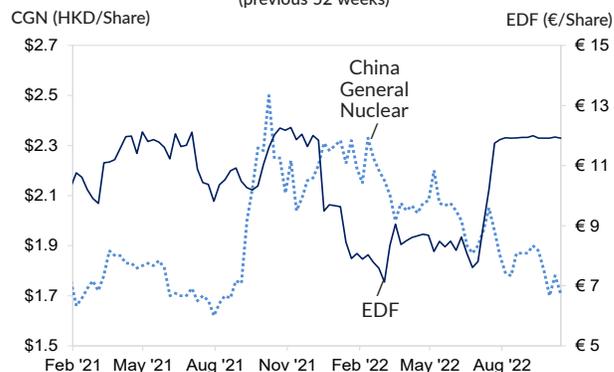
Canadian uranium miner Cameco's stock is valued in Canadian dollars compared with the US dollar on the Dow Jones Industrial Average (DJIA). Roughly two-thirds of DJIA's 30 component companies are manufacturers of industrial and consumer goods. The others represent industries ranging from financial services 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		
		Sep '22	Aug '22	Jul '22	Jun '22	May '22	Apr '22	Mar '22	Feb '22	Jan '22	Dec '21	Nov '21	Oct '21
Uranium (\$/lb U3O8)													
Low	+1.00	48.50	47.50	45.50	45.50	46.00	52.50	51.00	42.50	43.00	42.00	43.00	36.00
High	-1.00	52.50	53.50	50.50	52.50	54.00	64.00	60.00	44.50	46.50	47.00	47.50	48.00
Conversion (\$/kgU)													
Low	-	36.00	36.00	32.00	30.00	30.00	28.00	26.00	16.00	16.00	16.00	15.00	16.00
High	-	39.00	39.00	37.00	33.00	33.00	30.00	28.00	17.00	17.00	17.00	18.00	19.00
Enrichment (\$/SWU)													
Low	+2.00	92.00	90.00	89.50	84.00	84.00	82.00	100.00	59.00	57.00	56.00	56.00	55.50
High	+4.00	96.00	92.00	95.00	150.00	150.00	150.00	150.00	61.00	59.00	57.00	57.00	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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