

NUCLEAR INTELLIGENCE WEEKLY®

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Market Points

China National Nuclear Corp.s' Rossing uranium mine in Namibia was granted a 10-year life of mine extension to 2036.

Urenco announced an agreement to supply enriched uranium product to Ultra Safe Nuclear Corporation for use in its modular microreactor fuel beginning in 2025.

The price assessment delivered by Energy Intelligence's Uranium Price Panel fell more than a dollar this week to \$50.57 per pound U3O8 on Mar. 2, down from \$51.79/lb. last week.



WEEKLY ROUNDUP

X-energy Contracts with Dow for First-of-a-Kind Xe-100

- US multinational chemical giant Dow entered into a joint development agreement with X-Energy "to demonstrate the first grid-scale advanced nuclear reactor for an industrial site in North America," X-energy announced on Mar. 1. The contract expands on an August letter of intent between the two companies, and will take advantage of X-energy's \$1.2 billion cost-share award with the US Department of Energy (DOE) to demonstrate the Xe-100 high-temperature gas-cooled reactor, which Dow now plans to deploy at a US Gulf Coast site to be selected this year. "X-energy will remain dedicated on deploying the Xe-100" reactor in the state of Washington, "but will now focus our initial deployment at a Dow Industrial site," Darren Gale, the head of X-energy's advanced reactor demonstration project, said in a LinkedIn statement. The agreement entails up to \$50 million in engineering work, half of which is eligible for funding through the DOE demonstration program, and the other half by Dow. The work scope includes delivering a construction permit application. Meanwhile the consortium of prospective investor offtakers backing NuScale's demonstration small modular reactor project has decided to move forward with the Idaho newbuild thanks to NuScale offering incentives until the next investor "offramp" scheduled for year's end.
- This week the US DOE issued guidance for the second award cycle of its \$6 billion civil nuclear credit program, following the November 2022 conditional selection of the endangered Diablo Canyon nuclear plant in California for up to \$1.1 billion of first-round funding. The second round will be open to operators of nuclear reactors that are at risk of closure within four years, including reactors that ceased operating after Nov. 15, 2021. "Only one nuclear plant qualifies under these conditions: Holtec International's 805 MW Palisades facility," argued Washington DC-based energy research firm ClearView Energy Partners in a Mar. 2 note. "We think the Guidance represents an explicit endorsement by the Biden Administration to restart a closed nuclear plant, something that has not occurred in the US before." Holtec's application for Palisades in the first round was rejected, but the new DOE guidance "unequivocally encourages the company to reapply."
- French Energy Transition Minister Agnes Pannier–Runache this week spearheaded the creation of a "nuclear alliance" between 11 EU member states, continuing a French push for nuclear expansion at home and abroad. The 11 countries notably not including Sweden, which currently holds the rotating presidency of the European Council signed a declaration in Stockholm "jointly reaffirming their desire to strengthen European cooperation in the field of nuclear energy," according to a Feb. 28 statement. The statement referenced ensuring cooperation across supply chains, joint training programs and industrial projects. In an interview with French news site *Les Echos* on Wednesday, Pannier–Runacher said she has fielded industrial groups on the possibility of building more than 14 new reactors in France by 2050, despite the government having only nominally committed to six newbuilds. Meanwhile the government's nuclear acceleration law, which would streamline the deployment of new reactors, arrived at the National Assembly this week following Senate approval.

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NUCLEAR FUEL MARKET Rossing Life of Mine Extended to 2036

China National Nuclear Corp.'s (CNNC's) Rossing mine in Namibia was granted a 10-year life of mine extension to 2036 late last week, while this week Urenco announced that it will be providing enriched uranium product (EUP) to Ultra Safe Nuclear Corporation for use in its advanced reactor fuel.

The storied Rossing mine, which is the world's longest-running and fourth-largest uranium mine, was granted a life of mine extension to 2036, Rossing Uranium announced Feb. 24. The mine, in which CNNC subsidiary China National Uranium Corp. (CNUC) holds a majority stake, previously had a life of mine plan through 2025. Previous owner Rio Tinto had planned to close Rossing in 2020, but it sold its majority share to CNUC in 2019. That sale "created a limited duration preferential offtake agreement at subsidized prices and at a premium to production cost, assuring a positive cash flow and continued operation," explained Rossing, pointing to a generous offtake deal with CNNC.

The extension has been in the works for a while, with one source telling Energy Intelligence CNUC "wouldn't have gone to the trouble to buy the mine from Rio Tinto for just a few years of production." Given that the move was so anticipated, the extension is unlikely to have any material effect on the uranium market. Rossing produced approximately 5% of global output in 2022.

Following the Rossing announcement, Chinese equipment supplier Anhui Jiangnan Chemical Industry announced it had won a bid to provide NA\$12.6 billion (US\$688 million) worth of services to the Rossing mine from January 2024 to December 2036, according to Chinese financial newspaper Yicai Global.

Fuel Developments

For the week ended March 2, 2023

In the enrichment sector, Urenco announced on Wednesday an agreement to supply EUP to US advanced reactor vendor Ultra Safe Nuclear Corp. (USNC) to "manufacture tri-structural isotopic (Triso) particles and fully ceramic micro-encapsulated fuel" through USNC's planned joint venture with Framatome. But Ultra Safe's microreactor design specs require high-assay low-enriched uranium (Haleu) enriched to 19.75%, and Urenco did not specify that it would supply Haleu. Urenco's New Mexico enrichment facility is not currently licensed to produce Haleu, though Urenco applied in 2021 for a license amendment to enrich up to 10% with "additional flexibility for potential further enrichment increases." It therefore remains unclear how the USNC-Framatome JV will secure Haleu to produce the Triso fuel.

Regardless of enrichment level, USNC's EUP will be produced in Urenco's New Mexico centrifuge enrichment plant, with the first batch scheduled for delivery in 2025 — when the USNC-Framatome joint venture is set to begin operations. This fuel will then be used for USNC's modular microreactors, though "with some availability to the wider advanced reactor market."

Advanced nuclear fuel technology company Lightbridge is also making strides towards commercializing its own fuel, which it hopes will significantly enhance reactor safety and economics for the existing fleet. The company announced this week that it demonstrated a nuclear fuel casting process using depleted uranium under a government innovation program. The fuel is meant for use in existing light water and pressurized heavy water reactors, though Lightbridge is also developing a version for small modular reactors.

Juniors on the Move

Multiple Canadian juniors also reported developments this week. Baselode Energy Corp. announced an exploration agreement with English River First Nation on its Catharsis project in northern Saskatchewan. Fission Uranium Corp announced that it has filed a feasibility study for its PLS project in the Athabasca Basin. The study estimates that the project could produce 90.9 million pounds U308 over a 10-year mine life at an average unit operating cost of \$13.02 per pound U308. And following the annulment of a Nigerien court order against Global Atomic's Niger subsidiary, Global Atomic announced a C\$50 million (US\$36.8 million) bought deal public offering.

The uranium spot market price fell by more than a dollar this week, and Sprott Physical Uranium Trust's buying remained at just 100,000 lbs. U3O8 for the second week in a row. The average price assessment delivered by Energy Intelligence's Uranium Price Panel was \$50.57/lb. U3O8, down from \$51.79/lb. last week.

Grace Symes, London

URANIUMPRICEPANEL

	0.1.2,2020													
					We	ekly Spot N	Aarket Price	es						
		Mar	ar Feb					Ja	an		Dec			
	Chg.	2	23	16	9	2	26	19	12	5	22	15	8	1
Price (\$/lb U3O8)	-1.23	50.57	51.79	51.59	50.40	51.00	50.13	49.03	50.37	48.56	47.86	47.69	48.04	49.43
Total Assessments	-3.00	8.00	11.00	11.00	7.00	8.00	11.00	10.00	10.00	8.00	9.00	10.00	8.00	8.00
% within 1 StDev	23.86	87.50	63.64	72.73	71.43	75.00	72.73	70.00	90.00	62.50	55.56	90.00	75.00	75.00
Low (\$/lb U3O8)	-1.10	50.50	51.60	51.00	50.00	50.50	49.30	48.60	50.25	48.25	47.50	47.50	47.50	49.00
High (\$/lb U3O8)	-1.20	50.80	52.00	52.00	51.00	51.50	51.00	50.00	50.50	49.25	48.75	48.00	48.50	50.00
Variability*	-0.07	0.05	0.12	0.26	0.25	0.25	0.85	0.21	0.04	0.35	0.38	0.14	0.10	0.00
*This represents the valu	ue of the potent	ial range of c	onceivable f	inal averages	s that might r	esult when r	andom elimi	nation is use	d to balance	market posit	ions within t	he panel.		

CORPORATE

The Perils of Reliance on Russian Uranium Enrichment

Uranium enrichment trader Centrus may be the US company most exposed to the risk of geopolitics halting the import of Russian– supplied low–enriched uranium (LEU) to the US. Centrus' under– lying business model has for the past decade consisted of pur– chasing large quantities of uranium enrichment from Rosatom subsidiary Tenex, under a long–term contract now slated to finish in 2028, and then selling the material onto US nuclear operators at a higher price.

Multiple scenarios threaten to undermine that business model, including Canadian transport sanctions barring the last remaining carrier of Russian LEU to the US, Washington restricting the imports, or Moscow immediately cutting off all supplies to Centrus. Any of these scenarios would have a negative impact on Centrus, but the worst case involves an immediate cut-off of its Russian supply. "If they don't get the Tenex material, they're done," one market source told Energy Intelligence.

Following the closure in 2013 of its gaseous diffusion uranium enrichment plant in Kentucky, Centrus — then known as the US Enrichment Corp., or Usec — shifted from selling its own production to trading uranium enrichment. Longer term Centrus aims to bring its advanced centrifuge demonstration project to commercialization, first through the production of high-assay low-enriched uranium and possibly then through the production of LEU. This would allow Centrus to sell its own production again, but it's years away, if it happens at all, and meanwhile Centrus will remain a highly-exposed intermediary.

Centrus now supplies less than 5% of the global market for enrichment services, which is measured in separative work units (SWU). The world's largest SWU producer is Tenex, and Centrus' current business model largely entails receiving Tenex LEU in the US, selling the SWU to US customers, and then shipping back to Russia natural UF6 likely acquired from customers. This entails receiving Tenex LEU in the US, selling the SWU to US customers, and then shipping back to Russia natural UF6 likely acquired from customers. SWU and LEU sales account for approximately 80% of Centrus' revenue, according to the company's annual results, meaning its profits rest largely on its ability to continue flipping Tenex-sourced Russian SWU to end-user customers.

Centrus' second-largest SWU supplier is French governmentowned Orano, with which it has a long-term SWU contract starting this year and lasting through 2030.

Out on a Ledge

Even with that Orano supply, much of Centrus' ability to fulfill its \$1 billion order book, which extends through 2029, would be at

risk if the company is suddenly left without Tenex supply. "I think they're hugely exposed," said one market source, adding that even if Centrus could find alternate SWU supply, it would be at a much higher price than the company's contract with Tenex. The Tenex contract is partly related to spot prices, and after a renegotiation in 2018, Centrus is paying below-market prices for the Russian SWU.

Centrus' entire SWU inventory at the end of 2022 was worth \$24.1 million — less than the amount of SWU the company borrowed this year, and significantly less than its \$1 billion order book, even if that figure includes some sales of uranium and technical solutions. However, Energy Intelligence understands that the \$319 million of that order book already paid for in advance by customers is sitting at fuel fabrication facilities, meaning Centrus still has to take delivery of and source material to fulfill only the remaining \$681 million of order book contracts.

Centrus has significantly increased its SWU borrowing this year, as it aims to "further diversify" its supply sources and "obtain additional short and long-term supplies of LEU," according to its annual report. In 2022, Centrus borrowed \$28.3 million of SWU, marking a substantial increase from the \$20.7 million of SWU it borrowed between 2018 and 2020. These values are based on "the anticipated sourcing of inventory for repayment at the date of acquisition." Centrus expects to pay back its inventory loans in 2023–25.

Energy Intelligence understands that much of this borrowed SWU is Japanese. Over the past few years, traders and suppliers have been able to borrow Japanese inventories — mostly held as UF6 and LEU — and flip the material into supply contracts with utilities, before repaying it in kind. As Japanese reactor restarts continue to proceed at an anemic pace, this represents a key source of supply for Centrus considering the multiple risks it faces.

The Risks at Home and Abroad

Centrus' most existential risk is that the Kremlin cuts off all further Tenex sales to Centrus overnight, perhaps following some escalation in Ukraine or in retaliation to US measures against Rosatom. In such a scenario, Centrus would be suddenly forced to scramble for supply to service its contracts in the US and abroad. It's not clear to what extent supplies from Orano, spot purchases, loans and Centrus' existing inventories would suffice in such a scenario, or how much they would cost. Multiple sources speculated that Centrus might be motivated in such a scenario to borrow non-Russian origin material from Japanese operators to fulfill contracts with US utilities, and to then repay these loans with Russian-sourced enrichment.

The trader would face a slightly less dire situation if it maintained access to Tenex supplies, but these supplies were unable to be shipped to the US. This is actually the most realistic near-term threat to Centrus, as it could arise from sanctions imposed by Canada on the transportation of LEU from Russia by Canadianowned companies. The carrier Tenex uses to ship Russian LEU, Atlantic Ro-Ro, is Canadian, and is currently operating under a waiver that allows it to continue shipping the material from St. Petersburg to US ports. But this waiver is set to expire in July.

If that waiver is not renewed and no alternative transport method is found, Centrus would still have options: it could potentially redirect SWU purchased from Tenex to other customers in Europe and Asia. This might prove difficult, however, as Centrus would be competing with Tenex in non–US markets. Tenex "is fighting like hell" in the markets where it still has a foothold, according to one source, and because Tenex knows exactly how much Centrus is paying for most of its SWU and LEU, it would know precisely how to underbid the company.

Of all the risks Centrus faces, its business model is least likely to be directly undermined by policymakers in Washington, where Centrus CEO Dan Poneman — a former deputy secretary of energy — remains well-connected. If US lawmakers enact the current leading proposal to ban Russian nuclear fuel imports, alongside waivers through 2028 and billions in federal funding for domestic enrichment capacity, then Centrus may well weather the storm. Centrus would almost certainly receive a waiver under the new law, and its advanced centrifuge demonstration project would be in a pole position to receive federal funding despite longstanding concerns about its large centrifuges' technical readiness.

Any such move from Washington, of course, risks provoking a harsh response from Moscow, in line with the escalatory logic of the past year. While the US has not yet sanctioned Rosatom itself, on Feb. 24 the Department of State announced sanctions on two Rosatom subsidiaries, a research center that carries out research for Rosatom, and the Russian organization that took control of Ukraine's Zaporozhzhia plant. Even Tenex now sees its Centrus contract as "a potential risk," according to one source, though not one large enough to stop it from signing another contract with the company.

Grace Symes, London, Jessica Sondgeroth, Washington

UNITED STATES Pro-Nuclear Bills Pour into State Legislatures

US state efforts to repeal nuclear construction moratoriums are picking up steam as lawmakers eye small modular reactors (SMRs) and advanced nuclear technologies. This is driven by multiple factors, including ever-stricter state decarbonization goals and the economic opportunities provided by new federal incentives, particularly the billions of dollars in cost-share awards for advanced reactor demonstration projects. For now, however, the majority of state interest is in enabling a nuclear option, not necessarily in committing to reactor newbuilds. At least five states — Kentucky, Montana, West Virginia, Wisconsin and Alaska — have over the past several years repealed moratoriums on nuclear energy dating back to the 1970s. Today 11 states still have them intact, but a handful, including Illinois and California, are considering legislation to partially repeal their moratorium and open up their options to advanced nuclear energy. Last year, Connecticut paved the way and enacted an exemption to its moratorium for SMRs at its sole Millstone nuclear power plant site. After repealing its nuclear ban in 2010, Alaska enacted legislation in 2022 to streamline the local permitting of advanced reactors with a capacity of 50 megawatts or less, paving the way for the possible deployment of microreactors at remote communities or oil platforms. And Indiana lawmakers voted last year to support the development of SMRs at retired fossil fuel plants, following Wyoming's example in 2020.

The National Conference of State Legislatures (NCSL) tracks state energy policies, and since 2016 "has seen a near-doubling in nuclear energy-related policies considered by state legislatures — up from 74 total bills considered in 2016 to more than 160 bills during" the latest legislative sessions. Daniel Shea, who tracks state energy issues for the NCSL, told Energy Intelligence that states are attracted to nuclear energy for its reliability attributes, to meet decarbonization goals, and to take advantage of federal incentives.

Multiple Incentives

The 2022 Inflation Reduction Act not only provides production tax credits in 2024 for existing reactors, but it also opens up investment tax credits to advanced reactors that enter service after 2024 and introduces a new production tax credit for carbon-free electricity generation in 2025, along with a coal-to-nuclear bonus tax credit and clean hydrogen production tax credit. That's all in addition to the 2021 Bipartisan Infrastructure Investment and Jobs Act that provided \$2.5 billion — funding levels that attract jobs and provide local economic benefits — to demonstrate two advanced reactor designs: one in Wyoming and one in Washington state.

"For states that are transitioning from a traditional baseload generating fleet, there's some comfort in transitioning between like resources — coal and nuclear can operate in relatively similar fashions," Shea said, adding that nuclear could provide a transition for fossil fuel workforces. But as to why the focus is less on existing and proven large light-water reactor designs and more on advanced reactor designs, Shea speculated that "the capacity requirements over the past several decades have not been as substantial as when the US was building larger lightwater reactors." There's also the precedent of the cost overruns at the Vogtle newbuild project in Georgia, and the canceled VC Summer project in South Carolina. "I think that's certainly scared some people off," Shea said.

Shea noted that the initial costs touted by bullish advanced reactor and SMR vendors — a levelized cost of energy (LCOE) around \$70-\$90 per megawatt hour — appear more competitive than any new large reactors. Lazard's latest 2021 LCOE Analysis puts

existing nuclear at \$131-\$204/MWh, though that plunges to a marginal operating cost of \$29/MWh once the plant has been fully depreciated. It's hard to compare SMR or advanced reactor costs at this stage, of course, as most designs are preliminary, and costs will shift as the designs mature and real-world supply chain costs come into play.

In the meantime, federal funding for demonstration programs and tax incentives offer states a chance to develop technologies that in the near term could provide jobs and, if successful, could bring in supply chain infrastructure and long-term economic opportunity.

Nuclear Push and Pull

More than a dozen state moratoriums were enacted between the 1970s and 1990s, several of which were the result of voter referendums concerned with nuclear safety. Anti-nuclear sentiment picked up considerably following the 1979 partial meltdown of Three Mile Island-2, the worst accident in the US commercial nuclear fleet. Six states — including California, Illinois and Connecticut — also used various nuclear bans to hold the US government's feet to the fire when it came to the disposal of the nation's civilian spent nuclear fuel. State lawmakers enacted conditional moratoriums that would be lifted if the US government finally achieved a permanent disposal solution. Though a final waste solution is still a long way away, prioritization of decarbonization and energy security — especially given outages during recent extreme weather events — has now seen many states reverse course.

California currently prohibits state agencies from certifying nuclear power construction, but a proposed bill currently working its way through the state legislature would exempt SMRs. This isn't the first time a repeal of the ban has been introduced, but this latest push comes after the state legislated a pathway to keep the Diablo Canyon nuclear plant operating beyond 2025 and provided a \$1.4 loan to support that effort. The California legislation has yet to move out of committee.

Illinois — which has 11 operating reactors and has twice enacted nuclear subsidies for nearly half of them — this week saw its lawmakers debate a Democratic-led bill to remove its moratorium on new nuclear construction. With little opposition and plenty of hype around advanced reactors, the Illinois House Public Utilities Committee voted on Feb. 28 in favor of the bill.

"What's the harm of opening this up and letting Illinois let the market play out? Let the science play out," Republican Illinois state Rep. Dan Caulkins said in this week's hearing. "By keeping this moratorium in place, aren't we putting an artificial barrier up for future development?" This was countered by Nuclear Energy Information Services Director David Kraft, who testified at the hearing that "the market has played out, and the market required over \$3 billion of [state] bailouts for the existing reactors we have. If you add more, that's gonna distort the market more and it'll prevent the access of renewables to the transmission grid that we have." Indeed, not every pro-nuclear bill is being met with open arms. Colorado, Virginia and Minnesota have each recently dropped pro-nuclear language from consideration in their state clean energy plans.

Jessica Sondgeroth, Washington

CHINA Huaneng Accelerates Shidao Bay Newbuild Plans

China Huaneng Group is accelerating plans to build four new Hualong–One reactors at the Shidao Bay site in the northern Chinese province of Shandong, where it claims to have completed the commissioning of a much smaller 200–megawatt demon– stration plant consisting of twin–unit high–temperature gas– cooled reactors (HTRs).

China's second-largest electricity generator has long planned the Shidao Bay projects as part of its push into nuclear, but in regulatory documents released Feb. 14 it's clear that China Huaneng is hoping to reach a first concrete date (FCD) milestone this year for at least the initial 1.2 gigawatt Hualong-One reactors it is planning. For the first two reactors, Huaneng aims "to begin construction in 2023, targeting a 62-month construction period each, to be spaced 10 months apart," Huaneng revealed in the environmental impact (construction phase) study recently submitted to the Ministry of Ecology and Environment. That's a significant acceleration from last year, when the company's wholly-owned Huaneng Nuclear Power Development Co. said it was targeting an FCD by end-2025. Under Huaneng's new schedule, however, the two newbuilds are "expected to be completed and start generating electricity in 2028."

Shidao Bay's initial two Hualong-Ones will be built under what Huaneng describes as a "Phase-1 extension" of its Shidao Bay project, of which the HTR demonstration plant has "already entered commercial operations," the company said. But while Huaneng is just a minority partner in the HTR demonstration plant — the company has a controlling stake of 47.5% in that project, with China Nuclear Engineering & Construction Corp. holding 32.5% and Tsinghua University 20% — for the Shidao Bay Hualong-Ones it will control a 75% stake via three subsidiaries, with State Nuclear Power Technology Corporation (SNPTC) taking the remaining 25%.

Huaneng is the fourth Chinese generating company with a license to own and operate nuclear reactors, following China National Nuclear Corp. (CNNC), China General Nuclear (CGN) and SNPTC parent company State Power Investment Corp. (SPIC). Huaneng clinched State Council approval in 2020 for the Changjiang-3 and -4 reactors currently under construction on Hainan island — also



based on the Hualong-One technology — marking Huaneng's first entry into China's exclusive nuclear club.

The Taipingling Reference Plant

"We intend to utilize the Hualong-One technology for building the two Shidao Bay Phase-1 new reactors, referencing the Taipingling Phase-1 reactors by CGN in Guangdong," said Huaneng. CGN's Taipingling-1 and -2 reactors are among China's first-of-a-kind reactors using the integrated Hualong-One technology designed by the CGN and CNNC joint venture named Hualong-One Corp.

The two Taipingling reactors — also known as Huizhou-1 and -2 — have entered the equipment installation phase and are expected to commence operations in 2025 and 2026, respectively, said CGN in its fourth-quarter 2022 report. That's roughly six years after both projects marked their FCD milestones, in December 2019 and October 2020, respectively. CGN also plans to build two further Hualong-One reactors, Taipingling-3 and -4, at the same site.

Huaneng's timeline at Shidao Bay might be on the optimistic side. Even if it manages to secure all the necessary government approvals to start construction on the initial Shidao Bay Hualong-Ones this year, it would have only five years before the 2028 target of electricity production.

And given the typical gap of at least around a year to move from the stage of environmental impact study to final approval, the green light from Beijing for FCDs at Shidao Bay might come only in 2024, Shanghai-based David Fishman, a senior manager with the Lantau Group energy consultancy, told Energy Intelligence. This would then make the 2028 target even more uncertain.

The Uncertainties of Shidao Bay

Uncertainty is increasingly an important characteristic of many Shidao Bay nuclear projects, particularly given how little public information is coming out about them.

Take Huaneng's own HTR demonstration plant. "The HTR demo unit sited at the northeastern side of the Shidao Bay Phase-1 project has already entered commercial operations," Huaneng said in its environmental impact report, which was dated January 2023. But the company did not specify the exact date that commercial operations began, and its progress appears not to have been shared with the International Atomic Energy Agency (IAEA). The latest data from that Vienna-based agency shows that the HTR plant was connected to the grid in December 2021, but reveals no further progress. And according to the China's National Nuclear Safety Administration (NNSA), the HTR demonstration plant "loaded first fuel on Aug. 21, 2021 and had not yet reached commercial operations as of end-December, 2022." NNSA data also showed that the HTR demonstration plant generated a total of just 3 gigawatt hours of electricity in 2022, of which 1 GWh was dispatched to the grid.

Or take SPIC, which is building a pair of enormous SNPTCdesigned 1500–MW CAP1400 reactors at the Shidao Bay site. These first-of-a-kind CAP1400 twin reactors reached FCD milestones in early 2019 and 2020, respectively, though public statements have been scarce, and the newbuilds don't even appear in the IAEA's power reactor database. Unit 1 of these CAP1400 is now targeted for completion by SPIC by the end of this year, while the second CAP1400 reactor is scheduled for completion in end-June 2024.

But SPIC's scheduling also appears optimistic. Completion by end-2023 for CAP1400 Unit 1 implies a construction period of just under five years, which would be "a very ambitious goal for a first-of-a-kind reactor," Fishman observed. SPIC has so far been rather secretive about the progress of construction on its CAP1400s. The latest official update came from the NNSA, which said in a Jan. 20 safety report that CAP1400-1 — also known as Guohe-1 — was "undergoing pre-commissioning inspections after cold testing."

Kim Feng Wong, Singapore

INTERVIEW Candu CEO on the Future of SNC-Lavalin's Nuclear Business

On the sidelines of the Canadian Nuclear Association's (CNA's) annual meeting in Ottawa last week Energy Intelligence's Phil Chaffee sat down with Bill Fox, the head of SNC-Lavalin's Canadian nuclear operations and the President and CEO of Candu Energy, the SNC-Lavalin subsidiary that in a previous incarnation was responsible for designing and supplying Candu reactors in Canada and across the world. For the moment SNC-Lavalin is focused on helping enable the refurbishment of Candu reactors at Darlington and Bruce, two multi-unit sites in Ontario, and is providing "design, engineering and procurement support" to the GE-Hitachi-supplied BWRX-300 planned for Darlington, likely to be the first commercial small modular reactor (SMR) in North America. But Fox explained that SNC-Lavalin is still thinking bigger than just supporting other vendors. A shortened and edited version of the interview with Fox appears below.

Q: We just saw this big agreement for SNC-Lavalin to play a major role in the Darlington SMR project. Where does that fit into SNC's — and I guess Candu Energy's — broader nuclear strategy at this point?

A: SNC-Lavalin, a pioneer of nuclear in Canada, has its roots in the AECL company (Atomic Energy of Canada Limited), when we purchased all the commercial nuclear assets of AECL in 2011. And that [AECL] legacy dates back to the late '50s. So when we talk about SNC-Lavalin and nuclear, whether it be nuclear research, nuclear development, or new nuclear, we're part of the equation to get there. And because of our relationship and experiences, through



the AECL legacy, where we helped develop all 19 reactors that are operating in Canada, it puts us in a prime position to take this industry further in Canada.

We're in a renaissance now. Some people say we're at the foothills of a mountain that's going to be powerful and game-changing for the country of Canada, and that not only is being driven by all of the initiatives for carbon Net Zero, but also initiatives for energy growth and electric vehicles and population growth.

And we're going to be part of the equation. We're the only Canadian company — in Canada — that has developed from concept to putting in operation nuclear power reactors, through the licensing, preliminary design, and procurement stages of large components, and through detailed engineering construction. And we did that not only in the early stages with AECL and working with Ontario Hydro — the legacy company of OPG [Ontario Power Generation] — but also as ourselves, as we put these plants in operation around the world with utilities outside of Canada. And so we're proud OPG selected us as part of this integrated project team [for the Darlington SMR].

One of the reasons we're here today is because of what we've done so well for the industry in the last seven or eight years, and that's to execute multibillion-dollar projects for the clients and customers of Ontario, in the refurbishment of their nuclear reactors, in delivering projects on time and on budget.

Q: Obviously you played a huge role in these refurbishments, as you will in the Darlington SMR. But as far as I know, there are no plans for Candu newbuilds. Why not?

A: In fact, we've been planning a newbuild Candu for years, and we never stopped planning.

We've been developing our technology since the acquisition of the commercial operations of AECL, and looking at advanced reactor designs. Everybody's moving to advanced designs: passive designs, modular designs, designs that are more economical, that are built with digital tools, and reducing valves and making components more passive than active, with [no] operator intervention required. We've been doing all that, we've been working on multiple different technologies, and advancing them.

But development can only go so far until you have a customer that says "I want one, and I'm willing to pay for one."

So we have been working — quietly, but we have certainly been working to this point in time. We knew there was going to be a need, with the aligning of the stars between carbon Net Zero and electrical energy growth. And so we're ready to emerge from the positioning we've done, bring together more people in Canada that are in our nuclear industry family, and execute this project together. And I think the government's aligning, our utilities are aligning, and we're ready to launch this thing to get the next generation going.

Q: When you talk about launching what you have done, are you talking about the ACR-1000 or about some other design?

A: It's a combination of a lot. We can take off on the EC6. We can take off on the ACR [advanced Candu reactor] design. We can take off some of the work we were doing with our Argentine customer, and of course [our work] in China. So we're going to have to put together all of those kinds of programs and pick the best pieces of all of them, with a focus on safety, with a focus on economics. We know that the responsibility we have is to put a plant out there that is cost–effective, that's right for our customers, and that's right for the citizens of Canada to pay a low price for a highly–valued, reliable energy source. We've got to be competitive and use our digital tools and some of the aspects that we've done and research and advanced skills.

And we're also looking at what the right power slot is. Is it 800 megawatts? Is it 1000 MW? Getting that right — it has to be bound by the economics. That's what people will buy a plant on.

Q: You mentioned China. Obviously, you spent a lot of years working with CNNC (China National Nuclear Corp.) and China developing ACR technology. Then the geopolitics shifted, and I imagine that project is not going forward. But what has come out of that? What did you take away from that project that you could now offer into Canada?

A: Well that's a big part of what we have to offer for putting together next the next phase of this program. So you take the ACR, which was a large reactor of 1000 MW or more, and if a big reactor is where we slot this new design, a lot of what we did is going to be reused and repurposed and put in place, with an eye toward optimization and economization. It's not wasted at all.

Q: Have you started? I know that Ontario's independent electricity system operator recently released this aspirational 17.8 gigawatt number of new nuclear capacity by 2050, presumably not all of which would come from SMRs, but also large nuclear. Have you injected yourself into this discussion?

A: Absolutely. I mean, essentially 18 GW — that's massive. If you think about what it takes to put that into the grid in the next 25 years — which is the goal, by 2050 — we're going to launch a build program in Canada for large reactors like we saw in the last half of the 20th century, when we built all the operating reactors that are in Canada today. I mean, that's a new reactor going online, into the grid, once a year for 20 years in a row. Think about that. It seems like a daunting feat. And in today's world, people will say "You know, that's almost impossible." But we've done it before, and other countries are doing it.

I think it's going to be a mix of large reactors and SMRs in that deployment. Because the economies of a large reactor in more remote areas, where the grids aren't as large, the population centers aren't as big ... the economics doesn't work for a large reactor. So I think it's an all of the above equation. And we also think that there's a big spot in that solution for renewables like hydro, wind and solar, working alongside nuclear.

Q: If OPG or others were to pursue a large-scale newbuild you presumably have a home-court advantage to a certain extent, being the original equipment manufacturer (OEM) of the Candu technology. Do you also have a home-court disadvantage, given the political scandals that have enveloped SNC and the government over the past decade?

A: A home-court advantage, definitely. And the reason I say that is just look at the world and the geopolitical situation. The days of trying to rely on other countries for your survivability and sustainability — I think those days are over. I think the pandemic showed that if we're if we have to rely on other countries for medicines and things like that, you see where it got us.

The key now is on energy security and energy independence. We want to be able to control our destiny with a domestic technology and supply chain like a Candu reactor has. A reactor that runs on natural uranium. We mine it here. We manufacture fuel here. We're not relying on anybody else. And many of the components of a Candu reactor are manufactured right here in Ontario. I think Canada has a more mature supply chain from a nuclear pedigree standpoint than many other countries in the world. And the refurbishments at Bruce and Darlington will ensure that status is maintained for decades.

So advantage, huge. Disadvantage? We keep hearing that. And I don't think so. But I think people will realize the proof is in the results, and if we can deliver for the citizens of Canada, and if we can deliver for our customers. To me, that's what matters.

Q: We've talked about Canada, but what about export projects? I'll get to the specific newbuild plans of Argentina and Romania, but beyond those — are you doing any active marketing for newbuilds?

A: You can pick up an industry magazine or info every day and see countries cutting a deal on new nuclear somewhere in the world. What's interesting to note is that companies are not really selling to other companies. Countries are selling to other countries. I don't mean that literally, with contracts and agreements, but I mean in terms of paving the road with intergovernmental agreements, loan guarantees, project guarantees to finish. Because a lot of countries that aren't as well off as Canada and the US aren't going to have the external wherewithal to put in these large reactors, and they're going to need some sort of surety from external sources — export credit agencies, and guarantees from governments like completion guarantees, for example.

We are working with those places around the world. But when you take a new design into a foreign country, the first question you get is "Show me your plant operating like this in your home country."

I think Canada is now moving in a great direction with the move toward large reactors. At the CNA this week all the talk is about large reactors, where years ago it was only the small reactors. We're gonna do this in Canada, and I'm so bullish on the fact that we come out of the gate strong. Because that's what's going to pave the road into other countries, and with the government of Canada backing us. We're optimistic that that's going to be there for our current projects in Romania, and I think we're going to have a great springboard to go forward with.

Q: What's your role going to be in Romania?

A: Well there are two major projects going on in Romania right now.

We build Cernavoda-1 and -2 years ago, and they went into service. Unit 1 was 25–26 years ago, and Unit 2 was seven years later. Those plants are designed with a certain lifespan, and Unit 1 is approaching the end of its design life. We designed for a certain lifespan of so many hours of power reactor operating years. So our customers come to us because of our experiences with refurbishments. We call it a midlife refurbishment to get 30 more years, which is what we're doing at Darlington and Bruce. Cernavoda-1 is coming to that phase, and they're talking to us because of our experience with the refurbishments and our position as an OEM [original equipment manufacturer], as the designer and builder of that plant. We're in a prime position to do that, and we have announced some pre-project works for those units to set the stage for where we're going to go forward. The unit is going to come down in late 2027, and we're going to be in a position to move into Romania for a full refurbishment of Unit 1.

Now, that's one project, completely independent from the other aspirations: finishing what we started 30 years ago on Units 3 and 4, which were substantially started with construction, with much of the civil works already placed, but it was terminated before they got into the mechanical [work]. The same design was going to be moved from Unit 2 to Units 3 and 4.

So we're in discussions now with Romania, and what's pushing this is the same thing that's pushing everything else: greenhouse gas emissions, and in Eastern Europe, it's more about energy security and energy independence. If you look at the world politics happening in Eastern Europe, with the conflict in Ukraine, they want to be independent. And it's a very mature Candu nuclear country; they have a licensing infrastructure and a supply chain that's been supporting those plants. We have been working in Romania almost constantly since the plants were built to help them service and maintain those reactors. We're talking to them, with some other partners from the US, through an intergovernmental agreement between the US and Romania. And in trying to move that plant onto the next phase of its contracting, to give them what they want: two more reactors.

Q: And what about Argentina?

A: Argentina is a bit more geopolitical. We were there. We have a unit there at Embalse, and it has been operating very well. We

continue to service Embalse, to help them with engineering services and maintenance and outages services. But when we were starting that plant it got complicated with other countries, and financing, and some other commercial challenges. But we haven't given up on Argentina.

Nothing is firm there. But we continue to follow that because at some point, with a Candu reactor that's been operating wonder-fully there, it makes sense to go to the next phase.

Q: When I interviewed [Argentine operator] Nucleoelectrica Argentina President Jose Luis Antunez a year ago, he made a point about returning to the Candu newbuild plans after it was canceled by the previous government of Mauricio Macri. My understanding about the role of SNC-Lavalin is that there was previously a technology transfer of Candu technology, so they own the old technology of the EC6, but all of the upgrades that you have made over the subsequent decades — if they want access to those, you would have to have a role. Does that summarize it?

A: That's a fair summary.

Q: Are you in active talks with them?

A: We never stopped talking to them. But actively negotiating a contract — I'm not going to say we are. But from a pursuit perspective, it's certainly still there.

Q: Back to Canada, where are you most excited to potentially actually get a new newbuild off the ground?

A: The most favorable and nuclear-friendly province is Ontario, of course, and that's where the needs are. And so if you want to kick off a project, and you want to go back to the bread and butter and roots of where your existing fleet currently operates, Bruce Power and OPG are prime candidates to be in those positions. We're going to come out of refurbishment in a few years, and those units

will be fit for another 30 years. And OPG is pursuing the SMR, and we're working very diligently with them.

It's a bold mode move, and bullish, but OPG and Bruce Power both say "What's next, even after SMRs?" And as I said, we're going to have to deploy these [SMRs and large reactors] together, not one after the other, but together. And so I think it's going to be in Ontario. There are sites available. Now, for each of these sites there's a permitting process, an environmental approval process. And that process is a very lengthy process. We could have a plant ready to build way before that permitting is resolved. But I think there's a lot of work that's going on in government and other regulatory agencies to look at how we can expedite those.

Q: Final question, what would you like to see from the federal government to firmly launch a Canadian newbuild program?

A: Well the obvious answer is always funding. But support is the main thing. From a federal government standpoint, we need support, we need changes to help it be more efficient and streamlined through the regulatory process. The CNSC [Canadian Nuclear Safety Commission] has been wonderful in being open to — for some of these advanced designs — looking at different techniques to uphold the safety requirements. So that support is coming.

The financial backing of these things is always important too. Private companies like SNC-Lavalin and other companies, we're willing to invest, but it's a heavy lift, and support is required financially. Almost more important is a surety that there's a project. Because I've seen a lot of companies in the past 15 years that had a great widget, put a lot of money into the widget, got it done, but then nobody wants to buy it, and the company disappears. So we have to be careful with the balance. It's a balance between the surety of the product being deployed to meet the needs of the population, and the ability of the companies to deliver.

Phil Chaffee, Ottawa



URANIUM MARKET UPDATE

All prices as of Thursday, March 2, 2023



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.

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.



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.



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

	2023						2022						
С	Chg.	Feb	Jan	Dec	Nov	Oct	Sep	Aug	Jul	Jun	May	Apr	Mar
n (\$/lb U3O8)													
+1	1.50	50.00	48.50	47.00	49.00	47.50	48.50	47.50	45.50	45.50	46.00	52.50	51.00
+0	0.50	52.00	51.50	50.00	51.50	52.75	52.50	53.50	50.50	52.50	54.00	64.00	60.00
sion (\$/kgU)													
-0	0.50	38.00	38.50	38.00	38.00	38.00	36.00	36.00	32.00	30.00	30.00	28.00	26.00
-0	0.50	42.00	42.50	42.00	42.00	42.00	39.00	39.00	37.00	33.00	33.00	30.00	28.00
nent (\$/SWU)													
+5	5.00 1	20.00	115.00	100.00	93.00	93.00	92.00	90.00	89.50	84.00	84.00	82.00	100.00
-20	0.00 1	.30.00	150.00	110.00	96.00	96.00	96.00	92.00	95.00	150.00	150.00	150.00	150.00
+0 sion (\$/kgU) -0 -0 nent (\$/SWU) +5 -20	0.50 0.50 0.50 5.00 1 0.00 1	52.00 38.00 42.00 20.00 30.00	51.50 38.50 42.50 115.00 150.00	50.00 38.00 42.00 100.00 110.00	51.5038.0042.0093.0096.00	52.75 38.00 42.00 93.00 96.00	52.50 36.00 39.00 92.00 96.00	53.50 36.00 39.00 90.00 92.00	50.50 32.00 37.00 89.50 95.00	52.50 30.00 33.00 84.00 150.00	54.00 30.00 33.00 84.00 150.00	64.00 28.00 30.00 82.00 150.00	60 26 28 100 150

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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