NUCLEONICS WEEK

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Nuclear phase-out, EU capacity auction leave Belgium facing power gap

- **Nuclear power in 2020 to date has provided roughly 50% of Belgium's power**
- **Plans to build gas plant were rejected on environmental grounds earlier this year**

Belgium will end the use of nuclear energy in 2025, even if the government warns this could lead to power blackouts, according to French multinational power company Engie.

A coalition government last year decided against extending the lifespan of Belgium's two newest reactors, but is struggling to convince non-governmental organizations and regional governments that renewable energy and natural gas can fill the gap.

The Belgian government has said it will close all seven of Belgium's reactors by the end of 2025, switching instead to wind and solar power, but an Engie spokesperson said in an email Sept. 7 the French company was not holding out hope for the results of a national study into the need to maintain nuclear capacity in Belgium after 2025.

"Given the applicable legal, regulatory and operational constraints, an operating extension of the nuclear power plants is not an option," the spokesperson said.

Belgium has four reactors in the northern part of the country, Doel-1, -2, -3 and -4. These units have a combined capacity of 3.05 GW. A further three reactors, Tihange-1, -2 and -3, with a combined capacity of 3.16 GW, are located in the southern region of the country. The plants are operated and majority owned by Engie through its Belgian subsidiary Electrabel.

(continued on page 7)

Nuclear technology could spur low-carbon shipping transition: report

Nuclear power can produce zero-carbon fuels such as ammonia and hydrogen for marine shipping, as that industry strives to decarbonize, Clean Air Task Force, an environmental advocacy group, said in a white paper.

The International Maritime Organization, a United National agency with 174 member states, has established mandatory measures to reduce the carbon intensity of marine shipping from 2008 levels by 40% by 2030 and 50% by 2050.

CTF said in its report that nuclear power has sufficient energy density to supply zero-carbon fuels for a future fleet of ships.

Nuclear power is suitable to support long-distance shipping in part because of "the firm and available nature of nuclear energy and the availability of high temperature steam, among others," the report said.

Marine vessels have used nuclear technology for more than 60 years. There are 160 ships on the water today powered by small reactors, mostly military vessels, according to the World Nuclear Association. Some commercial ships are powered by nuclear reactors, but that technology has yet to reach mainstream availability due to higher costs and regulatory barriers.

However, rather than direct propulsion, nuclear energy is better suited as an intermediate fuel source, Brett Rampal, director of Nuclear Innovation at Clean Air Task Force, said in an interview Aug. 11.

"There are large potential obstacles associated with direct propulsion for ships —

(continued on page 7)

Nuclear energy meets ESG criteria, group says

- **ESG criteria should be applies even-handedly, nuclear group says**
- **Nuclear power can meet ESG standards, despite challenges**
- **Awareness of nuclear as an ESG investment is needed: industry**

Nuclear power has a strong case that it meets environmental, social and governance standards, and should be considered investable by the financial community, an association of countries developing advanced nuclear reactors said in a report this month.

Nuclear power, however, has had "a higher hill to climb than other low-carbon energy sources" in persuading the public it meets the ESG standards, the Generation IV International Forum said in the report. Forum members include Canada, China, France, Japan, Russia, South Korea, the UK and the US. The group was established to collaborate on research and development of advanced reactor technologies.

One of the challenges is that ESG criteria have been applied independently by a variety of different governments and international

INSIDE THIS ISSUE

organizations, the report, prepared by a Forum task force, said.

The group said it supports efforts by the World Economic Forum to standardize ESG criteria, taking into account the WEF's attempts to integrate with standards of global financial accounting bodies, which have also described principals for such a review.

ESG investing has the potential to stimulate positive financial and social goals, but only if the criteria for it are applied in an even-handed way, the report authors said. ESG standards "need to be applied consistently across asset classes," they added.

While there has recently been more interest from the financial community in investing in nuclear power, "there is a real issue around ESG and ESG reporting by companies. Each nuclear company needs to report against a broad range of metrics," Fiona Reilly, managing director of FiRe Energy Ltd. and one of the reports author's, said in an interview Sept. 14.

The report "can be used for investors to talk to their own stakeholders to consider their strategies in investing in nuclear companies," Reilly said, adding that it provides "a positive but balanced case for nuclear industry."

ESG investment principles initially emerged as a way for socially conscious investors to screen investments that meet their goals, the report said, but increasingly such measures are seen as providing important guidance to help investors understand long-term risks from some kinds of businesses. Companies are beginning to report how they measure up against the ESG criteria, although there is a lack of standardization on the definition of such criteria, the report noted.

The nuclear industry faces a challenge in increasing the awareness of financial investors that nuclear power could meet ESG criteria.

Many financial institutions "do not have a clear view on the ESG case" for investment for new nuclear capacity, Darryl Murphy, head of infrastructure, real assets at Aviva Investors, said Sept. 15.

"Financing of large new reactors is clearly massive and likely to require wide access to debt and equity investors, both domestically and internationally," Murphy said in his remarks at a UK nuclear industry webinar organized by the Westminster Energy, Environment and Transport Forum.

Nuclear power ranked favorably

The group said in the report that nuclear power does well when compared with the governance standards under ESG, because of the level of transparency and openness generally applied to the power source.

The industry, for example, typically has "gold standard training" on how to identify bribery, corruption and money laundering, it said.

While nuclear power is a low-carbon energy source, making it rate highly in environmental criteria, it is sometimes viewed as having a problem with waste generation, the report authors said. However, all forms of energy generation create waste, and nuclear energy has an advanced plan for managing this, they said.

"There is more that can be done, but nuclear leads the energy sector in decommissioning and the mitigation and management of waste," the report said, noting that large amounts of money are set

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aside for waste management and decommissioning of nuclear facilities.

Also, uranium mining has been subject to regulation of its environmental and pollution impacts for decades, the group said. Other energy activities that involved mining for fuel or materials used to make components for power facilities should also be judged on such attributes, it added.

"Nuclear, as an asset class, has the ability to report at least as well as or better than other energy sources against all these ESG" criteria, the report concluded. Investors should ask the same questions they ask about nuclear energy to operators of other energy technologies for a fair comparison to be made, the group said.

Simplistic taxonomies?

The report said some countries and groups of countries have embarked on establishing "taxonomies" that define what sources constitute clean energy for purposes of investment.

Such taxonomies can be helpful, but the group warned against those categorizations being "too simplistic," noting that a pass/fail approach for entire sectors is unwise.

The European Union has established a clean energy finance taxonomy in which the goal is to determine whether a class of investments should be considered to be "sustainable." The EU has not made a decision about whether nuclear energy should be included as sustainable. Two expert groups advising the European Commission have said nuclear energy is as sustainable as many other clean energy sources, but there is political opposition from some EU member countries, which have expressed concern about the creation of waste during the production of nuclear energy.

Reilly said that "taxonomies are policy frameworks, but do not negate need for ESG reporting by companies." She noted that "some countries using taxonomies to say this asset is sustainable and this is not (which can be harmful), but the investor community will require ESG reporting regardless of taxonomy."

High-level nuclear waste, including spent fuel, can be disposed of in geologic repositories, and while no such repository is yet operating for commercial spent fuel, plans are advancing in many countries to build such facilities, the group said. Nuclear power is unusual in that the costs for disposal of such waste and decommissioning of nuclear plants are pre-paid by operators, it added.

— *William Freebairn, Oliver Adelman*

Sizewell C construction to start 'as soon as possible' after site license

EDF Energy hopes to start the "early stages of construction" on its proposed 3.2 GW Sizewell C nuclear plant in eastern England "as soon as possible" after it receives a nuclear site license and other permits by the end of the first half of 2022, the project's managing director said during a London webinar Sept. 15.

Humphrey Cadoux-Hudson was speaking at the "Next steps for developing the UK nuclear sector and delivering new build projects" webinar, organized by the Westminster Energy, Environment & Transport Forum. The annual conference was held as a virtual event this year due to the coronavirus pandemic.

Cadoux-Hudson noted that the process to obtain a Development Consent Order for Sizewell C, another key regulatory approval needed for the project, had started in May 2020 and was also expected to be completed by the "middle of next year." Any move to start construction is still pending a final decision on behalf of EDF Energy to invest in the Sizewell C project.

A DCO is issued by the UK government's Department of Business, Energy and Industrial Strategy, following an investigation by a dedicated planning body, the Planning Inspectorate. BEIS is in charge of nuclear energy policy in the UK. In addition to the DCO, a nuclear site license for the project must also be issued by the UK's Nuclear Regulation Authority.

We will be in a "strong place with the site license and permits by the middle of 2022," Cadoux-Hudson said, while also noting that "good progress" was being made in discussions between EDF Energy and the UK government about establishing a Regulated Asset Base funding model for new nuclear construction in the UK.

The construction of the 3.2-GW Hinkley Point C, the only nuclear plant now being built in the UK, is being funded through a contract for difference, essentially a government-guaranteed price for the power. However, EDF Energy, multiple nuclear power sector participants and even the UK government have called for a move to the regulated asset base funding model for the construction of Sizewell C and any other large new nuclear units in the UK.

Under the RAB funding model, UK energy regulator Office of Gas and Electricity Markets would establish an estimated allowable cost for a nuclear project and set a fixed rate of return for investors. Payments from UK retail power consumers would be made during construction and operation to a project company building a plant, with payments increasing over the construction period in line with cumulative spending.

Cadoux-Hudson said that the RAB funding model would "allow a sharing of risk between investors, consumers and the taxpayer."

BEIS sees progress in RAB talks

Speaking during the same webinar Sept. 15, Declan Burke, director, nuclear projects and development at BEIS, also characterized the negotiations between EDF Energy and BEIS as positive and making good progress, but noted that legislation passed by Parliament would be required in order to establish a framework for the RAB funding model to be applied to nuclear construction.

Burke declined to provide a specific timeline as to how long this would take, but did say that the legislation would be put before Parliament for a final vote during the "current parliament," which will run until the next election. The government of UK Prime Minister Boris Johnson has considerable latitude as to the exact timing of the next election, but it must take place no later than December 2024.

Cadoux-Hudson also said that EDF Energy was "very focused on making the time gap" between construction of Hinkley Point C and Sizewell C as short of possible, as this would allow for the transfer of skilled workers from one site to the other and so help reduce construction costs as a lot of the knowledge gained from the

construction of Hinkley Point C could be swiftly and directly transferred and applied at the Sizewell C site.

Sizewell C is 80% owned by EDF Energy and 20% owned by China General Nuclear Corp., while Hinkley Point C is 66.5% owned by EDF Energy and 33.5% owned by CGN. EDF Energy is the operator of the existing UK nuclear fleet, although UK gas group Centrica holds a minority 20% stake in the operating fleet.

— *Oliver Adelman*

Czech Republic urged by IEA to draw up 'integrated' plans for SMRs

The Czech Republic would benefit from "an integrated road map" to help it evaluate how small modular reactors could be used in the country to reduce carbon emissions and for planning their eventual deployment, according to recommendations in an International Energy Agency country report published Sept. 13

Czech efforts in the area of SMRs "would benefit from the development of an integrated road map to assess how SMRs could contribute to the decarbonisation of the Czech energy mix as well as the potential role of nuclear stakeholders and industry players in supporting the development of these new industry designs," the report said.

Interest in exploring the potential of constructing and deploying SMRs in parallel with large reactors has been expressed frequently in the country over the past few years, with series-produced SMRs of up to 300 MW "suited to provide non-electric applications such as industrial and district heating, and could therefore support the decarbonisation of both the Czech electricity and heat sectors," the IEA said in the report.

Czech nuclear power plant operator CEZ outlined the most specific plans for the development and roll-out of SMRs in the country during its "Green Energy of Tomorrow" press conference May 20. One of the targets announced was preparation for the construction of SMRs with a total capacity of 1,000 MW after 2040.

CEZ general manager Daniel Benes, in an interview on the sidelines of the May 20 press conference, said that SMRs could be suitable not just for power production, but as combined power and heat plants for large cities. Benes also suggested during the press conference that the Czech Republic's first SMR could be sited at its Dukovany nuclear plant site.

Benes also cautioned that the Czech government has still not made any clear decisions about its nuclear power priorities and the possible role of SMRs beyond the current plans to construct one new nuclear power plant of up to 1,200 MW at Dukovany.

A main technology provider for the new unit, where construction is expected to start in 2029 and be completed by 2036, still has to be selected, with Westinghouse, Korea Hydro and Nuclear Power and EDF currently involved in a pre-tender qualification process, after Russian and Chinese companies were excluded on national security grounds.

The government plans to revise its long term energy strategy in 2022, Benes said in the interview.

Czech general elections to the lower house of parliament, which may determine the makeup of the next government, are scheduled to take place Oct. 8 and 9. One of the main parties with a chance of forming a government, the Pirate Party, has called for increased national research and spending on SMR technology.

The IEA report notes that the Czech Republic's long-term energy strategy, adopted in 2015, suggests that a further large reactor, additional to the one now planned, could still be built at Dukovany, as well as a two large reactors at CEZ's Temelin site. This could give an additional 3,400 MW of nuclear capacity by 2040, the IEA report added.

With such uncertainties and no link between ongoing preparations for the new Dukovany reactor and possible additional large nuclear units down the line, the Czech Republic will "not benefit from a programmatic approach and the associated series effect that could foster a reduction in the construction costs," the report said.

CEZ has so far signed memoranda of understanding with three SMR developers and vendors — GE Hitachi, NuScale Power and Rolls Royce — to better understand their ongoing SMR development projects. Czech nuclear research facility, UJV Rez, is also involved in SMR research and participates in Euratom research projects focused on SMR technical and safety features, the report noted.

— *Chris Johnstone*

FERC declines to resolve Maine transmission line spat, sparking delay concerns

- **Dispute over Seabrook circuit breaker replacement**
- **Extended nuclear outage may be required**

The troubled New England Clean Energy Connect transmission project is facing further potential delays after federal regulators on Sept. 7 opened an inquiry in response to a dispute over whether the 1,251-MW Seabrook nuclear plant should be required to replace a circuit breaker to accommodate the new power line.

Avangrid filed a complaint (EL21-6) with the Federal Energy Regulatory Commission in October 2020 after reaching an impasse with the plant's owner, NextEra Energy subsidiary NextEra Energy Resources, over upgrades identified through ISO New England's interconnection procedures.

The nearly $1 billion Clean Energy Connect transmission project would carry up to 1,200 MW of Hydro-Québec-generated hydropower from the US-Canada border in Beattie Township, Maine, through the state's western forests. State law requires Maine to reach 100% renewable power generation by 2050.

However, the Seabrook plant will need to replace a circuit breaker located at the facility before the 320-kV transmission line can be energized, according to an ISO-NE system impact study. The 145-mile power line, to be operated by Avangrid subsidiary Central Maine Power, could also cut into Seabrook's revenues by driving down wholesale electricity prices in the region.

For its part, NextEra in October 2020 asked FERC to issue a declaratory order (EL21-3) confirming that it can charge the transmission project's owners for opportunity costs and lost profits while Seabrook is offline making the required upgrades. In doing so, the utility warned the commission that further studies and procurement for the upgrades at Seabrook will take approximately 22 months, casting doubt upon whether they can be completed during a refueling outage scheduled for April 2023.

Transmission principles at stake

Despite calls from ISO-NE and Avangrid to act expeditiously, a divided FERC on Sept. 7 set the matter for further briefing through an inquiry initiated under Section 206 of the Federal Power Act. The commission noted that NextEra, in response to Avangrid's complaint, argued that the circuit breaker is not a transmission facility and therefore exempt from the requirements set out in ISO-NE's open access transmission tariff.

Avangrid, meanwhile, contended that ISO-NE would not have been able to identify the circuit breaker as a required upgrade for its new transmission line if that were the case.

In its Sept. 7 order, FERC said it is concerned that ISO-NE's tariff provisions may be unjust and unreasonable "to the extent they may allow generating facilities and their components to be identified as facilities on which adverse impacts must be remedied before an elective transmission upgrade can interconnect to the ISO-NE transmission system, even though generators are not subject to the commission's open access transmission principles."

Those principles generally prohibit discrimination by incumbent transmission owners.

"Without a requirement to adhere to the commission's open access principles, upgrades could be identified on an affected party's system without any obligation for the affected party to construct the identified upgrades," FERC explained.

FERC, therefore, preliminarily found that ISO-NE's tariff may be unjust and unreasonable and directed the grid operator to respond within 60 days. The commission specifically asked ISO-NE to address whether its related tariff provisions are just and reasonable or what changes need to be made to resolve disputes such as the one between Avangrid and NextEra.

FERC also invited additional briefs and evidence to address whether the Seabrook circuit breaker is in fact part of the generating facility, and if so, whether a potential workaround exists that could enable Avangrid's transmission line to enter service.

Commissioner dissents

In a dissent, Commissioner James Danly criticized the majority for failing to act in the still-pending proceedings before it.

"It is not clear whether [NextEra's] claim that it needs 22 months' advance notice establishes a real, inflexible deadline, or whether it would still have been possible to complete the upgrade during Seabrook's April 2023 refueling outage had we acted decisively today," Danly said. "But it does appear that, by requesting additional briefing, including on a novel theory, the commission has now all but guaranteed that the generation breaker upgrades will be delayed for at least a year and a half."

Avangrid did not respond to a request for comment.

The New England Clean Energy Connect's website states that the transmission line, which has already secured the necessary construction permits in Canada, is slated to come online in May 2023. But the project is also facing a Nov. 2 ballot initiative that would require retroactive approval by two-thirds majorities in the state legislature for any high-impact electric transmission lines.

In August, the Maine Department of Environmental Protection announced it is weighing whether to suspend a permit for the transmission line after a state judge invalidated a one-mile lease issued by the state's Bureau of Public Lands.

— *Zack Hale, S&P Global Market Intelligence*

French minister asks for nuclear energy to be included in EU taxonomy

At a meeting of European Union finance ministers in Slovenia Sept. 10, Bruno Le Maire, the French finance minister, called for the struggle against climate change to be "scientific" and not "ideological," appealing to the other EU ministers to include nuclear power in the EU taxonomy of clean energy sources.

"Either we fight against climate change with an ideological approach and we fail, or we fight against climate change with a scientific approach and in that case we are successful. But that means recognizing the added value of nuclear energy," Le Maire said.

He added that he wanted to "remind other European Member States and European citizens that two reports by experts have come to the same conclusion, that nuclear energy is necessary to fight against climate change. There is no reason why nuclear energy cannot be included in the EU taxonomy between now and the end of the year."

The EU is developing the taxonomy as a guide to help investors identify sustainable activities in a consistent manner. The classification system is voluntary but is designed to make it easier for companies and governments to invest in low-emission activities. The EU has yet to make a final ruling on the inclusion of nuclear power in the taxonomy and the issue has been subject to considerable political wrangling between anti-nuclear power countries like Austria, Germany and Luxembourg, which would like to see nuclear power excluded from the taxonomy, and pro-nuclear power nations like France and the Czech Republic, which would like to see it included.

In March, the Scientific Service of the EU Commission reported that "no analysis has provided scientific proof that nuclear energy is more harmful to human health or the environment than the other energies." The CRC report pointed out that over its full life-cycle, nuclear energy had a carbon impact equivalent to or less than renewable energy sources including hydro, solar and wind power.

In her State of the Union Speech to the European Parliament Sept. 15, EU Commission President Angela Von Der Leyen dealt with the subject of the taxonomy and carbon emissions reduction only in general terms, saying "you have seen the complexity of the detail. But the goal is simple. We will put a price on pollution. We will clean the energy we use. We will have smarter cars and cleaner air planes. And we will make sure that higher climate ambition comes with more social ambition. This must be a fair green transition."

Conflicting interests

Thomas Pellerin-Carlin, a director and senior research fellow, European energy policy, at the Jacques Delors Energy Centre, said in an interview Sept. 15 that "the EU Commission has to thread its way through conflicting national interests but that the most likely outcome" is that the commission include nuclear energy in the taxonomy, "given the CRC report and the politics involved."

He said that "a decision against would likely trigger attacks on the EU during the French election campaign" and that the EU cannot afford this, however unsatisfactory their ultimate decision may be to parties opposed to nuclear power's inclusion in the taxonomy.

"The decision is important politically because there are national elections in anti-nuclear Germany on September 26, 2021. On the other hand, the crucial presidential election campaign is just getting underway in pro-nuclear France for April 2022" elections.

Whatever the commission decides is "likely to be sued in the European Court of Justice by one side or the other in the taxonomy dispute," according to Pellerin-Carlin.

He also said that a "further complication is that in January France takes over the revolving presidency of the EU Council of Ministers."

The inclusion of an energy source in the taxonomy is also important because it makes investment easier under EU legislation, Pellerin-Carlin also said. This is especially significant for French nuclear power company EDF, he added.

— *Robert Harneis*

X-energy proposes new approach to NRC multi-unit environmental reviews

Advanced reactor developer X-energy is proposing a new approach for the US Nuclear Regulatory Commission's environmental review of its Xe-100 design that it says will be more flexible and efficient for considering the licensing of multi-unit plants, company officials told NRC staff during a Sept. 9 public meeting.

X-energy said that in order to meet deadlines for a US Department of Energy demonstration project, the environmental review of the reactor will need to be completed by the end of 2022, years before the total number of units to be built has been finally determined. The company is therefore proposing an environmental assessment of the largest capacity deployment under consideration, in order to provide what it called a bounding analysis of potential environmental impacts.

In October, DOE awarded TerraPower and X-energy $80 million each, subject to appropriation of that funding by Congress, in an initial award as part of its $3.2 billion Advanced Reactor Demonstration Program to build two advanced reactors that can be operational within seven years. Both companies are working with Energy Northwest, the company that operates the Columbia nuclear power plant in Washington state, to develop their designs for possible deployment by the utility in that area (Nucleonics Week, 15 Oct '20, 1).

X-energy said in in a statement Mar. 1 that it "and its supply chain partners will deliver a commercial four-unit nuclear power plant of its Xe-100 reactor design and a commercial scale TRISO fuel fabrication facility."

The Xe-100 is a high-temperature gas-cooled reactor design with a capacity of 80 MW, and it is "scalable" up to a "four pack" of modules with a capacity of 320 MW, the company said.

Because the total number of Xe-100 units to be built for the project has not yet been determined, a flexible approach is needed for NRC licensing reviews of the design, particular the environmental review, Pete Serrano, environmental planning manager for new nuclear at Energy Northwest, said during the Sept. 9 meeting.

Therefore, X-energy will submit to NRC staff by the end of September a white paper proposing "bounding design values" for various reactor attributes and environmental impacts that will allow the environmental reviews to be completed on a schedule consistent with DOE deadlines for the ARDP, Serrano said.

The company is not requesting formal NRC endorsement of the BDV approach at this time. Rather, the paper will form the basis for informal discussions between X-energy and agency staff as they develop an approach to the environmental reviews, Lucieann Vechioli Feliciano, a project manager in NRC's Office of Nuclear Reactor Regulation, said in response to a question during the meeting.

X-energy is requesting NRC staff complete its review of the proposed BDV approach by December, Serrano said.

"We realize that's a tight turnaround," but it is necessary "to ensure we stay on some critical path milestones," he emphasized.

Vechioli Feliciano agreed that the requested review schedule was "very aggressive," noting she would need to consult with NRC's environmental project managers to determine if it is feasible.

DOE's ARDP project guidelines require the environmental analysis to be submitted by Dec. 31, 2022, Energy Northwest and X-energy said in slides prepared for the Sept. 9 meeting.

'Highest impact scenario' to be analyzed

The proposed approach "sufficiently analyzes impacts based on [the] highest impact scenario," the companies said in their slides.

The white paper will seek NRC staff feedback on the acceptability of a BDV environmental analysis of a scenario to deploy up to 12 units over a period of about 15 years "to meet an evolving need for power," the slides said.

They said the approach would allow the companies "to shorten future licensing and NEPA [National Environmental Policy Act] processes," and would allow NRC to issue one environmental impact statement assessing the scenario with the "greatest potential impacts, resulting in reduced future rework in future NEPA documentation."

Such a bounding analysis is required because a decision on the number of units to be built will not have been made by the time a construction permit application would be submitted to NRC, and probably not even by the time an operating license application is filed, Milton Gorden, senior environmental licensing engineer for X-energy, said during the meeting.

The BDV approach also "allows [a] prospective owner to obtain new generating sources as-needed in the future" without the need to start an environmental review from scratch, according to the slides.

— *Steven Dolley*

CORRECTION

A Finnish spent fuel repository is being built at the Olkiluoto nuclear plant. The location was incorrect in the Sept. 8 issue of Nucleonics Week.

Belgium ...from page 1

Setting out plans for the nuclear exit, published September 2020, the Belgian government said a November 2021 report would look at the effect changes to the electricity mix caused by a nuclear phase out could have on security of supply and electricity prices.

Nuclear power so far this year provided about half of all electricity used in Belgium, with wind and solar power together adding an additional 10% to 15%, according to data from industry group the Belgian Nuclear Forum. Most of the remaining power comes from fossil fuels, primarily natural gas.

If the new government report showed that a nuclear exit could have "unexpected" impact on security of supply, particularly during the winter months, the government said it could temporarily extend the lifespan of some reactors. Specifically, this would mean delaying closure of the two newest reactors, the 1,038-MW Tihange-3 and the 1,039-MW Doel-4.

"We do not see how an operating extension of Tihange 3 and Doel 4 beyond 2025 would still be possible with the operational and regulatory constraints that currently exist," said the Engie spokesperson, who requested anonymity due to company communications policy.

Engie has on several occasions warned that any decision made after 2020 would be too late for investments needed to guarantee operation of the reactors after 2025.

"If the government comes to the conclusion in November 2021 that there is a real threat to Belgium's security of supply beyond 2025, ENGIE will not hesitate to examine all possibilities with the government," the spokesperson added.

Responding to the government decision last year, Engie said it would continue to invest in both renewable and fossil fuel energy but stop investments in the possible long-term operation of Belgian reactors. Electrabel, however, responded to the same decision with a tweet saying it would continue to work on the two options of "closure and prolongation."

Capacity probe

Following elections in 2019, Belgium faced 18 months of negotiations to form a new coalition government, including members of seven different political parties, representing both Flemish and French speaking regions of Belgium and led by Liberal Alexander De Croo. The coalition eventually installed includes 20 Green party politicians, who made an end to nuclear generation a condition of their support for the government.

The government said last year in its plans for the power mix that it will use renewable energy "in particular wind and solar" to replace "polluting energy sources — including nuclear."

The November report on security of supply was timed to allow for the results of a European Commission state aid probe into support for Belgian power capacity.

The Belgian capacity remuneration mechanism, subject to an EU probe, was designed to ensure security of electricity supply, given Belgium's decision to phase-out all nuclear capacity.

The commission Aug. 27 said the capacity mechanism was in line with EU rules, making it possible for energy companies to bid to replace the power capacity lost by closing reactors.

The capacity mechanism "will contribute to ensuring the security of electricity supply, in particular in view of Belgium's decision to phase out all nuclear capacity by 2025, without unduly distorting competition in the single market," concluded the EC in a statement Aug. 27.

The EU probe looked into assumptions made by Belgium to calculate likely shortfalls in power adequacy and levels of remuneration for companies providing back-up capacity. In particular, the commission considered whether the capacity mechanism would discriminate against renewable energy providers.

Responding to the capacity mechanism announcement, environmental group Greenpeace said in a statement Aug. 27 that the EU decision was "a wake-up call" for people living under a "nuclear illusion."

"Anyone who believed that nuclear power would be given an extension to avoid the use of gas has been overtaken by reality," Greenpeace said.

But the group, which also opposes the use of fossil fuels and wants a "100% renewable" energy grid, said Belgium needed to increase investments in wind and solar power, and in energy efficiency, to replace the capacity lost with nuclear plant closures.

Belgium's regions "have made too little progress in their management of electricity demand, onshore wind energy, and permits to strengthen the electricity network to double the wind power existing offshore," Greenpeace said.

Climate concerns

Efforts to replace nuclear capacity with natural gas have also run into regional climate concerns in Belgium, raising questions about who will bid under the newly approved capacity mechanism.

This summer the Brabant region refused permission for the construction of a combined cycle gas turbine project in Vilvoorde. The site is also operated by Engie, which bought the Vilvoorde site in April 2020 with a plan to build the 870-MW CCGT, if successful under the capacity remuneration mechanism. Engie in August said it will appeal the decision.

— *Emily Waterfield*

Shipping ...from page 1

training, port access, international concerns, as well as social concerns," Rampal said. However, he said, "The opportunity for zero-carbon fuels produced by nuclear energy seems more applicable and broader."

The report suggested using nuclear power and an electrolysis system to produce clean ammonia and hydrogen, which are zero-carbon but are mostly produced today using fossil fuels.

"Electrolysis is a likely path forward for hydrogen production," Nick Irvin, research and development director for advanced nuclear systems at Southern Company, said in an Aug. 23 interview.

Southern Company has partnered with the US Department of Energy and advanced reactor developer TerraPower to design a molten salt reactor that could provide cost-effective electricity and produce alternative fuels such as ammonia and hydrogen, Irvin said.

"In a future energy system, molten salt reactors can join with intermittent resources and provide the resiliency we need at the foundation of the grid," he added. "They have the flexibility to not only produce power but also heat, chemicals and fuels, giving them enormous optionality."

CTF said in the report that nuclear power provides clear benefits as an alternative fuel source to produce ammonia and hydrogen, as "nuclear energy utilizes less land and resources than any other large-scale energy source."

The report estimated that producing enough ammonia to fuel the world's container ships and bulk carriers would require 2.3 million GWh/year of electricity. This exceeds the total amount of electricity from wind and solar, which generated 1.8 million GWh globally in 2018.

"Roughly a quarter million square kilometers of land could be required for the wind and solar option," the report said. "The energy dense nature of nuclear energy offers an important complement for renewable and clean energy expansion to reduce overall resource usage for hydrogen-based zero carbon fuels."

Hydrogen-based marine fuels produced with nuclear-generated electricity might become more attractive to companies, as some analysts predict the share of ammonia and hydrogen in the market will increase.

In a 2021 report, the International Energy Agency said ammonia and hydrogen will account for 60% of the marine fuel market if the world reaches net-zero emissions in 2050, with ammonia powering 45% of ships.

Greenhouse gas emissions from the use of ammonia fuels are between 88% and 93% lower than conventional fuels, Brian Gallagher, head of investor relations at Euronav, the world's largest independent crude oil tanker operator, said in an interview Aug. 18.

Ammonia fuels would allow the industry to meet and potentially exceed the IMO's 2030 emission requirements. "If we can expedite and accelerate ammonia use, then we can have even more ambitious targets than that 2030 timeline," Gallagher added.

Whether nuclear power is the best option to produce zero-carbon ammonia and hydrogen remains debatable, according to some shipping industry officials.

"Nuclear-powered hydrogen is not among the main projects going on around the world," David Bolduc, executive director of Green Marine, an environmental certification program for the shipping sector, said in an Aug. 23 interview.

"Nuclear energy comes with different challenges, especially nuclear waste. It's not one of the main options that are being researched right now" for marine use, Bolduc added.

Clean shipping needed

Global shipping accounted for 2.6% of the world's CO2 emissions in 2018 — higher than the aviation sector, according to IMO estimates. Decarbonizing is an imperative to deal with the dual pressures of industry growth and climate change, Meghan Hammond, attorney at Pillsbury Shaw said in an interview Aug. 11.

"It is so important to address this issue now because every ship that we build is going to be on the water for the next 25 to 30 years or more. So, if we don't change the way that our ships burn fuel now this is a problem that we are going to be stuck with for a long time," Hammond said.

The International Maritime Organization has said it plans to revise its strategy for reducing global GHG emissions from shipping in 2023, based on how well the industry meets reduction targets.

— *Sidney Phillips*