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April 2022

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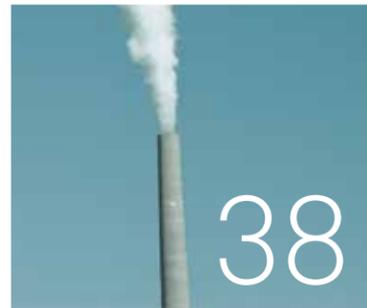
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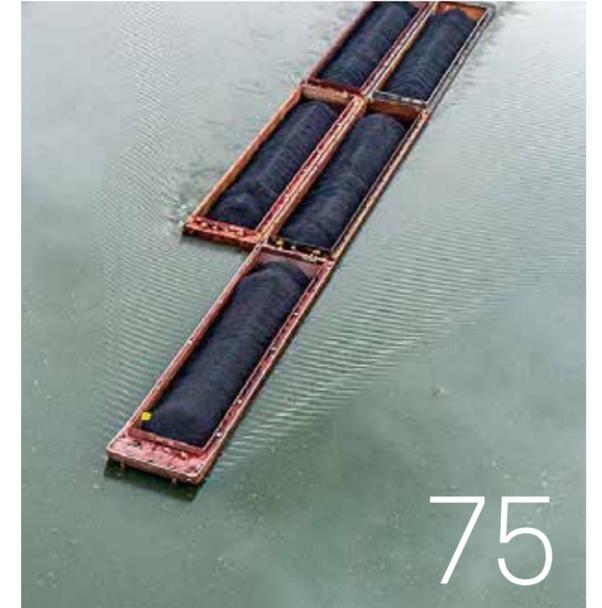
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Will the US hit net-zero targets amid expensive shipping and logistical issues stemming from geopolitical tension and pandemic-linked challenges?

Editor's Note



Barbara Lorenzo Caluag

Editor

Just as many parts of the world seemed to be learning to live with COVID-19, commodity markets got hit by another set of challenges early this year.

Energy prices were already on an uptrend, fired up by the brewing tensions between Russia and Ukraine. The escalation to a full-blown war, with Russia's invasion of Ukraine on February 24, sent prices even higher.

Conflict and sanctions are now forcing stakeholders in the commodities space to take a hard look at their prior assumptions about global energy supply. In a world of growing risks and uncertainties, how do governments, industry majors and policymakers strike a balance between ensuring energy security and energy transition?

Meghan Gordon highlights this challenge, looking at how the US might adjust its approach to energy transition as a result of the Russia-Ukraine crisis (page 32).

Several US states have already drawn up plans to accelerate clean energy goals, the latest of which is Maryland, whose Climate Solutions Now Act of 2022 takes effect on June 1. Kassia Micek outlines the key goals of US states as well as the challenges in achieving such goals (page 8), while Brandon Mulder and Kate Winston focus on efforts by key utilities and companies to hit net-zero targets (page 38).

The war has also driven up the cost of hydrogen production. James Burgess discusses viable pathways and import potential (page 26), and you can find a snapshot of S&P Global Commodity Insights' global hydrogen pricing, leading to our interactive hydrogen price wall.

Meanwhile, China is taking a different approach to energy transition by looking for solutions that do not necessarily mean avoiding fossil fuels altogether, to minimize risks to the country's energy security (page 68).

In this edition, we also carry several infographics to give a taste of our data visualization highlights, exploring topics from Russian crude flows (page 44), to the looming deficit in lithium supply (page 65).

Finally, a warm welcome to those of you who are joining S&P Global as the Global Power Markets Conference returns as an in-person event. I hope this edition of Commodity Insights magazine will be a useful resource as you navigate the ever-changing energy markets.

Explore Insights

Our website spglobal.com/commodityinsights contains an extensive selection of free news, videos, podcasts and special reports about energy and commodities. Here's a small selection of recent highlights



Interactive Periodic Table of Oil

Now on its fourth edition, the interactive Periodic Table of Oil features new crude grades, carbon intensity values, a significant redesign and new functionality to help customers plan and make more informed decisions in rapidly changing volatile markets. [Read more](#)



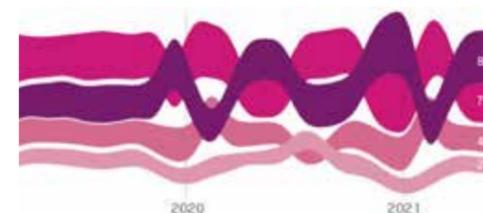
Deep-dive Oil Security Sentinel

There were 13 attacks on Gulf oil and energy infrastructure in Q1 alone, up from nine in the same period last year. Energy security has also come into sharper focus following Russia's invasion of Ukraine on February 24. We continue to explore the changing relationship between risk and the price of crude in the latest edition of the Oil Security Sentinel. [Read more](#)



Price watch Hydrogen Price Wall

A selection of Platts hydrogen assessments by S&P Global Commodity Insights, showing regional price differences and month-on-month changes. Early trade potential is emerging as technologies and regions compete to produce the cheapest low-carbon hydrogen through water electrolysis powered by renewables or from fossil fuels with carbon capture and storage. [Read more](#)



Big picture Platts Infographics

In a collection of visualization projects, S&P Global Commodity Insights' wealth of data does the storytelling to illustrate some of the most significant developments in commodity markets. [Read more](#)

Advancing clean energy goals

More than 20 states in the US have set aggressive clean energy plans, while 11 still have no state-wide goals. Kassia Micek writes about regional pushbacks and the lack of a federal plan



State-level clean energy goals continued to evolve as seven states raised or set clean energy targets in 2021, but so far in 2022 Arizona regulators shot down stronger goals and a push by Virginia Republicans to repeal the state's clean energy law failed.

Most of the 11 states with no statewide goal are in the Southeast, and it is unlikely these states will take action on clean energy goals in the near term.

"The political will isn't there in any of these states," said Matt Williams, emissions and clean energy analyst at S&P Global Commodity Insights.

Nebraska's three utilities have set goals to achieve net-zero emissions by 2050. The boards of Nebraska Public Power District, Omaha Public Power District and Lincoln Electric System are elected by the public, essentially making Nebraska the first Republican-led state to set decarbonization plans, despite any action from the legislature or governor.

Twenty-three states have aggressive clean energy plans either signed into law, written in executive order or through aspirational goals set by the governor, according to a collection of data from S&P Global. The remaining states have some form of clean energy plan on the books.

Maryland law

Maryland lawmakers recently approved the Climate Solutions Now Act of 2022, which requires the state to slash greenhouse gas emissions 60% by 2031 from 2006 levels and to hit an economywide net-zero target in 2045 after the state's Republican governor declined to veto the bill.

Governor Larry Hogan remains the only Republican governor to join the US Climate Alliance, a group of states committed to "real, impactful, on-the-ground action" to tackle climate change.

The new law puts Maryland on par with California in having a 2045 statewide net-zero goal, which no other

state aspire to at this point. Maryland is now the only state to have its ambitious target enshrined in law when the act takes effect June 1.

After a similar bill failed in 2021, Maryland legislators pared back a provision requiring all new buildings in the state to be equipped with electric heating and appliances starting in 2023. Instead, the law directs the state Building Code Administration to develop recommendations on how to electrify buildings and instructs state regulators to assess how such changes will affect the grid.

Virginia goal

A Virginia Senate committee February 28 stopped legislation that would repeal the state's clean energy law. House Bill 118 was "passed by indefinitely" in a 12-3 vote by the state Senate Committee on Commerce and Labor.

The Virginia House of Delegates voted 52-48 on February 15 to send House Bill 118 to the Democratic-controlled state Senate, where it encountered opposition. The bill was introduced in January by Republican Delegate Nicholas Freitas to essentially repeal the Virginia Clean Economy Act and its decarbonization goals.

Democrats hold a 21-19 majority in the state Senate, but are at risk of losing majority in the 2023 elections when all 40 seats are on the ballot, Williams said.

The Virginia Clean Economy Act, signed into law by former Democratic Governor Ralph Northam in April 2020, established that 16 GW of solar and onshore wind, including 100 MW of rooftop solar, is in the public interest. The act replaced the state's voluntary renewable portfolio standard with mandatory annual benchmarks that would eventually require electricity suppliers to produce 100% of their electricity from renewable sources.

Dominion Energy Inc. subsidiary Dominion Energy Virginia – known legally as Virginia Electric and Power Co. – and American Electric Power Co. Inc. utility Appalachian Power Co. must "retire all other electric generating units located in the Commonwealth that emit carbon as a byproduct of combusting fuel to



generate electricity" by December 31, 2045, under the Virginia Clean Economy Act.

Dominion must procure 100% of its electricity from renewable resources by 2045, with up to 5,200 MW of offshore wind in service by 2035. Appalachian Power must meet the renewables benchmark by 2050.

House-backed bills that will withdraw Virginia from the Regional Greenhouse Gas Initiative carbon cap-and-trade program and delay adoption of vehicle emissions standards also appear unlikely to advance in the Senate.

Arizona actions

Ending years of discussion, the Arizona Corporation Commission voted 3-2 in late January to reject a package of rules that would have required electric utilities to get all of their power supply from carbon-free resources by 2070.

In May, regulators also voted down a similar proposal that would have required utilities to receive all of their power from carbon-free resources by 2050.

"The Republican majority on ACC believes that mandate will raise rates and utility voluntary targets are sufficient," said Morris Greenberg, senior manager of North American power analytics at S&P Global.

It is unlikely there will be stronger clean energy goals in the state.

"I suspect some northeastern states will continue their gradual push to hit their emissions reduction/clean energy targets," Williams said.

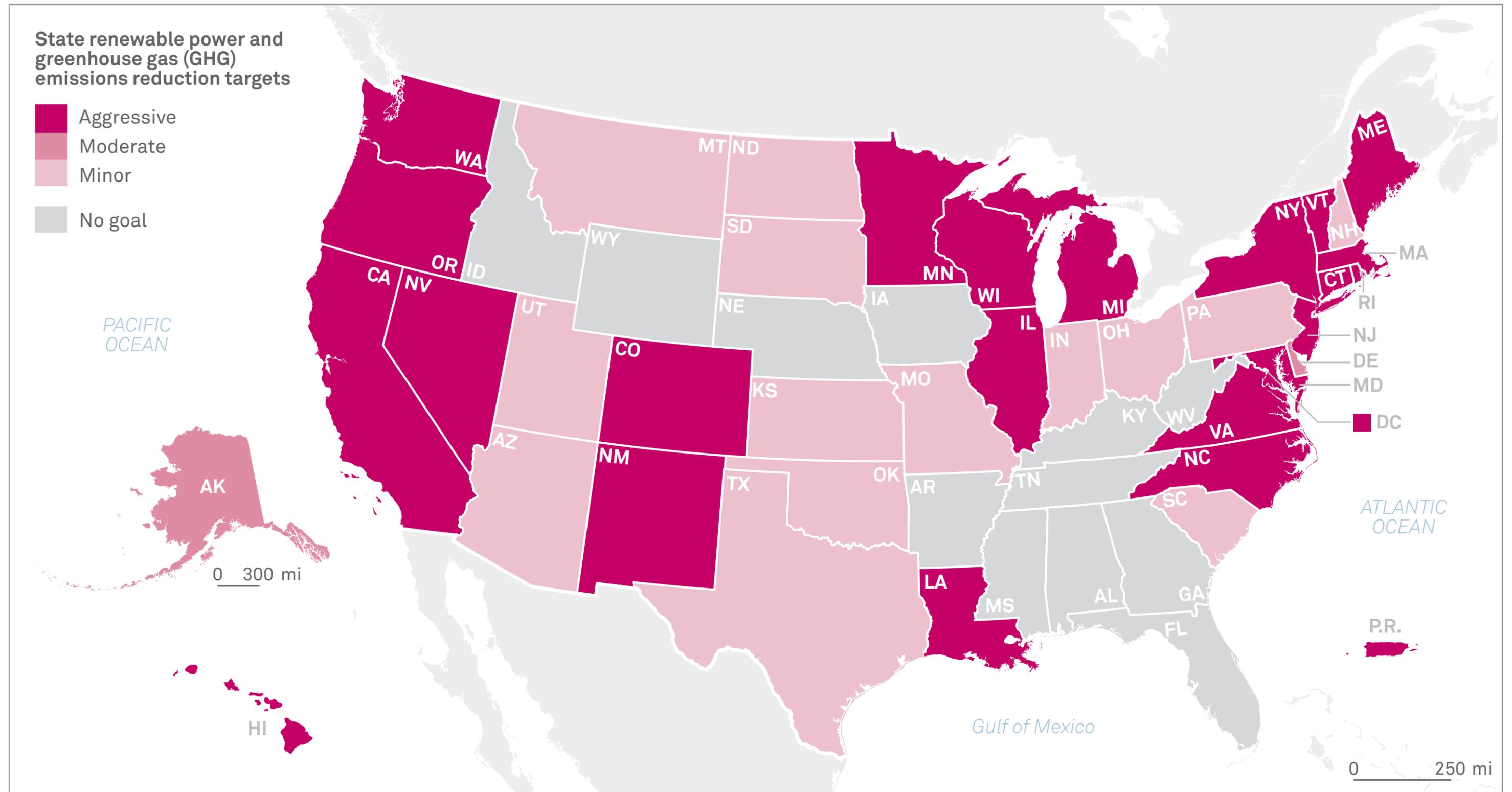
For instance, New York's Scoping Plan could result in more complementary policies and perhaps even new legislation, such as the Climate and Community Investment Act, but Williams said he does not see anything particularly new regarding changes to overall goals.

A federal clean energy plan is unlikely, although a tax credit extension is possible, Greenberg said.

There is support in the US House of Representatives and Senate for an electric industry clean energy tax package that includes tax credits for a wide range of technologies. In November 2021, the US House passed the roughly \$2 trillion Build Back Better Act along party lines. But the legislation has hit a wall in the evenly divided Senate, where all GOP lawmakers and Senator Joe Manchin, Democrat-West Virginia, have opposed the bill.

"It seems like tax credits are the only way forward in terms of legislation," Williams said, adding the Biden administration is developing rules of their own, particularly a new power sector emissions regulation is expected. However, there is a US Supreme Court case – *West Virginia versus EPA* – that could really scale back Environmental Protection Agency's authority to regulate CO2 emissions. ■

Nearly half of US states have aggressive goals to cut GHG, add renewables



Data as of April 2022
*Nebraskans elect the boards of state utilities and effectively set their GHG goals.
Source: S&P Commodity Insights, EIA, National Conference of State Legislatures, other associated sources for individual states and territories

State goals for greenhouse gas emissions reductions and renewable energy

State	Ultimate goal	Status	Wind, solar generation market share
Alabama	No goal		0 %
Alaska	50% renewables by 2025	Established by House Bill 305 (2010)	2%
Arizona	15% renewables by 2025	REST (2006); ACC rejected 100% clean power plans (2021, 2022)	8%
Arkansas	No goal		1%
California	100% carbon-free power by 2045	Legislation last updated with SB 100 (2018)	25%
Colorado	100% clean energy by 2050	Governor signed SB 19-236 into law (May 2019) for Xcel Energy	29%
Connecticut	100% carbon-free power by 2040 (aspirational)	Governor signed executive order (2020)	1%
Delaware	40% renewables by 2035	Governor signed legislation raising RPS (2021)	2%
Florida	No goal		4%
Georgia	No goal		4%
Hawaii	100% renewables by 2045	RPS mandate (2015); first 100% renewable RPS in nation	13%
Idaho	No goal		19%
Illinois	100% clean energy by 2050	Legislation signed by governor (2021)	10%
Indiana	10% renewables by 2025 (voluntary)	Legislation (SB251) created Clean Energy Portfolio Standard (2011)	9%
Iowa	No goal		55%
Kansas	20% renewables by 2020 (voluntary)	Legislation (SB91) changed RPS from a standard to voluntary (2015)	45%
Kentucky	No goal		0%
Louisiana	Net-zero emissions by 2050	Governor signed executive order (2020)	0%
Maine	100% renewables by 2050	Legislation signed by governor to increase RPS (2019)	25%
Maryland	Net-zero emissions by 2045	Climate Solutions Now Act of 2022 takes effect June 1	3%
Massachusetts	Net-zero emissions by 2050	Governor signed climate change legislation into law (2021)	10%
Michigan	Economy-wide carbon neutral by 2050	Governor signed executive order to create plan (2020)	7%
Minnesota	100% carbon-free power by 2040 (aspirational)	Governor's policy plan (2021)	24%
Mississippi	No goal		1%
Missouri	15% renewables by 2021 (IOUs)	Renewable Energy Standard approved by voters (2008)	8%
Montana	15% renewables by 2015	Goal enacted (2005) for investor-owned utility, retail supplier	12%
Nebraska	Net-zero emissions by 2050**	NPPD, OPPD, LES set net-zero goals (2021)	25%
Nevada	100% carbon-free power by 2050	Adopted in 1997, updated in SB 358 (2019)	16%
New Hampshire	25.2% renewables by 2021	RPS established (2007)	3%
New Jersey	100% carbon-neutral power by 2050	Governor unveiled Energy Master Plan (2020)	2%
New Mexico	100% carbon-free power by 2045	Last updated in Energy Transition Act (2019)	34%
New York	100% carbon-free power by 2040 (aspirational)	Governor signed into law (2019)	4%
North Carolina	Carbon-neutral power by 2050	Clean Energy Plan recommendations (2019)	8%

State	Ultimate goal	Status	Wind, solar generation market share
North Dakota	10% renewables by 2015 (voluntary)	Surpassed (2007); governor discussed carbon neutrality by 2030 goal (voluntary)	34%
Ohio	8.5% renewables by 2026	RPS target lowered (2019)	3%
Oklahoma	15% renewables by 2015	Legislature established goal (2010), goal exceeded	40%
Oregon	Reduce GHG 100% by 2040 from 1990 level	Legislature passed HB 2021 (2021)	18%
Pennsylvania	18% renewables by 2021	Alternative energy portfolio standard (2004)	2%
Rhode Island	100% renewables by 2030	Governor signed executive order (2020); House passed net-zero bill (2021)	6%
South Carolina	2% renewables by 2021 (voluntary)	Legislature authorized (2014)	2%
South Dakota	10% renewables by 2015 (voluntary)	Legislation established (2008); some providers noted barriers	52%
Tennessee	No goal		0%
Texas	10,000 MW by 2025	Mandate adopted (1999), Surpassed (2009)	23%
Utah	20% renewables by 2025	RPS adopted (2008) for electric utilities	10%
Vermont	80% below 2005 levels by 2050	RES adopted (2015); Global Warming Solutions Act (2020)	24%
Virginia	100% carbon-free power by 2045*	Governor signed into law (2020); SB 851; HB 1526	3%
Washington state	100% carbon-free power by 2045	RPS updated (2019)	9%
Washington, DC	100% renewables by 2032	RPS updated (2019)	12%
West Virginia	No goal	Repealed RPS in 2015	2%
Wisconsin	100% carbon-free power by 2050	Governor executive order set goal (2019)	3%
Wyoming	No goal		19%

Sources: S&P Global Commodity Insights, EIA, ACP, CESA, National Conference of State Legislatures, individual state agencies

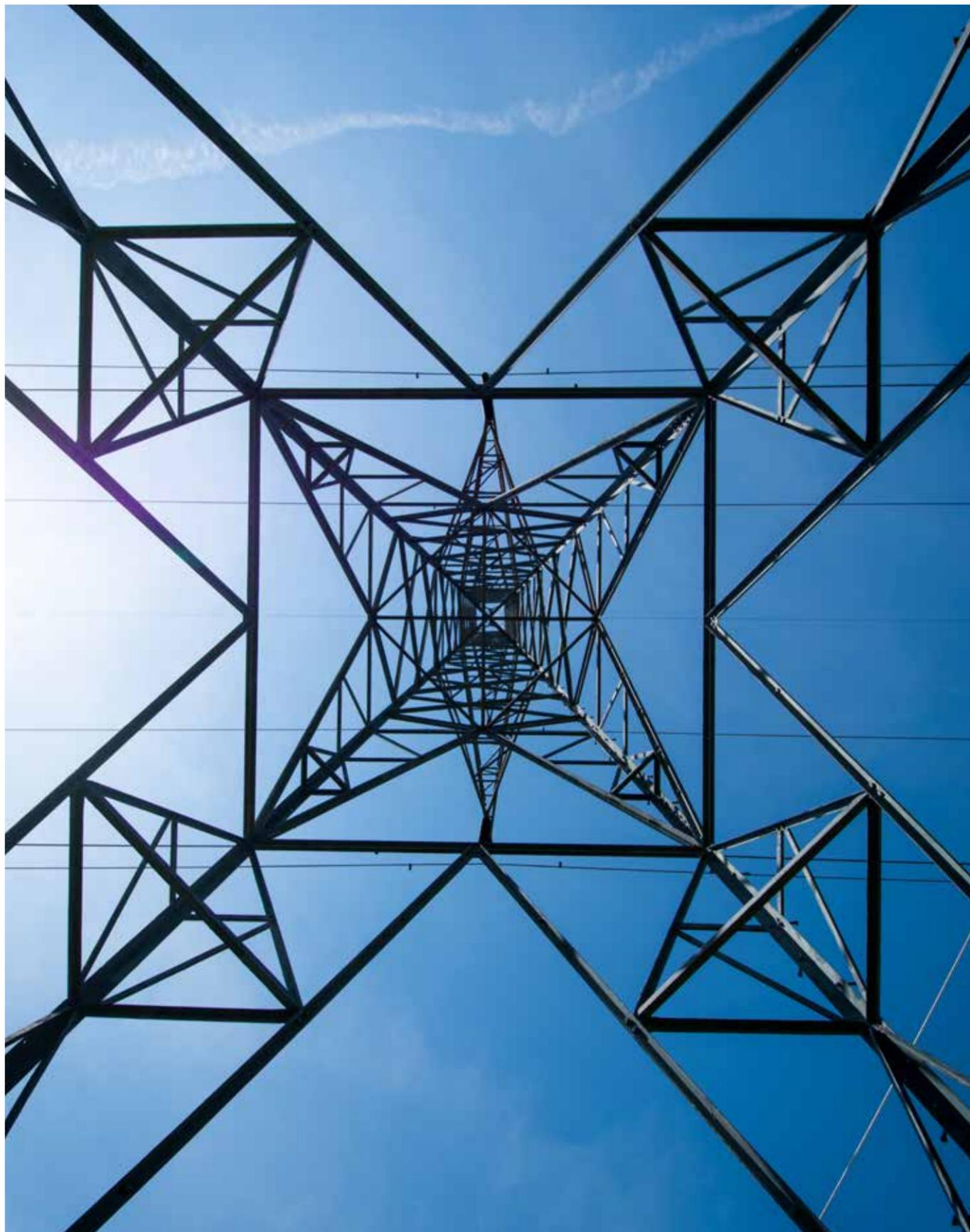
* for Dominion only; 2050 for Appalachian power

**NPPD board approved commitment in December 2021; OPPD, LES approved net-zero goals in 2020. Nebraskans elect the boards of the state's three utilities



Definitions

- RPS** Acronym for "Renewable Portfolio Standard," which typically is a goal for renewable power generation
- Net-zero emissions** A balance between all emissions produced and the emissions removed from the atmosphere; often interchangeable with "carbon neutral"
- Carbon neutral** Some emissions are generated but are equally offset somewhere else to make overall emissions zero
- 100% clean energy** Energy that produces no GHG emissions
- 100% renewables** All energy from renewable energy sources
- 100% carbon-free power** Electricity generation that does not emit CO2



Texas grid reliability in focus

Over a year since the deadly winter storm that crippled Texas' power system, regulators continue to work out solutions to prevent widespread power outages in the future. By Mark Watson

Experts differ regarding the summer 2022 and winter 2022-23 pricing effects of Texas regulators' work with the Electric Reliability Council of Texas (ERCOT) to implement short-term market reforms for grid reliability.

The Public Utility Commission (PUC) of Texas approved in December 2021 a "blueprint" for market redesign intended to satisfy mandates in Senate Bill 3, an omnibus ERCOT market reform bill signed into law in June. The blueprint contained a Phase I covering reforms that could be implemented relatively quickly and a Phase II covering more comprehensive, longer-term changes.

The Texas Legislature enacted Senate Bill 3 and other changes in response to the widespread power outages that resulted from the deadly mid-February 2021 winter storm.

Several of the Phase I efforts – e.g., allowing Emergency Response Service to be deployed before an Energy Emergency Alert is declared and lowering the high

ERCOT north hub summer and winter forwards



Source: S&P Global Commodity Insights

systemwide offer cap (HCAP) from \$9,000/MWh to \$5,000/MWh – have already been implemented.

Firm fuel product

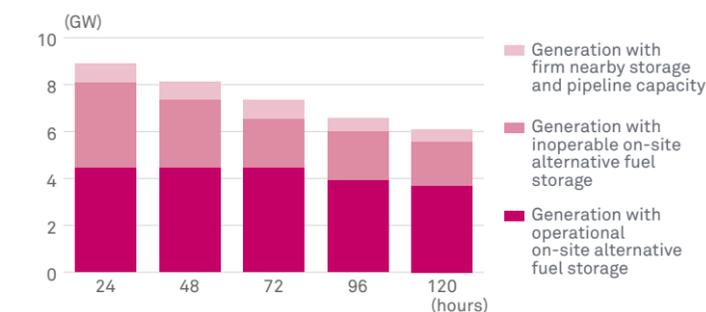
The establishment of a type of ancillary service known as a "firm fuel product" is considered a key effort which ERCOT plans to have in place for winter 2022-23, and which Giuliano Bordignon, a power market analyst at S&P Global Commodity Insights, said is "the first real milestone" of market reforms.

ERCOT March 10 released an updated survey of the existing generation fleet that shows about 4.4 GW of capacity with on-site alternative fuel storage that could operate for about 24 hours, and another 3.7 GW of resources that have facilities on-site, which are not currently operational.

“Depending on how it will be implemented, and how it will interact with the weather-reliability standards ... we can expect the current momentum around market changes to continue or slow down,” Bordignon said. “Both [the firm fuel product and weather reliability standards] are bearish drivers for wholesale prices – in the winter as well as summer – as they address potential scarcity at times of high demand, but together they might end up being too aggressive for market participants accustomed to high scarcity prices.”

Others, however, see market rule changes and potential increases in spending related to new and more frequent use of ancillary services as increasing “costs to the market.”

ERCOT's existing firm fuel generation capacity by category



Source: Electric Reliability Council of Texas

Alison Silverstein, an independent consultant working in the power sector who has worked at the PUC, the Federal Energy Regulatory Commission and a major public utility, said the impact on power prices this summer “will be higher and more unpredictable, since we will likely remain in drought and see even ... higher [than] normal temperatures.”



ERCOT Phase I market redesign proposals' tentative implementation timeline

Proposal	What it is	Implementation period	Abbreviations
Deploy ERS before EEA	Allows ERS to be deployed before consumers are urged to curtail demand	November 2021	AS: Ancillary Service BTM: Behind-The-Matter
HCAP at \$5,000/MWh, MCL at 3 GW	Adjusts ORDC price adder so higher prices occur more frequently	January 1, 2022	DR: Demand Response ECRS: ERCOT Contingency Reserve Service
Load resource participation in NSRS	Allows load resources to participate in NSRS	Summer 2022	EAA: Energy Emergency Alert ERS: Emergency Response Service
Biannual ORDC report to PUC	Updates on ORDC scarcity pricing effectiveness	Q4 2022	FERC: Federal Energy Regulatory Commission FFRS: Fast Frequency Response Service
FFRS	Pays for primary frequency response separately from RRS	Q4 2022	HCAP: High Systemwide Offer Cap IRR: Intermittent Renewable Resource
ECRS	Creates a new AS to back up RRS or frequency regulation service to mitigate EEA risk	Early 2023	ISO: Independent System Operator LMP: Locational Marginal Price
ERS procurement practices	Changes how ERS is bought, whether by quantity, price or expenditure limit	Six months after NPRR change	MCL: Minimum Contingency Level NPRR: Nodal Protocol Revision Request
ERS seasonal apportionment	Adjusts ERS quantities to account for increased risk in non-summer periods	Six months after NPRR change	NSRS: Non-Spinning Reserve Service ORDC: Operating Reserve Demand Curve
Decouple VOLL from HCAP	Could result in ORDC price adders being higher more frequently	Six to 12 months after PUC rule change	PUC: Public Utility Commission of Texas RRS: Responsive Reserve Service
Firm fuel product	Creates a new AS ensuring enough fuel is on-site to for a specific period	Winter of 2022-23	VOLL: Value of Lost Load
Backstop Reliability Service*	Creates a new seasonal or annual AS to back up potential loss of IRRs	After firm fuel product implementation	
LMPs for load resources	Switches load-managed resources (DR or BTM generation) from zonal to nodal pricing	Controllable resources to get LMPs 24 months after NPRR change	
Study customer aggregation in DR	Allows aggregated power demand to participate in wholesale power markets	After completion of study of other ISOs' implementation of FERC Order 2022	
Voltage support service	Creates a new AS to safeguard against wide voltage level deviations	Unknown — competes with ECRS, FFRS, firm fuel product	

*Considered part of Phase II, but prioritized to be implemented alongside Phase I.
Source: ERCOT



“Wholesale prices winter 2022-23?” Silverstein said. “Again, higher, because none of the measures that the PUC and ERCOT are undertaking consider cost-competitiveness, cost-effectiveness or affordability.”

Winterization

Mandatory winterization of generation was “Texas’ single most important reliability improving measure,” Silverstein said.

“Unfortunately, since the gas supply has not similarly been winterized, and gas contracting, delivery and pricing have not received similar scrutiny and correction, the other measures now under consideration may have limited reliability impact in a future arctic event,” Silverstein said.

Judging by summer and winter forward markets, traders foresee greater risk of higher prices currently

than they did in December, when the PUC adopted its market redesign blueprint.

ERCOT North Hub on-peak July-August power averaged about \$106/MWh in March, up from \$84.10/MWh in December, while on-peak January-February 2023 power averaged about \$74.75/MWh in March, up from about \$57/MWh in December.

“Despite the reduction in the cap to \$5,000, there is little doubt that the more conservative approach to acquiring ancillary services, the increase in services like ERS, [Non-Spinning Reserve Service], and Firm Fuel will increase costs to the market, particularly in the winter,” said Cyrus Reed, conservation director at the Lone Star Chapter of the Sierra Club.

Phase I reforms also included a provision that demand response participate in the NSRS ancillary service, which Reed noted March 23 “could actually lower prices for that service, but certain generators are

trying to tell ERCOT and others to reserve a substantial amount of non-spin for generation, so [I’m] not sure if it will be a huge savings compared to present day.”

‘Spending ... like drunken sailors’

Silverstein said the PUC and ERCOT’s plans indicate that they “are chasing the wrong reliability problem.”

“On the operational level, ... the PUC’s market changes are addressing resource adequacy by trying to increase the amount and availability of mostly thermal generation and industrial-scale load resources,” Silverstein said. “But paying lots more money to large, old fossil generators won’t solve the ramping problem, and the industrial customers who are willing to take ERS payments won’t want to deliver regular DR for ramping.”

The PUC and ERCOT are failing to analyze and understand the grid’s operational reliability problems “with current and growing energy resources and demand,” Silverstein said.

“They are doing even less to accurately recognize and account for the cost consequences of their current and proposed reliability-improving policies and practices,” Silverstien said. “They’re spending customers’ money like drunken sailors under the flag of improving reliability, while hoping that the PUC’s unwillingness to demand an accounting will continue to obscure whether these measures are working and how much they cost.” ■

Blending for decarbonization

Utilities across the US are experimenting with combining power generation capabilities, including next-generation gas turbines that offer hydrogen capabilities. By Brandon Mulder



Several US power utilities are moving in the hydrogen direction as they experiment with hydrogen blending in natural gas turbines and announce goals of replacing gas with 100% hydrogen by midcentury.

One of the latest hydrogen commitments from the power sector came earlier this year when Duke Energy announced a \$4 billion investment in hydrogen-enabled natural gas generation as the utility winds down its coal assets. During the company's latest quarterly earnings call, CFO Steve Young said "we believe our natural gas units are well-positioned to take advantage of hydrogen technology as it evolves."

Duke's announcement builds on hydrogen's momentum in the power sector. In 2020, the Long Ridge Energy Terminal in Ohio announced plans to transition a 485-MW gas-fired power plant to run on General Electric's new hydrogen-capable turbine, which is able to burn a gas stream blended with 15%-20% hydrogen. On the Gulf Coast, Entergy Texas is developing the Orange County Advanced Power Station, a 1,215-MW power facility along the Texas-Louisiana border that will be capable of using 30% hydrogen by 2026 using turbines developed by Mitsubishi Power.

Experimentation with hydrogen blending in turbines is happening elsewhere around the US as well, including in Siemens Energy's Intermountain Power Project in Utah and Mitsubishi's proposed \$1 billion facility slated to produce green hydrogen for gas-fired turbines in Montana.

"Hydrogen does a lot of things that we really need done," said Alex Kizer, senior vice president of research and analysis at Energy Futures Initiative. "We need clean, flexible, load-following resources for the grid, and these are things that gas generally does today, where you can call on it at any time. Many people are thinking that that's maybe something hydrogen can do, too."

The move toward hydrogen in the power sector is also attractive to investors, Kizer said, because hydrogen allows utilities to start small. In contrast with other clean technologies with high upfront capital spending

Manufacturer	Turbine model	Blending rate
GE	7Ha.002	15%-20%
GE	7Ha.003	50%
Siemens	SGT industrial gas turbines	15%-60%
Siemens	SGT heavy-duty turbines	30%
Mitsubishi Power Americas	M501JAC	30%
Wärtsilä	34SG	25%
INNIO	Type 4 gas engines	up to 100%
Rolls-Royce	Series 500, Series 4000	25%
Existing gas combined cycle turbines		~5%

Source: Turbine manufacturers

investments, like advanced nuclear plants, utilities can leverage existing facilities to begin blending hydrogen at low levels in the near term, then ramp up to higher levels over time.

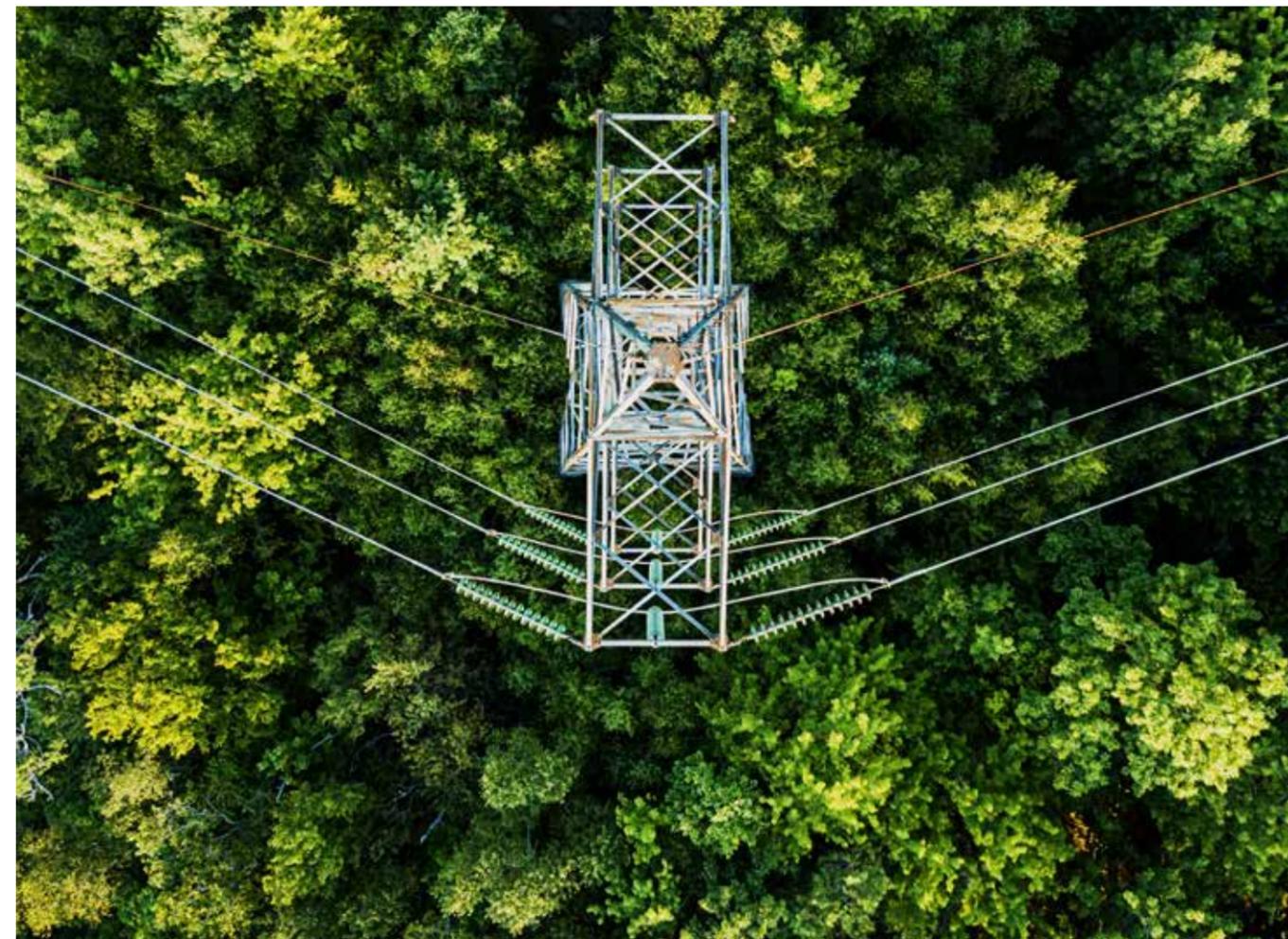
A Duke Energy pilot project, for instance, has an initial goal of co-firing hydrogen in gas plants at a 30% rate by 2024 and a midterm goal of 100% hydrogen by 2030.

"I think investors really like that it can do that smoothing of the transition – I think that's very compelling," Kizer said. "There's scalability in your financial commitment."

The right blend

There are unique challenges to blending hydrogen in gas streams at all points along the value chain. Within turbines, gas and hydrogen respond differently to combustion. Hydrogen ignites faster than gas, which brings the flame closer to the nozzle through which the gas stream comes.

"Because hydrogen combusts so much faster, you have to design the nozzles differently so that they keep the



flame further away and don't melt themselves," said Joshua Rhodes, a research associate at the University of Texas Energy Institute. "If you were to try to run high blends of hydrogen in an older vintage facility, you would essentially get what they call blowback, and it would melt itself from the inside."

Yet there are some older vintage turbines capable of burning gas streams with low levels of hydrogen, and there are a variety of factors that determine blending capability – turbine age, the speed of turbine rotation, and, among others, the size of the hydrogen versus gas molecules.

"These are tuned instruments, and you really got to understand how this different product will impact your expensive assets," Kizer said.

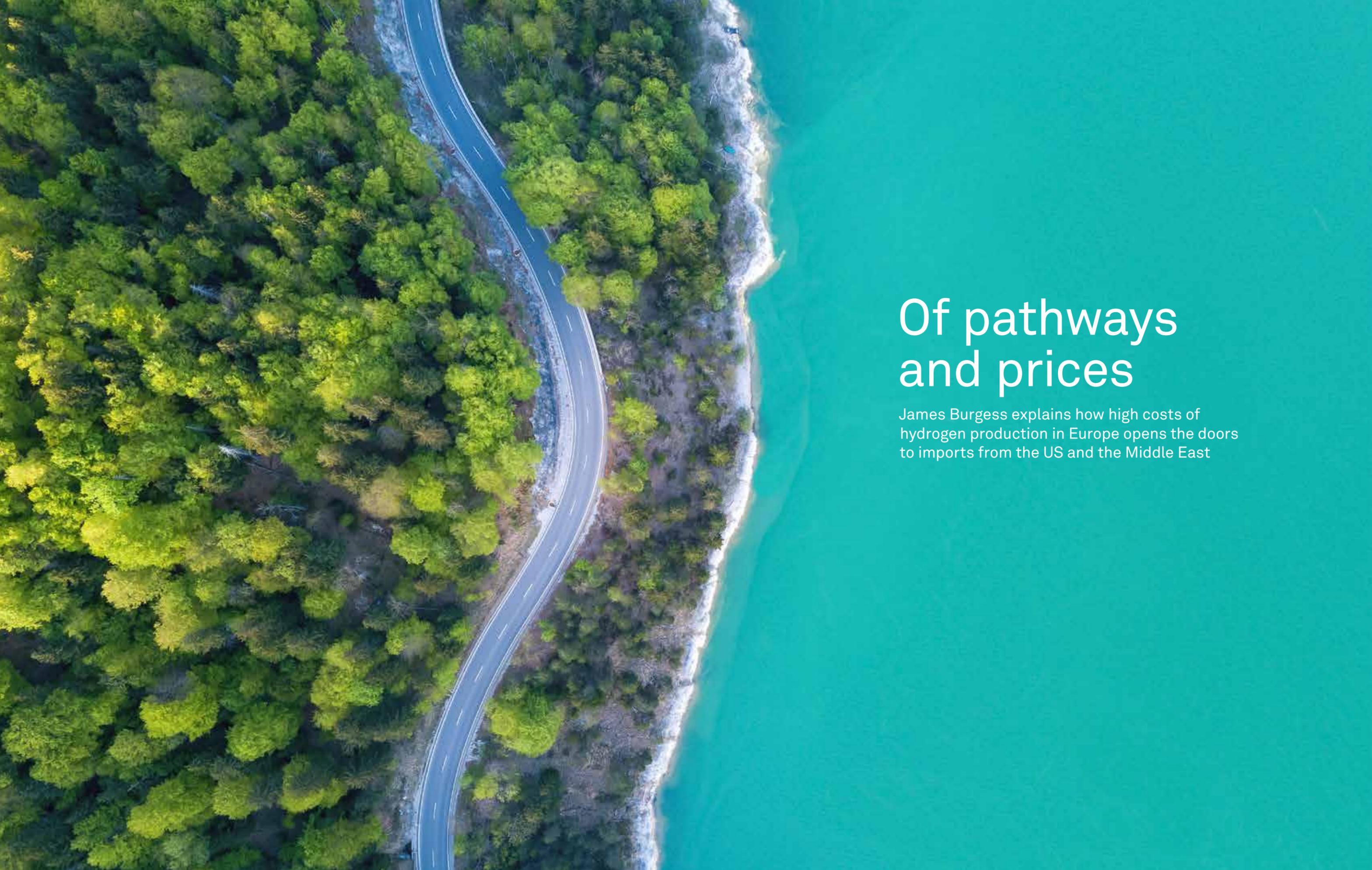
Raising blending levels up to the 30% range and beyond typically requires a whole new category of technologies,

and a variety of companies have brought a range of hydrogen-capable turbines to market in recent years.

General Electric, for instance, has its 7Ha models that are capable of blending up to 50%. And the gas technology company INNIO claims its converted gas turbine can run on a variable fuel mix with up to 100% hydrogen.

But the full impacts of incorporating hydrogen into the gas system remain to be seen. Policy support to usher hydrogen into the power sector will be critical, Kizer said, but it's not yet clear what policy mix will be necessary or how it could impact consumer-level prices.

"It's vitally important that we figure this out, and I think utilities are spending time experimenting right now," Kizer said. "There [are] unique challenges to actually generate electrons from hydrogen." ■



Of pathways and prices

James Burgess explains how high costs of hydrogen production in Europe opens the doors to imports from the US and the Middle East

Soaring feedstock gas and power prices following Russia's invasion of Ukraine February 24 have sent hydrogen cost of production assessments sharply higher in Europe, underlining the region's potential for imports of the renewable energy carrier.

The UK remained the highest priced region globally for low-carbon hydrogen production, with the Netherlands close behind, the S&P Global Commodity Insights Hydrogen Price Wall showed.

UK electrolysis production prices averaged around \$20/kg in March, more than six times the cheapest locations in Western Australia and the US Midcontinent. UK prices were more than 40% higher than in Japan, another potential importer. Low production costs in Australia, meanwhile, highlighted the country's credentials to supply Japan and South Korea.

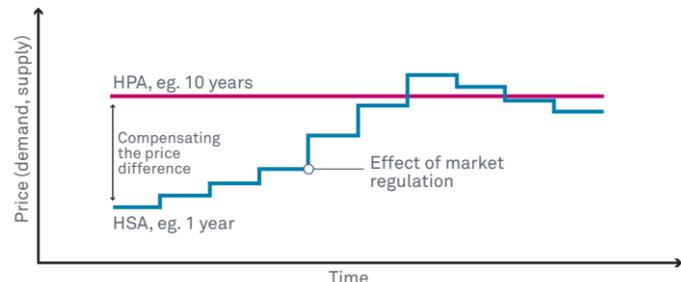
"Understanding how differences in regional power markets impact hydrogen production costs around the world will be an increasingly important factor in determining future trade flows," S&P Global Head of Energy Transition Pricing Alan Hayes said. "These regional differences will also be important for decision makers who want to compare options to achieve the most cost-effective routes to decarbonization."

"As well as regional comparisons, understanding the different options across different production pathways is also vital when considering the most appropriate option in each region," Hayes added.

The US is emerging as a low-cost steam methane reforming hydrogen production center, with that production pathway shown as the cheapest globally. The Hydrogen Price Wall shows the lowest cost region for hydrogen production (via conventional steam methane reforming without carbon capture and storage, or CCS) was the US Midcontinent at just \$1.21/kg. Prices slipped below other US regions, with power and gas input prices falling steeply on mild weather and reduced demand.

The price wall also shows, however, that in locations where power feedstock is cheap, electrolysis production is already under \$3/kg. Electrolysis

H2Global auction model for German hydrogen imports



Note: actual HSA values depend on annual tenders
Source: H2Global

production costs in Australia and the Middle East are lower than fossil-based production with CCS in the same locations.

Prices also rose sharply in Japan, with knock-on effects from global surging LNG prices following the Russian invasion and an earthquake that hit northern Japan March 16, temporarily shutting down several thermal power plants in the region.

The data showed the comparative cost advantage CCS-based low-carbon hydrogen pathways have in Europe versus electrolysis.

"While most European countries are focused on expanding hydrogen produced from electrolysis, the UK government has provided a 'twin-track' hydrogen strategy recognizing the role of fossil plus CCUS [carbon capture, utilization and storage] hydrogen as a pathway to achieve carbon emissions reduction," said S&P Global Future Energy Signposts Manager Anne Robba.

Security of supply

The energy security of supply crisis in Europe triggered by Russia's aggression in Ukraine has prompted an acceleration of energy transition policies across the continent, including specific measures for hydrogen.

The European Commission has brought forward increased hydrogen production capacity targets by 2030 in response, aiming for 20 million mt/year, double the initial target set out in the EU's hydrogen strategy from 2020.



Key to achieving this target will be imports, with Germany in particular signing a series of agreements with major potential global producers of green hydrogen.

Europe's leading economy has signed bilateral alliances on hydrogen production with countries including Chile, Australia, Canada, Morocco, Namibia, Saudi Arabia and Ukraine.

Germany's H2Global import initiative plans to open a first auction window for a 10-year contract for green ammonia imports in the second quarter of 2022, with a first cargo expected in 2024, a senior adviser for the government-funded agency said April 4.

The first sale is planned for 2023, Kirsten Westphal, executive director analysis at the H2Global Foundation, told S&P Global in an interview.

"We are hearing from the industry that H2Global with its criteria will set the gold standard for a lot of other deals," Westphal said.

The agency is developing a World Trade Organization-compliant catalogue of standards, focused on ensuring project additionality and trustworthy certification of renewable hydrogen. Westphal said certification across the supply chain was challenging for many countries.

The focus on existing liquid markets for ammonia, methanol, and jet fuel ensured there was ready demand for green versions of the products, Westphal said, allowing new applications in transport or power generation to emerge.

With interest in hydrogen imports to Europe coming thick and fast, several companies have been outlining plans for hydrogen and ammonia terminals, as well as agreements to ship the energy carrier to European ports. ■

Platts hydrogen price wall

Larger panels represent higher prices. Prices in \$/kg as of end-March.

Below is a selection of S&P Global Commodity Insights hydrogen assessments showing regional price differences and month-on-month changes. Early trade potential is emerging as technologies and regions compete to produce the cheapest low-carbon hydrogen through water electrolysis powered by renewables or from fossil fuels with carbon capture and storage.



Notes: Prices are month average cost-of-production assessments, including capex. European prices include carbon costs for SMR and ATR assessments. Prices for the Netherlands and UK are converted to \$/kg from assessments in Eur/kg and GBP/kg. Darker shade means greater month-on-month price move. Developed by James Burgess and Henry Edwardes-Evans. Designed by Reynaldo Dizon.

Key

- WA/ALK 2.67 — Area/pathway
- Mar-22 avg price
- Pathway symbol
- Price direction

Production pathway

- PEM electrolysis
- Alkaline electrolysis
- ATR + CSS
- SMR + CSS
- SMR without CSS
- Coal gasification + CSS
- Lignite gasification + CSS

Producing region

←less change more change→

- United States
- Asia-Pacific
- Europe
- Middle East

Interactive

Scan here for the latest updates on the Hydrogen Price Wall.

Russia crisis exacerbates tension between climate and energy security risks

Whether US shale producers could help to boost non-Russian supplies in the global market has now become a trickier debate.
By Meghan Gordon



Spiking oil and gas prices and pressure to shun Russian energy imports in the days after the Ukraine invasion forced a colossal rethink of the Biden administration's approach to domestic oil and gas production.

The flows had already fallen off while US lawmakers were still debating a formal ban, and Treasury Department guidance continued to permit energy transactions through sanctioned Russian banks.

Whether US shale producers could contribute to a global increase in non-Russian supplies became a trickier debate, with some drillers saying investors remained wary of anything but slow growth while many progressive Democrats argued the crisis shows the need for a quicker energy transition.

A bill by Senator Ed Markey, Democrat-Massachusetts, said the US should go further than just banning Russian imports by developing a comprehensive strategy to replace the barrels with "domestic carbon-free energy sources" and accelerate investments in renewable energy.

"Actively decarbonizing the United States energy economy is of vital strategic interest to the national security and climate change reduction targets of the United States," Markey said in the bill, called the "Severing Putin's Immense Gains from Oil Transfers (SPIGOT) Act."

And yet other longtime climate champions, like State Department envoy John Kerry, started talking about natural gas as a bridge fuel again.

The US imported 672,000 b/d of Russian petroleum in 2021, including 199,000 b/d of crude.

But how to encourage more supply in the short term without sacrificing climate ambitions?

Antoine Halff, co-founder and chief analyst at Kayrros, contends that striking that balance is possible.

US Gulf of Mexico fields rank among the lowest for carbon intensity in the world, according to the latest calculations by S&P Global Commodity Insights

"With industry's help, Biden could negotiate bipartisan support for carbon price in exchange for pro-industry measures such as fast-tracking permits," he said March 7.

By analyzing satellite data from 2019 and 2020, Kayrros created the first systematic estimate of large methane leaks, finding about 1,800 so-called "ultra-emitters," of which 1,200 came from oil and gas facilities. Those high-emitting events, which are normally undetectable and not accounted for in national greenhouse gas inventories, represented as much as 12% of global methane emissions from the oil and gas industry, according to the study.

The study demonstrates that climate-related data is improving every day, potentially creating more political support for carbon pricing that distinguishes between the cleaner and dirtier upstream sources.

US Gulf of Mexico fields rank among the lowest for carbon intensity (CI) in the world, according to the latest calculations by S&P Global Commodity Insights.

The updated rankings published February 15 look at the carbon intensity of 104 crude streams across the world, with values expressed in kilograms of carbon dioxide equivalent per barrel of oil equivalent.

Many oil and gas producers are scrutinizing the emissions impact of their portfolios to determine which fields will have staying power as fossil fuel investment shrink. Carbon pricing and other climate policies could create a premium for the least-intensive crude streams.



The Oil and Gas Climate Initiative, a CEO-led consortium of companies responsible for about one-third of global production, has set targets to reduce upstream carbon intensity to 17 kgCO₂e/boe by 2025 and bring an end to routine flaring by 2030. Of the 104 fields ranked by S&P Global, 39 would currently meet the 2025 target.

Producers are reducing upstream emissions through cogeneration facilities, modernizing compression plants, improving leak detection, ending venting and reducing flaring.

Environmental groups say the efforts do nothing to eliminate Scope 3 emissions, which are the vast majority of global warming emissions tied to the use of fuels in airplanes, cars, petrochemicals and elsewhere downstream.

S&P Global Analytics' calculations represent the greenhouse gas emissions of a field's current operations from the wellhead to storage or export terminal, including upstream activities like flaring and venting but not exploration and drilling.

The calculations show a massive range of upstream impact, from 1.6 kgCO₂e/boe for Norway's offshore Johan Sverdrup to 1,460 kgCO₂e/boe for Venezuela's Orinoco Belt.

Offshore UK and Norway producers increasingly use renewable power to run their platforms instead of coal or natural gas, which sharply reduces emissions for barrel produced.

Offshore Gulf of Mexico production also claims low carbon intensity because advanced subsalt imaging practices have helped drillers target the most efficient



reservoirs. These fields range from 12.1 kgCO₂e/boe to 23.1 kgCO₂e/boe under the latest estimates.

Kuwait's Burgan field, new to the list, is the lowest onshore stream at 16.8 kgCO₂e/boe.

S&P Global carbon analyst Varaleka Pant said Burgan – along with Saudi Arabia's offshore Safaniya and UAE's onshore Fateh, both of which are below 20 kgCO₂e/boe – show that even aging fields can have low per-barrel carbon intensities, given high production volumes and limited flaring.

Cleaning up the upstream

Methane controls largely determine where US onshore shale drillers fall on the CI scale, and the entire sector will be forced to tighten these emissions further under the Environmental Protection Agency's latest proposed methane rule. US onshore operations range from about 18.1 kgCO₂e/boe in the Permian and Delaware basin to 95.4 kgCO₂e/boe near the Louisiana Gulf Coast, according to S&P Global.

Canadian oil sands operations on the list have CI values of 43.6 kgCO₂e/boe to 119.8 kgCO₂e/boe, driven

by the need for gas-powered steam injections to mine the heavy bitumen. Some producers are trying to lower emissions with cogeneration and solvent-based assistance.

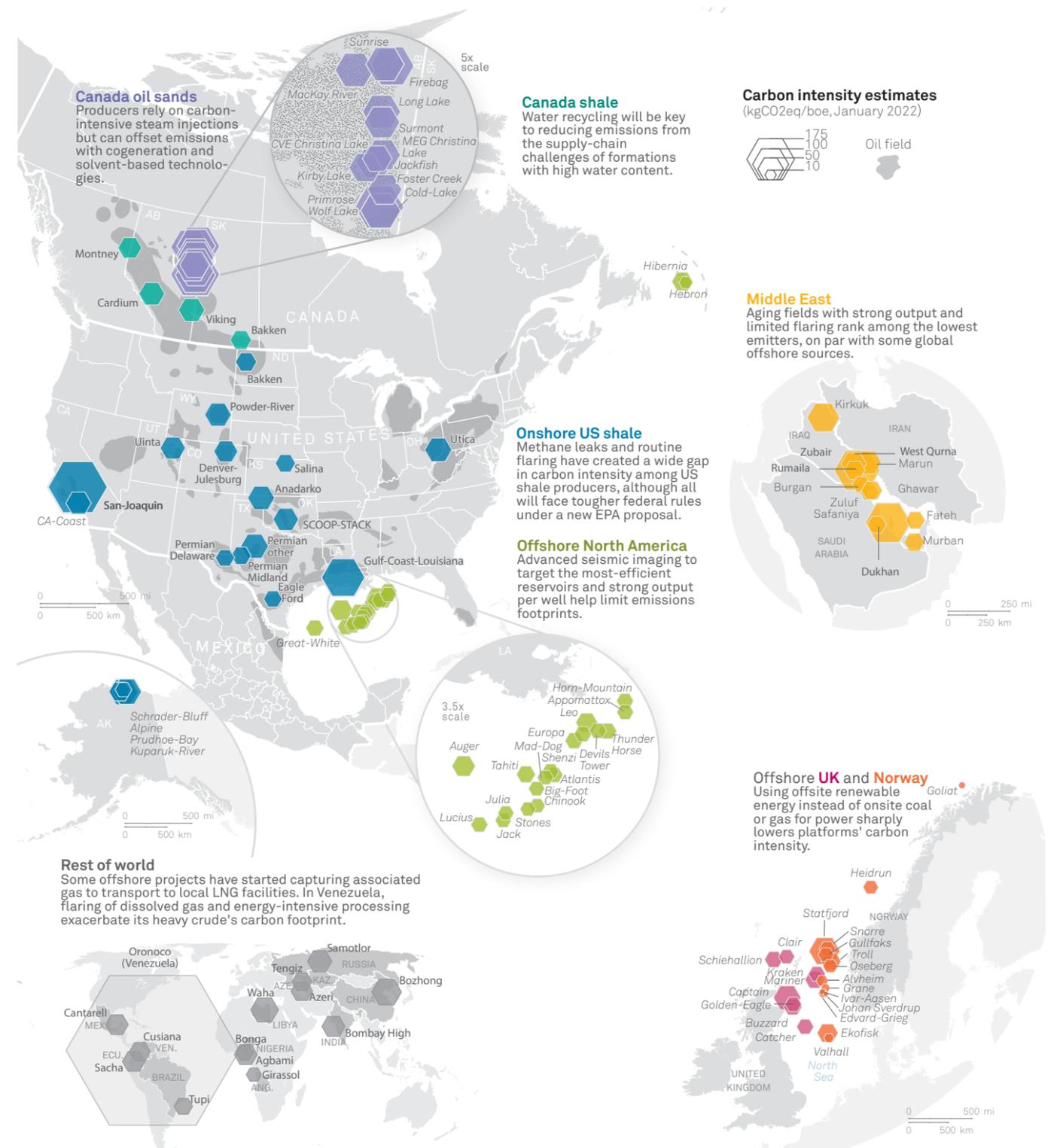
California's medium to extra-heavy San Joaquin oil ranks second-highest on the list at 177.9 kgCO₂e/boe because the aging field requires large steam injections and heavy water management.

The extreme carbon intensity of Venezuela's Orinoco belt shows that this crude stream would face challenges in a world with tight carbon budgets, even if not for the existing sanctions limiting its reach. The crude has high levels of dissolved gas that gets flared out, and the fields use energy-intensive processes like delayed coking and hydrocracking to upgrade the crude quality, Pant said.

"Reduction in wellhead flaring and adoption of integrated energy technologies such as cogeneration systems can help significantly bring down the carbon intensity for the oil-rich Orinoco Belt," she said. ■

Chasing the lowest-carbon crudes

Global oil producers are increasingly touting efforts to reduce the carbon intensity of their upstream operations to stand out as investment dollars shrink during the energy transition. Some producers see carbon intensity rankings as a measure of which fields will have staying power, while environmental groups say the efforts ignore the much larger global warming emissions created downstream when the oil is refined for transportation, shipping, petrochemicals and other uses. S&P Global Commodity Insights has expanded its carbon intensity calculations to include 104 fields, representing the greenhouse gas emissions of current operations from the wellhead to storage or export terminal.





First movers

Scope 3 emissions are the hardest to quantify and reduce. Several companies in the US have started to include this category in their net-zero goals, paving the way for others to follow suit.

By Brandon Mulder, Kate Winston

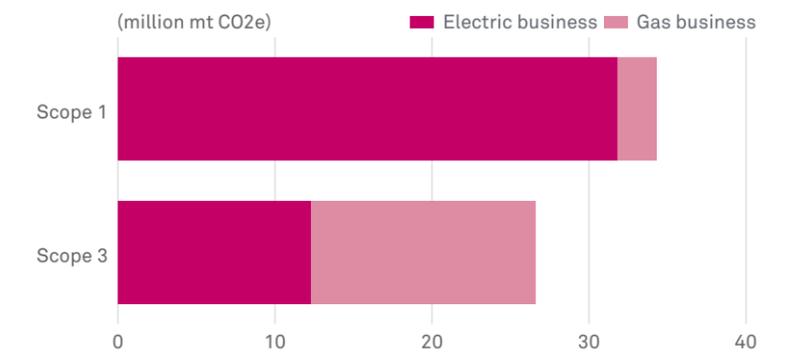
With a supermajority of major US electric companies now working towards net-zero goals, a new set of first movers are evolving their climate ambitions to include Scope 3 – the largest portion of the power sector’s total carbon emissions.

Scope 3 emissions, generated by a company’s indirect impacts across its value chain, accounted for 75% of the power sector’s total emissions in 2019, according to S&P Global Commodity Insights data. Most utilities’ net-zero goals don’t currently include Scope 3, which is the hardest category of emissions to quantify and reduce, and instead pertain exclusively to Scope 1 and 2, or the emissions directly associated with a company’s operations and energy use. But that appears to be changing.

In February, for instance, both Dominion Energy and Duke Energy expanded their net-zero goals to include Scope 3 emissions stemming from purchased power, their gas distribution systems and consumption by natural gas customers.

For a company like Dominion, whose large gas distribution business comprises a substantial portion of its total emissions, the expanded commitment is

Dominion GHG emissions*



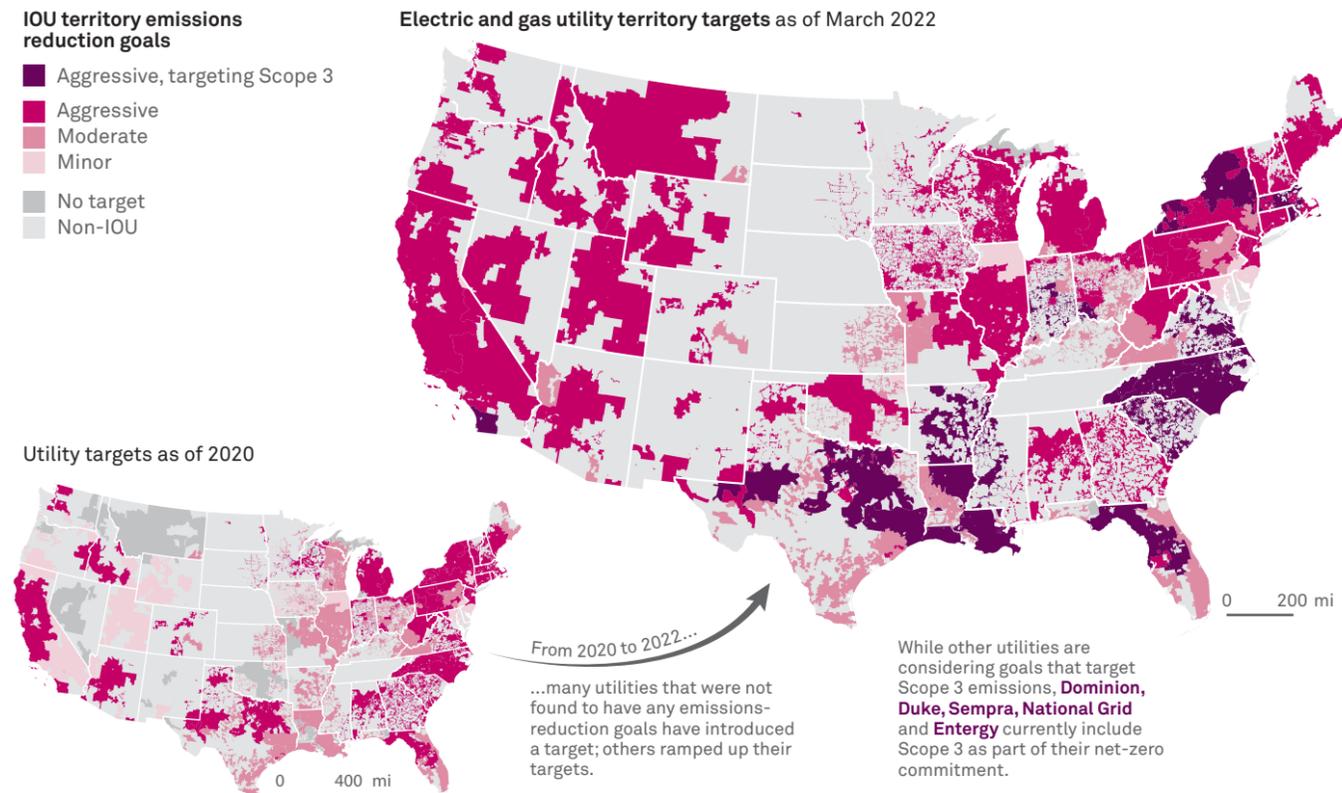
*Data is from 2019 and includes only carbon and methane emissions
Source: Dominion Climate Report 2021

significant. In 2019, Dominion’s Scope 1 emissions were 34.4 million mt CO2e while its Scope 2 emissions were less than 100,000 mt CO2e, and Scope 3 emissions were 26.6 million mt, the company said in its 2021 climate report.

For Duke, which said that its new goals were now targeting “certain Scope 3 emissions,” the category represented about 33% of all its associated emissions, according to the company’s 2020 sustainability report.

Sempra, which owns San Diego Gas & Electric and Southern California Gas Co. in California and Oncor Electric Delivery in Texas, similarly has aims to cut Scope 3 emissions to zero by 2050, recognizing that

Aggressive net-zero and emissions reduction goals in power sector continue to proliferate



Source: S&P Global Commodity Insights, individual companies

“being a leader in a net-zero future includes measuring and reducing emissions across the energy value chain,” the company said.

“I do think we will see a lot more of them setting Scope 3 goals,” said Dan Bakal, senior program director of climate and energy at Ceres, a climate-focused investor network. “You need some utilities to break the ice, and that now has happened,” he said.

With the ice now broken, others are working to fall in line. In its latest Sustainability Report, Public Service Enterprise Group in New Jersey said that it has partnered with consultants to conduct a comprehensive Scope 3 emissions assessment, who found that 77% of its Scope 3 emissions – about 12.2 million mt in total – stems from consumer use of its products.

Southern Company has stated similar aims, saying that while its net-zero goal presently only includes Scope 1 emissions, it is “also committed to working with partners and customers to reduce upstream and downstream emissions,” the company says on its website.

While utilities still don’t know exactly how to achieve Scope 3 goals, they recognize there is no alternative, considering dire international climate forecasts and pressure from big investors, Bakal said.

But there may be more than meets the eye with Scope 3 goals, precisely because there is not a clear path to address these emissions, said Sharon Allan, chief strategy officer with the Smart Electric Power Alliance. Just because a company is considering its Scope 3

emissions does not mean it is further along in meeting its carbon-reduction goals.

“Right now, while it’s a noble goal, there’s a lot of things that still have to be unpacked in Scope 3 emissions,” Allan said.

The power sector’s drive to grapple with Scope 3 may also be accelerated by the Securities Exchange Commission’s newly proposed climate disclosure rules, which were unveiled March 21.

If adopted, the SEC would require publicly traded companies and international companies operating in the US to annually report Scope 1 and 2 greenhouse gas emissions. Additionally, companies would be required to report Scope 3 emissions if deemed “material” to their business and if they have emission-reduction goals.

“That will likely add another layer of accountability,” said Bakal.

Although the proposed rules wouldn’t cover privately held companies that don’t fall under SEC jurisdiction

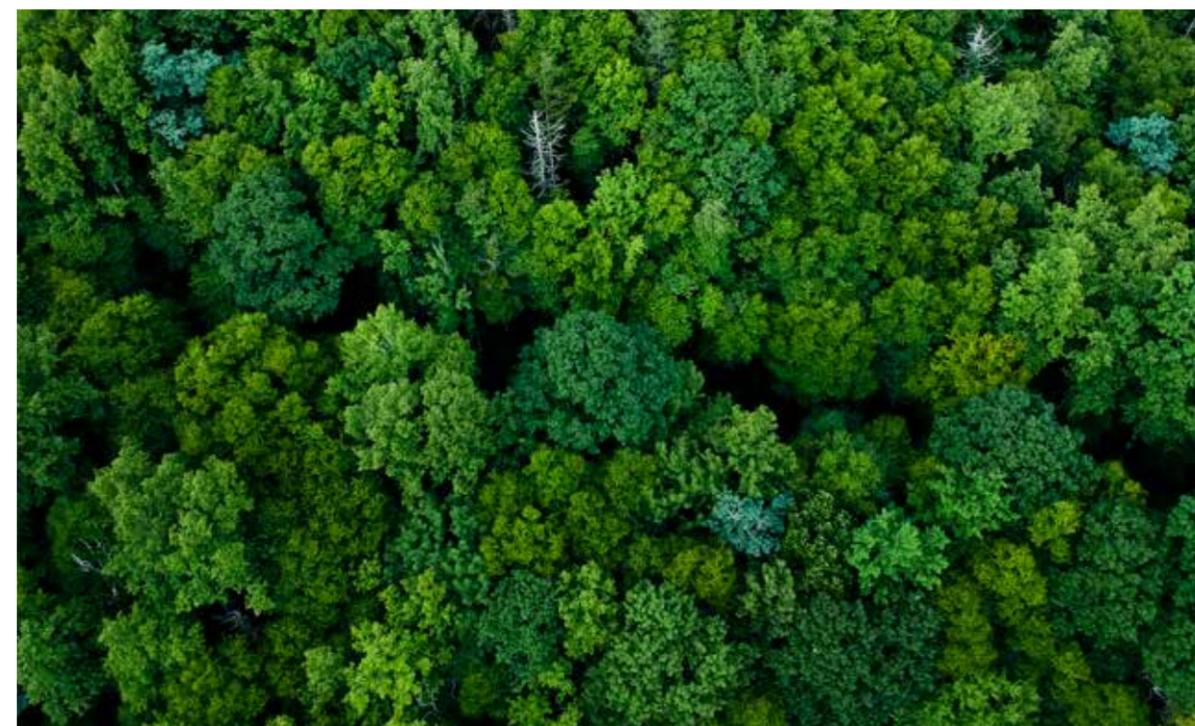


Greenhouse gas emissions scopes

- Scope 1:** Emissions associated with a company’s direct activities
- Scope 2:** Emissions associated with any electricity, steam, heat or cooling purchased by a company
- Scope 3:** Emissions stemming from a company’s upstream and downstream impacts on its value chain

the measure would be a historic win for the Biden administration’s climate agenda. It would be the first effort by US financial regulators to standardize climate change reporting in annual reports and other public documents.

“Depending on the framing of that, it will provide a methodology and consistency of approach among utilities,” Allan said. ■





Russia looks east to mitigate sanctions impact

India and China are potential targets for higher exports.
By Rosemary Griffin

Russia's decision to invade Ukraine February 24, followed by the introduction of harsh sanctions by the West, is accelerating Russia's drive to redirect export flows to Asia, and replace the US dollar in energy trading.

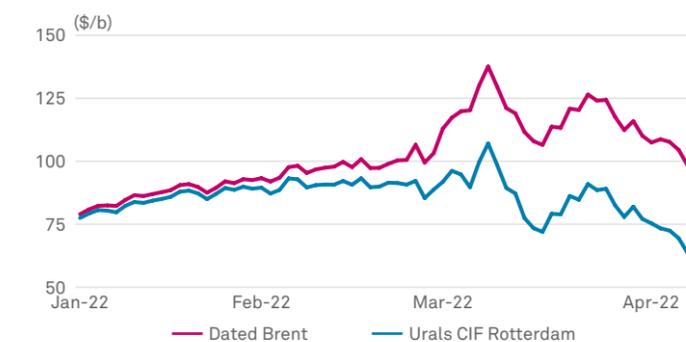
Active fighting continues to threaten security of supply to Europe, including operations at key oil and gas pipelines running through Ukraine, as well as Southern Russian and Ukrainian ports.

Western sanctions triggered by the conflict – including blocking Russia's access to the SWIFT financial messaging system and sanctioning major banks as well as energy producers and suppliers – complicate trading with Russian producers.

Several sanctioning countries have announced plans to completely wind down purchases of Russian energy. Western companies are also seeking to reduce their exposure to Russia and have announced plans to exit upstream projects and reduce purchases of Russian oil.

Despite these measures, Russia continues to export large volumes of oil, gas, coal and receive sizable

Urals vs Dated Brent



Source: S&P Global Commodity Insights

revenues from exports to Europe. EU foreign affairs chief Josep Borrell said April 6 that the EU is paying Russia around Eur1 billion/day for energy.

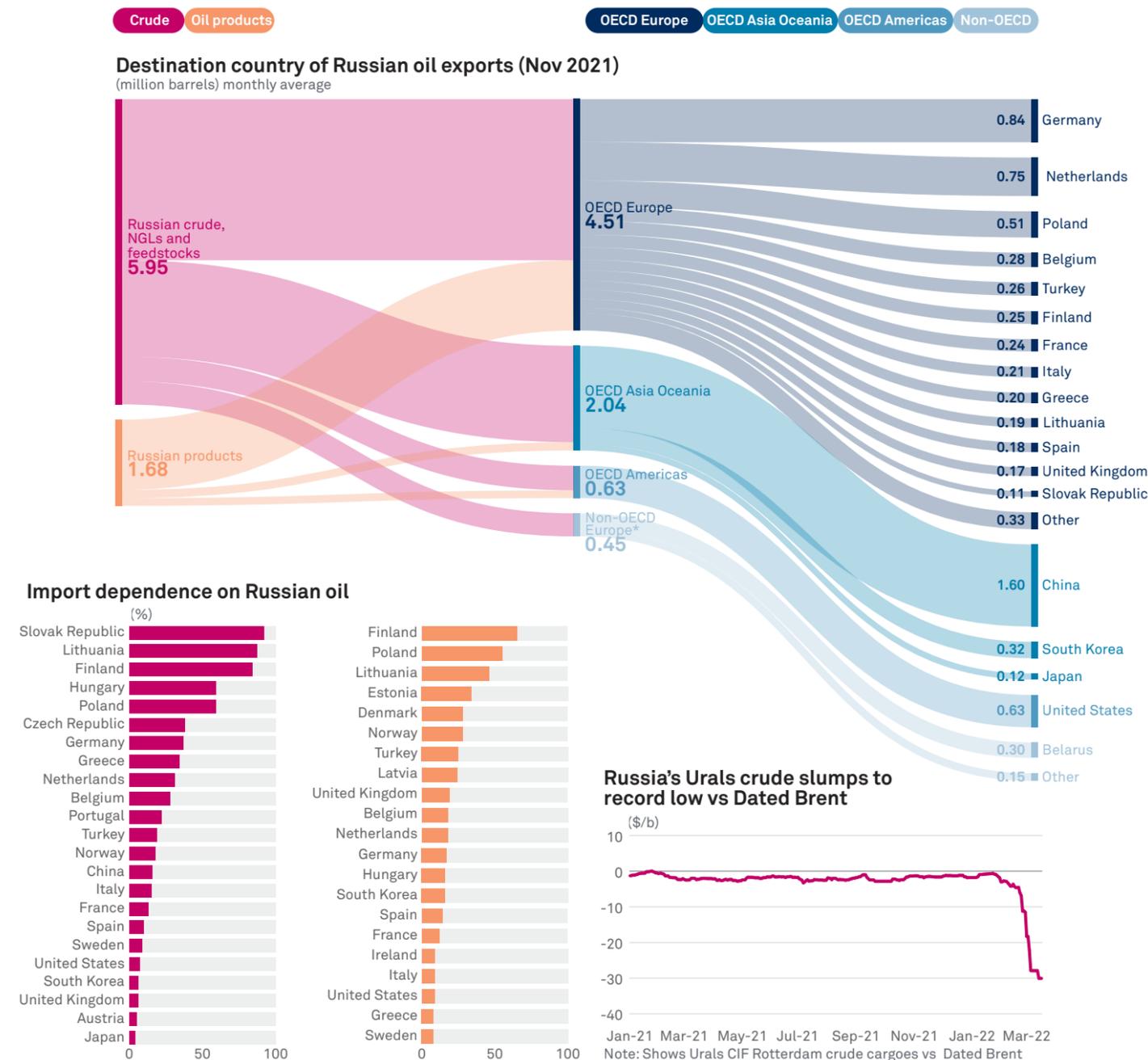
Risks in targeting Asia

Russia's response to Western sanctions has been to seek greater energy cooperation with some Asian countries, and push for the use of alternative currencies to the US dollar and euro in trading.

Russian officials have said producers can shift volumes to alternative destinations, and they do not see any risk that their oil will not find a market.

Russian oil crunch risks widening on sanctions threat

Russia's war on Ukraine has already disrupted more than 2 million b/d of crude and oil product supplies from the world's second biggest crude exporter, according to S&P Global Commodity Insights, as both official sanctions and industry avoidance crimp flows. The biggest casualty so far is Europe, which imports about 30% of its oil from Russia including 1.5 million b/d of mostly diesel and gasoil. A collapse in demand for Russia's oil in the region has already seen Urals crude prices hit record lows. As the conflict grinds on, Western importers are looking to cut their dependence on Russia's oil, and the potential for tougher sanctions squarely hitting Russia's global exports means more countries could be forced to replace its vital energy flows.



*Non-OECD Europe data is sourced from the EIA
Source: IEA, EIA, S&P Global Commodity Insights
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Developed by Robert Perkins, designed by Jack Merlin Bruce.

Since the invasion of Ukraine, China, India and Turkey have increased their purchases of seaborne Russian Urals crude, which is trading at significant discounts as key Western customers shun the grade.

This adds to deliveries under long-term supply contracts. Russia has steadily increased its ability to supply Asian markets over the last two decades. It developed major infrastructure projects, including the East Siberia Pacific Ocean pipeline, the Power of Siberia gas pipeline and LNG projects in Arctic and Far East Russia. It has also ramped up oil and gas production in Far East and Northern Russia to supply these routes.

In addition to importing energy, analysts see Asian investors as potential buyers for stakes in Russian projects that Western companies are exiting. Chinese and Indian companies have joined several Russian upstream projects in recent years.

Despite these talks, there are risks to Russia's Asian plans. Not all Asian consumers are willing to increase trade with Russia following the invasion of Ukraine. Japan, South Korea, Singapore, and Taiwan have introduced sanctions and, in turn, been added to Russia's list of unfriendly countries.

The progression of the conflict will also play a key role in these plans. Ongoing fighting risks triggering new, harsher sanctions or secondary sanctions on those cooperating with Russia.

Alternative currencies

Russia's interest in switching away from the US dollar has also grown since the invasion of Ukraine and EU member states freezing the foreign exchange reserves of the Russian Central Bank.

Russia had been looking into ways to increase non-dollar trade since 2014, when the possibility of restricting access to the US dollar was first raised in discussions over potential sanctions in response to Russia's annexation of Crimea.

Ongoing fighting risks triggering new, harsher sanctions or secondary sanctions on those cooperating with Russia

Russia introduced new legislation March 31 requiring customers from sanctioning countries to pay for Russian gas in rubles.

Under the new rules, European buyers are required to transfer funds in euros or dollars to a new Russian account, from which payments would be made to state-controlled Gazprom in rubles after conversion.

Many EU officials have spoken out against the switch and the G7 - Germany, Italy, France, Japan, Canada, the US and the UK - rejected the move in a joint statement released March 28. Others, including Hungary and Slovakia, have indicated that they may pay for Russian gas in rubles.

For now, this has yet to impact export flows.

In the coming months, the speed at which sanctioning countries can reduce their Russian imports and Russia can increase shipments to Asia, will likely be the key driver of production and export volumes. ■

Go Deeper

Russia's invasion of Ukraine has triggered an unprecedented wave of sanctions against Moscow that are rippling through global commodity markets. [Download our Russian Commodities Sanctions Tracker](#)



Conflict drives radical shift

Henry Edwardes-Evans examines how the war between Russia and Ukraine, and its impact on energy flows, is driving changes in Europe's energy market design

Conflict accelerates change, and Russia's invasion of Ukraine has lit a fire beneath Europe's gas and power markets.

Heavily dependent on Russian gas and partly dependent on Russian coal, these markets were described as "broken" in early March by participants exposed to a Dutch TTF spot gas price assessed by S&P Global Commodity Insights at a record Eur212/MWh, up 1,190% year on year. In fact, the crisis began well before Russia's February 24 invasion of Ukraine, prompting EU Member States to challenge the status quo back in October 2021 as economies emerged from COVID-19 outbreaks.

That month, EU Member States charged the European Commission to study gas, power, and carbon markets to determine whether fundamental action was needed to address the astronomical rise in energy prices.

The European Union Agency for the Cooperation of Energy Regulators, or ACER, produced an interim

Extreme gas prices in gas-dependent power markets



Source: S&P Global Commodity Insights

report in mid-November, and is due to report in depth this May. In between then and now everything has changed, making the regulator's imminent findings of vital interest to the whole sector.

Meanwhile, EU Member States are taking matters into their own hands with an array of short-term interventions, from Italy's clawback tax on green generators to Greece's monthly subsidies to households and Spain's gas-price cap.

These are temporary emergency measures. Beyond these, the EC recognizes the need to review fundamental market design and this is what ACER is doing.

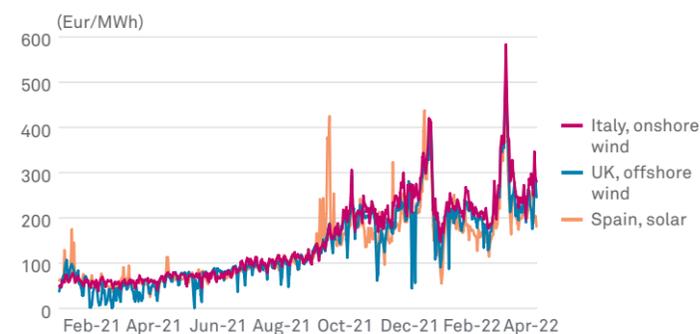
The point of departure is Europe's pay-as-clear or marginal price electricity market model.

In these energy-only markets, producers are placed in merit order starting with the cheapest and ending with the most expensive. The last plant needed to meet demand (the marginal unit) sets the price for all producers.

All participants (including demand response and storage) are incentivized to bid their true costs to make the merit order and be dispatched.

The theory is that those with lower operational costs, such as nuclear or hydro, can recoup higher capital costs, while those with lower capital costs, such as gas plants, can cover higher running costs. The problem has been that the marginal gas unit has been extortionately expensive, in part due to coal and nuclear closures, allowing inframarginal units not encumbered by gas feedstock costs to earn high profits.

Wind and solar: all the benefits, few of the costs



Source: S&P Global Commodity Insights

This has prompted calls from France, Spain and Italy to isolate or cap the gas component from or in power price formation.

Given the likely evolution of Europe's electricity markets in the years ahead, there are broader issues at play.

As thermal plants close, Europe's electricity system is moving toward increasing shares of low marginal cost generation, notably from wind and solar. This raises



the question of whether marginal pricing focused on short-term optimization and cost-efficiency offers the secure investment signal needed for new generation at scale.

This is why ACER's assessment, set to be released on May 5, is to look at the benefits and drawbacks of enhanced hedging instruments, more liquid forward markets, contracts-for-difference mechanisms and multi-year power purchase agreements that serve to underpin capital-intensive investments with low operational costs.

It will also look at how to serve the growing need for flexibility to support renewables, for instance via demand response, storage, energy community interaction, increased interconnection between countries and facilitating trading closer to real time.

Valuing flexibility

Speaking to S&P Global Commodity Insights in March, Håkan Agnevall, president and CEO of Wärtsilä Corp, said a radical shift in both market design and project permitting was needed to help deliver an efficient transition away from fossil fuels.

"Change begets change, as Dickens wrote. The democratic world is coming together in a way we've not seen in a long time," Agnevall said.

Today's energy-only markets failed to place sufficient value on flexibility, he said.

Power market design needed to evolve from an opex to a capex model, placing more emphasis on the value of balancing power and backup capacity.

Continually sinking operational expenditure into fueling and maintaining coal, oil and gas plants was untenable. In its place, a new capex model would drive investment in renewables as well as the flexibility needed to ensure stability of supply.

The challenge is daunting. Annual additions of renewables need to double to 2030 to hit the European Commission's REPowerEU goals, Agnevall said.

Current electricity wholesale pricing method and possible alternative

Current pricing method



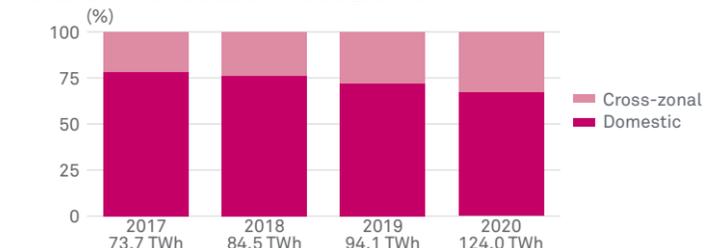
Possible alternative pricing method



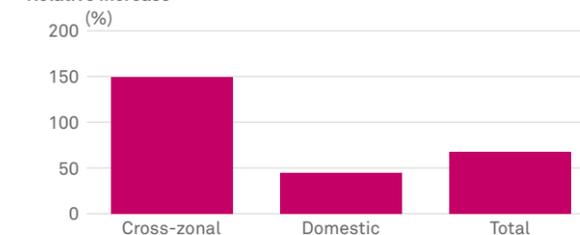
Source: ACER elaboration

Evolution of continuous intraday traded volumes, breakdown

Breakdown into cross-zonal and intra-zonal trades



Relative increase



Source: ACER calculation based on NEMOs data

Even more important that market reform, then, was simplified permitting procedures to ease development bottlenecks.

“Many countries in Europe have huge numbers of projects in the pipeline, many of which are struggling with permitting. I'd like to see a move beyond the not-in-my-back-yard mentality for the greater good,” he said.

New realism

The dramatic increase in gas and power prices necessitated a fundamental review of power market design, ContourGlobal CEO Joseph C. Brandt said in March.

“We have been saying for four years that the future of the European power generation market looked to be increasingly a regulated one with the abandonment of marginal cost pricing and its replacement with some

form of a guaranteed regulated rate of return applied to the entire generation sector,” Brandt said in the company’s annual statement.

Numerous policy proposals have been floated by European governments and the EC to reduce the impact of rising energy prices on consumers and businesses.

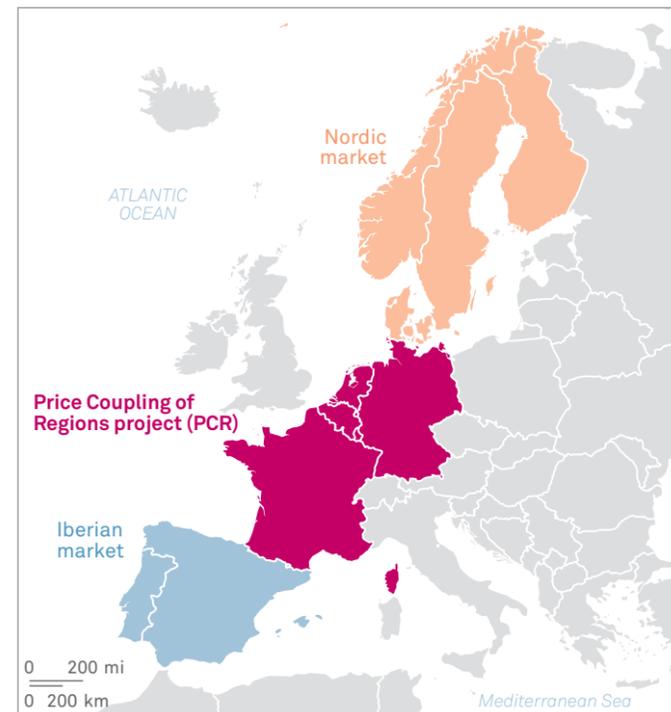
“Such policies may alter the markets into which electricity from our plants is sold, impacting the profitability of uncontracted power plant[s] such as [the 800-MW Spanish combined cycle gas plant] Arrubal,” he said.

At the same time, the introduction of regulated pricing contained in recent proposals would positively impact ContourGlobal’s European thermal fleet.

The current geopolitical turmoil would slow the energy transition, he said.

Evolution of day-ahead market coupling

Market areas coupled in 2010



Market areas coupled in 2021



Source: S&P Global Commodity Insights. ACER elaboration



“A new realism about the geopolitics of electricity supply emphasizing the need for diverse sources of baseload generation and decreased reliance on Russian gas supports our view that we are in the midst of a lengthier transition, which will see a larger-than-previously-expected role for power generation based on lignite coal, nuclear and liquefied natural gas,” Brandt said.

Trader concerns

For its part, the trader community has warned against upsetting years of incremental market development with interventions that would distort price and destroy liquidity.

“The current level of gas prices and threats to security of gas supply do not justify interventions – particularly in the electricity market – that threaten energy affordability and our decarbonization goals in the medium to long term,” the European Federation of Energy Traders (EFET) said in March.

“We advise extreme caution with regard to wholesale price-control measures, such as price caps and mandatory sales at fixed prices,” it said.

Price control measures in the forward, day-ahead and intraday markets would distort long-term price signals needed to hedge risk, and short-term price signals needed to dispatch the most efficient assets.

Inframarginal power generation revenue clawbacks, meanwhile, “can perversely disincentivize” renewables and low-carbon power production, while encouraging carbon-heavier production “for those who can optimize a portfolio across different technologies,” EFET said.

Finally, uncoordinated national decisions moving to alternatives to marginal pricing would prevent pan-European market coupling from functioning, it warned.

“There are ways in which we can make existing electricity markets function more efficiently – such as standardizing the issuance of forward transmission rights, promoting PPAs, making available more cross border capacity, reducing gate closure times and accelerating the transition towards short imbalance settlement periods. We are confident that ACER’s upcoming report will focus on these opportunities,” it said. ■



Powered by challenges and opportunities

In transitioning toward cleaner energy, transmission and storage could be key to reducing revenue volatility. By Kate Winston and Daryna Kotenko

As the US shifts toward cleaner electricity, the regions of the country with the most wind and solar foreshadow the potential for renewables to erode their own revenue. But opportunities for transmission and storage could help to offset this trend, experts said.

Renewable price cannibalization is already showing up in places like California, where solar power floods the market during the central hours of the typical summer day and power prices dip close to or below zero, said Giuliano Bordignon, lead analyst for North American power at S&P Global Commodity Insights.

This trend is highlighted by renewable capture prices, which are new indexes S&P Global publish. The indexes track the weighted average prices renewable generators receive for the electricity they produce throughout the day, based on hourly generation and pricing data from grid operators.

In 2021, day-ahead wholesale power prices averaged \$50/MWh in CAISO SP15, but solar capture prices averaged just \$36/MWh in the region last year, Bordignon said. In other words, solar capture prices were well below market prices, he said.

Meanwhile, wind capture prices at the CAISO SP15 were above market prices, averaging \$52/MWh in 2021. This is because not all wind generates at the same time, and there is more wind output at the beginning and end of the day when prices are higher, Bordignon explained.

In contrast, wind capture prices in the Southwest Power Pool North Hub trended lower than day-ahead wholesale prices. And wind capture prices in Texas vary widely by region.

Capture price trends

Renewable capture price data could help developers decide where to build new renewable facilities. For instance, wind could be the focus in California, but solar could be the priority in other US regions where there is still an opportunity for solar to earn a premium compared to wholesale prices.

“The trends that we obtain from capture prices indicate a small advantage of solar over wind in the next few years,” Bordignon said. “This applies in particular across the eastern, US where fossil fuel technologies are still dominant across the various power markets,” he said.

Renewable capture prices are expected to see a relatively steep decline through 2025, according to the S&P Global Long-Term Outlook. “But afterwards, and at least through the mid-2030s, the rate of decline decelerates or flattens, and in most regions remain in positive territory through 2050,” Bordignon said.

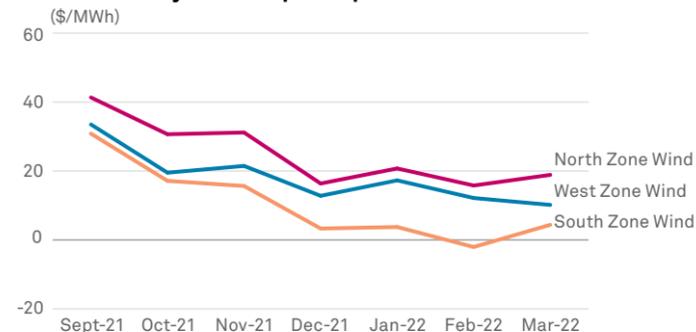
Renewable capture prices will also likely see short-term swings due to variations in fuel prices, said Joshua Rhodes, a research associate with the Energy Institute at the University of Texas at Austin. During the hours renewables are producing the marginal generator is often gas-fired, so market prices for renewables will be higher when the price of natural gas is higher, he explained.

And while capture prices will generally trend down over time, prices could make abrupt jumps up when expanded transmission gives renewables better access to markets, Rhodes said.

Transmission and storage

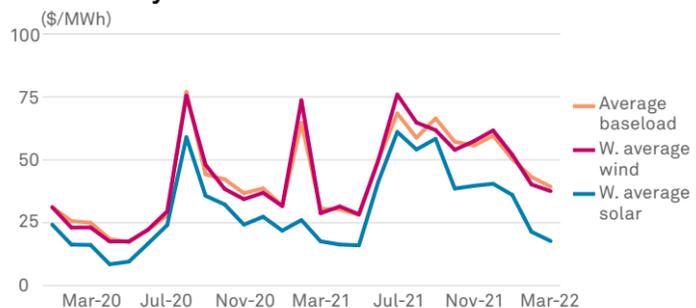
Looking at transmission, anyone working on integrated resource plans could use capture price data to build a case for grid investments, said Eric Smith, associate

ERCOT monthly wind capture prices



Source: S&P Global Commodity Insights

SP15 wind, solar monthly average capture prices vs baseload day-ahead SP15 LMP



Source: S&P Global Commodity Insights

SPP north hub monthly wind capture price vs baseload day-ahead LMP



Source: S&P Global Commodity Insights



director at Tulane Energy Institute. “The ability to move such power across the country could be quite profitable, assuming the volume to be moved can justify the incremental investment,” he said.

The data could be used to determine best investments to limit curtailment, as well as the potential impact of adding storage to the mix to reduce revenue volatility and increase the gross revenue earned, Smith said.

The capture price impact of storage like, batteries or, after 2030, hydrogen, will be determined by the costs of different technologies, Bordignon said.

Analysts at grid operators could also use the data as they design innovative market products that accommodate generation volatility and compensate storage assets, Smith said.

And capture prices could also be used to inform power purchase agreement prices. While developers know the details of power plant costs, the counterparty may not have that information and therefore could use capture prices to determine the best deal, said Jeff Schroeter, managing director at Genova Power Advisors.

Other data points

But capture prices are just one part of the picture. For instance, developers looking to site a new project

will also weigh whether they will have to pay for expensive upgrades to the transmission system in a region, Rhodes said.

It would also be helpful if the capture price data was paired with capacity factors, Rhodes said. Higher capture prices in a particular location could be offset by lower capacity factors, he noted.

In addition to the daily capture price data, it could also be useful to have weekly, monthly or seasonal capture price data, Smith said. ■

Go deeper

North American Renewable Capture Price Indexes

S&P Global Commodity Insights’ Renewable Capture Price Indexes will provide the market with an independent and transparent view on how renewable revenues are changing through time as the energy transition accelerates and renewable generation, such as solar and wind, make up a greater share of the generation mix. [Learn more](#)



Ambitious but achievable

Stakeholders once thought the US offshore wind power capacity goal of 30 GW by 2030 lofty. But with momentum on its side, the target is now looking more realistic.
By Ellie Potter, Jared Anderson

While describing the Biden administration's goal to deploy 30 GW of offshore wind power capacity by 2030 as "ambitious," several industry representatives and observers said the target seemed achievable given interest in the space.

"Certainly 30 GW in total by 2030 seems to make sense and frankly seems to be necessary in the direction that we're headed," Stuart Nachmias, president and CEO of Con Edison Transmission, told S&P Global Commodity Insights.

In February, the US Department of the Interior auctioned off six leases in the New York Bight, netting \$4.37 billion in the nation's largest-ever offshore energy lease sale – including oil and gas.

Nachmias estimated that it could take roughly five to seven years before those leases see steel in the water, potentially putting them on track to contribute to the 30-GW target.

'Huge leap forward'

Josh Kaplowitz, vice president for offshore wind for the American Clean Power Association, told reporters in February prior to the lease sale that the goal was "ambitious but achievable," with the New York lease sale playing a role in offshore wind deployment.

"It's a huge leap forward," Kaplowitz said. "That combined with existing leases definitely puts us on track ... but we need a pipeline of leases into the future."

The "building blocks are in place to move us in that direction," noted Lathrop Craig, PSEG's vice president for offshore wind development. States from Virginia to Massachusetts collectively have set targets for purchasing offshore wind that exceed 30 GW of installed capacity, although some of those goals extend to 2035, Craig said.

States along the Eastern Seaboard have set offshore wind power capacity targets that total 33.1 GW by 2035, according to S&P Global. However, capacity targets by 2030 total 8.2 GW, with Maine accounting for 5 GW, a target that is being reevaluated after being deemed "not realistic at this point," according to the governor's office.

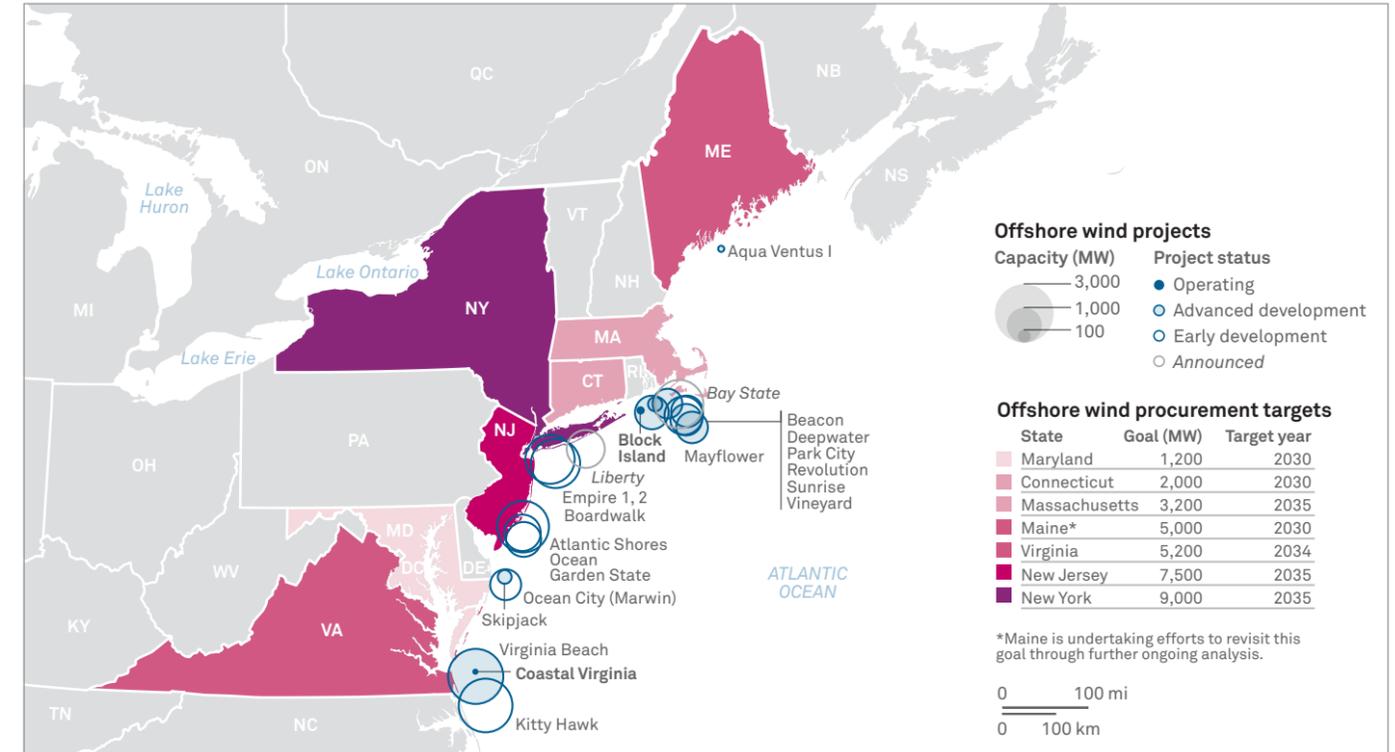
Across that region, about 15 GW of projects have already gone through the bidding process and been awarded, Craig added. But most of those projects still need to secure permits.

"There's definitely a lot of movement toward making these projects real and securing their financing ultimately," Craig said. "The vast majority of those are still working their way through federal and sometimes state and local permitting processes, but the federal one is generally the longest term of any of those."



US East Coast could add over 33 GW of offshore wind capacity

US offshore wind power development is slowly moving forward with just over 23 GW of project capacity in the works along the East Coast, which is an enormous increase from the 42 MW currently operating. The Biden administration has also set a nationwide goal to develop 30 GW of offshore wind power capacity by 2030, which appears achievable, according to experts.



Source: S&P Global Commodity Insights, S&P Global Market Intelligence, Bureau of Ocean Energy Management, NYSERDA

The US Bureau of Ocean Energy Management expects to review at least 16 construction and operation plans for commercial offshore wind energy facilities by 2025, which would represent more than 19 GW of capacity.

Lauren Bachtel, an attorney with Mayer Browns' global project and infrastructure group, acknowledged that she initially thought President Joe Biden's goal was lofty. But the industry's progress, state interest and federal agency support make the "perfect storm" for meeting the 30 GW target, the attorney said.

"The offshore wind industry is just experiencing this sudden burst of momentum, which should be enough to really push to the targets if not over the targets," Bachtel said.

Policy needs

American Council on Renewable Energy President and CEO Gregory Wetstone acknowledged that the US has plenty more steps to take to reach the president's goal but agreed it was doable.

"We can point right now to 30 GW of offshore wind already in the development pipeline," Wetstone said. "But we know we need to ramp up efforts to build the domestic supply chain for offshore wind. We need to improve transmission planning and permitting to ... take full advantage of all the power that will bring to the grid. And broadly, we need to be able to catalyze the long-term investment that we're going to need by extending the current tax platform to ensure that the incentives will continue to be in operation."



While the Trump administration was less friendly to the offshore wind sector, the industry seems to have since gathered steam, he added.

“I think there is a sense of momentum, and that really goes to economic opportunities that are being created in this sector, jobs that are created, investment that’s helping local communities and helping really to resurrect activities in ports,” Wetstone said.

Tax provisions included in the Build Back Better Act, which stalled in the US Senate, would greatly aid in making these projects “as economic and financeable as possible,” PSEG’s Craig added.

“The amount of investments that 30 GW of offshore wind in a reasonably short period of time implies is going to put very significant strains on the tax equity market,” Craig said. “There are provisions in those clean energy tax proposals ... that would significantly alleviate that pressure and make it easier to finance these projects.”

One such provision is called “direct pay” that would allow nontaxable entities to receive the value of clean energy incentives through a direct-pay option. The investor-owned utility trade and lobbying group Edison

Electric Institute has been pushing Congress on direct pay as part of a clean energy tax package.

Transmission planning

As the US offshore wind industry continues to grow, transmission planning will become more important, the industry representatives said.

Many offshore wind power generation projects today are being built with their own transmission line to shore. But with more turbines in the water, it could become increasingly difficult to find an onshore interconnection point, especially given that much of the East Coast is used for residential and recreational purposes.

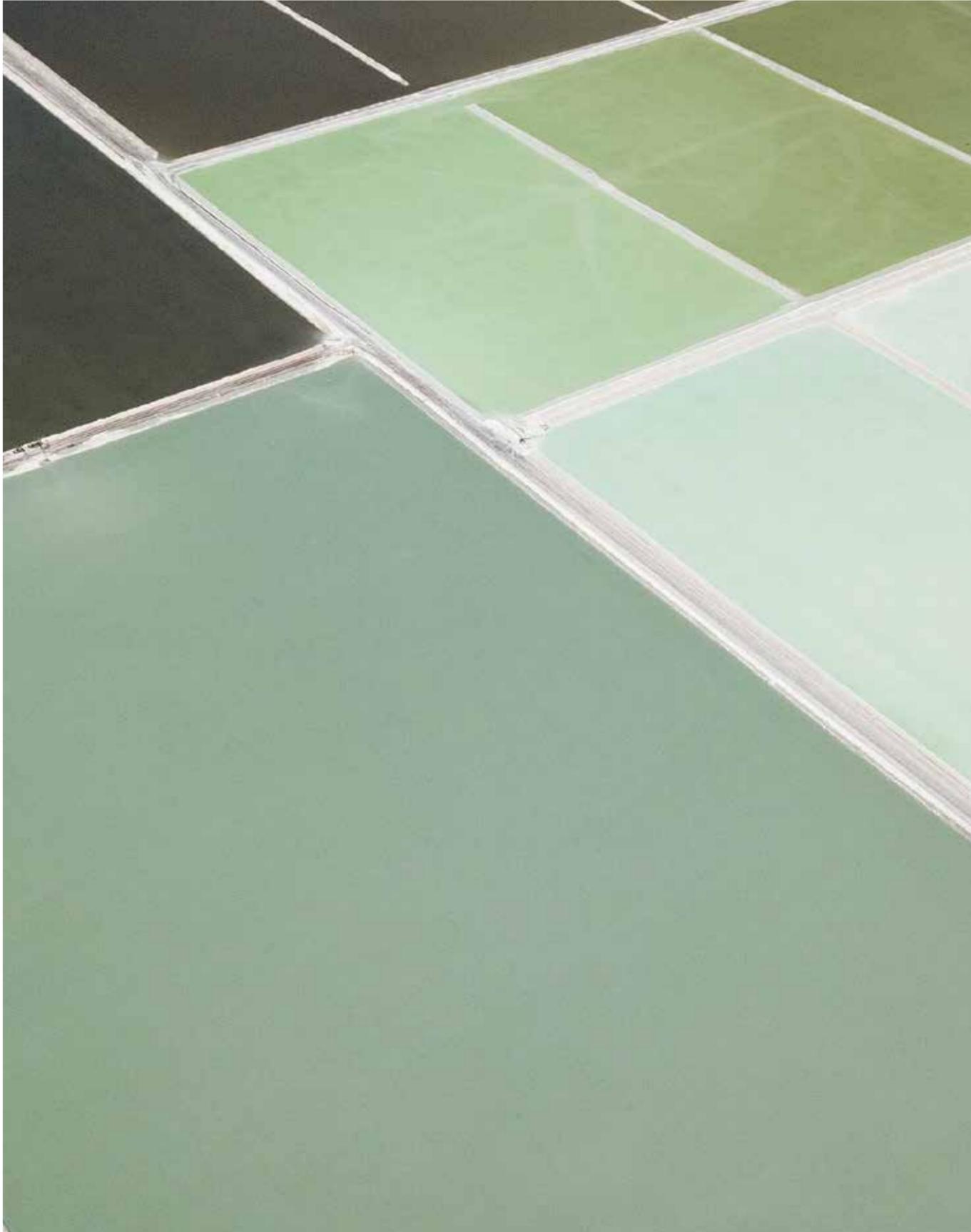
Some in the industry have called for a more integrated approach, perhaps with an offshore grid, so each project does not require its own transmission line to shore.

“Down the road we anticipate that good onshore interconnection points will be in shorter supply,” the ACP’s Kaplowitz said. “We think it’s important to move toward some sort of regional transmission collector lines for multiple projects.” ■

Platts Methane Intensity and Methane Intensity Price Premiums

Commodity Insights methane intensity calculations provide you with the most accurate picture of the methane emissions rate generated by the US natural gas industry. Additionally, our daily methane intensity premiums bring pricing transparency to the cost of continued cost of methane emissions, encouraging faster mitigation practices.

Get in touch about these calculations at AmericasGasPricing@spglobal.com



Lithium conundrum

A drought in investments in lithium means a structural supply-demand imbalance could be looming in the years ahead, Henrique Ribeiro writes

A structural deficit throughout the coming decade could be looming for the lithium market. For a metal that is a key raw material in electric vehicles and energy storage systems – both of which are currently in high demand – there has been an undeniable lack of investment to ramp up its supply.

In the last lithium price bear run, from mid-2018 to mid-2020, investments effectively shriveled. An expected ramp-up in EV sales failed to materialize in time to meet previously boosted output capacity of spodumene ore, one of the main sources of lithium, along with brine, a lithium-rich saline solution. The resulting oversupply of lithium crashed prices and halted investments.

This time the situation is completely different. Demand is growing much faster than supply.

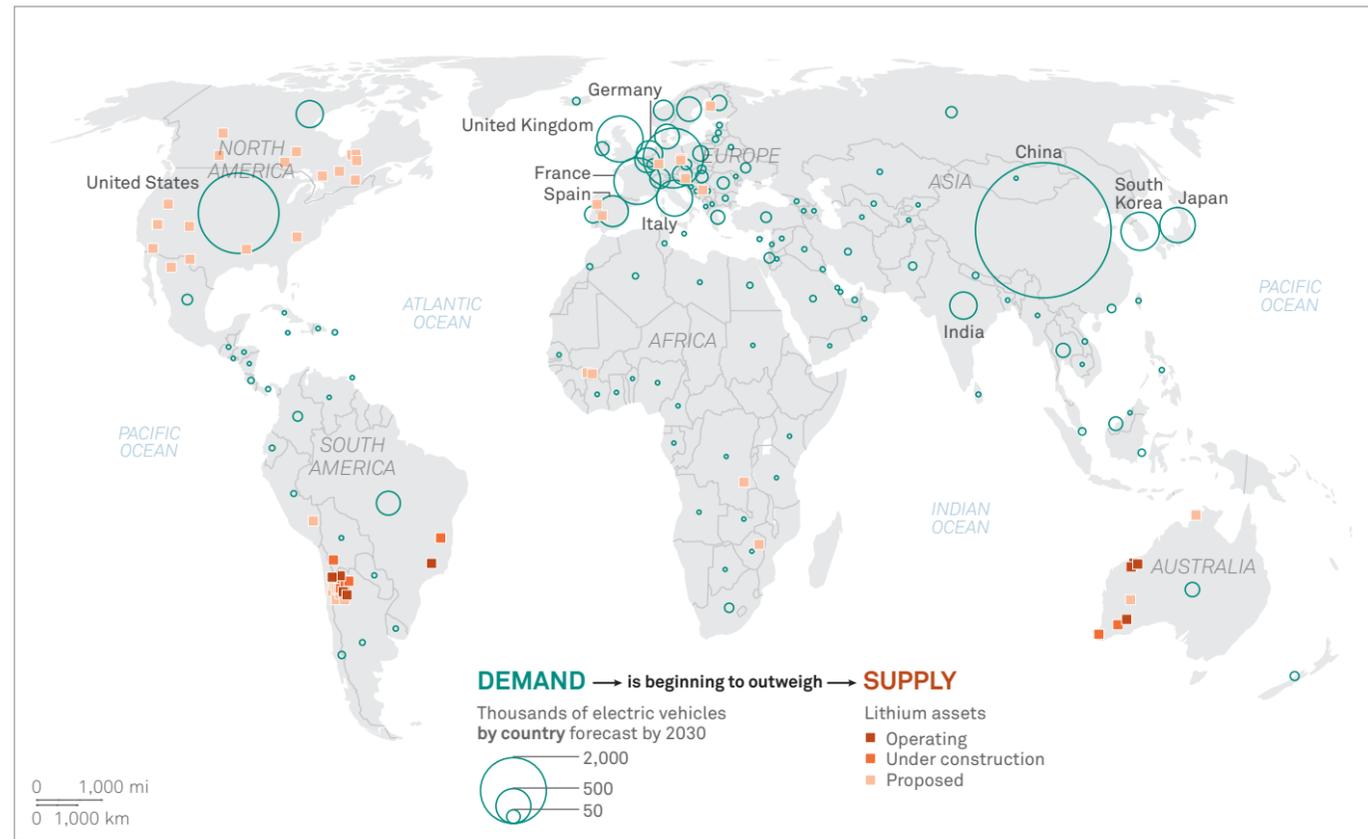
EV sales accounted for almost 20% of new car sales in China and over 25% in the EU in recent months, forcing lithium suppliers to try accelerating expansion and new projects. Financing and permitting, however, are still significant hurdles.

The current situation has translated into surging lithium prices. Since early 2021, Platts lithium carbonate CIF North Asia assessment by S&P Global Commodity Insights has risen 1,128% to \$78,000/mt as of April 14. Lithium hydroxide CIF North Asia has moved up 822% to \$83,000/mt and the spodumene concentrate, used for conversion in lithium chemicals, has surged 1,088% to \$5,350/mt on a FOB Australia basis.

Supply-demand imbalance

While the battery industry has been investing significantly in downstream battery capacity to power surging EV demand, the expansion of lithium supply could come too late to prevent a structural deficit in the coming years.

Light duty plug-in electric vehicle demand and global lithium production



Source: S&P Global Commodity Insights, S&P Global Market Intelligence, company announcements

“Unfortunately, battery capacity can be built much faster than lithium projects,” said Joe Lowry, president of consulting firm Global Lithium. “The lack of investment in lithium capacity over the past five years will extend the supply shortage.”

The supply and demand imbalance could be so serious that supply might end up capping demand, he added.

Even well-capitalized major lithium companies have struggled to meet their expansion targets, while new producers have experienced project delays because of COVID-19 and supply chain issues.

Original equipment manufacturers “and battery producers that assumed ‘market forces’ would ensure adequate battery raw materials are finally taking note of the supply-demand issue, but much too late to solve the problem in the near to mid-term,” Lowry added.

S&P Global 2030 supply and demand estimates also show that supply is unlikely to meet projected demand of 2 million mt by the end of the decade.

Carbonate vs hydroxide

Despite greater interest in lithium hydroxide, which is required in nickel-rich battery chemistries with higher energy density (allowing EVs to drive farther on a single charge), most of the existing integrated capacity is dedicated to lithium carbonate.

More greenfield projects – including some brines, which produce carbonate – are expected to include hydroxide conversion, and most of the hard rock supply coming onstream is targeted for hydroxide. Carbonate, however, will still represent a significant portion of supply, and hydroxide production will depend on adequate supply of raw materials for conversion.

THE LITHIUM DEFICIT ROAD MAP

High probability of deficit if supply is not achieved in Level Two or Three scenarios by 2030

FUTURE LITHIUM DEMAND BY 2030



FUTURE MINE CAPACITIES AND THEIR OUTPUTS (SUPPLY)

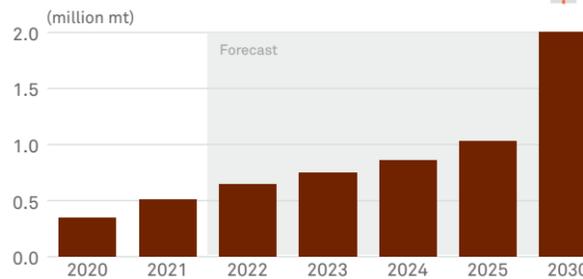


WILL FUTURE SUPPLY MEET LITHIUM DEMAND?

As companies and countries continue to eye net-zero targets and generate energy transition plans, the already growing global demand for lithium is poised to pick up momentum. But a lack of investment in new production of the key raw material used in electric vehicles and energy storage systems might lead to a structural deficit throughout this decade.

Even if all lithium projects expected to be online by 2030 are perfectly executed, there remains a 220,000 mt gap to the 2 million mt in demand expected in 2030.

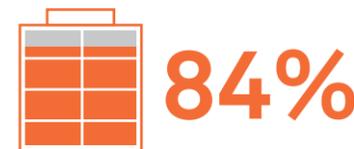
LITHIUM DEMAND FORECAST



LITHIUM PRODUCTS AND ASSETS

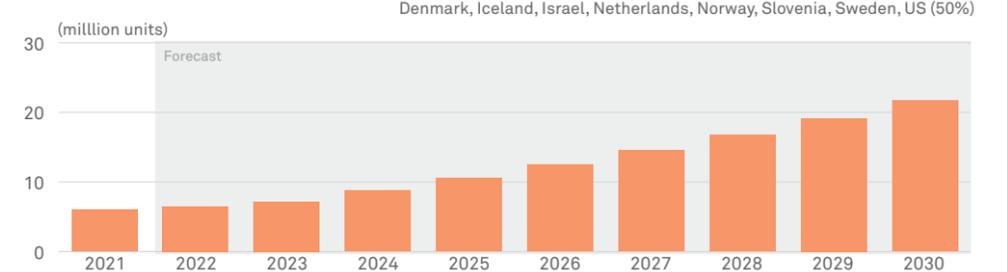
Hard-rock assets will keep accounting for most of the lithium output in the future, but all production routes – even those which have never operated at a commercial scale – will be necessary to mitigate the increasing supply deficit. Within the product base, there will be limited integrated hydroxide capacity, meaning converters will keep playing an essential role in the future.

IT COULD TAKE ALMOST A DECADE FOR A MINING PROJECT TO REACH CAPACITY



of all lithium produced is expected to be used in batteries for EV, ESS and portable electronics by 2025

GLOBAL EVs SALES FORECAST



Note: This analysis is based on company announcements and considers the “best case” scenario. 1) The portion marked as lithium carbonate equivalent (LCE) product is either because the owner has the option to produce both carbonate and hydroxide, or because the expected output was announced in LCE only. 2) Some projects might do several feasibility studies

Sources: future mine capacities from company announcements; lithium demand evolution up to 2025 by S&P Global Market Intelligence, 2030 by BloombergNEF; EV sales forecast by S&P Global Commodity Insights; lithium use by segment by iLi Markets

Developed and designed by Henrique Ribeiro, Melenie Yuen



The lack of feedstock (usually spodumene) should be a concern for several projects of non-integrated conversion capacity, most of which are eyeing the supply of hydroxide. Adding conversion capacity is less capital-intensive and faster than building the underlying feedstock capacity, meaning there could be a mismatch that could leave some hydroxide converters with idled capacity despite surging demand, sources said.

Some projects will also have the option to produce either carbonate or hydroxide depending on market conditions. The surge in demand for nickel-free lithium-iron-phosphate battery chemistries, including official announcements from the likes of Tesla and Volkswagen, means demand for lithium carbonate should stay healthy throughout the decade.

Developing different kinds of assets and technologies will be necessary to mitigate the risk of a multiyear deficit, which would have severe implications for electrification and reaching emissions-reduction targets.

The second generation of lithium projects should also bring new kinds of assets that were never developed before, such as clay and geothermal brines, as well as the potential employment of direct lithium extraction technology. Most of these will also target increased integrated hydroxide capacity, but they will still need to prove their commercial viability.

DLE has been touted by some as the holy grail for the lithium industry, yielding higher quality products at a faster production schedule, with lower costs and less water consumption. Others stress that DLE is not an off-the-shelf solution that can be applied the same way for all projects. "In addition, DLE has never been tested on a commercial scale, meaning its success is yet to be proven.

Lithium demand is expected to keep growing faster than supply in the coming years. Developing different kinds of assets and technologies will be necessary to mitigate the risk of a multiyear deficit, which would have severe implications for electrification and reaching emissions-reduction targets. ■

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Establish the new before destroying the old

Ivy Yin and Eric Yep unpack China's approach to transition
that has energy security at its core



When Chinese President Xi Jinping met with delegates from Inner Mongolia Autonomous Region in Beijing for the country's 13th National People's Congress in March, he emphasized that China's energy transition will be based on the principle of "establishing the new before destroying the old."

The phrase is a reversal of a slogan used during China's tumultuous Cultural Revolution that spoke about "destroying the old before establishing the new."

Xi's revised take on the slogan is not only loaded with historical significance as he views energy transition as the new industrial revolution on which Beijing is staking its future economy. It also reflects China's response to what it feels is a misplaced global approach to energy transition.

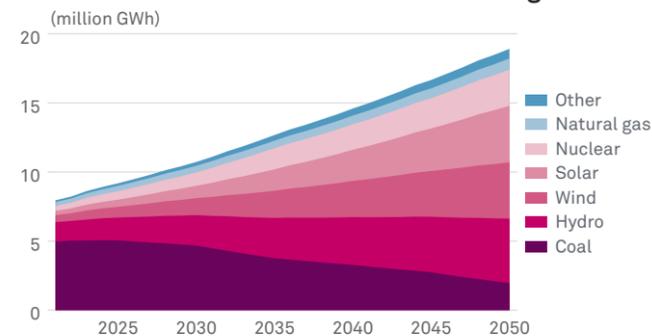
Global decarbonization efforts have been focused on cutting supply of fossil fuels and risking energy security without investing sufficiently in the low carbon ecosystem, as seen in the current crisis in Europe. There is not much to transition to, while fuel supply is being choked off.

China's energy policymakers faced similar challenges just in the past 12 months – energy-intensity targets crimped industrial activity and economic growth, a fuel crisis in 2021 triggered provincial blackouts, record high oil, gas, and coal prices hit in 2022, and now the Russia-Ukraine war has exacerbated global energy market turbulence.

As a result, when China published its 14th Five-Year Plan (FYP) for Modern Energy System in March, it put energy security at its core.

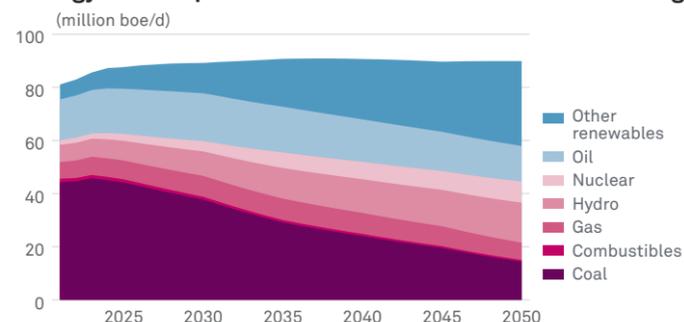
The plan highlights energy security as "the premise" on which China's modern energy system will be built, with a dedicated chapter titled "Enhancing the stability and safety of energy supply chains." It says the government will "promote energy transition alongside supply security" and "coordinate rather

Generation mix needed for China to meet 2 C target



Source: S&P Global Commodity Insights

Energy consumption mix needed for China to meet 2 C target



Source: S&P Global Commodity Insights

than create competition between fossil fuel and non-fossil fuel sources."

Supply focus

The plan, drafted by the country's energy regulator National Energy Administration (NEA) and top economic planner National Development and Reform Commission, is also significant because it is the first economic plan after Xi's pledge to achieve carbon peak by 2030 and carbon neutrality by 2060.

It covers energy targets for the 2021-2025 period and explains the role of coal and natural gas in the country's energy transition.

China's domestic energy supply is sometimes described as "rich in coal, poor in oil, short of gas" – the three pillars of its current energy security.



Its 14th FYP focuses on stabilizing domestic oil supply, expanding natural gas production, expanding energy storage capacities, and retrofitting – instead of rushing to phase out – coal-fired generation units to solve the intermittency of renewables.

The government also recognized sweeping changes in global energy trade flows.

"There's an in-depth adjustment of the global energy supply-demand pattern. The center of gravity for consumption is shifting to the East, while the center of gravity for production is shifting to the West," the plan said.

China plans to boost natural gas production to 230 Bcm/year, which is a 12% increase from 2021 levels, and maintain domestic crude production at 200 million mt, or 4.02 million b/d, from 2022 to 2025.

China's crude output was 198.98 million mt in 2021, and hit a six-year high of approximately 4.16 million b/d in January-February, data from the National Bureau of Statistics showed. China currently relies on imports for over 70% of its crude supplies.

For natural gas, China plans to boost shale and conventional gas output, expanding natural gas storage capacity to 55 Bcm-60 Bcm by 2025, accounting for about 13% of the country's total natural gas consumption, mainly comprising underground gas storage depots and LNG tanks.

Much of this is to address growing shortages.

An NEA official pointed out in an interpretation of the plan that China's economic recovery and energy demand growth exceeded expectation in 2021, which stretched the limits of the energy supply chain and resulted in shortages of coal and power in some regions.

"In the 14th Five-Year Plan period, rigid growth in energy demand will continue, and the pressure to secure energy supplies will remain," the official said. "We need to enhance our independent energy supply capacities, and we need to ensure supply and demand movements to be orderly and stable," he said.

Compared to previous five-year plans, the 14th plan for the first time emphasized the development of domestic oil and gas upstream projects, international

cooperation with producers and consumers, and developing international trading capabilities.

The plan also highlighted the role of natural gas in China's future renewables-dominant power system. It said gas-fired plants will be used for peak shaving purposes in provinces with favorable conditions, and integrated with local solar and wind plants. It also called for building coal-to-liquids (CTL) projects, which convert coal into liquid fuels like gasoline, diesel, and jet fuel, and coal-based synthetic natural gas or SNG projects. Five CTL and SNG "strategic bases" were identified in the regions of Inner Mongolia, Shaanxi, Shanxi and Xinjiang.

Accelerated renewables

In previous policy documents, China emphasized building renewables-based power generation but installed capacity cannot be converted into electricity without reconfiguring the grid.

The new plan focuses on integrating both centralized, large-scale renewables and many scattered smaller facilities by "devoting greater efforts to construct a new energy supply-demand system, with large-scale solar and wind power plants as the base, with clean, efficient coal-fired plants as the pillar, with stable, reliable ultra-high voltage transmission channels as the carrier."

The next phase of China's renewables growth is centered heavily on transporting green electricity from remote parts of Yunnan, Guizhou, Sichuan and Tibet as well as provinces in northwest and central China – which are rich in hydro, solar and wind power – to densely populated coastal regions.

The 14th FYP aims to increase annual domestic energy production to 4.6 billion mt of standard coal equivalents by 2025, a 12.7% increase from 2020 levels, or 520 million mt standard coal equivalent. Out of this growth, 67% will come from clean energy production bases in west China, which includes natural gas, and



29% from non-fossil fuel energy in east and central China, along with 60 GW capacity of cross-provincial power transmission.

By 2025, China aims to reach 3,000 GW power generation capacity, an 800 GW increase from the previous five-year plan ended in 2020, of which conventional hydropower will reach 380 GW, pumped storage hydropower 62 GW, and nuclear to 70 GW.

"We expect strong growth in renewables, and believe China will add about 450 GW of new capacity by 2025," said Andre Lambine, Senior Analyst, Global Power Analytics at S&P Global Commodity Insights. "Installed wind power capacity should grow from 330 GW in February to about 500 GW by 2025. Centralized solar capacity could increase from 200 GW currently to 340 GW by 2025, and in addition we assume distributed solar capacity to grow from 110 GW to 250 GW."

He added it is likely that China will reach its goal of 3,000 GW capacity by 2025, and while the exact output of non-fossil fuels depends on many factors, S&P Global's base case is slightly lower than the 39% objective set in the latest Five-Year Plan.

China's total installed power generation capacity is currently expected to reach 2,600 GW in 2022, compared with 2,377 GW in 2021, according to data from the China Electricity Council (CEC). Under the new plan, China will raise the share of non-fossil fuels in its electricity supply to 39% by 2025, up from around 29% currently.

In October 2021, China said it planned to increase total installed capacity of wind and solar power to over 1,200 GW by 2030, according to its Nationally Determined Contributions, or NDCs, submitted to the UN.

To put these numbers into context, global renewable energy capacity at the end of 2020 was around 2,800 GW, according to the International Renewable Energy Agency, which is roughly 30% of global power generation capacity.

China's NDC also commits to increasing non-fossil fuels' share in total energy consumption to 25% by 2030, up 5% from the 2025 target level.

China plans to phase out 30 GW of inefficient coal-fired power capacity, equivalent to 2.7% of current installed capacity of around 1,100 GW

The plan said by 2035, the share of non-fossil fuels will increase even further, renewables will become the dominant source for power, carbon emissions will stabilize and then reduce from its peak in 2030.

Role of coal

The plan also outlines the role of coal in China's large coal-dominant economy and its energy future, saying that coal will shift into a supportive role "providing fundamental security and system flexibility."

China has adopted a conservative approach to coal usage and plans to phase out 30 GW of inefficient coal-fired power capacity, accounting for 2.7% of current installed capacity of around 1,100 GW, according to CEC.

It emphasized retrofitting rather than phasing out existing coal-fired generation, which allows them to be restarted at short notice to back up solar and wind capacity to resolve intermittency. Around 200 GW of coal-fired generation will be retrofitted to enhance flexibility, especially small units below 300 MW, the plan said.

China also plans to optimize existing coal supply structure, building up five coal supply bases in north and west China – Shanxi, West Inner Mongolia, East Inner Mongolia, North Shaanxi and Xinjiang – adding that cross-regional transportation and distribution channels for coal shall be expanded, in order to enhance the nationwide supply security. ■

Diminishing demand

Coal-fired generation's share of power output in the US is expected to drop by more than half in 2027 from 2021 levels. Gas and renewables are likely to fill the gap, write Taylor Kuykendall and Mark Watson



Coal-fired generation's share of total US output is forecast to drop by more than half to 11.7% in 2027 from 23.5% in 2021, which may coincide with a general downward drift in wholesale power prices, according to an S&P Global Commodity Insights analysis.

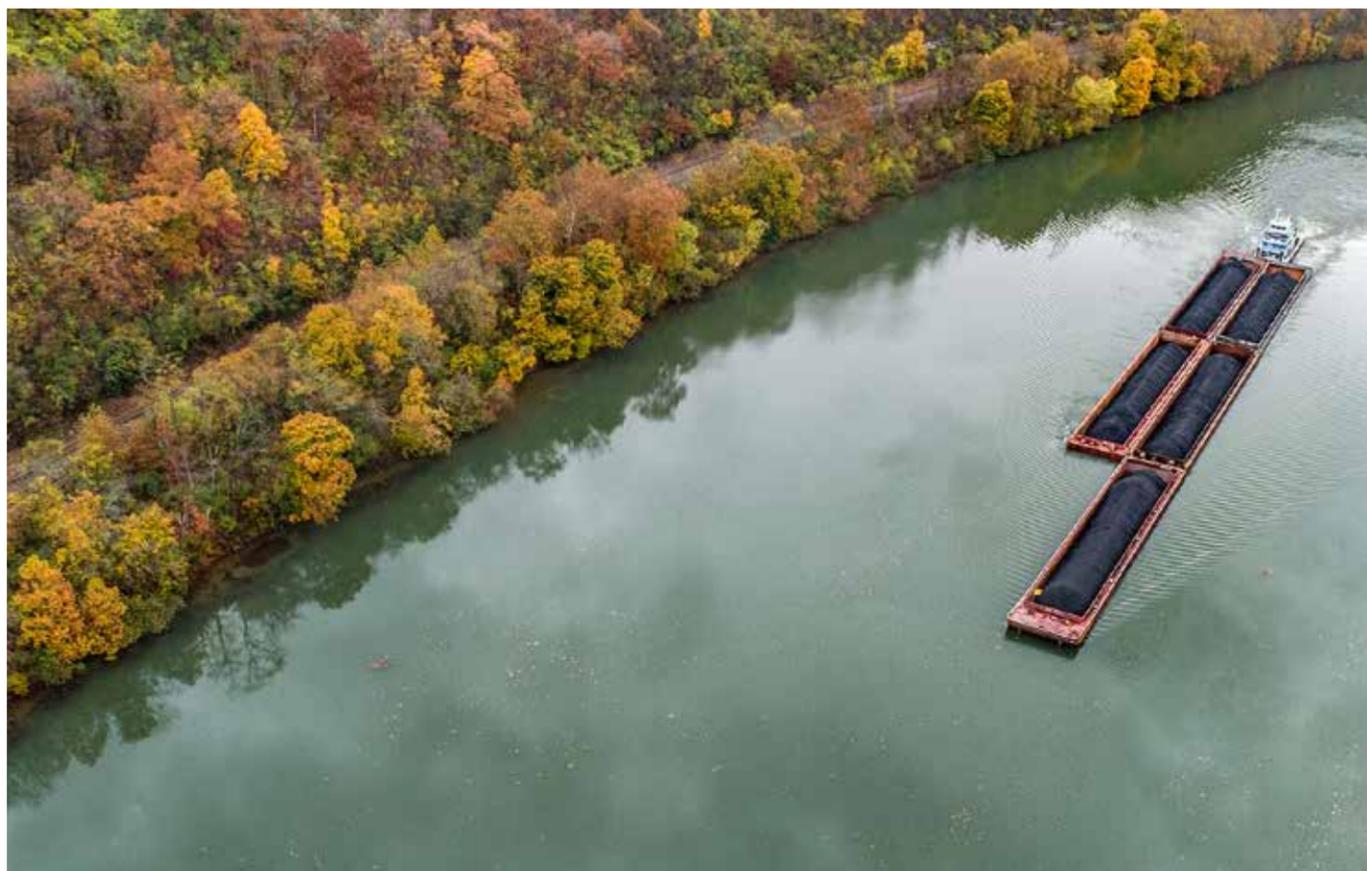
S&P Global's North American Electricity Long-Term Forecast data indicates that coal plants' share of the nation's average generation level fell by more than half to less than 20% in 2020 from 2014's 40.1%, but coal plants' share climbed to 23.5% in 2021.

The top five independent system operators or regions, in terms of the percentage of average generation levels claimed by coal-fired generation, were as follows in 2014, according to S&P Global's analysis:

Midcontinent Independent System Operator	60.3%
Southwest Power Pool	56.4%
PJM Interconnection	44.8%
The North American Electric Reliability Corporation's SERC region (formerly the Southeast Electric Reliability Council)	42.8%
Electric Reliability Council of Texas	36.4%

S&P Global forecasts the long-term trend to continue through 2027, with coal's share falling to about 3.1% in ERCOT, 11.9% in PJM and 14.7% in the SERC region.

"I think that coal burn will continue to decline, even if the near term sees an increase due to global energy prices," said Joshua Rhodes, a research associate



at the University of Texas' Webber Energy Group, in a March 21 email.

Sempra Infrastructure spokesperson Kym Butler said, "While coal generation may increase in the near term due to a reversal of coal-to-gas fuel switching due to marginally higher natural gas prices, and some regulators may slow down coal retirement plans due to inflationary pressures on consumers, over the medium to long term, coal plant owners, utilities, and regulators are unlikely to continue to invest to meet ongoing capital investment needs, especially related to environmental controls."

Replacing the power supply

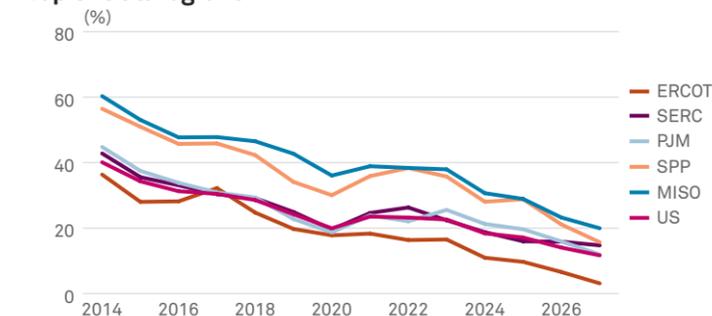
ERCOT and PJM have nearby natural gas reserves, which are likely to meet a substantial fraction of the demand formerly supplied by coal plants. SERC has two large nuclear units slated to start up this year, and its ability to import hydropower from the Tennessee Valley Authority and the Catawba-Watauga River Authority may provide other zero-emissions alternatives.

Prices at benchmark pricing hubs in each of the locations dependent on coal-fired power were mixed in 2021, when a deadly winter storm wrought havoc in gas markets across the central US. Day-ahead on-peak prices were down by 24.1% to \$43.12/MWh at the PJM West Hub and down by 5.1% to \$42.06/MWh at Into Southern, according to S&P Global's power price database, but they were up substantially at ERCOT's North Hub and SPP's South Hub and up slightly at MISO's Indiana Hub.

S&P Global's pricing forecasts indicate double-digit percentage price decreases by 2027 for all except Into Southern, for which S&P Global offers no price forecasts.

Into Southern's current forward trading for 2027 indicates that traders may foresee risks for increased prices as nominal full-year 2027 forwards show a premium of almost 9% from S&P Global's average day-ahead on-peak bilateral indexes in 2021.

Coal's percentage of generation mix for US, top 5 ISOs/regions



Note: Percentages of average generation levels at each region. Source: S&P Global Commodity Insights

Day-ahead on-peak average annual power prices* in coal-heavy pricing locations



* For 2014 through 2021, these are day-ahead on-peak locational marginal prices at each location except Into Southern. Into Southern are S&P Global Commodity Insights day-ahead on-peak bilateral indexes. For 2022 through 2027, numbers are S&P Global forecasts except for Into Southern, which represent S&P Global assessments of forward curves as of the most recent trading dates.

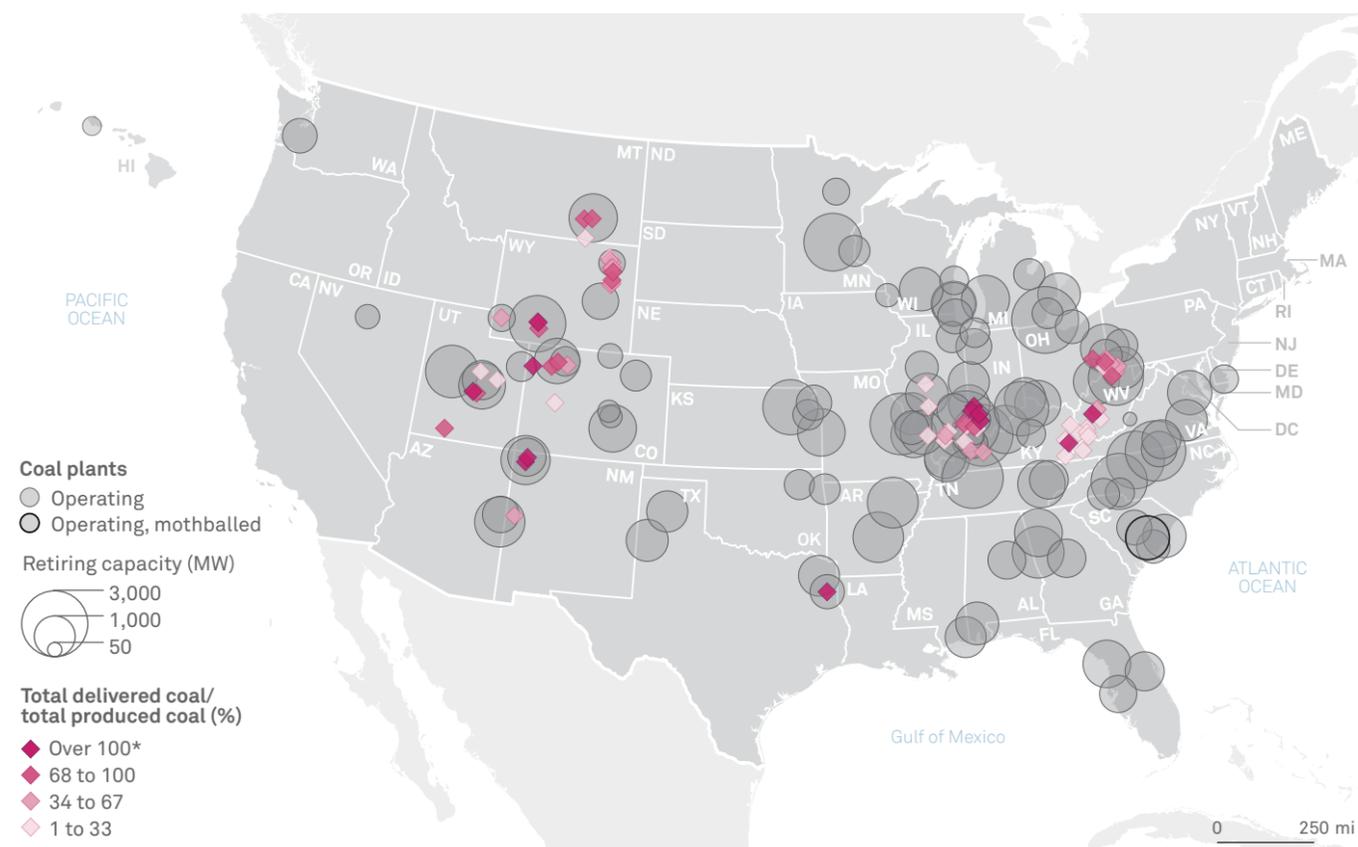
Note: SPP South Hub's 2014 number is for the period from March 1 through December 31. Source: S&P Global Commodity Insights

Fundamentals in pricing

In March, S&P Global's senior manager for North American power analytics Morris Greenberg said the pricing impact of decreasing coal-fired generation "depends on load growth and the resources replacing the coal capacity [if any]."

"Load growth has been stronger than expected this year but may weaken if the [Federal Reserve Board] attempts to slow the rate of inflation," Greenberg said. "There are still significant gas-fired resources in development, while solar capacity additions should accelerate as supply chain issues resolve. Finally, storage additions will be significant in California and

US coal mines exposed to retiring coal-fired plants



Texas in the near term and in other areas toward the end of the five-year horizon.”

Therefore, Greenberg's colleagues expect no “material impact from the loss of coal capacity,” but off-peak prices may rise relative to on-peak, as the grid increases its reliance on solar capacity.

Sempra's Butler said in a March 21 email that “during periods of sustained low renewable output [low wind output seasons, drought, winter peaks that occur at night], the loss of fuel diversity from coal retirements will make availability of natural gas supplies to power plants the critical component that will drive volatility in wholesale power markets [especially in winter months].”

Coal plants scheduled to retire in 2025 alone account for about 3.8% of the amount of coal mined in the US in 2021

The impact to the US coal mining industry may be substantial over the next eight years, as almost 27% of US coal mined in 2021 went to plants scheduled to retire by 2030.



Public health and environmental groups have put coal power under relentless pressure to clean up its high levels of air pollution, while the falling cost of renewables and low price of natural gas have undercut the economic case for the product. No clear plans for the construction of a new US coal plant exists in the near term and announcements of more retirements are still trickling in.

Coal production's demand peak

A previous S&P Global analysis showed that 2028 would be a record year for retiring coal plant power capacity, but 2025 will be the single roughest year in US coal production's near future based on 2021 destinations. The coal plants scheduled to retire in 2025 alone account for about 3.8% of the amount of coal mined in the US in 2021.

UT's Rhodes said, “I think that many locations will be repurposed for their existing on-site water and electrical infrastructure, but it will be pretty site-dependent.”

Greenberg said some coal plants in the South Central region are slated for gas conversion, “but gas steam

units do not dispatch at very high rates so it is difficult to recover the cost of conversion plus pipeline ... if there is not a need for capacity.”

“Some plants will have solar and/or storage installed to take advantage of existing transmission interconnection,” Greenberg said.

Sempra's Butler acknowledged the grid reliability risk of losing so much baseload coal-fired capacity, increasing “the importance of robust electric and natural gas transmission ... to load centers.”

“Grid operators will increasingly rely on battery storage to meet super peak periods, but grid operators will likely struggle with reduced inertia and dispatchable resources on power grids absent a robust ancillary services/dispatchable capacity market construct,” Butler said.

“While many events will be manageable with demand response and conservation calls, shifting and unpredictable net peaks in renewable-heavy markets will potentially have an increasing number of hours with thin operational reserves.” ■

Storage additions drive US clean energy capacity growth

Utility-scale clean energy capacity in the US jumped 7.3% in Q4 2021, with Texas and California leading the pack. By Kassia Micek



Renewable generation is expected to more than double by 2050 and supply 44% of US electricity, with solar surpassing wind by the early 2030s, according to the US Energy Information Administration (EIA).

“This increase in renewable energy mainly consists of new wind and solar power,” according to EIA. “The contribution of hydropower remains largely unchanged through 2050, and other renewable sources of power generation, such as geothermal and biomass, collectively remain less than 3% of total generation.”

Early growth in wind and solar is driven by federal tax credits that are set to expire or significantly decline by 2026, but declining costs for both technologies play a significant role in both near- and long-term growth, EIA said in a March 18 statement.

There is about 4 GW of battery capacity under construction with 2022 in-service dates, in addition to 8 GW of onshore wind and 14 GW of solar, said Morris Greenberg, S&P Global Commodity Insights senior manager for North American power analytics.

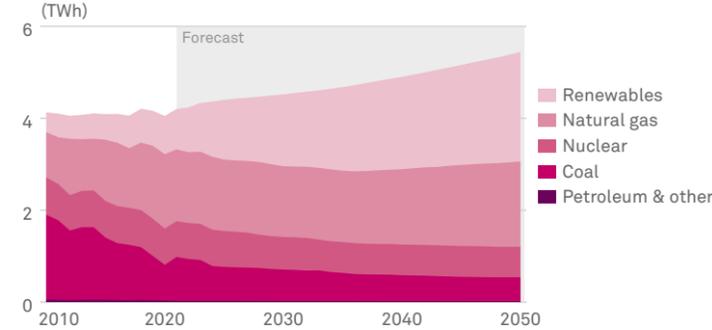
Renewable leaders

The Electric Reliability Council of Texas (ERCOT) has the most renewable generation output across the US based on the latest data covering fourth quarter 2021. Texas ranks first for total utility-scale clean power capacity, more than double California, which ranked second.

There is 45.077 GW of combined utility-scale wind, solar and battery storage capacity in Texas for Q4, a jump of 19% year on year due to strong gains in solar and battery storage, according to the American Clean Power Association’s quarterly report. Renewable generation output in ERCOT, which represents about 90% of the state’s electric load, totaled 331,555 GWh/day in Q4, an increase of 41.6% year on year, according to ERCOT data.

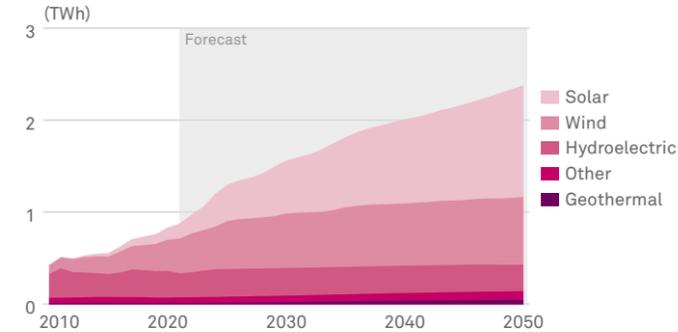
Meanwhile, California’s combined utility-scale wind, solar and battery storage capacity totaled 22.929 GW,

US electricity generation breakdown projections



Source: EIA

US renewable electricity generation projections



Source: EIA

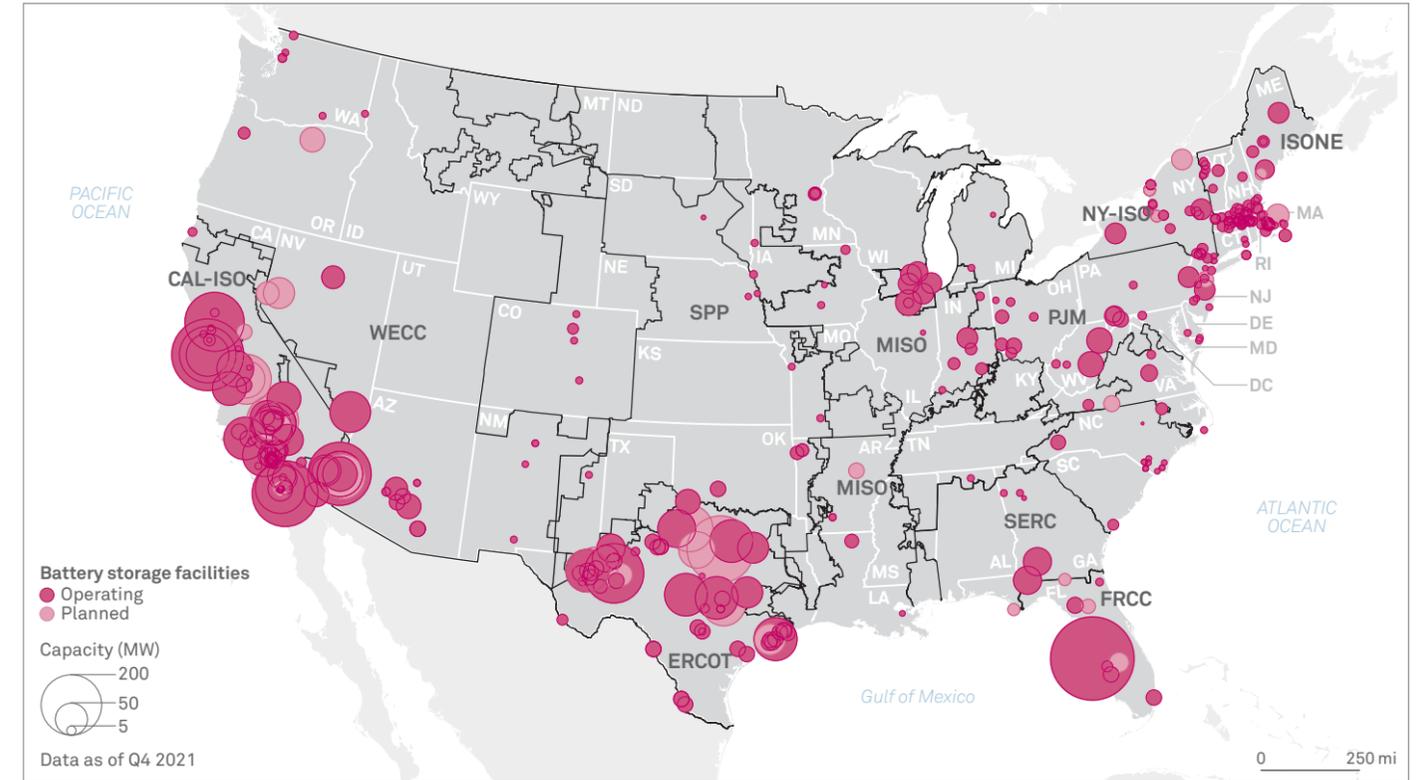
up 13% year on year, thanks to a focus on battery storage additions, according to ACP. Data from the California Independent System Operator (CAISO), which manages the flow of electricity for about 80% of the state, showed that renewables account for nearly 30% of the total fuel mix in Q4, up 2.1 percentage points year on year.

Battery storage soaring

Power plant developers and operators expect to add 85 GW of new generating capacity to the US power grid from 2022 to 2023, 60% of which will be made up of solar power and battery storage projects, the EIA announced March 7. In many cases, projects combine these technologies.

California, Texas continue to lead rapid US battery storage expansion

US battery storage capacity climbed 257% year on year for fourth quarter 2021 with the California Independent System Operator leading the way, followed by the Electric Reliability Council of Texas. CAISO capacity spiked 320% to 3.325 GW, while ERCOT skyrocketed 476% to 1.314 GW. There are nearly 1.32 GW of additions planned for Q1 2022, including 374 MW in CAISO and 734 MW in ERCOT, which would bring the US total to more than 7.5 GW if all projects are completed and connected to the grid.



Source: S&P Global Commodity Insights, Federal Energy Regulatory Commission EQR filings

“Battery storage capacity, as well as renewable capacity, significantly increased in the United States during 2021, partly because of tax credits and partly because of falling technology costs, especially for batteries,” EIA said in the March 7 statement. “Depending on the configuration and charging sources, both solar power and battery storage units may be eligible for the solar investment tax credit, which is scheduled to phase down by 2024.”

More than half of the 51 GW of planned solar and battery storage capacity within the next two years will be located in three states:

- 12 GW (23%) in Texas
- 11 GW (21%) in California
- 4 GW (7%) in New York

Power plant developers and operators expect to add 10 GW of battery storage capacity in the next two years, according to EIA

California ranks first for battery storage capacity with 2.16 GW, a 138% year-on-year jump, according to ACP. CAISO has 102.106 GW of battery storage in its interconnection queue. Of that amount, nearly 3.5 GW have 2022 proposed online dates and have executed interconnection agreements, according to CAISO data.

Texas ranked second for battery storage capacity with 8.547 GW, a jump of 79% year on year, according

Top 20 states ranked by installed capacity (MW)

Ranking	Wind		Solar		Storage	
	State	Installed	State	Installed	State	Installed
1	TX	35,697	CA	14,628	CA	2,160
2	IA	12,212	TX	8,547	TX	832
3	OK	11,137	NC	5,557	FL	456
4	KS	7,947	FL	4,819	MA	149
5	IL	6,997	NV	3,551	IL	134
6	CA	6,142	GA	2,895	AZ	97
7	CO	4,809	AZ	2,697	AK	92
8	MN	4,544	VA	2,175	HI	79
9	ND	4,288	UT	1,456	NY	67
10	NM	4,001	MN	1,219	WV	66
11	WA	3,623	MA	1,156	NJ	62
12	OR	3,614	SC	1,117	ME	44
13	IN	3,468	CO	1,047	GA	42
14	WY	3,178	NJ	981	IN	38
15	MI	3,159	OR	777	OR	35
16	SD	2,921	NY	758	OH	34
17	NE	2,916	NM	742	MN	31
18	MO	2,425	IN	634	PA	28
19	NY	2,191	IL	621	NV	26
20	PA	1,459	MD	515	AR	22

Source: ACP

to ACP. ERCOT expects as much as 3.9 GW of battery additions in 2022 with another 1.224 GW possible in 2023, according to ERCOT's Capacity Changes by Fuel Type report.

Florida also made big gains in battery storage, jumping 1,472% year on year to 456 MW to rank third in the US. There are 14 states that have no battery storage capacity, while 31 states have less than 100 MW, according to ACP.

Texas and California will continue to lead the battery storage buildout in the US, Greenberg said, adding states with significant solar additions or penetration

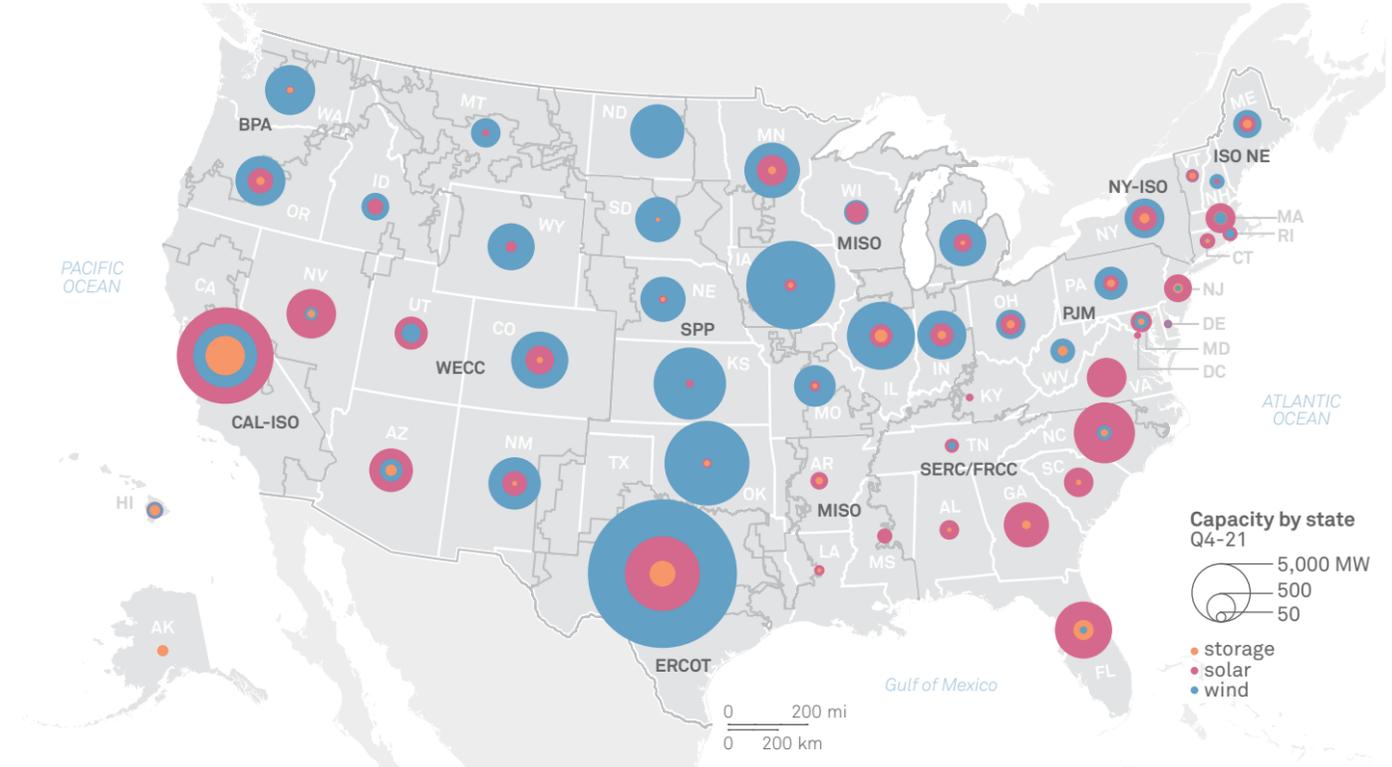
and states with storage mandates or clean peak standards could see strong battery additions as well.

There is a large amount of battery capacity in grid operator interconnection queues, although it is not clear how much will actually be built. Battery projects in queue exceed wind capacity, but not solar.

Energy storage shifts energy usage from one time to another and is not an original fuel source of energy, according to EIA.

Natural gas-fired generators will face competition from energy storage systems, such as stand-alone batteries

Installed renewable capacity by state, Q4-21



Source: ACP, S&P Global Commodity Insights

and solar -battery hybrid systems, to provide electric power generation and back-up capacity for times when non-dispatchable renewable energy sources, such as wind and solar, are unavailable, according to EIA.

The total capacity of grid-connected battery storage facilities across the continental US climbed nearly 4.5 GW, or 257%, year on year in Q4 of 2021 to 6.191 GW with nearly 1.3 GW of additions planned for Q1 2022, according to Federal Energy Regulatory Commission data compiled by S&P Global.

In the next two years, power plant developers and operators expect to add 10 GW of battery storage capacity, according to EIA. More than 60% of this capacity will be paired with solar facilities. In 2021, 3.1 GW of battery storage capacity was added in the US, a 200% increase.

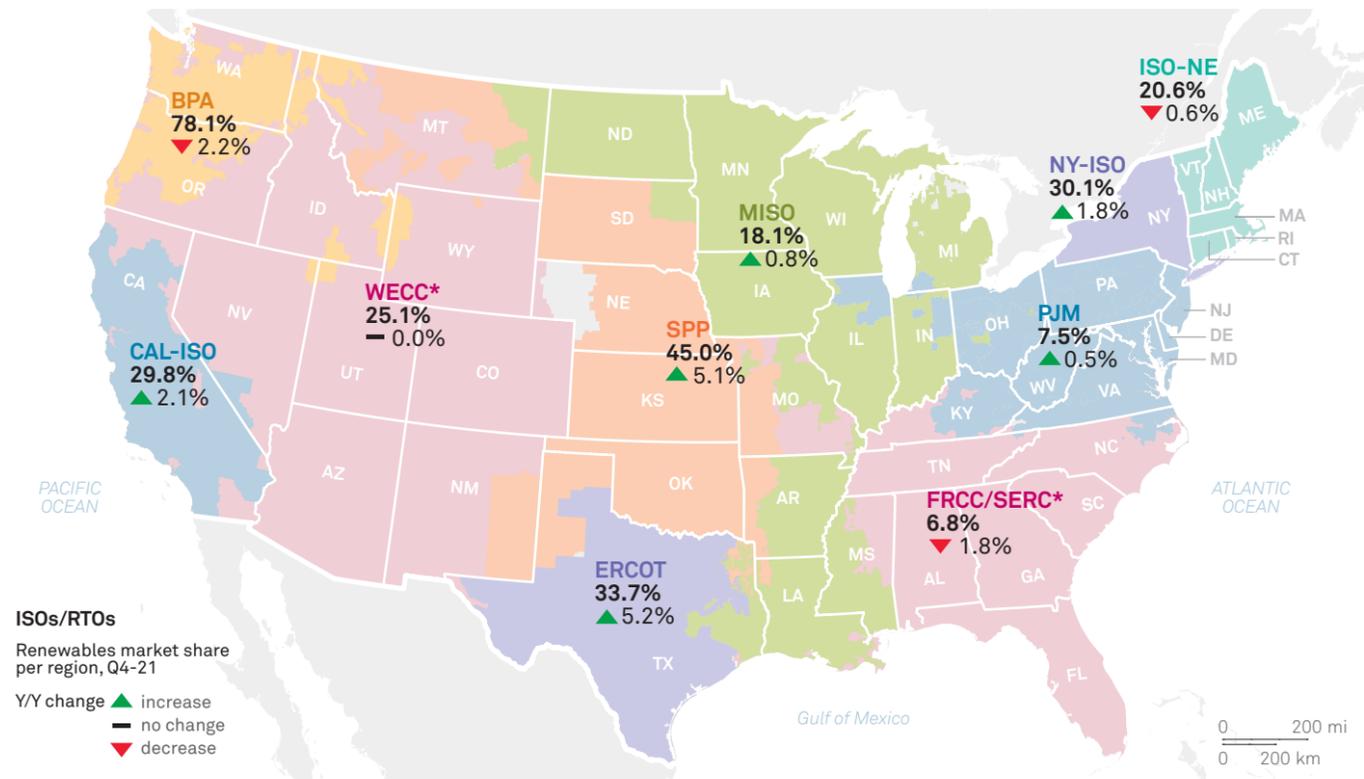
“Declining costs for battery storage applications, along with favorable economics when deployed with renewable energy [predominantly wind and solar PV], have driven the expansion of battery storage,” EIA said.

Windy ways

Texas has the most wind-power capacity at 35.967 GW, up 9% year on year, according to ACP. ERCOT expects as much as 9 GW of wind additions in 2022 with another 2.2 GW on top of that possible in 2023, according to ERCOT's Capacity Changes by Fuel Type report.

New Mexico had the biggest year-on-year wind capacity movements jumping 52% to 4 GW for Q4, ranking it 10th in the US, up from six spots from Q3, according to ACP data.

ISOs/RTOs by renewables market share, Q4-21



Source: US independent system operators and regional transmission organizations, *S&P Global Commodity Insights

Several states in Southwest Power Pool's footprint ranks in the top 10 states for wind capacity. Oklahoma added 1.5 GW in Q4, Kansas 931 MW and Iowa 595 MW, while the Dakotas added a combined 915 MW, according to ACP.

SPP has 2.87 GW of wind capacity in its interconnection queue that have complete interconnection agreements and are on schedule to start commercial operations in 2022, according to SPP data. At 35.6% of the total fuel mix, coal narrowly beat out wind for the top generating fuel in 2021 due to higher natural gas prices making coal more economical.

Eight states still have no utility-scale wind capacity, while seven states have less than 100 MW – Arkansas, Rhode Island, Tennessee, Florida, New Jersey, Connecticut and Delaware.

Solar rays

California ranks first in solar capacity at 14.628 GW, rising 9% year on year, according to ACP data. CAISO has 38.4GW of solar capacity in its interconnection queue, of which 1.436 GW has 2022 proposed online dates and executed interconnection agreements.

Texas was second with 8.547 GW, a jump of 79% from Q4 2020, according to ACP data. ERCOT expects as much as 10.3 GW of solar capacity in 2022, with an additional 15.56 GW in 2023.

While most of the top 10 solar capacity states are in the South, Virginia ranks eighth with 2.175 MW, up 67% on the year, Utah ninth with 1.456 MW, up 22% year on year, and Minnesota follows with 1.219 MW, up 7% from Q4 2020, according to ACP.

Renewables output average per day, Q4 2021 (GWh/change on year)

	Hydro	Y-o-Y	Wind	Y-o-Y	Solar	Y-o-Y	Other	Y-o-Y
BPA	177.6	1%	17.5	-5%	-	-	-	-
CAISO	29.2	-7%	42.9	36%	69.9	8%	32.6	0%
ERCOT	0.4	-76%	294.	46%	40.8	23%	-	-
SPP	19.7	-12%	288.	16%	-	-	-	-
MISO	21.5	-13%	270.6	14%	-	-	-	-
PJM	39.2	6%	92.	3%	12.6	66%	15.1	7%
NYISO	80.9	-25%	14.4	-31%	-	-	5.6	36%
ISO-NE	20.4	2%	10.8	-7%	5.4	46%	16.2	0%
SERC/FRCC*	90.	-15%	8.9	26%	57.4	26%	-	-
WECC*	336.6	-10%	113.8	28%	24.7	143%	-	-

* S&P Global Commodity Insights
Source: Various entities indicated above

The only states that have no utility-scale solar are North Dakota, West Virginia and Arkansas, according to ACP.

Meanwhile, ERCOT had the largest gains in wind output, rising 46% year on year to average 294 GWh/day, based on ERCOT data.

Renewable market share

The West, Texas and SPP continue to lead the US in renewable generation.

The Bonneville Power Administration continues to have the largest market share of renewables at 78.1% for Q4, thanks to its strong hydro fleet, which accounts for 70.8% of the total fuel mix, according to BPA data.

The PJM Interconnection was one of the few places to make gains in hydro output, up 6% to 39.2 GWh/day in Q4, according to PJM data. Most regions saw declines in hydro, which is strongest in spring and summer after the snowmelt feeds water into rivers leading to hydro dams.

SPP ranks second overall for total renewable generation market share and leads the nation in wind market share at 42% for Q4, according to SPP data.

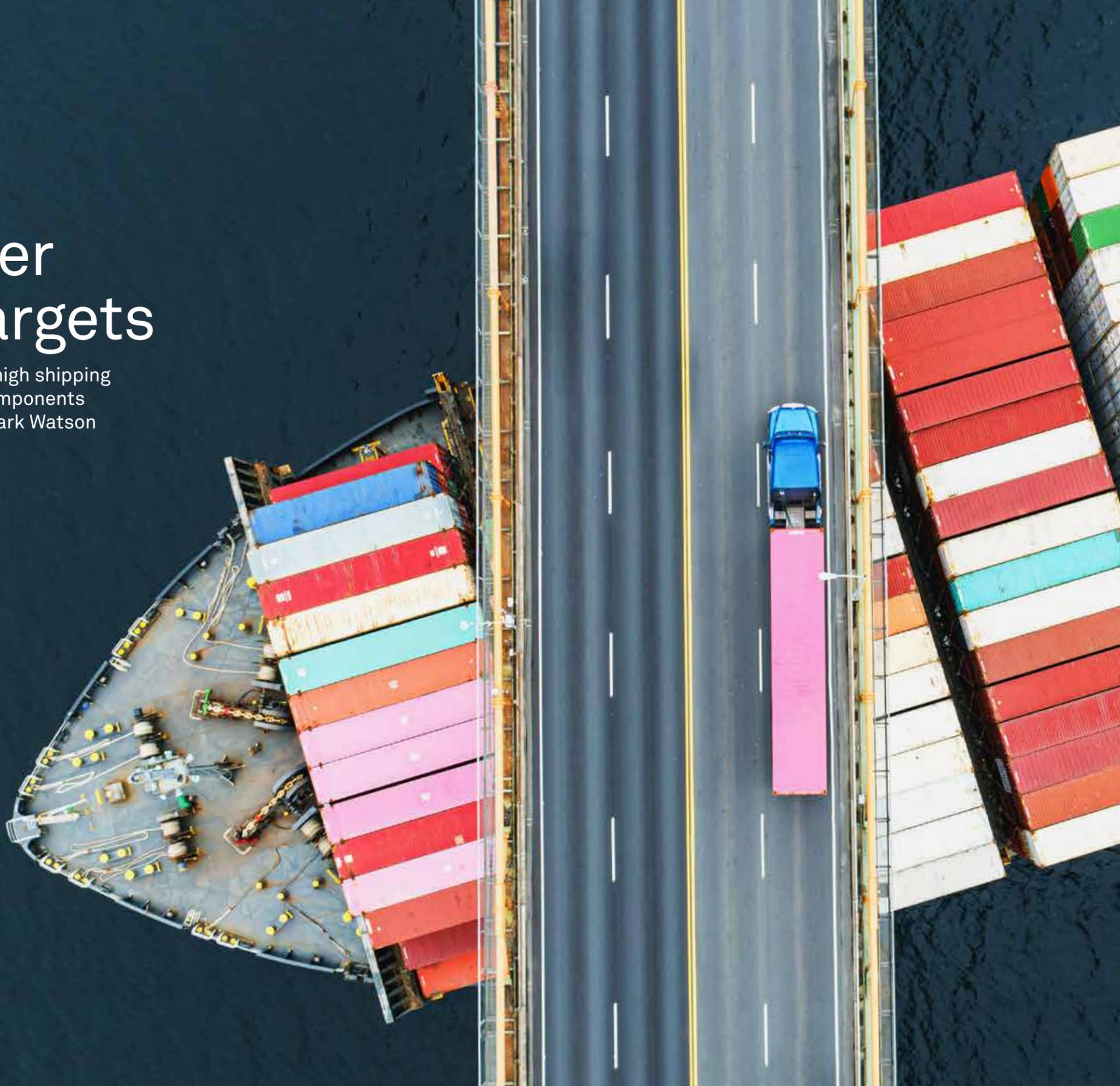
CAISO leads the US in solar market share at 12% of its total fuel mix for Q4, while PJM solar output jumped 66% year on year to average 12.6 GWh/day as ISO New England's solar output rose 46% year on year to average 5.4 GWh/day, according to respective grid operator data. ■

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Roadblocks to power sector's net-zero targets

The struggle is real: the power sector is having to deal with high shipping costs, logistics issues, and price surges in materials and components needed in renewables development and transmission. By Mark Watson



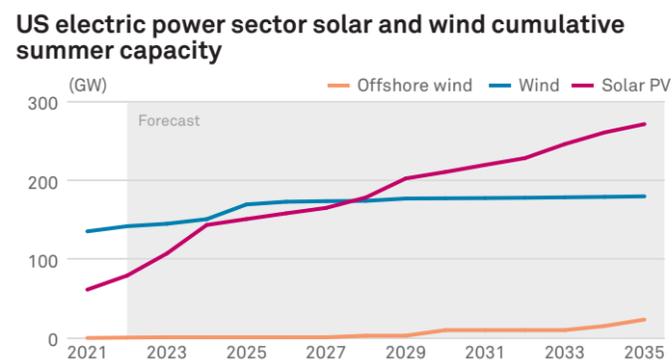
ingering supply chain issues – exacerbated by the Russia-Ukraine war – could hamper efforts to ramp up the renewables development and transmission construction required to achieve the Biden administration's goal of net-zero emissions from the power sector by 2035.

The US Energy Information Administration's latest Annual Energy Outlook projects US power sector photovoltaic solar summer capacity to more than quintuple by 2035, wind to grow by about 33% and battery-storage capacity to grow by more than 565 times – from less than a GW in 2021 to almost 23.4 GW by 2035.

A variety of metals and components must be transported, processed, and installed to achieve that level of energy transition, including lithium and cobalt, which is important for battery storage, and steel and copper, which are important for transmission, distribution, and the electrification of functions now served by fossil fuel energy. Prices for these commodities have grown from January 2021 to end-March 2022:

- Lithium carbonate, up 11.6 times to \$33.57/lb., in North Asia, including insurance and freight
- Cobalt, up 2.4 times to \$38.95/lb., in the US
- Steel, up almost 39% assessed at the steel mill in Indiana, or up almost 36% delivered, duty paid, at Houston
- Copper, up almost 33% to \$4.71/lb. for prompt-month copper futures on the CME

The cost of shipping a 40-foot-equivalent container from Southeast Asia, where many solar and battery components are manufactured, to the West Coast of North America has more than doubled to \$9,500



Source: US Energy Information Administration

During a panel discussion at CERAWEEK by S&P Global about the role of copper in the energy transition, Daniel Yergin, energy expert and S&P Global vice chairman, said, "A lot of the future of net-zero carbon depends on big shovels."

The prices of commodities themselves constitute just one factor: the cost of transporting the materials or components has also surged over the past year. The cost of shipping a 40-foot-equivalent container from Southeast Asia, where many solar and battery components are manufactured, to the West Coast of North America has more than doubled to \$9,500. However, industry experts have said costs were less important than availability with regard to materials needed for the energy transition.

"The stationary storage industry was mostly able to weather earlier pandemic-driven impacts in 2020, as manufacturing first slowed down in China, but the more recent broader cascading supply chain woes have begun to significantly impact battery imports to the United States," said Dan Finn-Foley, an energy storage expert at PA Consulting, in a March 28 email.



During that CERAWEEK panel discussion, Bold Baatar, CEO of Rio Tinto's copper operations, said two large copper mines are slated to start production over the next two years, which may put the copper market into a near balance of supply and demand. Russia is one of the world's largest copper producers, and the rest of the world cannot easily ramp up production to cover the loss of Russia's copper, if it persists.

"The next three years, there's a massive deficit everybody is facing," Baatar said. "For the energy transition and decarbonization, and to meet the goals of the Paris [climate] agreement, you will need a lot of copper, and the copper is not there."

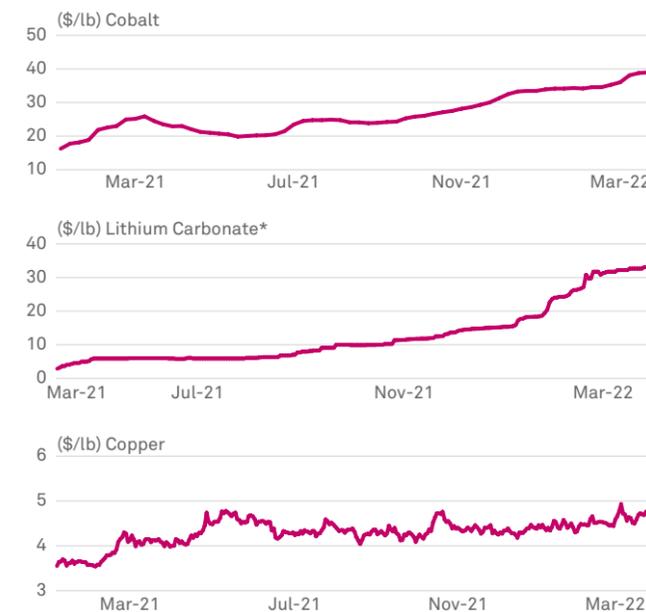
During the same panel discussion, Richard Adkerson, Freeport McMoRan chairman and CEO, noted that the average age of the world's 10 largest copper mines is more than 100 years, and the most recent large copper mine was established by his firm in Indonesia in 1988.

Freeport McMoRan is involved in developing a brownfield copper mine in Arizona that is relatively simple, with thoroughly vetted mine tailings disposal and no local opposition, but Adkerson said completing it will take five to six years.

"We have a very long-term business, and we have a very short-term government," Adkerson said. "People are

elected every two years or every four years, and they are driven by a lot of political issues, so it's very difficult for governments to interact with us on presenting a project like this."

Key nonferrous metals for energy transition



*Daily pricing for Lithium Carbonate began May-21. Note: Cobalt is delivery and duties paid in the US. Copper is Comex prompt-month futures. Lithium carbonate is for North Asia, including cost, insurance and freight. Sources: S&P Global Commodity Insights, CME

Adkerson advised governments to “bolster the resources they have, have clear-cut standards of evaluating [projects] and engage with companies and other interested parties on a good-faith basis and put a priority on timing to get these issues identified and resolved.”

PA Consulting’s Finn-Foley said the federal government’s surge in funding for electric vehicle and stationary battery storage has highlighted that the market is “over-reliant on overseas manufacturing for a keystone net-zero technology.”

“A surge in demand, primarily interest in electric vehicles, has broadened the supply crunch beyond the conventional bottlenecks of lithium and cobalt to even conventionally reliable components like graphite,” Finn-Foley said.

Renewable components from China face significant importation restrictions and delays, due to the federal policy of ensuring such materials have no components provided by forced labor, said J.C. Sandberg, chief advocacy officer at American Clean Power, during another CERAWEEK panel discussion. After all of the relevant paperwork has been submitted to US Customs officials, investigations typically take three months, which must be done for each shipment, Sandberg said.

Getting power to load

Once components have been assembled and are generating power, there remains the question of getting that power to load.

For example, during a March 29 University of Texas Energy Symposium, Caitlin Smith, senior director for regulatory affairs at Jupiter Power, an Austin, Texas-based developer of battery storage, said virtually all of the large battery storage in Texas now is located in West Texas, where wind and solar resources are plentiful, but hundreds of miles away from loads in the eastern half of the state.

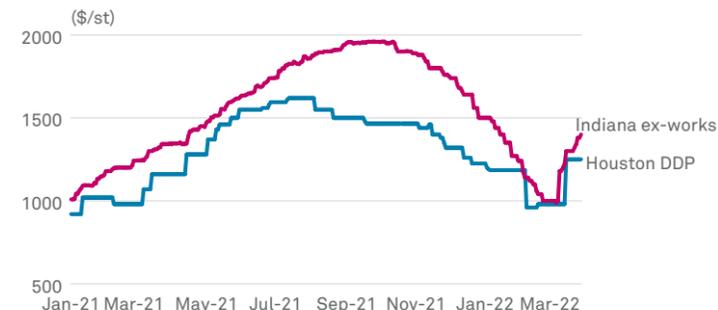
“Across the country, I would say most batteries are in rural areas,” Smith said.

Shipping costs, SE Asia to North America west coast



Note: For 40-foot equivalent container. Prices are “freight, all kinds” and exclude premiums charged in the market, such as peak season surcharge or equipment imbalance surcharge.
Source: S&P Global Commodity Insights

Hot-rolled coil steel assessments* in US



*Ex-works is the price at the steel mill. DDP is delivered, duty paid.
Source: S&P Global Commodity Insights

Therefore, renewable energy advocates have been pushing for expanded transmission capacity and greater interconnectivity among the US grid’s three big interconnections – the Eastern Interconnect, the Western Interconnect and the Electric Reliability Council of Texas.

Meanwhile, the US Department of Commerce’s probe into possible circumvention of tariffs on solar products from Southeast Asia has resulted in cancellations or delays of solar panel deliveries, according to a recent Solar Energy Industries Association survey.

Therefore, investors may see increased risk on two big links of the renewable energy supply chain: the possibility that transmission will not get built to move green energy to load, and the possibility that renewable resources may not be developed to start the flow of clean electrons across those wires. ■

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