



JERA and IHI start demo project on ammonia co-firing

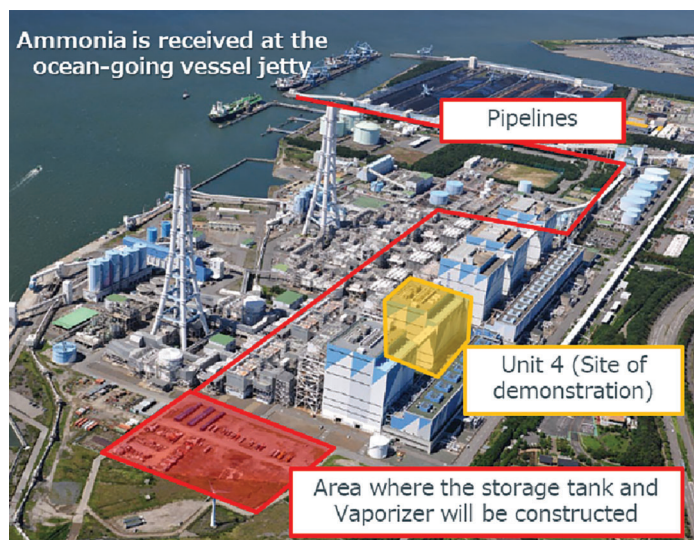
Japan's largest LNG importer and power producer JERA and IHI Corporation have received a government grant to set up a demonstration project for ammonia co-firing at thermal power stations in Japan. Ammonia does emit carbon dioxide when burned, and test runs for coal and ammonia co-firing are due to start in June 2021.

Ammonia makes it possible to transport and store hydrogen at a low cost, or it can be used directly as an emission-free fuel for power generation. With the demonstration project, JERA aims to establish a new technology of co-firing coal and ammonia at large-scale commercial power plants. Test runs will evaluate both boiler heat absorption and emissions of exhaust gases. Various tests are scheduled to run for approximately 4 years from mid-June until March 2025.

The plan is to demonstrate an ammonia co-firing rate of 20% at Unit 4 of JERA's 1 GW Hekinan thermal power station in fiscal year 2024, the two partners announced. JERA is in charge of ammonia procurement and construction of a storage tank and vaporizer, while IHI's role is to develop the burners to be used in the demonstration.

The project is currently in the design and construction phase, JERA and IHI said, underlining it will be the world's first demo

Ammonia is received at the ocean-going vessel jetty



Scheme of JERA's Hekinan thermal power station

project which a large amount of ammonia will be co-fired in an utility-size coal power station.

To ensure reliable operations during high-volume ammonia co-firing, the two partners need to develop demonstration burners by conducting small-scale ammonia co-firing tests. Different materials are being tested and evaluated at Unit 5 of the Hekinan plant from August to December 2021.

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Tesla to open Berlin factory for electric cars and batteries in July

American electric car maker Tesla sticks to its timetable to open its 'Gigafactory' near Berlin in July, gradually turning the site into the world's largest battery cell production. CEO Elon Musk said an annual production capacity of up to 100 gigawatt hours (GWh) was possible, "and then possibly" an increase to 200 or 250 GWh.

Abattery cell plant with an annual capacity of 100 GWh alone could produce enough batteries for 1.3 million model Y vehicles with a 75 KWh battery. The Tesla CEO specified the plan is to make new "4680 cells" measuring 80 by 46 mm (hence the name) with a higher energy density at the Berlin plant.

Battery production could start in roughly two years, said Brandenburg economy minister Jörg Steinbach, who was instrumental in bringing Tesla to the region. EU official in January even permitted so-called German state aid for the battery project.



Works progress on Tesla's Gigafactory-4 at Grünheide near Berlin

Tesla's decision to build Gigafactory-4 – its first European factory for battery cells and e-vehicles – in German is expected to bring an "enormous

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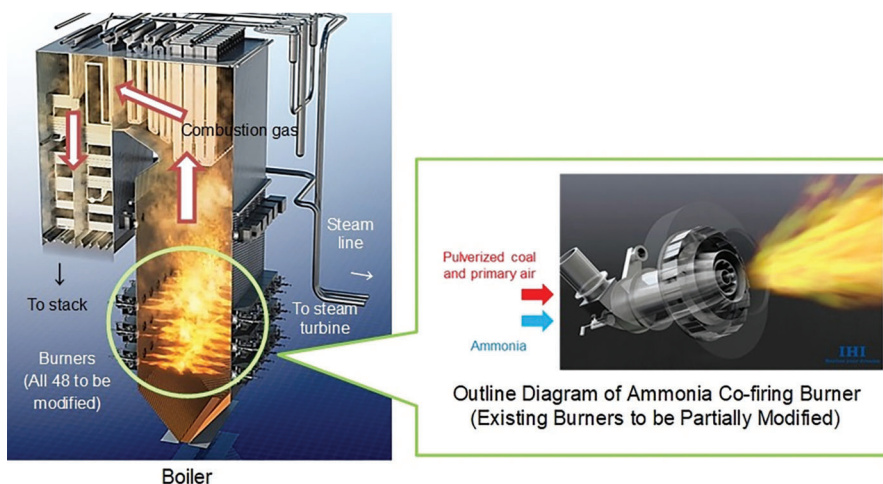
Mitsubishi ships JAC gas turbine to Marlim Azul project in Brazil

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Going forward, JERA is committed to reduce CO₂ emissions from its domestic and overseas businesses to zero by 2050, promoting the adoption of greener fuels and pursuing thermal power that does not emit CO₂ during power generation.

The heavy-industry manufacturer IHI has developed hydrogen and ammonia utilization technologies and seeks to establish supply chains. Contributing towards government policies of the CO₂-free society, IHI offers solutions such as carbon recycling technologies. ■



Henry Hub spot price to top \$2.90/MMBtu amid growing LNG exports

Natural gas spot price at the US bellwether Henry Hub keeps rising amid growing LNG exports and higher gas industrial consumption. Analysts expect spot prices to reach \$2.92 per MMBtu in the third quarter, up from \$2.66/MMBtu in April, prompting a fuel switch to thermal coal for power generation.

Burning gas to produce electricity is not economic at current prices, hence power producers tend to dispatch their coal-fired units instead. The lower gas-burn leads to a slight, 0.5% year-on-year decline of overall US gas consumption, forecast to 82.9 billion cubic feet per day (Bcf/d) in 2021.

The share of electricity produced from gas is seen average 36% this year and 35% in 2022, down from 39% in 2020. Generators' gas burn declines in response to a higher price for delivered gas to power plants which the EIA forecast will average \$4.09/MMBtu in 2021 compared with an average of \$2.39/MMBtu in 2020.

Coal currently out-competes gas on cost, and the share of thermal coal in the US power generation mix consequently rises from 20% in 2020 to 23% this year.

Economic rebound spurs demand

A strong rebound of the US economy from the pandemic, combined with a cold winter in 2021, has resulted in a rising gas use outside of the power sector. The US Energy Information Administration (EIA) anticipates commercial and residential gas use combined to rise 1.2 Bcf/d from 2020-levels, while industrial gas consumption 0.7 Bcf/d from last year. Strong industrial growth drives demand and supports prices

at Henry Hub.

In 2022, the EIA projects Henry Hub price to average a tick higher from Q3-2021 levels at \$2.93/MMBtu amid slowing growth in LNG exports and rising domestic gas production.

Though the February cold freeze halted much upstream activity and lowered output and prices, gas production recovered swiftly with the onset of warmer weather. U.S. dry natural gas production rose by 6.0 Bcf/d in March to 92.3 Bcf/d.

The EIA expects dry natural gas production will average 92.9 Bcf/d in the second half of 2021, and then rise to 93.9 Bcf/d in 2022. ■

Gas to Power Journal

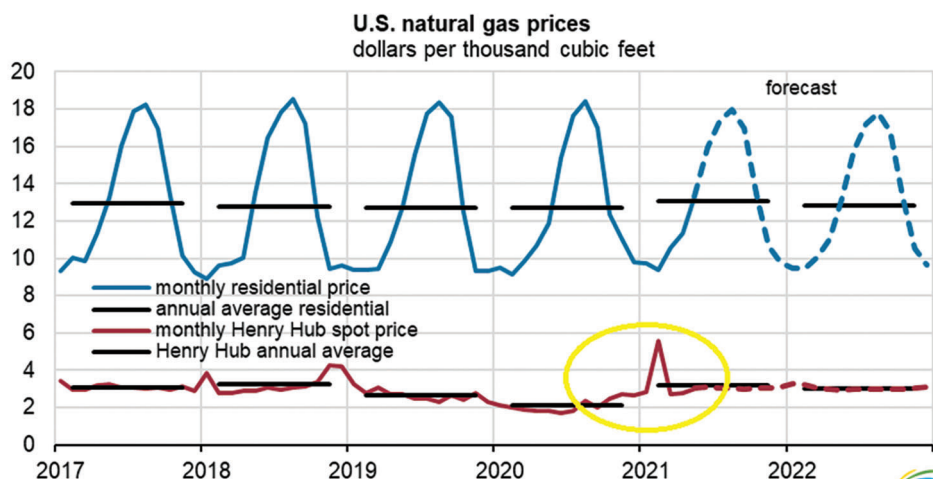
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Audi to focus exclusively on battery-electric cars from 2026

German carmaker Audi will launch its last combustion engine car in 2026 and then focus exclusively on pure battery-electric cars. CEO Markus Duesmann told press the VW premium brand will sell only battery models from the start of the 2030s at the latest, in a move that will boost electricity use for transportation and could exacerbate peakload demand.

If all German motorists were to switch to e-cars, the overall electricity demand would surge by about 20%. This would require a rising dispatch for fossil power plants to ensure sufficient electricity is available when needed.

"Today, electric vehicles are in fact running 100% on coal-fired electricity," said Ulrich Schmidt, researcher at the Institut für Weltwirtschaft (IfW) in Kiel. "The share of wind and solar power capacity is currently not large enough to crowd out fossil power plants, and the rising electricity demand [from e-vehicles] requires an additional use of fossil-fuelled power plants."

"Only when the Energy Transition has progressed and electricity is derived nearly exclusively from renewables, then electric cars will be really more climate-friendly than modern diesel vehicles," he underlined.

Carmakers race towards e-vehicles

Still, German carmakers eagerly embrace electric vehicles as they are trying to emulate the success of e-car pioneer Tesla. Audi vowed to invest half a billion Euros to cushion the loss of combustion engine jobs

within the company, and wants to eventually also sell only e-vehicles in China, its biggest market.

In Europe, the EU's upcoming Euro 7 emission regulation, which is slated for introduction in 2025, could effectively ban combustion engine cars before the end of the decade.

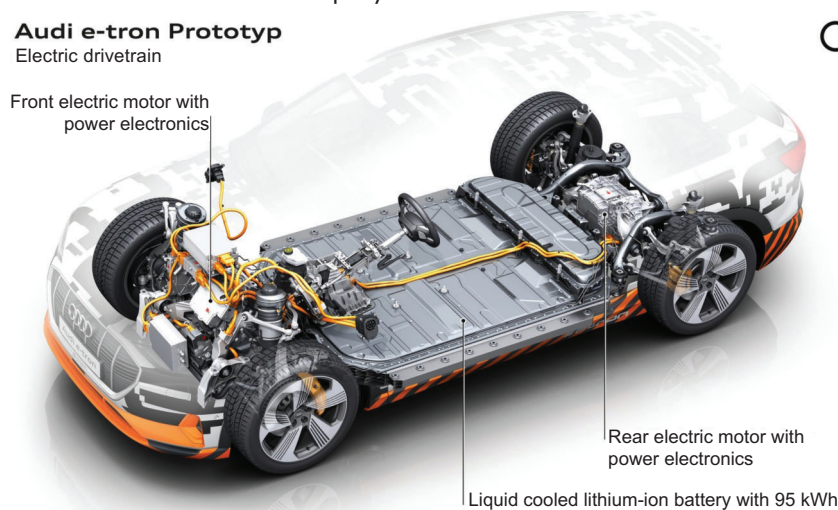
Early e-car adopter BMW had launched the dedicated EV brand "i" already in 2013 but the initial uptake of e-mobility was slow and sales lower than the company ex-

pected, which severely dampened its electric ambitions. Ultimately, US rival Tesla managed to poach many BMW clients with its Model S and Model 3, which overtook both BMW and Daimler in European e-car sales in early 2019.

Daimler, in contrast, is more hesitant and has not yet committed to stop developing combustion engine cars. The maker of Mercedes-Benz has, however, confirmed plans to make its cars entirely CO₂-neutral by 2039.

Audi e-tron Prototyp
Electric drivetrain

Front electric motor with power electronics



Rear electric motor with power electronics

Liquid cooled lithium-ion battery with 95 kWh

Continued from page 1

boost" for the country's lagging shift to electric mobility. Elon Musk announced his company will build batteries, power-trains and vehicles, starting with the much-anticipated Model Y – an electric SUV – in Germany. Currently, the two most sold battery electric vehicles are the Nissan LEAF and the Tesla Models S and X.

Once the initial expansion phase is complete, the factory is set to employ up to 12,000 people, who will produce 500,000 cars per year for the European market, according to Tesla plans. The Palo Alto-based company also vowed to turn the site near Berlin into the world's largest battery cell plant.

Christian Hochfeld, head of the think-tank Agora, hailed the Tesla's move as "a huge gain" for Germany's transition to cleaner mobility. "Tesla puts German carmakers under pressure in the shift to green mobility and will give them a run for their money," he said. Deployment of electric cars could reach a 30% market share in developed economies by 2030, depend-

ing on development costs and customer acceptance.

Construction without final permit

Tesla still has no final environmental approval but proceeds with construction on the basis of provisional licenses. Despite a court case over questions regarding the factory's environmental impact, the first electric cars will most likely to roll off the production line this summer.

German law allows the investor to proceed with construction if the applicant is ready to compensate for all damages. In accordance with the law, Tesla made a €100 million deposit in January to ensure that the site can be restored to its original condition before construction began.

A final verdict at a court case about environmental concerns is not expected before the end of March 2022 – about six months after electric car making has started at the Grünheide factory. The US electric car giant had said it was "irritated" by administrative delays and disgruntled

about the slow permitting process.

The "most glaring problem," according to Tesla's Brandenburg subsidiary, was that current procedures and laws treat projects that combat climate change and those that accelerate it the same. Hence, the current permit framework "discourages necessary investments in clean energy projects and infrastructure and makes it virtually impossible for Germany to achieve its climate targets."

Sales of Tesla cars have soared over 80% in Germany in the first quarter of 2021, compared to the same period in 2020 – not least due to generous subsidies for first-time buyers as Angela Merkel's coalition government is pushing for a green post-Covid19 recovery.

To revive the economy, the German government coalition in July 2020 agreed a €130 billion stimulus package. Measures includes VAT reductions, lower levies on power prices for households and small businesses as well as a €50 billion 'future package' for investments e-mobility and hydrogen technologies.

Electric cars could save UK's National Grid nearly £1.2bn a year

Rolling out a network of electric vehicles (EV) charging stations across Britain to fast-track consumer adoption could reduce National Grid's need to build extra power storage, potentially saving the network some £1.16 billion a year by 2040. Smart chargers can help balance the grid as they would allow for EV only to be charged outside of peak demand hours.

By charging their EVs overnight, consumers help to avoid peaks in electricity demand which facilitates grid balancing for the network operator. It also takes any surplus energy off the grid at night-time, hence making good use of intermittent supply from Britain's offshore wind power installations.

The continued consumer acceptance and uptake of electrical vehicles, combined with smart overnight charging, is estimated to save four EU countries more than €4 billion (£3.56bn) a year, a study from energy consultancy Element Energy finds.

Calculations the UK could make the largest annual savings of €1.3 billion (£1.16bn) by 2040 through a switch from passive to smart charging. Similarly, Italy could save up to €1.26 billion, France an estimated €1.21 billion and Spain some €560 million.

If charged during day-time, EVs tend to

“

Electric vehicles will not crash our power grids. On the contrary, 'batteries on wheels' can spare Europe's grids from costly upgrades and allow more renewables to come online faster

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- Julia Poliscanova, e-mobility manager at T&E.

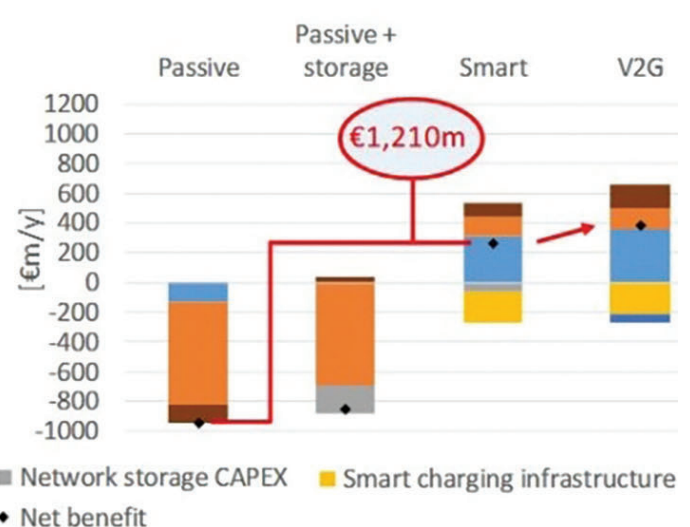
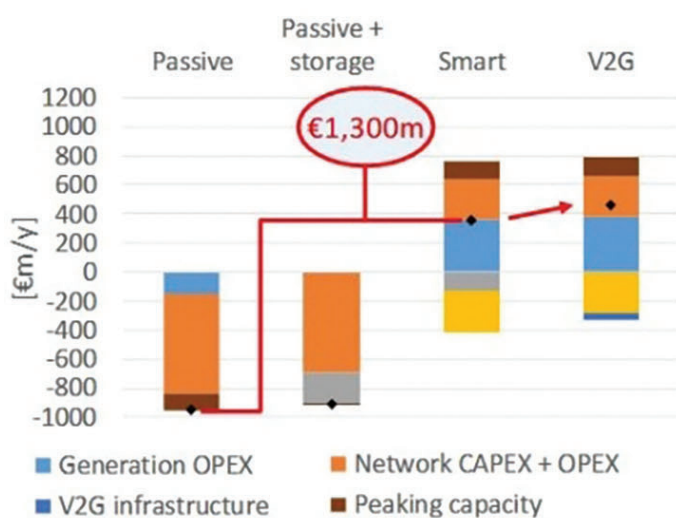
increase peak electricity demand and prompt power generators to dispatch more flexible fossil power plants. When charged with electricity generated from coal and gas, the EVs lose their green energy credentials.

The opposite is true if they are charged by excess wind or solar power. Better still, smart charging technology measures the available energy on the grid and charges EVs only during low-demand periods. This helps to smooth out the peaks in demand

on the grid, boosting energy efficiency and reducing costs.

"Electric vehicles will not crash our power grids. On the contrary, 'batteries on wheels' can spare Europe's grids from costly upgrades and allow more renewables to come online faster," said Julia Poliscanova, e-mobility manager at T&E. "All that's needed is to charge them at the right time of the day." That can be night-time in Britain, or during daytime in sunny countries. ■

Whole system cost and benefits 2040: GB (left); FR (right)



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Australia's first gas and hydrogen power plant to run with GE turbine

GE gas turbine technology will power Australia's first natural gas and hydrogen-fired power unit at the Tallawarra B station in New South Wales. The 316 MW Tallawarra B unit, driven by a 9F.05 gas turbine, helps to stabilize the grid in the face of the closure of the 1,680 MW Liddell coal power plant in 2023.

With the forthcoming closure of the Liddell coal-fired 1,680 MW power station, the Australian Federal government called on the private sector to identify alternative solutions to deliver up to 1,000 MW of dispatchable power.

EnergyAustralia has signed an agreement with the NSW government to get Tallawarra B built and commissioned by 2023 or early 2024 at the latest. The flexible B unit will be dispatched as a "peaker" plant, firing up rapidly when needed and it will utilize partial loads of hydrogen to decrease its emissions footprint.

Clough is carrying out Engineering, Procurement and Construction (EPC) for the unit B, to be built adjacent to the existing 435 MW Tallawarra A gas power plant, about eight miles southwest of the city of Wollongong.

The Tallawarra project is expected to contribute AU\$300 million to the economy of New South Wales and create 250 jobs during construction.

Partially fuelled by green hydrogen

The NSW State Government and Australian Federal Government contributed AU\$83 million to support the financial close and support the use of hydrogen. Under the funding agreement signed on May 3rd, EnergyAustralia will offer to buy green hydrogen up to 5% of the plant's fuel use from 2025 and

offset direct carbon emissions from the project over its operational life.

EnergyAustralia will also invest in engineering studies examining upgrades for Tallawarra B so that it can use more green hydrogen in its fuel mix in the future. Tallawarra B will use GE's F-class turbine technology for 50 Hz applications, capable to burn hydrogen levels from 5% (by volume) up to 100%.

GE's scope of supply also includes a A78 generator, an exhaust stack with an innovative Plume Dispersion Device, a generator step up transformer, and the Mark* VIe control system and gas turbine accessories packaged in module, which will reduce on-site installation work.

"New South Wales' Energy Security Target is the tightest reliability target in the country and this project will help make sure that we achieve that even after Liddell has closed," said New South Wales energy minister Matt Kean. "This project sets a new benchmark for how gas turbine technology can be consistent with NSW's plan to be net zero by 2050 by using green hydrogen and offsetting residual emissions."



Tallawarra A power station in NSW, Australia

Worley to carry out EPC for Ireland's first hydrogen plant

Green energy company EI-H2 has appointed Worley to develop the concept design for Ireland's first green hydrogen production facility. To be built at a cost of €120 million, the 50 MW plant in County Cork will supply over 20 tonnes of green hydrogen per day for industrial use and power generation, once operational in 2023.

Situated in close to the Lower Cork harbor, the plant will produce green hydrogen through electrolysis and will remove 63,000 tonnes of carbon emissions annually. For EI-H2, owned by Cork businessman Pearse Flynn, this first-of-its-kind project is meant to become the start of many hydrogen developments across Ireland.

"We firmly believe that Ireland is incredibly well positioned to become a global leader in green energy. At EI-H2, we believe in partnerships that last. In that context, Worley are the natural choice to develop this key infrastructure," said CEO Tom Lynch.

Worley's technical and commercial experts are drawing up the concept design for

the hydrogen plant, using best practice from similar projects around the globe to accelerate project delivery. The 50 MW electrolyser is meant to be operational before the end of 2023, and will generate jobs and tax earnings in the local area.

By getting a head-start on commercial hydrogen production, EI-H2's can help meet the targets of Ireland's recent Climate Bill which mandates emissions reductions of 51% by 2030.

Eoghan Quinn, Vice President for Power



View of Lower Cork harbour, where EI-H2 will produce green hydrogen

and New Energy at Worley called the project in County Cork an "exciting opportunity" as the company seeks to grow its footprint in Ireland.

Schneider Electric, Wärtsilä power lithium mines without grid access

Wärtsilä and Schneider Electric have developed a reference design aimed at powering lithium mine operations where there is no access to a grid supply of electricity. The end-to-end design ensures total process expenses are economically viable, notably costs for consulting, project design, the power infrastructure, equipment delivery, installation and commissioning.

Using global demand for lithium for battery-based energy storage is putting pressure on mining companies to run their operations more efficiently.

"Cost-effective supply of electricity is a key element in this, hence we designed a solution that not only guarantees a reliable energy supply, but will do so with economic and environmental benefits that will raise the efficiency of the mining operations," said Jean Nabb, Director, Strategic Partnership, Wärtsilä Energy and Vivek Kapoor, Vice President & Regional Segment Leader, Mining, Minerals and Metals Segment at Schneider Electric.

By leveraging microgrids and renewable energy sources, it provides the mine operator with a high-efficiency decentralised power solution with a minimal environmental footprint.

Plant dispatch linked to mine's productivity

The concept links the availability and performance of the power generating plant to a mine's productivity. Shared business case incentives, based on key performance indicators for the power generation reduce operational cost and enhance power availability, supporting thus a mine's production targets. Predictability of parts and maintenance costs reduces the need for working capital.

Wärtsilä and Schneider Electric first agreed in March 2020 to jointly design and develop specific energy solutions for mining companies. The business white paper Recommended power generation and electrical distribution for high altitude lithium mine



Lithium mining in Peru

was published in June 2021.

As the digital partner, Schneider Electric helps integrate process and energy technologies, endpoint to cloud connecting products, controls, software and services, across the entire lifecycle, enabling integrated company management, for homes, buildings, data centers, infrastructure and industries. ■

"Hybrid power units need other profitability metrics than LCOE"

Lowest levelized cost of energy (LCOE), a widely-used metric to compare the profitability of power sources, is "not the right approach" for hybrid units. "A paradigm shift is underway," the U.S. National Renewable Energy Laboratory (NREL) says, arguing that decentralised hybrid power plants with energy storage need to be rewarded for flexibility and grid ancillary services.

Researching how to optimise the physical design of hybrid power plants, NREL look at how utilities maximise their return by move beyond the traditional LCOE focus for hybrid energy systems.

Hybrid plants combine multiple generation assets, e.g. energy storage technologies, wind, solar power and gas-fired generator sets. When producing electricity,

they can shift between the various power gen technologies, which provide more predictable and controllable power output to help enhance grid system reliability.

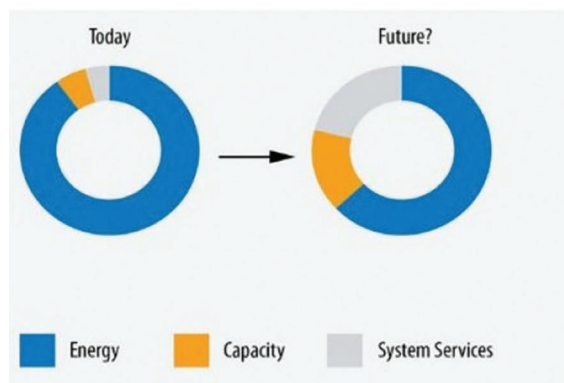
Capitalising on multiple fuel options

"By combining generation assets - notably storage, solar, and wind - into 'hybrid power plants, an individual plant owner can

develop economies of scope in terms of land usage, infrastructure costs, and operational expenditures. This increases the assets' system value by capitalizing on revenue streams through forward capacity markets (where present), 'dispatchable' operation in markets with time-varying energy pricing, and ancillary service markets," argue NREL researchers, led by Katherine Dykes.

To date, feasibility studies for most power plant projects are being designed with Power Purchase Agreement (PPA)-type structure in mind, focused on LCOE optimization. However, NREL researchers pointed out that such an approach is "sub-optimal" for hybrid power system.

"The complexity and uncertainty involved in the physical design optimization of hybrid power plants goes beyond current practice," the report concludes, "... and creates opportunity for research and innovation to realize the full potential of future hybrid power plants with low cost and high value to the electric grid system." ■



The morphing electricity market system (Source: NREL, based on a figure in [5])





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Mitsubishi ships JAC gas turbine to Marlim Azul project in Brazil

One M501JAC gas turbine has been shipped from Mitsubishi Power Americas to Marlim Azul Energia's power project in Macae, Rio de Janeiro. The fuel-efficient 565 MW unit, due operational in January 2023, will enable Marlim to backup intermittent renewable power supply and turn pre-salt gas into attractively-priced electricity.

The gas peaking plant is being built at cost of 2.5 billion Brazilian real (\$600 million) by a joint venture of Mitsubishi Power, Shell, and Patria Investments. Shell committed to supply the power plant with natural gas from Brazil's offshore deep-water pre-salt basin.

Peaking power from pre-salt gas

Bruno Chevalier, CEO of Marlim Azul Energia, outlined the utility's goal is to generate electricity from domestic gas from Brazilian pre-salt deposits. "Mitsubishi Power's tailored solution for a 565 MW plant will enable us to lead the energy transition in South America. The JAC gas turbine is a reliable investment that will enable further decarbonisation in our region," he said.

M501JAC turbines achieve an efficiency of more than 64%, reliability of 99.6%, and the lowest carbon emissions per unit of power when used in combined cycle. The

turbine's flexible operations will enable Marlim Azul to dispatch the plant as a backup for intermittent supply from wind and solar power sources, as well as for cost-efficient peak-load power.

Hydrogen-ready gas turbine

M501JAC turbines can run on up to 30% hydrogen fuel and can be upgraded to 100% hydrogen fuel. "The gas turbine, like all our gas turbines, shipped hydrogen-ready for future deep decarbonisation. We are committed to help our partners Shell and Patria achieve these ambitious goals," said CEO of Mitsubishi Power Americas, Paul Browning.

Mitsubishi Power's overall solution includes TOMONI software to optimise power plant performance, flexibility, and reliability. It also includes a 25-year service agreement

providing all parts, repairs, and services as well as 24-hour support and remote monitoring services to detect anomalies and diagnose plant performance.

On-time delivery

Designed in Japan and manufactured in the United States, the M501JAC unit was shipped on schedule to South America. Mitsubishi underlined its 430,000 square foot Savannah Machinery Works in Georgia has maintained its 100% on-time delivery record throughout the pandemic.

The Marlim Azul unit is the fourth JAC to ship from Savannah. Globally, Mitsubishi Power has booked 41 JAC gas turbine orders and Marlim Azul is the 12th JAC shipment. ■



M501JAC leaves Savannah Machinery Works in Georgia, en route to Brazil

New Fortress gets permits to regas LNG in Mexico for power projects

New Fortress Energy, the US LNG supplier in the Americas, has received three permits from Mexican Energy Regulatory Commission (CRE) for regasification, storage and distribution of the superchilled gas at its Pichilingue LNG facility near La Paz. The imported LNG will be used to fuel the LaPaz and Baja California Sur power plants.

New York-based New Fortress Energy (NFE) stated in its May earnings report that its LNG import projects in Mexico and Nicaragua would be completed by around July 2021.

Quick time-to-market is meant to be achieved through NFE's "Fast LNG" modular liquefaction technology, whereby NFE pairs midsize liquefaction units with jack up rigs or similar floating infrastructure. This approach is said to enable a much lower cost and faster deployment schedule than floating liquefaction vessels.

The share natural gas in Mexico's power sector has risen to 50%, up from about 33% a decade ago. Other US utilities like Sempra Energy are also investing in the country, with a \$975 million LNG import terminal in Baja California.

Financial closes on 1st Fast LNG plant

In March, NFE reached a final investment decision (FID) on its first 'Fast LNG' modular liquefaction plant. With a capacity of 1.4 million tonnes per annum (mtpa), the plant will provide low-cost gas supply to NFE's growing customer base. CEO Wes Edens said: "Fast LNG liquefiers should allow us to produce LNG between an expected \$3-4 MMBtu."

The pilot plant is being built together

with Fluor, Chart Industries and Backer Hughes, who all received a limited notice to proceed by NFE. The first 'Fast LNG' project is anticipated to become operational in 20 months. ■



Render of Pichilingue LNG facility near La Paz

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