Gas to Power Journal
Peakload Power and Energy Storage

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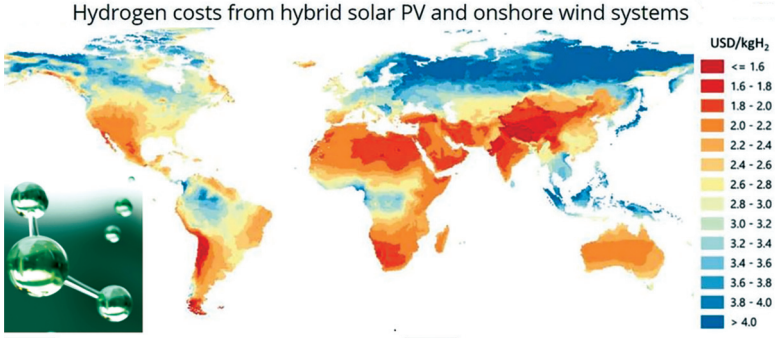
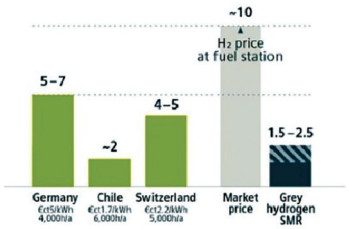
Can green hydrogen become the 'new oil'?

Green hydrogen, produced with renewables using electrolysers, is hoped to become the 'new oil' and develop into one of the most essential vectors in the decarbonisation process. "The technology already exists to make it possible; the next step is to scale it up to enable it to serve the common interest," argues the French author Thierry Lepercq.

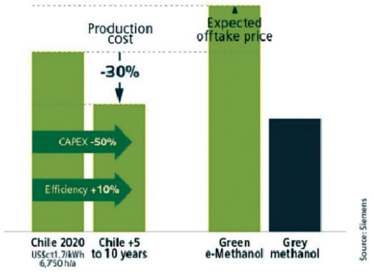
Hydrogen costs from hybrid solar PV and onshore wind systems



Green hydrogen's positive business case: hydrogen production cost depending on power supply and electrolyzer CAPEX



e-Methanol becoming competitive to bioethanol levelized costs of e-Methanol from electrolysis (US$/t)



Hydrogen is one of the leading options for storing excess renewable energy, and hydrogen and ammonia can be used in gas turbines to increase power system flexibility. Ammonia could also be used in coal-fired power plants to reduce emissions.

"With declining costs for solar PV and wind generation, building electrolysers at locations with excellent renewable resource conditions could become a low-cost supply option for hydrogen, even after taking into account the transmission and distribution costs of transporting hydrogen from (often remote) renewables locations to the end-users," analysts from the International Energy Agency (IEA) urged.

In his book, Lepercq explains that "hydrogen is potentially much more than a cheap and plentiful energy source". It could be a "quantum leap towards a new order in energy and climate". France launched a €100 million national plan for hydrogen already in June

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Ansaldo considers selling stakes in PSM and Ansaldo Thomassen

Italian turbine manufacturer Ansaldo has approved its 2020-24 Business Plan to reposition its service segment by "exploring partnerships" for its subsidiaries PSM and Ansaldo Thomassen, or the "sale of company stakes." Compared with past years, Ansaldo said its order book is "more balanced" in 2020, hence some 100 million Euros can be spent on new production technology.

Ansaldo's board of directors issued guidelines focusing on cash flow and capital restructuring to help accelerate the company's reposition its service activities. A 'diversification plan' will be implemented in 2021 to create a "national champion" in the power generation industry.

Orders rebound

In 2020, a "strong growth in orders" is expected largely due to the greater contribution of "New Units" (new machines and new plants) and the resulting increase in workload for the production facility.

The 2020-2024 Business Plan also makes provision for investments totaling over €100 million investments in 2020 to introduce, among other things, new production technology in the factory. The aim is to boost production volumes, notably EPC and service work like after sales service, maintenance and assistance.

Adapting to changing energy markets, Ansaldo said it will "realign the group's workforce and reduce external costs." Improved competitiveness is meant to be achieved by shortening time-to-market through lean production and a sharper commercial focus. ■

AGENDA

Continued from page 1, top story

2018, whereby industry is urged to use 10 percent green hydrogen by 2023, while the transport sector is meant to increasingly rely on hydrogen-fuelled vehicles. Germany, meanwhile, aspires that 20 percent of hydrogen consumed should be CO2-free bay 2030.

Oil majors eye hydrogen

The French oil major Total keeps an eagle eye on German projects that use electricity to produce synthetic fuels. "There are a number of projects in Germany that want to produce fuels via electrolysis," said Total's European head Benoit Luc. "These projects are interesting and we observe them very closely."

Producing of "green hydrogen" with renewable power via electrolysis has lately become a hot topic in German industry. The steelmaker Salzgitter, for example, developed a "technically feasible but not economically viable" concept to replace the fossil fuels used in conventional steelmaking with a gradually rising share of renewable hydrogen made with electrolysis technology provided by start-up Sunfire. Applications projects are in the making with Climeworks and Rotterdam The Hague Airport.

Aiming to be climate-neutral by 2050, Germany will have to replace natural gas in its energy mix with hydrogen, which could eventually become carbon-free if made with renewable power using electrolysis. Germany's steel and chemical industries are also betting heavily on the use of green hydrogen in their long-term decarbonisation plans.

Liquid ammonia 'more attractive'

Power-to-X through electrolysis can swiftly utilize large overcapacities of wind and solar power, helping to balance the grid. Producing ammonia – a hydrogen liquid – is deemed even "more attractive than hydrogen gas" given that its energy density is higher by a factor 300.

Storing surplus renewable energy as hydrogen or ammonia is more lucrative than curtailing the capacity of offshore wind and solar at times of peak production. Green hydrogen is deemed to become the "backbone of future, largely decarbonized power generation," a Siemens white paper finds. This is because chemically stored electrical energy is, to date, "the only way to overcome renewable sources or times where there is little or no wind or sunshine."

Japan already retrofits existing coal plants to run with ammonia, a hydrogen liquid, NH3.

With cheap renewable energy and up to 6,000 full-load hours of wind or solar PV installations for some locations, green hydrogen generated from electrolysis can already compete with grey hydrogen from steam methane reforming (see graph). Considering today's prices for hydrogen at fuelling stations, e.g. in Switzerland, green hydrogen would make a positive business case, a Siemens white paper finds. ■

"Regulatory risk rises as global emissions gap grows;" Fitch warns

The stark gap between government pledges to reduce emission and the lack of far-reaching actions heralds a growing regulatory risk. According to Fitch Ratings, energy-intensive industries, thermal power producers and the transport sector can be hit by a sudden rise in more stringent climate rules.

Most countries around the global currently lag substantially behind their existing Nationally Determined Contribution (NDC) pledges, let alone the emissions trajectories required to limit warming to 1.5 Celsius. Hence, analysts anticipate that the timings (2020 and 2023) of the stock-take of NDC performance and 'ratchet' mechanisms of the Paris Agreement "could trigger a change in policy direction."

"Governments have been helping to mitigate direct and indirect costs of carbon, but older and inefficient plants will increasingly struggle to obtain support. In the meantime pressure for carbon reduction is likely to erode financial support," Fitch Rating said.

Fall in free carbon allowances

"Canada, Japan, South Korea, Mexico, South Africa and the EU are expected to see a significant fall in free carbon allowances by 2023," Fitch Rating forecasts. Ultimately, the effects on companies' bottom line will ultimately depend not just on carbon pricing. It will rather hinge on net allowances - which will be influenced by plant-level factors and some of the company-level characteristics outlined above.

Looking ahead to 2030 and beyond, analysts say the impetus to turn pledges into action is far from uniform across the world. To date, the effectiveness of carbon pricing schemes in reducing emissions is limited by low coverage and prices. But given that carbon pricing is a technology-agnostic policy measure, "prices, coverage and exemptions may tighten in the near future to align with NDCs."

Difficulty to 'clean-up' some technologies

Steel, cement, ammonia fertilizers, and ethylene manufacturers will be hit hard any tightening of emission credits because of technical difficulties to decarbonize these technologies, and the lack of substitutes. Hereby, regional differences in industrial and manufacturing processes will affect compliance costs.

"Impacts of carbon pricing will not be felt uniformly - not even within affected regions - given that it will be determined by a range company- and technology-specific characteristics like asset lifespan, availability of substitutes and mitigation possibilities," analyst said, concluding "the competitive position [of individual companies] are key determinants of exposure to climate policy risk." ■

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Lack of upstream investment jeopardizes U.S. energy independence

Energy independence of the United States will be tested in the 2020s, unless there's a sharp reversal in the collapse of fresh capital expenditure in the shale sector, CME Group finds. Currently, CAPEX in the shale oil and gas sector is dwindling, so rig counts are falling.

Appalachia, Permian and Haynesville are the most prominent shale oil and gas producing regions in the U.S. However, Appalachian production growth slowed significantly in 2019 due to dwindling capital investment in new rigs.

The number of operating rigs in Appalachia between April and December 2019 dropped from 81 to just 50, and from 63 to 52 in Haynesville. Meanwhile, the rig count in the Permian fell from 485 to 402 between February and December.

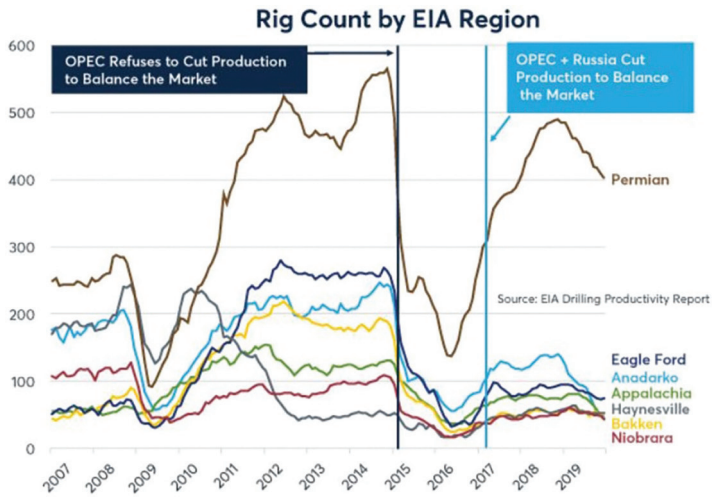
CAPEX cuts amid falling revenues

"The recent natural gas sell off will put even further downward pressure on rig counts," analysts commented. Bearish markets exert additional pressure on the exploration and production sector, which has been suffering from falling revenues and tight cash flows.

Pursuing different restructuring strategies, some producers have been imposed strict saving measures while others have been raising capital through debt.

"Unfortunately, the low-price environment has eroded equity valuations, amplifying the problem of holding uneconomic assets," analyst noted. This has been "pushing some companies to write-offs, fire sales, financial distress and even bankruptcies."

The decline in CAPEX, for the moment, has had little impact upon production amid soaring productivity per rig – but this can be short-lived. The average shale play lasts for only 18-24 months. Eventually per-rig productivity could begin to decline. "If that happens, the combination of low rig counts and falling productivity could cause U.S. oil and natural gas production to begin to fall," analyst suggested. "Falling US production could, in turn, reduce storage levels and allow prices to drift higher."



Exports rise despite narrowing price spreads

The U.S. shale revolution, unfolding since 2009, has been key to reduce risk premium in oil market and has been closing price gaps with Asia and Europe while putting the focus on Henry Hub as a pricing benchmark.

Even if prices at Henry Hub were to "go somewhat higher," the gap between U.S. and gas global prices will "remain significant, so US LNG exports will likely to continue to rise," concluded CRM Group analysts

Natural gas exports from the United States increased to over 4.5 billion cubic feet (Bcf) per day by mid-2019, up 37 percent from the pre-year period. Total US LNG export capacity rose from 5.4 billion Bcf per day in June 2019 to 6.1 Bcf by year's end.

By the end of 2020, US LNG export capacity is expected to rise to 8.9 Bcf per day. Soaring gas production and falling prices have also accelerated the coal-to-gas switch in the U.S. power generation sector, and spurred demand from the petrochemical industry. ■

NNPC gets $1 million grant to develop 1,350 MW power plant in Abuja

The Nigerian National Petroleum Corporation (NNPC) has secured a grant worth nearly $1.1 million from the US Trade and Development Agency (USTDA) to evaluate the technicality and economics of developing a 1,350 MW combined-cycle gas power plant in Abuja. The CCGT would run on domestic gas.

The USTDA-funded feasibility study will evaluate the Abuja CCGT project as a means to enhance critical electricity supply in Nigeria. The aim is to reduce recurring power shortages, load-shedding and frequent blackouts that cripple the local economy.

NNPC Group's managing director, Mallam Mele Kyari, said he was convinced the grant will help "concretize arrangements to provide stable power supply to Abuja in the foreseeable future." The project is hoped to soon reach financial close.

Developed as an Independent Power Project (IPP), the Abuja plant will be fuelled by natural gas from NNPC's large upstream resources, delivered to the plant's site through the proposed AKK gas pipeline. Mr. Kryandi explained the Abuja CCGT project was part of the national strategy towards monetizing Nigeria's abundant natural gas resources

Most of the generating equipment will be supplied by GE.

Technical support for the project will also come from the U.S.-firm Continuum Associates whose chief operating officer, Sandeep Baidwan, said the proposed CCGT "will provide important relief to the power deficit situation" in and around the Federal Capital Territory region, and northern Nigeria. ■

U.S. Congress mulls new sanctions against Nord Stream 2

Lawmakers in the U.S. Congress are preparing to hit European investors in the Nord Stream 2 pipeline with a new set of sanctions in an effort to derail the project. Uniper, Winterhall, Engie, OMW and Shell are invested in the Baltic Sea interconnector, and the sanctions could come as soon as February or March.

Determined to stop the completion of the controversial Russian-German gas interconnector, the U.S. Congress already threatened to levy sanctions against construction and pipe-laying companies involved in the project. Allseas, a Swiss pipelay firm, consequently suspended works.

Just 160 km of the 2,460 km long pipeline is left to be laid. AllSeas' deep sea pipe laying ship Solitaire has been laying most of Nord Stream-2 but the Swiss company had suspended works due to the U.S. sanctions.

The Nord Stream consortium, a purely commercial entity, stressed it remains focused on bringing the $11 billion pipeline project to a "successful end." The twin pipeline – designed to carry up to 55 Bcm of gas per year from Vyborg, Russia, along the bottom of the Baltic Sea to the city of Greifswald in eastern Germany – was scheduled to start up in the first half of 2020, but will now be delayed.

Russia determined to go it alone

Russia vowed to complete construction works anyway and is now trying to mobilize its own capacities to do so. A pipe-laying vessel named Akademik Cherskiy, currently moored in the port of Nakhodka, is widely expected to carry out the work.

Allseas pipe laying vessel

However, the Russian President Vlamimir Putin cautioned recently that the pipeline may not start flowing gas until the first quarter of 2021.

The Russian gas giant Gazprom is financing half of the project worth about 9.5 billion Euros ($10.5 billion). Other partners in the project are Austria's OMV, the German firms Uniper and Wintershall, Royal Dutch Shell and France's Engie. The European project partners have each invested between 950 million and 9.5 billion Euros into the project, adding up to 50 percent of total cost.

ROI likely to come "later" but at "higher level"

Austria's OMV, one of the investors in Nord Stream 2, has already financed around Eur700 million of its share in the project. Chief executive Rainer Seele remains calm, saying "we are not expecting high cash calls from the Nord Stream 2 company in 2020."

The delay, in his view, means that the Return on Investment (ROI) would come "a bit later" but at a higher level.

Nord Stream is a highly political project; so much of the goodwill – both from EU-member states and the United States – will depend on whether Gazprom and Naftogaz Ukrainy will reach a permanent gas transit agreement for the time after Nord Stream-2 will come onstream. Initially, Gazprom had threatened to halt all deliveries and transit through Ukraine after the second Baltic Sea interconnector will be fully operational. ■

Karpowership gets ready to help close South Africa's electricity gap

Turkey's Karpowership has submitted a proposal to the government of South Africa to provide a several ships to avert a looming power crisis. State-owned utility Eskom frequently resorts to load-shedding and in December, the government issued a request for information (RFI) to source up to 3,000 MW at short notice, and at the least cost.

The RFI calls for start of commercial operation, following financial close, of either three to six month or six to twelve month.

In its proposal, Karpowership informed South Africa's energy department on "what is possible, where and how we would look to do it," said Patrick O'Driscoll, global sales director at Karpowership.

Karpowership Ayşegül Sultan, moored off Dhakar

Several locations have been identified as potential mooring points for the ships, suitable to inject the electricity generated offshore into the South African power grid. Each ship can provide a range of power supply options between 30 MW and 600 MW, and can be hired for different time spans.

Gas-fuelled powerships cheaper than diesel gensets

Eskom currently needs to spend billion of South African rand annually to buy diesel for emergency power units, mostly driven by open-cycle gas turbines. Karpowership underlined that the operational cost of one of its gas-fuelled ships will be "significantly less, maybe even half the cost of those [Eskom's] peakers."

Speed of delivery is crucial for emergency power solutions; hence O'Driscoll pointed out that a Karpowership was recently delivered and operated a 120MW contract in Senegal within just nine weeks. In addition, the 235 MW Powership Ayşegül Sultan is moored off Dakar since August 2019, contracted to supply 15 percent of Senegal's electricity needs for 5.5 years.

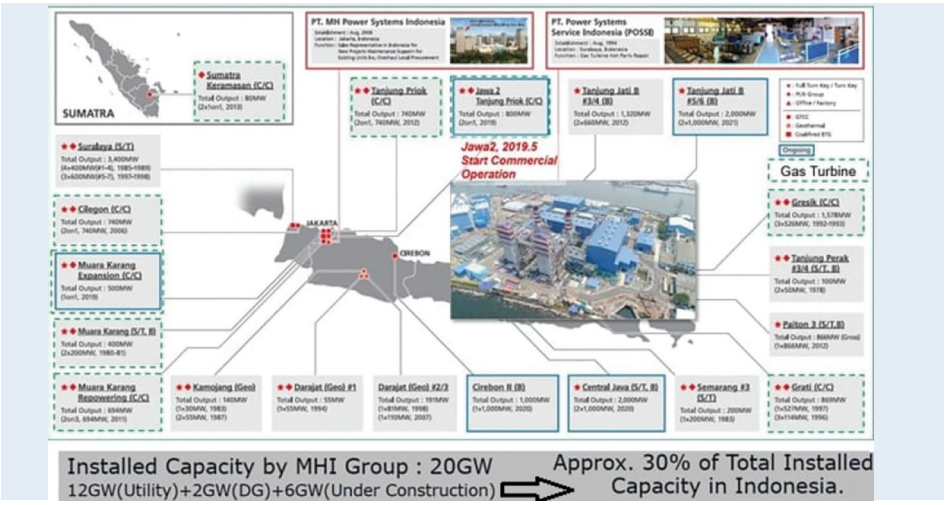
Headquartered in Istanbul, Karpowership is the only owner, operator and builder of the first Powership fleet in the world. It has 25 powerships, all built in Turkey, in operation and an order book to build new vessels in excess of 4,400 MW. ■

Indonesia's power demand forecast to top 4,400 TWh/year by 2030

Indonesia, home to 260 million people, will see its population reach 300 million by 2030 which pushes up power consumption 6.4 percent annually from 2,400 TWh per year seen today to 4,400 TWh/year. Considering Indonesia's "limited renewables potential," MHPS reckons the country's rising electricity demand will largely be met by new gas-fired power units.

Air pollution is a major health hazard in Indonesia, particularly in the capital Jakarta. However, there are "limited areas" where renewable energies could be introduced, as Indonesia's territory consists of some 17,500 islands and sees "comparatively less sunshine and wind than other countries."

Natural gas, a less emissions-intensive thermal fuel, could help Indonesia reduce air pollution. MHPS encourages state energy companies to make use of Indonesia's rich gas reserves to generate electricity in combined-cycle power units.



Probing clean fuels on Java

Together with Indonesia's Bandung Institute of Technology (ITB), engineers at MHPS are analyzing big data from local power plant operations on the island of Java to advance clean energy technologies. The aim is to probe new fuels like ammonia and hydrogen.

Diagnosing operations of Indonesia's power plants through artificial intelligence (AI) and big data analysis is meant to enhance efficiency. To that end, MHPS and the ITB seek to establish a joint research and development base in Indonesia.

"Through this joint research, not only will we develop new technologies for clean energy, but also we will improve the performance of existing power plants in Indonesia through big data analysis and Artificial Intelligence (AI)," said MHPS President and CEO Ken Kawai.

In the Java – Bali region, the Japanese manufacturer supplied and installed over 30 percent of the power generation capacity. MHPS shipped its first steam turbine there in 1971 and continues today to contribute equipment for ensuring stable power supplies.

Some sixteen month ago, MHPS commissioned the 300 MW unit-2 of the Tanjung Priok combined-cycle power plant ahead of schedule. Unit 1 of the Jawa-2 project initially went into operation as a simple gas turbine system this June with output nearing 300 MW, and Unit 2 doubled that capacity to 600 MW. In Indonesia, MHPS claims to hold the top market share for large gas turbines, with a total power gen equipment supplied reaching 12 GW. ■

MAN launches fluid monitor for lube oil

MAN Energy Solution has launched an intelligent constant monitoring device for industrial lube oil. The certified device has recorded over 18,000 test hours on pilot industrial sites and complies with CE standards. It also received its first order is for third-party equipment in the Pacific region.

In a first application, the fluid monitor ensured the protection of engines during bench tests at the MAN Saint-Nazaire factory. The solution has been certified by Bureau Veritas marine applications after extensive tests, and MAN is currently filing for a patent.

"We know that lube oil is the life blood of an engine and that 70% of major damage reveals lube-oil contamination. We wanted to develop a global monitoring solution capable of conforming to the demands of all rotating machines – such as four stroke engines, and turbomachinery – and whatever the application, whether it be marine, power plants, or anything else," said Arnauld Filancia, Vice-President within MAN Energy Solutions.

The new fluid monitor is the result of targeted research on operational security. Designed as an easy-to-implement solution, it helps enhance installation performance and security.

Used alongside laboratory analyses, the device alerts operators with alarms and stop recommendations as soon as it detects any degradation in lube-oil quality, thereby revealing minor wear of mechanical parts. By swiftly detecting anomalies - especially important during restarts where 50 percent of damage occurs - the device allows to identify part-wear before breakdown to help maximize machine availability. ■

Bench tests at the MAN Saint-Nazaire factory

NEWS NUDGES

Ofgem expects green energy to cost more

Britain's energy regulator Ofgem has been seeking to incentivize investment in green energy. However, the watchdog's new head, Johnathan Brearly, cautioned "more investment does mean higher cost." Though investors' returns could come down, technology improvements will reduce down capital costs further in the long run.

Opel plans Gigafactory for battery cells

German carmaker Opel, part of French PSA, plans to manufacture enough battery cells for half a million e-cars annually in a new factory in the western German town of Kaiserslautern from 2024. Two billion Euros would be invested in the factory, designed to house three units with 8 GWhs each, which would be the largest in Europe so far.

Batteries vs. hydro power

More than 28 GW of lithium batteries deployed for stationary storage applications by the year 2028, according Navigant Research. Pumped hydro power plants, however, dominate the market as they account for 96% of installed energy storage worldwide. ■

Edge LNG uses mobile liquefaction units at Marcellus Shale

Stranded gas wells at the Marcellus Basin in Pennsylvania are being tapped via mobile trailor-mounted liquefaction units. Initial operations were launched and are set to last until at least 2020, Edge LNG announced, stressing the technology allows to "reap economic benefits on assets unreachable by pipeline."

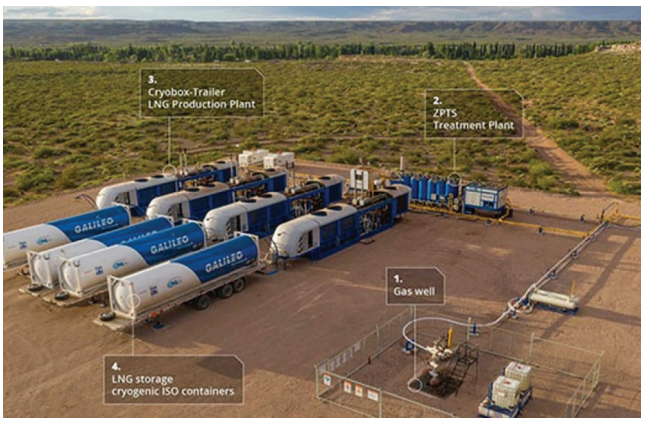
In early 2020, Eagle LNG monetized a source of previously stranded gas in the Marcellus field and delivered it as LNG to a New England electric utility where the gas is used for power generation.

Under the latest contract, Edge LNG's second deal in 2020, it is acting as a service provider at stranded gas wells in Tioga County in Pennsylvania. The name of the owner of the gas wells was not disclosed.

"The Marcellus is an important region for us, there is lots of potential here with a large number of stranded wells," said Mark Casaday, CEO of Edge LNG. "So much gas goes unharnessed, purely because lack of access to a pipeline has meant there is no economic way to take it to market. We provide operators with an opportunity to profit from wells that would otherwise not be used and we make it into valuable fuel," the CEO added, calling it a win-win solution.

To tap stranded wells, Edge LNG uses Cryobox liquefaction units, created by Galileo Global Technologies, which can be delivered to any site accessible by road. ""After set-up and safety checks, production can begin within hours, with minimal investment required of the site owner and without the need of pipeline infrastructure," Edge LNG explained.

The LNG produced from these stranded wells is being purchased by Edge and delivered to nearby customers by truck. A supply deal is also in place with City of Norwich, Connecticut, where the LNG will be re-gasifed and used in local homes and businesses. ■



Fortescue adds gas genset, solar PV and battery to Pilbara mine

Australian mining giant Fortescue Metals Group is fast-tracking a US$450 million power generation project at its Pilbara iron ore mine. Featuring 150 MW of gas-fired capacity, 150 MW of solar photovoltaic and a large-scale battery storage, the hybrid project will help reduce the mine's energy costs.

Backing up solar PV with gas gensets and energy storage, Fortescue taps various energy sources to lower its overall generating costs. The Pilbara Generation Project also allows Fortescue to leverage its existing energy infrastructure including the Fortescue River gas pipeline and generation capacity at the Solomon power plant and make use of renewable power sources.

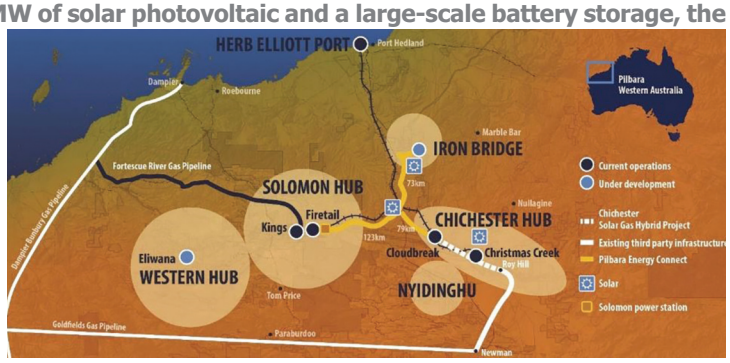
Capital expenditure for the project will be funded by a combination of operating cashflow and low cost asset finance. Fortescue stressed its capital expenditure guidance of US$2.4 billion for fiscal year 1020 is maintained, incorporating the Pilbara Energy Connect program.

Connecting remote gensets at various mines

Striving for sustainability, Fortescue said the new-build units will add to the Chichester solar-gas-hybrid project. Developed with Alinta Energy, this project will see up to 100 per cent of daytime stationary energy requirements of the Chichester Hub iron ore operations powered by renewable energy.

"Importantly, Pilbara Energy Connect allows for large-scale renewable generation such as solar or wind to be connected at any point on the integrated network," said Fortescue's CEO Elizabeth Gaines.

Alinta will build, own and operate the 60 MW solar PV generation facility at the Chichester Hub and 60km transmission line linking the Christmas Creek and Cloud break mining operations with Alinta Energy's Newman gas-fired power station. On completion this will integrate with the Pilbara Energy Connect program, via 275km of high-voltage transmission lines.



Components of the Pilbara Energy Connect project

Going forward, Fortescue plans to invest $700 million in various energy projects, with $250 million dedicated for Chichester phase one while the Iron Bridge hybrid project will receive the remaining US$450 million. Rival mining companies have invested in similar solar PV and energy storage capacity, notably B2Gold, Gold Fields, Harmony Gold and Norgold. ■

Russia: Voronezh CHPP adds four LM6000 aero-derivative turbines

Quadra's 233 MW Voronezh CHP plant has successfully run its first week of commercial operation since February 1, using four of GE's Sprint LM6000 gas turbines. The additional aeroderivative gas turbines enhance flexibility reliability of the Voronezh combined-cycle unit.

"The power plant provides heat and power to more than half of Voronezh city's residential buildings, as well as industrial and social facilities. Situated in southwestern Russia, Voronezh is inhabited by more than 1 million people.

"It is extremely important that the new combined-cycle power unit of the Voronezh CHP-1 will allow us to reach new heights in the reliability of the city's heat supply, increasing electric power output by 50 percent and improving energy efficiency," said Quadra's chief engineer, Evgeny Zhadovets.

Quadra's upgraded CHPP in Voronezh

Use of new aeroderivative unit will support the "gradual decommissioning" of technically obsolete equipment present at the old plant.

Fast-start capability and fuel flexibility

Flexible LM6000 turbines have fast-start capability (down to five minutes from cold iron), enabling daily/multiple startups with no impact on equipment maintenance cost through its low turndown level. In Russia, GE's areoderivative gas turbines have demonstrated up to 42 percent efficiency in simple cycle and up to 56 percent in combined cycle mode, said Michael Rechsteiner, CEO of GE Gas Power in Europe. ■

Myanmar orders Wärtsilä engines to avert blackouts in Yangon

Eager to avert power shortages in Yangon, the government of Myanmar has asked Wärtsilä to deliver eight 50SG engines for two power plants with 292 MW combined capacity. The two LNG-fuelled gensets are meant to be installed and operational within a matter of months.

During the past summer, the Yangon area of the country was subjected to power cuts of up to six hours a day. The government wants to avoid a repeat of this dire situation, hence Wärtsilä engines will be delivered on a fast-track basis before the end of February.

The two power plants will be owned by a consortium between China National Technical Import and Export Corporation (CNTIC) and VPower Group of Myanmar. Each plant will comprise eight Wärtsilä 50SG pure gas engines delivering a combined output of 146 MW, and running on regasified LNG. ■

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