



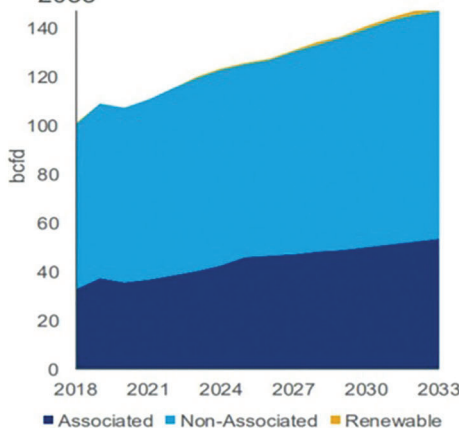
US gas production could triple in size by 2033, spurred by LNG exports

Driven by soaring LNG exports, the North American gas market will support 29 billion cubic feet per day (bcfd) of production from 2022 to 2033, tripling its current size, Wood Mackenzie forecasts. Though producers still focus on capital discipline, investment in new fields slowly increases with the market expansion seen to be "equivalent to adding two new Permian basins."

Supply is expected to return "at a measured pace," as upstream companies will only gradually increase investment over the next few years to support the market expansion. But the onset of new supply will put downward pressure on gas prices until new LNG export facilities come online towards the end of the decade, creating an outlet to international demand centers.

"As Europe diversifies to more secure gas supply sources and international buyers across the globe seek reliable low-cost supply, North America is poised to deliver," said Dulles Wang, WoodMac's director, Americas Gas and LNG Research.

Associated supply grows at a CAGR of 2.8% between 2023 and 2033



After 2030, growth is forecasted to slow although the US Inflation Reduction Act of 2022 provides a variety of incentives for carbon capture and hydrogen which is expected to keep up gas-burn for power generation in the long-term.

LNG buyers in Europe and Germany in particular are reluctant to enter long-term offtake agreements as the clean energy transitions progresses. Though Germany is quickly building up its own LNG

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Philippines braces for brownouts as LNG terminal are not ready yet

Electricity will be in short supply in the Philippines next year as AG&P will not get its PHLNG import terminal in Ilijan, Batangas, in commercial operation before April, while the rival BWLNG terminal will unlikely be onstream before June. This limits fuel deliveries to four gas-fired power stations on Batangas with a combined capacity of 2,011 MW.

Atlantic, Gulf & Pacific International Holdings (AG&P) is determined to start bringing LNG to the Philippines "for the first time" in March 2023, though market observers say this timeline for the PHLNG regas terminal may slip. The Department of Energy (DOE) already warned of a power supply deficit on Luzon next summer.

Eager to import LNG for its power stations at Batangas, AG&P has converted a Japan-built 137,512 cubic meter LNG carrier into a Floating Storage Unit (FSU) which will be part of the offshore-onshore PHLNG import terminal with



Render of PHLNG terminal

an initial capacity of 5 mtpa. The terminal is scheduled for commissioning in March, but is unlikely to go into full commercial operation before April or May 2023.

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import infrastructure, energy minister Robert Habeck cautioned that involved must be aware that gas demand in Germany will go down as it aims to become climate neutral by 2045, so that volumes might have to be sold "elsewhere in the world" at that time.

Falling gas-burn frees up volumes for export

Gas consumption in the US electric power sector is forecast to fall in 2023 amid continuing growth in LNG exports. Though gas

storages in Europe are now largely full, analysts say it will require significant volumes of LNG in the coming months to maintain adequate wintertime supply now that Russia has largely cut off pipeline gas deliveries.

This year, US utilities keep burning more gas to produce electricity despite a stark rise in fuel prices, reaching a peak of 6.37 million Megawatt-hours (MWh) on July 21, 2022, according to the EIA's Hourly Electric Grid Monitor. Analysts relate the soaring gas-burn throughout the summer to above-

normal temperatures, reduced coal-fired electricity generation, and recent natural gas-fired capacity additions.

Looking ahead, analysts at the US Energy Information Administration (EIA) expect gas-burn in the US power sector to fall in the fourth quarter of this year and during 2023, as more wind and solar power capacity becomes operational – though cold temperature over the winter, especially in January, will increase gas demand for space heating. ■

RWE follows Uniper in initiating arbitration case against Gazprom

German utility RWE has launched arbitration proceedings against Russia's Gazprom over missing gas deliveries, just days after the country's largest gas importer Uniper filed a similar case aiming to get compensation. Uniper incurred losses of €11.6 billion to date for replacing 200 TWh of Russian gas supplies, while RWE's exposure was just 15 TWh.

Gazprom's deliveries to RWE were reduced to 4 TWh following Russia's invasion of Ukraine in February, down from a contractual agreed amount of 15 TWh. "In the event of a full cut of supply, we calculate that the replacement of the remaining 4 TWh could cost at least an additional 400 million euros (\$422 million)," Stifel Research analyst Martin Tessier commented.

Uniper also initiated arbitration proceedings against Gazprom Export before an international tribunal in Stockholm. "Since June, we received only 40% of the contracted gas volumes from Russia and had to source the replacement volumes in the market at significantly higher prices," Uniper CEO Klaus-Dieter Maubach said. These gas replacement costs alone, currently amount

to at least €11.6 billion and will continue to grow until the end of 2024.

In September, the German state had to nationalise the country's largest gas importer in in a €30 billion bailout. Under the deal, the government bought Fortum's 78% stake in Uniper and promised it may inject a further €8 billion at a later stage, if necessary, which could boost Berlin's stake to over 90%.

German gas importer VNG, owned by



Gazprom may have to pay compensation for missing supplies

EnBW, has not disclosed whether it plans to also launch arbitration proceedings against Gazprom over halted supplies. ■

Continued from page 1

Electricity offakers hence brace for potential brownouts due to fuel shortages for

power generation. "2023 is the most challenging, because LNG [import terminals] are not yet prepared so there may be not enough supply," said Isidro Consunji, CEO of Semirara Mining and Power Corp.

Rival import projects in the making

At Batangas Bay, several other LNG import and integrated power projects are at an advanced stage: BW LNG and the utility First Gen are working to complete construction and commissioning for their floating LNG import terminal 'BW Batangas' by the end of March, though the first LNG cargo is not scheduled to arrive at the 5.26 mtpa terminal before June 2023.

For First Gen, one of the largest power providers in the Philippines, the timely start-

up of the FSRU is crucial source fuel for four gas-fired power stations – the 1,000 MW St Rita, 500 MW San Lorenzo, 414 MW San Gabriel and the 97 MW Avion plants – which currently run on gas from the Shell-operated Malampaya field where production will cease by 2024.

Vires Energy, meanwhile, is proceeding with a FLNG import unit with a capacity of 3 mtpa and an integrated 500 MW power station, which will be mounted on a barge. Targeted to be built and commissioned by January 2023, the floating power plant will be the largest units of its kind in the Philippines.

Shell is also planning to deploy a leased FSRU at Tabango, Batangas, while simultaneously trying to divest its 45% operating stake in the large but fast-depleting Malampaya offshore gas field. ■

Gas to Power Journal

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SMC offers Ilijan plant's power gen capacity to Meralco at P1 per kWh

San Miguel Corp (SMC) has offered to make Ilijan gas power station available to Manila Electric at a fraction of its cost. The 1,200 MW plant covers up to 12% of Luzon's electricity needs and SMC president Ramon Ang said Meralco would pay a minimal 1 Peso per kilowatt-hour, or half of SMC's capital cost on the facility.

The offer means that the incremental power supply costs from such gas-fired capacity for households may be cut down significantly compared to prevailing costs from coal power generation.

"Because of unforeseen global events such as the Russia-Ukraine war, fuel prices are at unprecedented highs, and supply is tight. We are in a crisis and this is a shared burden by all Filipinos – power consumers, the power sector, government. By immediately foregoing returns, we continue to carry our share of the burden, while getting just enough to make sure plant operations continue and remain sustainable," said Ang.

However, the Ilijan CCGT is currently on extended outage following the refusal of Shell Philippines Exploration BV (SPEX) to supply the 70 petajoules (PJ) in banked gas from the Malampaya field, which Shell acquired from PNOC in June. The original gas supply agreement of the Ilijan Plant with Malampaya also expired in June 2022.

To address fuel constraints, SMC is offering to fuel from its own allocation of Malampaya gas or liquid fuel – which Meralco will have to pay for. SMC Global is also willing to work with Meralco in using its 70 Petrojoules banked gas acquired from NOC at a cost much lower than the prevailing cost of coal power generation.

The Philippines's Department of Energy has warned of a "massive power supply deficit in Luzon" unless the Ilijan power



Ilijan power station at a seashore near Batangas City

plant is reactivated. Malampaya gas will be replaced by imported LNG, with a floating regas terminal that SMC has tolled expected to be completed by March 2023. ■

Singapore seeks proposals for zero carbon power plants

The Energy Market Authority (EMA) of Singapore, together with the Maritime and Port Authority (MPA) are inviting companies to build, own and operate zero-carbon power plants and bunkering facilities on Jurong Island. The aim is to generate at least 50 MW of electricity from hydrogen and ammonia for up to 25 years, and support ammonia bunkering.

Interested parties are asked to submit their proposal under an expression of interest (EOI) by April 30, 2023. "Hydrogen and ammonia have the potential to be a needle-moving decarbonisation solution for the power sector. Through this expression of interest, EMA is keen to collaborate with interested industry partners to explore what could possibly happen," said EMA's chief executive, Ngiam Shih Chun.

Ammonia can transport and store hydrogen in a liquid state at low cost. Hydrogen gas, in contrast, needs to be liquefied, com-

pressed or converted into ammonia for transport and storage due to its low energy density.

Both fuels are seen as key to reach Singapore's 2050 net zero emissions target, alongside a build-out of wind and solar power sources and electricity imports. To that end, the government just set aside \$129 million for phase two of the Low-Carbon Energy Research Programme. This funding was in addition to the \$55 million awarded as of October.

Jurong Port, MHI Asia Pacific and JERA have already teamed up in August to build an ammonia direct combustion power plant. The trio will carry out a joint study whereby a 60 MW gas turbine in combined-cycle mode will run fully on ammonia to generate carbon-neutral electricity. ■



View of Jurong Port in Singapore

NEWS NUDGES

Russia's LNG production up over 10%

Russian LNG production increased by 10.6% to 26.9 million tonnes during the first ten months of this year, while overall gas production fell by 13% to 474 Bcm largely due to cut off supplies to Europe. Though the Kremlin's invasion of Ukraine in February prompted an array of sanctions by Western nations, Russia's LNG exports were not added to the list and continued to reach the EU and Asia.

Producing hydrogen from LNG onboard ships

Finland's clean energy pioneer Hycamite is working with Wärtsilä to cost-effectively produce hydrogen from LNG onboard marine vessels. A concept design is being compiled by mid-2023 with the aim to start prototype testing during the second half of 2024.



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GE reduces emissions at mobile gas turbines to low single digits

In California, GE Power has developed a solution on four TM2500 aeroderivative gas turbines that reduces nitrogen oxide (NO_x) and carbon monoxide (CO) emissions by over 90%. The Selective Catalytic Reduction (SCR) technology transforms the nitrogen oxides contained in the exhaust gas into water vapor and nitrogen, slashing emissions while maintaining a stable electricity output.

The four TM2500 gas turbines are installed at the Department of Water Resources' (DWR) sites in Yuba City and Roseville, where the flexible units are dispatched to provide emergency power, e.g. to support the grid during extreme climate-driven events including drought or wildfires.

Reducing pollutants to 2.5 ppm

Each of the four TM2500 turbines can produce up to 34 MW of electricity for a total of 136 MW and is now equipped with a system to reduce pollutants to 2.5 parts per million (ppm), the legal limit set by the state of California.

GE worked with Kiewit Power Constructors to install the novel SCR solution at Yuba

and Roseville. The emissions control solution includes 11-meter-high modules and a 22-meter-high stack, helping to meet the operator DWR to meet California's most stringent emissions standard requirements.

Capable to provide full power in five minutes after start-up, the TM2500 allows grid operators like the California Independent System Operator (CAISO) or the Western Area Power Authority (WAPA) to quickly support the grid in case of emergencies or loss of in-



DRW's power unit at Roseville, California

termittent power. Such quick-starts were used to stabilise the strained grid during California's extreme heat wave on September 6, 2022. ■

Toho Gas develops Direct Air Capture at LNG regas terminals

Japan's Toho Gas is building a prototype direct air capture plant by 2024 that will absorb one tonne of CO₂ a year by using "cold energy" from LNG regas terminals. The coldness from LNG expanding into gas is used to cool a solvent containing CO₂ to -140 C, turning that CO₂ into dry ice for later conversion into synthetic methane.

As one of the world's largest LNG buyers, Japan imports around 80 million metric tons of the super-chilled gas per year – but most of its cooling power is wasted and released to cool seawater. Researchers at Nagoya University are using this "cold energy" to capture carbon in cheaper way than with conventional sorbents.

Typically, carbon dioxide is captured by using monoethanolamine as a sorbent but

then a lot of energy is needed to heat that sorbent to force out the absorbed CO₂ gas. On the contrary, Cryo-DAC uses cold energy to turn CO₂ into dry ice as it exits the sorbent the resulting pressure drop pulls more of it out of the sorbent than through heating. The dry ice is eventually brought to room temperature which leaves gaseous CO₂ under high pressure, without requiring much energy.

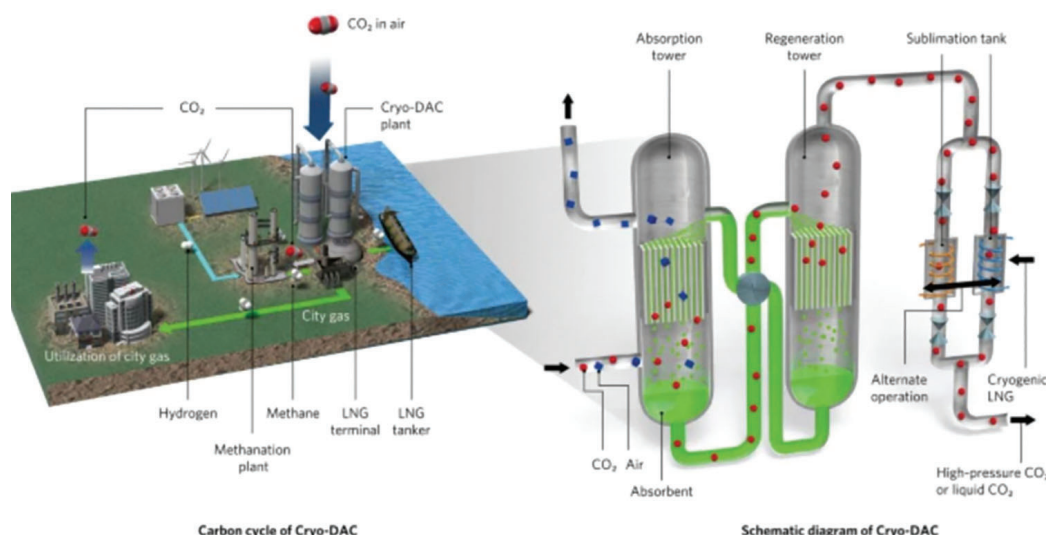
"Efficiency has continued to be a chal-

lenge for direct air capture, as the steps that isolate CO₂ from atmospheric air require the input of energy," said Soichiro Masuda at Toho Gas' R&D/Digital Division. "Burning fossil fuel to provide the energy input ends up creating more carbon emission for the sake of capturing carbon."

Researchers calculated that if the carbon dioxide absorption takes place at standard atmospheric pressure (101.3 kPa) and the desorption and dry ice deposition

occurs at 1 kPa, the required energy to capture CO₂ could be as low as 0.25 GJ/ton under ideal conditions — just one-eighth of the energy needed compared with the usual heat-driven sorbent regeneration process.

Toho Gas wants to convert the captured carbon to synthetic methane for use as a clean fuel for power generation. "While CO₂ for methanation is typically prepared with compressors, Cryo-DAC has the potential to separate CO₂ from air and generate high-pressure CO₂ at low cost," Masuda pointed out. ■



H2-Industries' pyrolysis tech transforms flaring gas into clean hydrogen

Flaring associated gas from oil wells creates emissions and wastes some 144 Bcm of gas each year – enough to power the whole of sub-Saharan Africa. H2-Industries' pyrolysis technology converts harmful emissions into a valuable resource: The process can produce up to 100 kg of clean hydrogen and 730 kg of solid carbon from a tonne of flaring gas.

The World Bank dismisses flaring as a monumental waste of a natural resource and seeks to end routine gas flaring at oil production sites no later than 2030. Instead, the World Bank wants the resources to be used for productive purposes like generating electricity and, according to H2-Industries' CEO Michael Stusch, that is what the pyrolysis technology can achieve:

"Pyrolysis is when a solid, or a liquid, undergoes thermal degradation into smaller volatile molecules without interacting with oxygen or other oxidants. It is essential to understand that pyrolysis is not a phase change but a chemical process. It is a thermal degradation process that occurs under heat and degrades larger molecules into smaller ones," he explained.

Flare gas composition differs from flare to flare; therefore, the pure methane (CH₄) needs to be separated with membranes that remove the various blends of carbon hydrates so that only pure CH₄ remains. This CH₄ is then cracked in a methane pyrolysis process into clean hydrogen and solid carbon with no CO₂ emissions released into the atmosphere.

Hydrogen bound in LOHCs

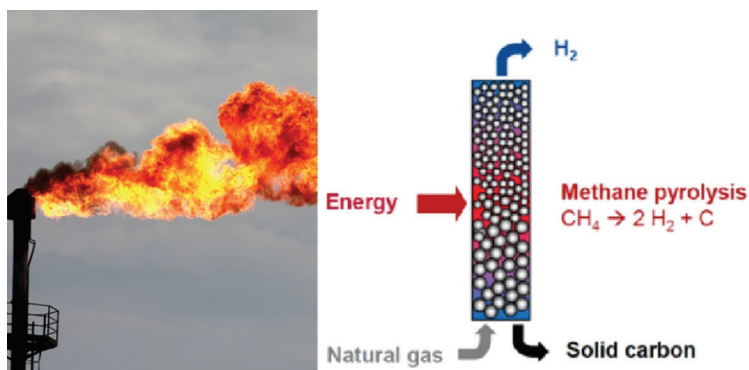
The technology is delivered in self-contained 20 or 40-foot ISO containers and can be pre-assembled in a semi-serial production and shipped for installation to the flaring site. The process provides clean hydrogen bound in liquid organic hydrogen carriers

(LOHC) which are organic compounds that can absorb and release hydrogen through chemical reactions.

"LOHCs can therefore be used as a storage medium for hydrogen. H2-Industries has developed and commercialized the use of LOHC to make hydrogen handling safer and cheaper. With LOHC, the volatile hydrogen gas no longer needs to be cooled or compressed in a costly and energy-intensive manner to enable economical transport," Stusch explained.

Any process is only as economic and ecological as its primary feedstock, and in the case of H2-Industries, the critical feedstock is a waste product. But the process also needs electricity, supplied by internal power generation units that do not use fossil fuel energy sources or the grid. CO₂-free electricity can be provided either by hydrogen fuel cells that transform the hydrogen produced on-site into electrical power or Organic Rankine Cycle (ORC) units that recover heat from the hydrogen storage in LOHC units and wasted heat from the water gas shift process to produce power for the entire process.

The process can produce up to 100 kg of clean hydrogen and 730 kg of solid carbon



from a tonne of flaring gas. A typical, medium-sized oil platform releases 13,500 tonnes of flaring gas annually, and a single H2-Industries 'Flare to Hydrogen' container can produce 158 tons of clean hydrogen per year. By processing 100 million tons of flaring gas per year, the amount flared in 2021, ten million tonnes of clean hydrogen can be produced.

"The clean hydrogen comes for between \$2 and \$3 per kg, while market price levels are between \$3 and \$4 for grey hydrogen and \$7 for CO₂-emission-free hydrogen," Stusch pointed out.

The only by-product of the process is solid carbon black that can be shipped for export to any place in the world using ISO container tanks. Carbon black is mainly used to strengthen rubber in tires. But it can also act as a pigment, UV stabilizer, conductive or insulating agent in various rubber, plastic, coating applications, and other everyday use, including hoses, conveyor belts, shoes, and printing. ■

Doosan strives to develop 380 MW hydrogen turbine by 2027

Doosan Enerbility, previously known as Doosan Heavy Industries, has announced plans to complete the development of a 380 MW gas turbine that is run purely on hydrogen by 2027. The combustor for this turbine is meant to be ready a year earlier, the manufacturer said at it strives to make South Korea a global leader for hydrogen co-firing.

The global market for hydrogen is expected to reach 40 trillion won (\$20 billion) in 2030, according to the Yano Economic Research Institute in Japan, and global turbine makers like Siemens and GE are developing hydrogen turbines ready for commercialisation by the end of the decade or earlier.

Eager to win the race, Doosan Enerbility is currently preparing to test a 50% hydrogen co-fired combustor for a 300 MW turbine together the Korea Institute of Machinery and Materials. Following suc-

cessful tests of co-firing 30% hydrogen in August, the manufacturer will now blend natural gas and hydrogen in equal volumes and start test runs in early 2023.

Gas combustion with a 30% hydrogen blend lowered CO₂ emission by 10.4%, compared to LNG-fuelled generation, and once hydrogen will make up 50% of the fuel, emissions are expected to fall by 21.4%. However, hydrogen has a substantially higher combustion speed and flame temperature than natural gas, hence the manufacturer needs

to adapt the material of the combustor and the turbine coating to withstand it. ■



Model of Doosan's 380 MW hydrogen gas turbine

TVA to replace Cumberland Fossil Plant with gas, not solar power

Tennessee Valley Authority (TVA) wants to replace an ageing coal power plant in Cumberland with a combined-cycle gas power station, opting against zero carbon solutions. A flexible CCGT can integrate renewables, while batteries currently do not have enough power output to support the system when solar is unavailable, argues TVA Power Operations' senior vice president, Jacinda Woodward.

According to her experience, "natural gas is needed to produce power during early morning winter peaks or during overcast or rainy days. Solar power added to our system through Green Invest and other programs will displace gas generation in the summer reducing fuel costs and carbon emissions."

In fact, investments in flexible natural

gas – like the proposed combined-cycle plant at Cumberland – will allow TVA's system to be ready to reliably integrate a planned 10,000 MW of solar by 2035, the utility argues.

TVA published the final environmental impact statement (EIS) for the combined-cycle gas power plant this week, and if approved the utility will retire the two units at 2,470 MW Cumberland Fossil Plant, idling

one unit by the end of 2026 and the second unit by the end of 2028. The CCGT could be built and commissioned by 2026 and is meant to replace the capacity of unit 1 of the coal-fired Cumberland Fossil Plant.

A solar and storage combination was also

evaluated, but dismissed, because the technology is energy-limited and would require costly transmission upgrades, including new lines and substations, that wouldn't be in service by the 2026 retirement deadline.

"The amount of solar and storage required to replace a Cumberland Fossil unit is also more expensive – \$1.8B more expensive per the final EIS – and it requires transmission upgrades that could take more than a decade to complete," said Woodward.

Looking at size requirements, a large enough combination of solar and battery storage would have to be spread across numerous sites, requiring more than 21,900 acres of land. In contrast, the proposed gas power plant would require a maximum of 50 acres on the existing Cumberland brown-field site.

TVA provides electricity to 10 million people in Tennessee and parts of the surrounding states of Alabama, Mississippi, Kentucky, Georgia, North Carolina and Virginia. The publication of EIS for the Cumberland project is followed by a minimum 30-day wait period, then a final investment decision is meant to be made in early 2023. ■



Cumberland Fossil Plant (2.47 GW)

Mitsubishi Power refurbishes Hartha Unit 1, reinstates full output

Mitsubishi Power, part of MHI, has completed the refurbishment of Unit 1 of the Hartha thermal power station near Basra in southern Iraq. After more than 30 years of operation, the plant's degraded gas- and oil-fired boilers and steam turbines were replaced, restoring its original electricity output rated at 200 MW.

Commissioned in 1982, the Hartha power station accounts for about 25% of the province's power generation capacity. But the plant's Mitsubishi-built equipment suffered damage and gradual degradation during years of conflict in the region, reducing its power gen capacity to just 60%.

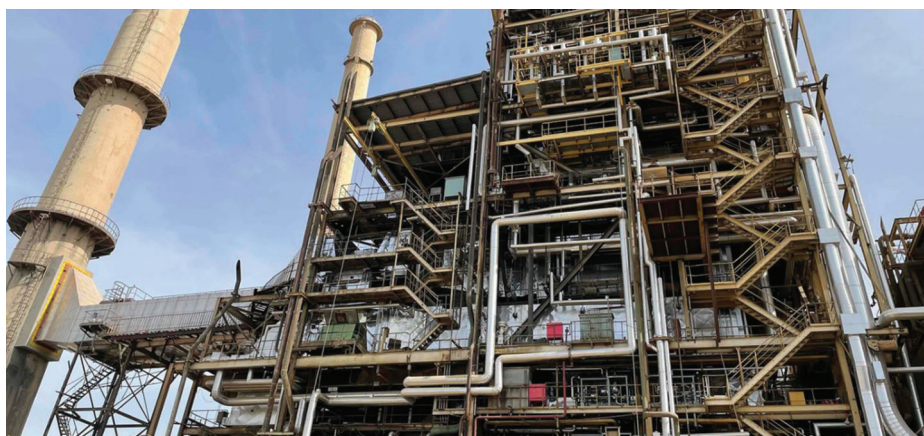
Works were carried out by Mitsubishi Power, which replaced the core components, in consortium with the Turkish engineering company GAMA which handled local transportation and installation. Both companies sent numerous highly experience engineers to successfully complete the project despite challenges caused by the Covid-19 pandemic.

Funding for the Unit 1 refurbishment, similar to the Unit 4 project, was provided

by the Japanese Official Development Assistance (ODA).

Besides the Hartha project, Mitsubishi Power has also refurbished the Al-Musaib

and Mosul thermal power stations in Iraq, helping to ensure a stable supply of electricity which is vital for the country's social stability and economic revitalisation. ■



Hartha power station unit 1

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