



HYFLEXPOWER successfully runs gas turbine on 100% green hydrogen

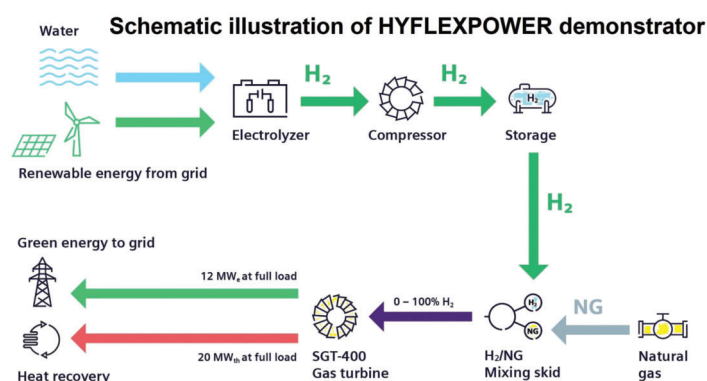
Field trials and tests have proven that the HYFLEXPOWER consortium can run a Siemens Energy SGT-400 industrial gas turbine fully on hydrogen, produced by an 1 MW electrolyser on-site. Installed at an industrial combined heat and power (CHP) plant at the Smurfit Kappa paper mill in France, the project consists of producing, storing and re-electrification of renewable hydrogen.

The 12 MW industrial CHP at the Smurfit Kappa mill in the French town Saillat-sur-Vienne, operated by Engie Solutions, had been used as a demonstration plant for hydrogen co-firing to lower conversion costs and reduce lead times. Having successfully tested full H₂-firing for power production, the aim is now to extend the technology to industrial heat production.

As a next step, the HYFLEXPOWER project aims to power the paper mill by a completely carbon-free energy mix. This would save up to 65,000 tons of CO₂ per year for an SGT-400 at baseload operation. ENGIE vice president of Energy Solutions, Frank Lacroix said the project would "open up prospects to use renewable hydrogen in the industrial sectors most difficult to decarbonize."

Aiming for carbon-free electricity

Ultimately, project partners want to scale up the technology and



commercialise their solution of fully decarbonised electricity generation. "Knowledge and experience gained from the HYFLEXPOWER project where we installed the first gas turbine to run on 100% hydrogen will help us to continue develop our entire gas turbine fleet for a hydrogen-based future. The interaction between electrolysis, storage, and hydrogen conversion at one site has been impressively demonstrated, and now it's a matter of scaling the results," said Karim Amin, board member of Siemens Energy.

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Hanwha sets up H₂ value chain, having achieved near-60% co-firing

South Korean petrochemical company Hanwha is working with seven affiliates to set up a hydrogen value chain encompassing production, storage, transportation and utilisation by industry and power generators. Tests recently demonstrated a 59.5% hydrogen co-firing rate at an 80 MW gas turbine, installed at a plant in Seosan City run by Korea Western Power.

The H₂ co-firing technology was able to reduce CO₂ emissions by 22% compared to LNG-fired power generation, and limited NO_x emissions to 6 parts per million (ppm) – just 30% of the 20 ppm deemed acceptable by European standards – without an additional reduction device.

Going forward, Hanwha Impact plans to implement its technology also at the 150 MW unit 1 gas turbine of the West Incheon power station. Though co-firing can significantly lower emissions, hydrogen has a substantially higher combustion speed and flame temperature than natural gas, hence the manufacturers need to adapt the material of the combustor and the turbine coating to withstand it.



Hanwha turbine installed at a plant in Seosan City

Establishing a H₂ value chain

Striving to source a steady supply of hydrogen as a fuel, Hanwha is working with seven of its affiliates to use renewable energy and ammonia and encompass clean hydrogen production, storage, transport, and utilization.

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The HYFLEXPOWER consortium consists of Siemens Energy, ENGIE via its subsidiary ENGIE Solutions, Centrax, Arttic, the German Aerospace Center (DLR), and four European universities. First announced in 2020, the project involves significant funding, with two-thirds of the €15.2 million investment coming from the EU's Horizon 2020 program.

As the consortium lead, Siemens Energy supplied the electrolyser for hydrogen production and developed the hydrogen gas turbine. ENGIE built the hydrogen production, storage and supply for the demonstrator. Centrax were responsible for the package upgrade to ensure safe operation with hydrogen fuel. The German Aerospace

Center (DLR) and the Universities of Lund in Sweden, Duisburg-Essen in Germany, and University College London, UK; contributed to the hydrogen turbine technology development. Arttic supported the operational project management, while NTUA in Athens carried out economic, environmental, and social analysis of the concept. ■

TTF curve looks undervalued as early-October mildness dissipates

Near curve prices at Europe's benchmark TTF gas trading up look undervalued as a plunge in temperatures over the weekend put an abrupt end to early-October mildness. The Israel-Hamas conflict poses a risk to gas balances, with analysts cutting Egyptian LNG export forecasts after Israel ordered Chevron to halt production at the Tamar field.

Though Tamar's sub-sea wells are 160km away from Gaza, the produced gas gets delivered to the Ashdod on-shore terminal which is only 37km from the Hamas-run territory. The field is feared to become a target for Hamas in retaliation for Israel's full blockade of the Gaza Strip, which includes food, fuel and electricity supplies.

Tamar used to supply around 0.24 billion cubic meters per month to Egypt via the EMG pipeline, which now came to a halt. Israel also capped output from the large Leviathan field due to lower domestic demand, forcing Egypt to use more of its own production for the domestic market rather than for LNG exports.

Bullish sentiment for winter months

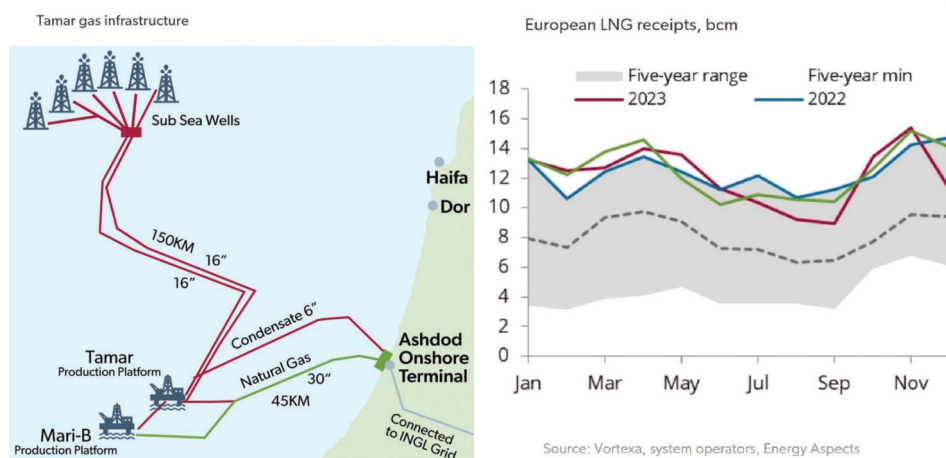
Analysts at the London-based consultancy Energy Aspects said they were already bullish on the TTF winter markets before

the new risks emerged and think that out-turn prices will be higher than the current market on the curve, even if these risks dissipate in the coming weeks. Analysts warned, "the demand increase we expect to see this winter will leave Europe struggling to refill its gas storage by end-October 2024."

Aggregate gas demand in Europe is forecast likely increase by 23.4 bcm year-on-year this winter, while supply is likely to

climb by only 3.4 bcm. This results in an end-March inventory carryout of 48.7 bcm, which is down by 11.6 bcm year-on-year.

Last winter was a lot milder than usual, hence there is significant weather-related risk for gas use in heating systems this winter. Industrial demand also recovered to lose to the pre-crisis average and could increase by 7.2 bcm year-on-year this winter as analysts see "little sign of permanent demand destruction." ■



Source: Vortexa, system operators, Energy Aspects

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Anion exchange membrane water electrolysis (AEMWE) technology is under development, which can produce hydrogen using less power and with a lower initial investment cost than existing water electrolysis methods. Ammonia can store hydrogen at higher volumes and is hence viewed as a "promising carrier." Hanwha Impact conducting research with the aim of commercialising ammonia cracking by 2027.

Hanwha Cimarron has joined hands with Shell to build extensive hydrogen refuelling infrastructure in California by supplying its Neptune 517-bar hydrogen tanks, the highest among Type IV tanks. Hanwha Ocean,

meanwhile will handle the transportation of hydrogen and its derivative with its dedicated carriers.

At the end of the value chain, Hanwah Power System is striving to refine its co-firing technology and aims for 100% hydrogen-derived electricity. Alongside its partners Thomassen Energy in the Netherlands and Power Systems Mfg. (PSM) in the U.S., Hanwha has advanced hydrogen co-firing gas turbine solution which led to the world's first 60% hydrogen co-firing of an 80 MW gas turbine. Moreover, hydrogen fuel cells have been fitted to 3,000-ton submarines and are meant to be used for urban air mobility. ■

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China's CNOOC and French utility Engie settle LNG trade in yuan

China National Offshore Oil Corp. (CNOOC) and the French utility Engie have completed a yuan-settled LNG trade through the Shanghai Petroleum and Natural Gas Exchange – the third such LNG trade achieved by the Chinese. According to the exchange, a cargo of around 65,000 metric tons of LNG will be delivered in November possibly from Abu Dhabi.

As one of China's largest gas producers, CNOOC aims for gas to account for half of its domestic hydrocarbon output as gas-burn increases in the country's power sector. LNG complements CNOOC domestic gas production and the government recently urged companies to settle oil and gas trades in yuan "where possible" in an effort to weaken the U.S. dollar's dominance in energy trading.

CNOOC's first yuan-settled trade was arranged with TotalEnergies in March, while Singapore's Pavilion Energy is understood to have also settled such a deal this August. In April, PetroChina carried out a yuan-settled LNG trade with ADNOC which also involved TotalEnergies. The cargo for that transaction arrive from Das Island in Abu Dhabi in May and was unloaded at the main terminal in southern Guangdong province.

Analysts suggest the Chinese economy could "benefit hugely" by partly paying for its oil and gas imports in the local currency. Asia's largest economy imported more than 500 million tonnes of crude oil last year and more than 100 million tonnes of natural gas by pipeline and as LNG and with the LNG portion amounting to 63.44 million tonnes.

Gas consumption could stage 7% rebound

In an optimistic outlook, the National Energy Administration (NEA) of China sees the country's gas demand rebound in the sec-

ond half of 2023 and reach up to 390 Bcm for the full year, a 7% increase. Growth is largely driven by city gas demand from the commercial sector and several gas-fuelled power stations being dispatched during the summer and winter season.

As one of China's main energy market regulators, NEA underlined the country's gas strategy is to strengthen domestic production and long-term contract, complemented with some spot LNG, to maintain price stability. Natural gas produced in China increased to 220 Bcm in 2022, up 6% year-on-year. The government aims for domestic gas to cover more than half of demand in the long-term, allowing for gas to be used as a peak-shaving tool at times of high electricity demand.

To stabilise supply, Chinese companies sealed nearly 17 million ton per year of long-term LNG offtake accords last year, with Free-on-Board (FOB) making up nearly 60% of the total. At the same time, pipeline gas deliveries saw a staggering 54% increase, which according to NEA underlines the importance of this partnership in China's energy import strategy. ■



CNOOC's Fujian LNG terminal in southeast China

France goes ahead with LNG expansion despite easing demand

France faces potential overinvestment in LNG import infrastructure as existing terminals are less in use amid falling gas-burn for power generation. The utilisation rate of French LNG terminals fell to 60% through August, down from 74% last year, hence IEEFA analysts raise doubt over the need for a new floating storage and regas unit (FSRU) at Le Havre.

Gas consumption in France declined 9% in 2022 and continued to fall this year, mainly due to higher prices but the government is still backing the build-out of operational LNG terminals. The projected Le Havre FRSU, for instance, would have a regasification capacity of 5 billion cubic

metres (bcm) and is meant to be operation for the next five years.

"Gas and LNG infrastructure is currently at risk from falling demand and high and volatile prices," said Ana Maria Jaller-Makarewicz, energy analyst at the Institute for Energy Economics and Financial Analysis (IEEFA). "If demand continues declining, France and neighbouring European countries risk investing in gas infrastructure that will fail to improve security of energy supply and could become underutilised.

Importing Russian LNG

Although France, like other European nations, vowed to improve Europe's energy supply security by reducing its dependence on Russian gas, that very gas is finding a way to French ports in the

form of LNG. French gas buyers continue to import Russian LNG and allow transshipments, destined for other markets.

The European Union is considering banning Russian LNG before the next big wave of super-chilled gas enters the market by 2026. However, France and Spain do not support such a ban given that they have been receiving around 0.3 bcm/m and 0.5 bcm/m of LNG from Russia, respectively, over recent months.

TotalEnergies holds 4 mtpa of offtake from Yamal LNG and CEO Patrick Pouyanne recommended this month that France not ban Russian LNG until "later this decade." Engie signed a 23-year deal in 2015 to import 1 mtpa from Russia's Yamal LNG project for transshipment at the Montoir-de-Bretagne terminal on France's west coast. The contract has since been inherited by TotalEnergies. ■



View of Le Havre port in France's Normandy region

Changes in Europe's power mix drive down gas demand; IEA finds

Demand for natural gas has already peaked in mature markets, notably in Europe where weak economic growth subdued electricity use while high renewable power output drove down gas-burn. Gas-to-power demand fell 18 bcm in the first three quarters of 2023 and made up 55% of Europe's gas demand reduction over this period, the International Energy Agency (IEA) finds.

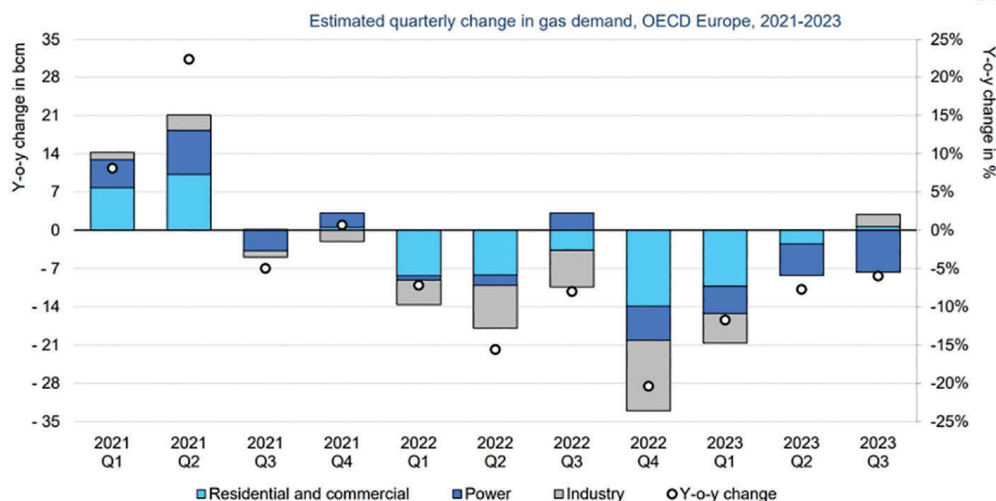
Subdued activity of energy-intensive industries, energy efficiency improvement and behavioural changes lowered electricity consumption by an estimate 5%, or 58 Terawatt-hours, in the second and third quarter. In addition, an 8% rise in renewable power output and strong nuclear availability in France, up 25%, further reduced the need to dispatch gas-fired power plants.

Industrial gas use fell by 3%, or 3 bcm, in the first three quarters of this year, though lower gas prices helped to gradually improve industrial activity. For the full year of 2023, OECD Europe's gas demand is forecast to dwindle by 7%, mainly due to a massive 15% drop in gas-burn in the power sector and rangebound gas use from industry.

Supply risk remains

Though gas prices decreased from record highs in the first three quarters of 2023, supply risks remain for the coming winter. Steep demand reductions, notably by in-

European gas consumption dropped by over 9% in Q1-Q3 2023



Sources: IEA analysis based on Enagas (2023), [Natural Gas Demand](#): ENTSOG (2023), [Transparency Platform](#): EPIAS (2023), [Transparency Platform](#): Trading Hub Europe (2023). Aggregated consumption.

dustrial consumers in Europe and some Asian markets helped reduce strain, but supplies remain tight.

According to IEA findings, "the increase in LNG supply was not enough to offset the sharp declines in deliveries of pipeline gas from Russia to Europe."

The risk of price volatility is cause for grave concern: Though Europe's gas storage sites entered the winter heating season at 96% capacity, this is no guarantee for

stable prices – particularly in the event of an exceptionally cold winter, analysts warn.

Come 2024, however, European gas demand is forecast to grow by a moderate 2%, as higher demand in the residential, commercial and industrial sectors is expected to offset the decline in gas-to-power demand. This rebound in demand could exacerbate supply risks unless some of the demand could be covered by green fuels or reduced by efficiency improvements. ■

US gas-burn recovers but set to fall in 2024 due to renewable build-out

Gas-burn for power generation has risen by 3% to about 42% of the US power mix due to relatively low prices for the fuel, retirement of 10 GW of coal-fired generating capacity and addition of 5 GW highly efficient gas turbine capacity. Come 2024, however, analysts anticipate a significant drop in fossil fuel-fired generation as the renewables build-out progresses.

Some 40 GW of solar and wind-based generating capacity is scheduled to enter service next year, up 16% from this year, making the share of electricity produced from renewables rise from 22% this year to 25% in 2024. The rapid build-out of renewables with near-zero operating costs is reducing the need to dispatch gas- and coal-fired power plants – particularly if renewables are paired with energy storage.

Fuel cost of gas cheaper than thermal coal

Between March and July 2023, the US Energy Information Administration (EIA) estimates that the cost of producing power from combined-cycle natural gas power plants averaged \$25 per megawatt-hour (MWh), lower than the estimated \$31/MWh cost for generation from coal-fired power plants. During the same months last year, the cost of operating CCGTs stood at \$55/MWh – 90% higher than for coal-fired power plants (\$29/MWh).

The price of gas will likely increase in 2024, which should bring the costs of generating electricity from coal and natural gas closer together. Analysts peg next year's cost of gas-fired electricity \$32/MWh compared with an average

\$29/MWh for coal-fired power.

Renewables displace fossil fuels

However, the share of gas in the American power mix is hence forecast to fall to 41% next year, EIA analysts find. Despite a rise in overall electricity output in 2024, analysts expect the contribution of both natural gas and coal will fall, displaced by offshore wind and solar power.

Solar PV will power the lion's share of new renewable capacity, with a staggering 25 GW to be added throughout 2023, complemented by an 8 GW rise in wind-generating capacity. Analysts note the share of wind and solar tends to peak in the spring months when overall electricity demand is low – and the share of green power is bound to rise further in spring 2024. ■



Precise radar measurements improve fluidised bed combustion

High-frequency radars, developed by Chalmers University of Sweden, improve the conversion of solid fuels into electricity and district heating via fluidised bed combustion. The pulse-Doppler radars – at frequencies up to 340 Gigahertz (GHz) – measure the distribution of particles and their velocity to scale up process reactors that are also used for carbon capture, energy storage and thermal cycling.

Fluidisation allows converting biomass and waste into electricity and process heat. To that end, operators need to ensure an efficient and consistent rate of combustion because the solid particles assume a liquid-like state which helps to distribute the heat homogeneously in the combustion chamber. In brief, fluidization technology is based on a gas being blown through a bed of small sand-like particles in a reactor, so that these solid particles, the fuel and the gas become thoroughly mixed.

“To achieve even greater efficiencies in this process, you need to be able to understand and control how the solid particles behave in the mixture. But the reactor environment is often hot, dirty and corrosive – like a sandstorm and a wildfire in one – effectively preventing any type of measurement and thus limiting our understanding of what is actually happening inside the reactor,” said Diana Carolina Guío Pérez, researcher in energy technology at Chalmers.

Unrivalled accuracy of terahertz radar

The solution to this problem is a high-frequency terahertz radar that can measure the flows of solid particles in fluidized beds with unrivalled precision. Demonstration of the pulse-Doppler radar with submillimetre

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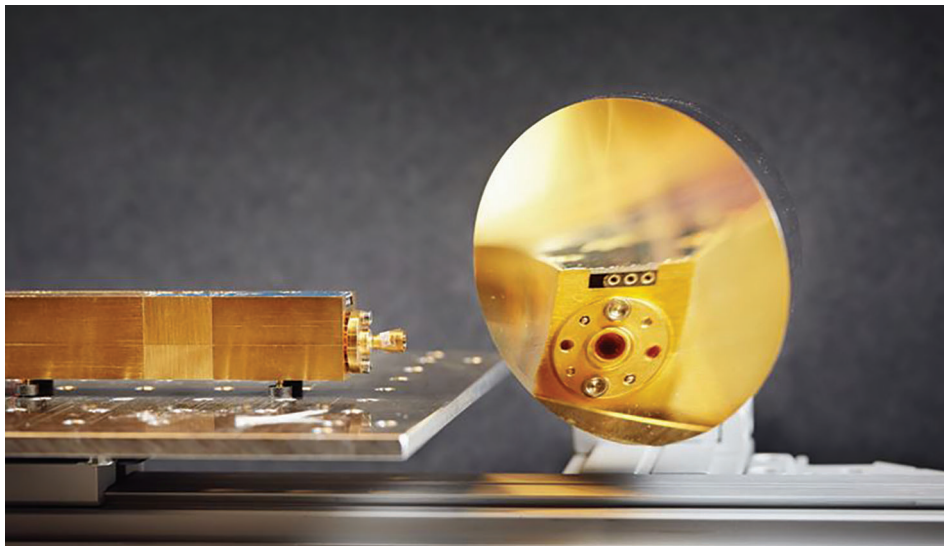
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– Diana Carolina Guío Pérez, Chalmers

wave frequencies allowed to make precise measurements in a fluidized bed.

“We have been able to show that pulse-Doppler radar technique at frequencies up to 340 GHz can measure both the distribution of particles and their velocity inside a process reactor at a much higher resolution than other technologies can. This is information that has long been lacking in the field and will make it possible to improve and scale up process reactors and – in the case of energy conversion – reduce emissions of unwanted residual products,” explained Marlene Bonmann, post-doc at the Terahertz and Millimetre Wave Laboratory at Chalmers University of Technology.

Knowledge acquired with terahertz radars could herald designs for a completely new fluidized bed-based conversion, to be used for processes such as carbon capture and storage, energy storage and thermal cycling. ■



Radar signals, redirected via a gold mirror towards a fluidised bed



INNIO gets H2-Readiness certification for engine power plant concept

Austria-based INNIO Group has received a 'H2 Readiness' certification from TÜV SÜD for its power plant concept based on the Jenbacher Type 4 and 6 product lines. The certification does not refer exclusively to new 'H2-Ready' engine power plants, but also defines a roadmap for retrofitting existing plants – from gradual admixing to pure hydrogen operation.

TÜV SÜD's certification consists of three stages and three corresponding certifications:

- During the bidding phase, a Concept Certification is issued for the conceptual design including all boundary conditions. INNIO is the first manufacturer worldwide to receive this Concept Certificate.
- In the implementation phase of a specific project, a Project Certificate is issued based on the final plant design and its specifications.
- Finally, a Transition Certificate evaluates the conversion/retrofitting of an existing engine power plant to hydrogen operation. This third stage also includes a review of the retrofit measures and their impact on safety and performance. The certification offered by TÜV SÜD can be applied to a wide range of engine power plants.

INNIO has pioneered technology designed for gas and hydrogen mixtures. It is one of the first companies to offer engines in the 1 MW class that can operate on 100% hydrogen. Dr. Andreas Kunz, INNIO's chief technology officer said “the independent certification from TÜV SÜD provides even more investment security for companies and municipalities.”

As of 2025, the entire Jenbacher product portfolio will be rolled out for operation with 100% hydrogen. Due to their huge operational flexibility and short start-up times, the engines are essential for stabilizing the grid in energy systems that are increasingly dependent on volatile renewable energy sources. ■

Start-up of six more plants to bring US gas capacity additions to 6.8 GW

Another six gas-fired power plants with 1.8 GW capacity combined are expected start up in the United States this year, bringing total 2023 capacity additions to 8.6 GW. So far, ten new gas-fuelled plants were fired up and the awaited further additions include both combined-cycle and open-cycle units in the gas producing regions near the Gulf Coast and Appalachia.

If realised, the combined capacity year's addition will dwarf the 5.6 GW added last year, when 11 gas-fired power plants came online, figures from the US Energy Information Administration (EIA) shows. This year and last, gas-fired capacity additions increased amid rising domestic production and comparatively cheap fuel prices.

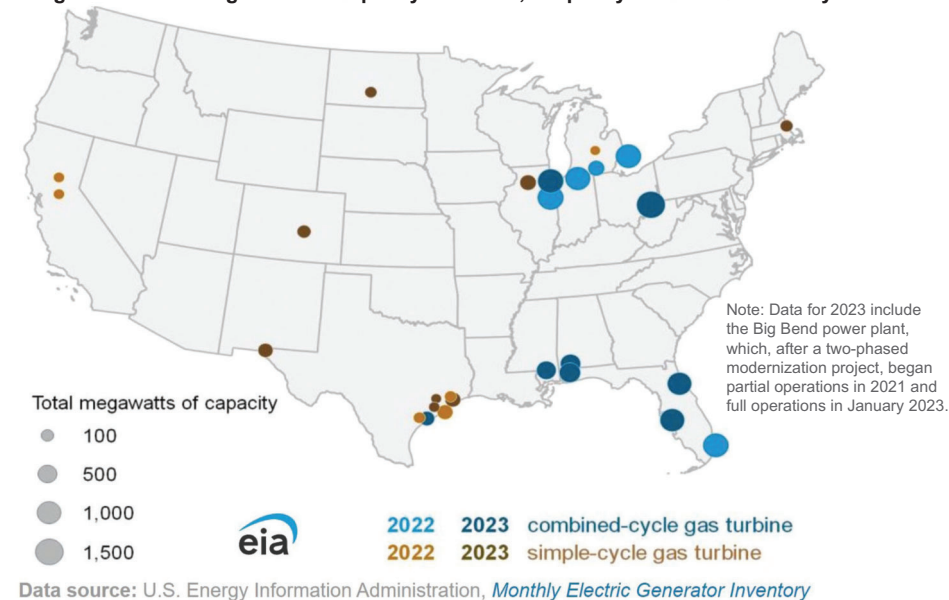
For 2024 and 2025, analysts expect a staggering number of 20 new gas-fired power plants to come online with a total capacity of 7.7 GW.

CCGTs outnumber OCGT additions

Combined-cycle gas turbine (CCGT) plants commonly serve both base and peak electricity load because they are highly efficient and designed to run for extended periods of time. This year and last, 13 new CCGTs with a combined capacity of 12.4 GW will have entered service – compared to 14 open-cycle gas turbine (OCGT) plants with just 1.9 GW capacity combined.

The average output of each new CCGT is the equivalent 900 MW, compared with 140 MW for each of the new OCGT, figures from

U.S. gas-fired electric generation capacity additions, simple-cycle and combined-cycle turbines



the EIA show. Despite their comparatively smaller capacity, OCGTs can ramp up quickly in response to sudden changes in demand or fluctuating supply from wind and solar source.

Over half of new OCGT capacity is situated in Texas which has high daily peaks in demand during the summer and is home

fast-growing renewable energy. New open-cycle plants with 2.8 GW capacity combined are announced to enter service in Texas in 2024 and 2025, while most of the anticipated 4.9 GW of combined-cycle capacity will be built in Florida and Michigan where gas is used as a baseload power source. ■

Mitsubishi starts up M701 turbines at Rayong CCGT in Thailand

Japan's Mitsubishi Power, part of MHI, has completed installation and commissioning of the second of four M701 JAC turbines at a combined-cycle power plant in Rayong Province. First turbine at the CCGT was fired up at the end of March and follows the commissioning of a CCGT Chonburi Province. All eight turbines at Rayong are due operational by autumn 2024.

The four turbines already commissioned at Chonburi and Rayong have exceeded 50,000 actual operating hours, producing reliable power. As part of the same project, Mitsubishi Power built a sister plant in Chonburi Province in October 2022 and this combined-cycle plant consists of four M701 JAC turbines which are currently in stable operation.

The project underway at Rayong, situated 130km southeast of the Thai capital Bangkok, is owned and operated by a joint venture of Gulf Energy Development and Mitsui. All electricity generated at the plant will be sold to the state-owned Electricity Generating Authority of Thailand (EGAT).

"As with the previous project in Chonburi Province, we faced several challenges, but were able to draw on our previous experience in executing the project. I commend the fact that the second unit started operation as originally scheduled," said Worapong



Combined-cycle plant in Rayong

Vivatanavanich, chief project development officer for Gulf Energy Development. The peak construction period for the project was disrupted by the COVID-19 pandemic.

Akira Takahashi, managing director of Mitsubishi Power underlined the team utilized the know-how gained through the construction of two other power plants in Thailand. The overall project comprises of two CCGTs, each with four power trains based on a gas turbine, steam turbine, heat recovery steam generator, and generator. ■

NEWS NUDGES

Ansaldo to refurbish Cernavoda Unit 1

Ansaldo Nucleare, Candu and KHNP have agreed to cooperate for the retubing and refurbishment of Cernavoda Unit 1 at the nuclear power plant in Romania, consisting of two 700 MW units. Once refurbished, Unit 1 will deliver around 5.5 million MWh of clean energy to the grid, reducing the need for coal- and gas-fired power.

Cummins rebuilds engines in Poland

US-based engine maker Cummins has opened a new rebuild centre in Krakow, Poland. Developed at a cost of \$10 million, the centre remanufactures Cummins high horsepower engines with displacements of 19 to 78 litres, and in the 450 to 3500 horsepower range. This includes QSK19, QSK38 and QSK60 engines.

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