

POWER PLANTS OF THE WORLD 2020-2021

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**Diesel & Gas Turbine
WORLDWIDE**

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POWER PLANTS

Diesel & Gas Turbine Worldwide invited prime-mover original equipment manufacturers to submit one specific power generation project it feels merits special attention because of advances in one or more of the following areas: efficiency increase, environmental aesthetics, operation characteristics, emissions improvements or construction principles. Here are some of the most innovative power generation installations around the globe.



CHINA: GE POWER

GE helping make 'Blue Sky' a reality in China

The battle for blue skies is a priority in China and governments at all levels are strictly enforcing laws to ensure control of air pollution. A smog-busting program like the "Blue Sky" plan aims to quickly cut pollution in China's largest cities. One of the targets of the plan is nitrogen oxide (NOx), a pollutant emitted by power plants that burn fossil fuels and a contributor to ground level ozone. Reductions in its emissions will help improve air quality and public health.

Shenzhen is a major sub-provincial city located on the east bank of the Pearl River estuary on the central coast of southern Guangdong province. With a vibrant economy, Shenzhen was one of the fastest-growing cities in the world in the 1990s and the 2000s and it is a significant high-tech hub, therefore it's often defined the "China's Silicon Valley."

Once it was also known for spewing out dark clouds of toxic smoke, but now it has

done much to clean up and become a more sustainable city in less than six months.

Thanks to "Shenzhen Blue Sky" initiative, the area managed to reduce its average air pollution by around 50 per cent, thanks to GE, that helped five power generation enterprises in Shenzhen (Shenzhen Nanshan Power Corporation, Shenzhen New Power Corporation, Shenzhen Datang Baochang Gas Power Generation Co. Ltd., Shenzhen Yuhu Power Co. Ltd., and CNOOC Shenzhen Power Co. Ltd.) meet their goals.

Shenzhen's power producers faced strict and firm requirements to lower the NOx emissions within the target deadlines set by the authorities, and if they failed to comply with these requirements will be taken offline. GE tackled the root problem in the combustion system of the gas turbines, and modernized nine GE units installed at the plants with a new pre-combustor system called DLN 1.0+ Ultra Low NOx.

"Power generation companies are currently facing dual pressure from environmental indicators and economic performance," said Liang Jianqiang, Head of Shenzhen Nanshan Power Plant. "We continue to search for a two-way solution to help contribute to local blue skies while improving asset performance. GE's DLN 1.0+ Ultra Low NOx combustion upgrade is a perfect fit for our needs. Through this cooperation, GE has not only confirmed its technological advantage, but also demonstrated its excellent capabilities in execution. With the help of GE, we have succeeded in upgrading our plants while maintaining a steady supply of energy."

GE's Dry Low NOx (DLN) solution dramatically reduces NOx emissions. The previous versions "DLN1" standard, emitted 15 parts per million (ppm) of NOx, but the DLN1+ upgrade, which is receiving its first global application in China, can bring that down to 5 ppm.

"We admire the Shenzhen Municipal Government's adherence to greener and lower-carbon development and the efforts to improve the living standards of their citizens," said Yang Dan, CEO of GE Power China. "GE's DLN1.0+ with Ultra Low NOx

OF THE WORLD

The upgrade will allow the CNOOC Shenzhen Power Co. to keep its power plant online



IMAGE: GE Power

reduced emissions and is contributing to the Shenzhen Municipal Government's 'Blue Sky' sustainability plan to improve air quality. The successful modernization of nine gas turbines – in a record time of less than six months – provides a reference for many 9E units to repower and adapt to the needs of the new era”.

TEMPERATURE CONTROL

The secret behind lowering the gas turbine's NOx emissions involves reducing the temperature of the flame inside the combustor. A leaner fuel mix, whereby the natural gas burns in a higher volume of air, can deliver this cooler, low-NOx flame. In addition to hardware modifications, the software called Corrected Parameter Control (CPC) gathers mountains of data about the turbine's environment. This includes ambient humidity and temperature readings, as well as inlet and exhaust pressure, which are all factors that can affect the production of NOx and other pollutants. These inputs are always changing, so the software is constantly correcting the air-fuel mix to deliver lower NOx emissions.

“In addition, from a technological

GHANA: SOLAR TURBINES

Mining power from Solar Turbines

Genser Energy is an independent power producer headquartered in the USA with operations across West Africa. Genser's largest operation is located just outside the town of Tarkwa in the jungles of southern Ghana. The Tarkwa Plant is on the mining concession of the Golf Fields Ltd. Tarkwa gold mine in the West African jungle.

In this region, the majority of power is provided from hydroelectric and thermal sources. However, the energy industry in Ghana is constantly evolving, including the type of power being produced and the method to produce it. Genser energy's vision is to increase generation capacity in Ghana and West Africa by providing sustainable and cost-effective solutions to the gold mines as well as the people in nearby villages. Genser previously purchased three Mars 100 generator sets in the secondary market. Pleased with the operation of the equipment, Genser decided to purchase an additional unit to provide the power required by the mine. However, upon searching the secondary market independently as well as leveraging Solar's knowledge of available equipment, suitable equipment was simply not available without extensive modifications. As a result, Genser elected to purchase Solar's new PGM130 powered by the Titan 130 to add to its power plant. For more than three years, Genser has operated the three Mars 100s as well as the new PGM130 on vaporized propane. Genser delivers the fuel via truck daily from the Takoradi port, enabling the plant to operate around the clock. Genser also understands the needs of its customers and invested and built a natural gas pipeline to permanently secure the fuel supply and ensure their success. The Tarkwa power plant currently produces 48 MWe of power. Genser Energy is currently in the process of upgrading the Tarkwa Plant from simple cycle to combined cycle with the addition of one PGM130 and a steam turbine to increase capacity to 91 MWe. ■



perspective, GE's DLN1+ ULN solution is much better compared to other solutions available to reduce NOx” said Bruno Monetti, GE Power Product Manager. “Selective Catalytic Reduction (SCR) systems are more expensive and can have negative environmental impact as they are using ammonia and water to remove NOx. Gas turbines equipped with SCRs have reduced efficiency, thus emitting more CO₂ than gas turbines with DLN1+ Ultra Low NOx”.

Completed in a record time, less than six months from receiving the request to

complete the project, the modernization of the nine GE's 9E gas turbines mobilized more than 200 experts from China and around the world for factory repairs to meet specific timeframe requirements and exceeded performance expectations.

GE is engineering cleaner, more accessible energy that people depend on, powering growth and prosperity everywhere. This milestone – in terms of execution excellence and innovation – serves as a model for plant operators that are operating more mature gas turbine fleets in China and around the globe. ■ ➤

GERMANY: JENBACHER

A modular concept from Jenbacher replaces coal-fired plant



In 2015, Stadtwerke Kiel set out to replace a 50-year-old hard coal-fired cogeneration plant in Kiel, Germany. The project, distinguished by its efficiency and flexibility, is one of its kind in Europe and is future-oriented and exemplary

for the successful implementation of the energy transition by using highly efficient and flexible combined heat and power generation.

As part of the project, INNIO Jenbacher provided 20 of its Jenbacher J920 FleXtra

gas engines, which went online in December 2019.

The new plant has an electrical output



NETHERLANDS: SIEMENS

Siemens engines address ever-challenging customer needs

Sensation is an innovative greenhouse in the Netherlands and considered a leader in flower quality and consistency. The company is well known for a certain breed of flower called the Pina Colada, bright white in color, reminiscent of the cool drink on a hot summer day.

Located in Tuil, Netherlands, Sensation required an upgrade of their combined heat and power systems existing of two 1 MW engines, to increase efficiency, with integrated CO₂ recovery for fertilization into the existing footprint.

The CO₂ generation had to be taken into

account for fertilizing of the plants while also ensuring climate temperature control needed to maintain the quality and consistency of each flower. Finally, the customer also wanted the ability to operate in a microgrid mode if needed.

Sensation turned to Siemens and its local Dutch Partner Dordtech for expertise and the SGE42-HM was determined to be the right solution to meet all requirements. Siemens said the H Series engines represent a new concept in engine design with advanced technology incorporated into the cylinder heads, valves, camshafts, and turbochargers.

This enabled the customer to run 1MW of power in a microgrid configuration using a combined heat and power system with only a slight elevation in water temperatures, ensuring all environmental requirements were being met. Two SGE42-HMs engines,

combined with a tailor-made heat exchange and control system designed and fabricated by Dordtech, were designed to operate in a microgrid configuration. The engines were also connected and actively integrated into the Dordtech exhaust gas cleaning system to deliver optimal power efficiency and CO₂ levels for the plants.

Through this partnership, Siemens advised Sensation that the gas utilization for a 2 MW output with 2 SGE-42 HMs would achieve an efficiency of approximately 42%, savings of close to 10% on gas consumption compared to its existing system. In the first four months of operation, actual performance values indicated an increase in efficiency to 44%, with a calculated LHV of 8.61kWh/Nm₃ measured over intervals containing an 80% power demand. Even with the challenges of inter connecting systems and still having the ability to operate as a microgrid, the SGE42-HM demonstrated its ability as the right solution for our customer to maintain

Sensation's innovative position in the market, while ensuring reliability, efficiency and cost optimization. One of the most admirable features of the SGE42-HM is the ability of the system to be easily modified into different configurations in terms of hardware, to offer the flexibility of integration into other system types.

This flexibility along with the guarantee of a 42% increase in efficiency for the plant, made this partnership a technically innovative journey to ensure Sensation operates one of the most technologically advanced greenhouses on the market.

The customer valued Siemens' expertise, professionalism, and technical knowledge along with delivering on its guarantees, make Siemens a key solution provider and leader in the energy industry.





of 190 MW and has a thermal output of 192 MW. Power and heat from the power plant are fed into the electricity grid and district heating network operated by utility provider Stadtwerke Kiel and thus play a major part in maintaining grid stability in North Germany.

MODULAR CONCEPT

The power plant's modular generation concept allows the facility to respond to changing demand in the energy market with a high degree of flexibility. Each of the 20 Jenbacher gas engines can be ramped up to full load – its maximum generating output – in less than five minutes. This capability means that the power plant can react flexibly to variations in the grid at all times and makes it an excellent counterbalance to the copious yet volatile

wind and solar energy resources in this region.

The overall efficiency of the installed INNIO Jenbacher systems is above 92%. The coastal power plant started commercial operations just in time for the 2019/2020 heating season and hereafter will make a significant contribution toward Germany achieving its aim of phasing out coal-fired plants by 2038.

INNIO and KAM engineered and implemented the coastal power plant. While INNIO provided the gas engines and engineering expertise, KAM operated as the general contractor responsible for engineering, procurement, construction and commissioning the turnkey power plant, including the auxiliary buildings and integrating the heat storage and electrode boiler. The team arranged the

power plant in four units of five blocks each, with the advantage of being operable in slices.

FLEXIBLE, EFFICIENT

The large-scale turnkey facility replaces a coal-fired power plant on Kiel Fjord that had been generating electricity and heat since 1970. The high overall efficiency of more than 92% will enable Stadtwerke Kiel to reduce its carbon dioxide emissions by around 70% compared to the previous coal-fired power plant. As a result, the city of Kiel is on track to achieve its climate change goals as early as 2020.

“We are proud that our flexible, highly efficient and advanced gas engine solution will make a significant contribution to this lighthouse project by Stadtwerke Kiel. With Germany's plans to shut down all coal plants and rely primarily on renewable energy, our Jenbacher J920 gas engines will help balance the Kiel grid,” said Carlos Lange, [resident and CEO of INNIO.

“As renewable energy usage will continue to grow across Germany, INNIO will continue to make significant investments in research and development and will further expand its technological leadership in power generation based on regenerative gases-in specific, hydrogen and hydrogen carrier gases-to help build out 100% carbon neutral and carbon free power plants.”



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UK: WÄRTSILÄ

Peak power in two minutes: Wärtsilä's flexible generation solution for Centrica's Brigg power station

Centrica, an international energy services and solutions company, has recently completed the biggest medium-speed peaking power plant in the country, at its existing site in Brigg in North East Lincolnshire. The peaking plant comprises 5 x Wärtsilä 34SG engines, running on natural gas and delivering a total capacity of 50 MW, enough to provide electricity for almost 100,000 homes.

The background to this story is the changing energy landscape in the UK, with the country increasingly turning to renewable and low carbon sources of energy for its electricity generation,

while old baseload plants close across the country. This development has been driven by government policies and advances in technology.

The government in the UK is working toward closing all the UK's remaining coal power stations by 2025. While the future definitely looks green, the big question on everyone's mind is how to maintain flexibility and reliability of power generation. Incorporating more renewable sources into the grid, as the country is intent on doing, requires having back-up generation for when the sun doesn't shine or the wind doesn't blow. One solution is

hybrid power solution systems.

Centrica is among those leading the charge on this front, buying two 50 MW power plants from Wärtsilä, one for the new plant at Brigg and another for a new unit at Peterborough, to provide balancing



The government of the UK is working toward closing all coal power stations by 2025.

power to the UK national grid.

“This will help us accommodate an increasing share of renewable energy in our power mix while ensuring that supply remains stable,” says Alan Barlow, UK & Ireland Distributed Energy Director at Centrica Business Solutions, which provides energy expertise and distributed energy solutions to organizations around the world.

“The ramp-up time was a critical factor in us choosing these engines, which will together be capable of providing electricity in just two minutes from start to full load.”

TWO-MINUTE START-UP

Wärtsilä supplied the engines on an EPC (engineering, procurement and

construction) basis to Centrica and were the only company able to provide this very quick start-up time. Achieving this, by paying attention to preheating and pre-lubrication systems, was the key factor in Centrica’s decision to opt for Wärtsilä’s solution.

This speed and flexibility is critical as it allows utility companies to switch over to the supporting generators when renewable energy sources falter. It helps optimize the energy system well in advance, thus keeping the energy grid stable.

“The two-minute start-up time that Wärtsilä’s solutions deliver is a rare feature and very important to the UK grid,” Mr. Futyan said.

When looking for partners for the

Brigg project, the company wanted to find someone with a solid track record of delivering quality products safely. Wärtsilä, in Futyan’s words, ticked all the boxes.

PEAK DEMAND

The sites at Brigg and Peterborough play a critical role in supplying peak demand to the national grid. This is backed up by a long-term service agreement (LTSA) between Wärtsilä and Centrica. The six-year agreement ensures Centrica has access to 24/7 emergency support from Wärtsilä’s Expertise Centre in Vaasa, Finland.

Bent Iversen, Senior Business Development Manager at Wärtsilä Energy Business, said: “The UK is the leading country in shaping the electricity markets and Centrica is one of its leading operators. Today, renewable power sources provide roughly a third of the country’s total generation capacity, compared to five percent in 2006, and the share is increasing all the time. To support this trend, fast-starting, flexible generation is essential.”

The new power station at Brigg, specially adapted to Centrica’s requirements, is based on Wärtsilä’s modular internal combustion engine (ICE) units. The unique operational flexibility of the ICE technology, with ultra-fast starts and stops and quick loading, ensures seamless control over load fluctuations. As energy demand grows, the modular design makes it easy to expand the power plant to meet any future needs. Plants can be upgraded at any time without risking operational reliability.

FLEXIBILITY FROM GAS

While the UK market will be looking to energy storage solutions and sophisticated energy management systems to improve its capacity to react to fluctuations in peak energy supply, Jan Andersson, Senior Market Development Analyst at Wärtsilä Energy Business, sees a continued role for gas. The country will increase its gas capacity to supplement the remaining nuclear and coal plants when renewable generation is low.

“The focus is on renewables, but gas will be used to bring needed flexibility to the system,” he explained.



GERMANY: MAN ENERGY SOLUTIONS

MAN Energy Solutions delivers CHP power plant in Stuttgart

MAN Energy Solutions handed over a new solution for combined heat and power generation (CHP) to German energy company, EnBW (Energie Baden-Württemberg AG), in early 2019. The 30 MW HKW3 plant lies in the Gaisburg district of Stuttgart, Germany with three MAN 20V35/44G gas engines at its heart, producing 31.2 MW of electrical power for the local grid and up to 30 MW of district heating simultaneously, while operating at a total efficiency of up to 90%.

The new engines are part of an extensive modernization program for the HKW3 cogeneration unit. In addition to the



BOLIVIA: SIEMENS

Siemens helping energize Bolivia

About 10 years ago, Bolivia had one of the lowest electrification rates in Latin America: Only half of the rural population had access to electricity. An ambitious Siemens project is helping turn this situation around by making an enormous contribution to the provision of universal electricity coverage in the country by the year 2025.

This huge task – known by the project name Energizing Bolivia – resulted in 1 GW being added to the national grid back when Bolivia's power production in 2015 was only about 2 GW in total.

In the initial phase from 2007 to 2015, Siemens supplied 13 gas turbines for three new-build power plants owned and operated by the state-owned power generation utility

Ende Andina SAM in three different regions of the country. Nine SGT-800 gas turbines were provided to the power plants in Warnes and Del Sur, while four SGT-700 gas turbines were supplied to another plant in Entre Rios. Running in simple cycle mode, the three power plants were the primary cause of the doubling of total power generation in Bolivia between 2007 and 2016. The Siemens project then proceeded to the expansion phase by initiating upgrades to the country's three largest power plants.

In an effort that became a master class in logistics, 14 more SGT-800 gas turbines, 11 SGT-400 steam turbines with condensers, 22 steam generators, 25 electric generators, 25 transformers, and the SPPA-T3000 instrumentation and control system were

shipped to the three plant sites between May 2017 and August 2018. Beginning on three different continents, this global effort traversed thousands of miles. Up to 400 heavy-load transports crossed the Andes to bring equipment to the three power plant construction sites, overcoming a 4680 m. elevation change, passing over specially modified bridges and covering a distance of 1800 km. in constantly changing and often extreme weather conditions and rugged topography. Due to their location in



CHP plant, EnBW, has also constructed a heat storage and a boiler plant with up to 175 MW thermal energy output to cover fluctuations in supply and demand.

REPLACING COAL

The new facility replaces a coal power plant – after 60 years of operation – and is projected to save up to 60000 metric tons of CO₂ annually. Its new chimneys are half the height of the old ones, and the entire plant is also smaller than its predecessor, although both efficiency and output have both increased.

The main advantage of the entire solution is flexibility. The CHP plant is a core element of the modular concept of the new construction: while the gas boilers exclusively produce heat and are primarily designed to cover peaks in demand over winter, the gas engines are ideally run continuously to provide both electricity and heat. By combining the facility with a district heating accumulator, EnBW can fully exploit the flexibility offered by the engines and react to price signals. When demand for heat is low, the waste heat from the engines can be stored. The high reaction-speed of the MAN gas engines

facilitates this flexibility with the units capable of reaching their full output in less than five minutes, while handling load changes effortlessly.

The plants engines can be turned off in less than three minutes, and ramped back up to full load within three minutes in contrast to other, similarly-sized power plants that typically have much longer startup times, the company said. MAN Energy Solutions' global after-sales brand, MAN PrimeServ, will handle the engine's service and maintenance for 10 years.

"Large gas engine power plants are a new but important technology in Germany: They help to reduce harmful emissions and guarantee an extremely reliable supply," said Dr. Tilman Tütken, vice president and European sales manager for MAN Energy Solutions' Power Plant division. "Gas engine power plants have the potential to replace coal power stations in a way that is not only effective but better for the environment. Our modular power plant concept for cogeneration [...] works on the modular principle and can be scaled up as required from 7 MW."

Jens Rathert, Project Manager at EnBW said the reconstruction of HKW3 enables



IMAGE: Berthold Steinilber/Laif

the company to significantly reduce emissions of CO₂ and other pollutants, which is particularly important given the urban surroundings of the power plant.

"Looking at the bigger picture of the energy transition, we regard facilities like HKW3 as a blueprint for further fuel-switch projects and relish the opportunity for more projects along these lines," Rathert said.

Indeed, the partly state-owned energy supplier's plans align perfectly with Germany's climate goals as a whole. According to a recent study, replacing coal with gas plants across Germany could save around 70 million metric tons of CO₂ annually, amounting to 40% of the reduction target set by the country's long-term climate strategy. ■

very different regions of the country with diverse climatic conditions, the engineers had to devise customized methods of cooling appropriate for rainforests, scrub woodland, and tropical savanna. During construction, up to 1700 workers were deployed across the three sites. It was worth the effort, because in combined cycle mode the three plants' efficiency was increased from 40 to 51%.

Inauguration ceremonies for the three power plants were held in August and September



of 2019. The newly installed turbines were a decisive factor in the huge 1 GW increase in the power plants' performance, boosting both output and efficiency. The 14 state-of-the-art SGT-800 turbines have a power output up to 53 MW each and a turbine speed of 6608 rpm. The 11 SST-400 steam turbines provide a power output up to 47 MW each at a turbine speed of 5146 rpm.

Thanks to Energizing Bolivia, the country is on its way to energy independence. Bolivia is also looking to become a regional power hub by achieving the goal of increasing generating capacity to 6000 MW by 2025, 3000 of which will be designated for export. "The process of converting gas into energy is now more efficient, the country has the opportunity to find a use for surplus or residual amounts of gas that will be produced as a result of the integration of the new, much more efficient Siemens technologies," said Ramiro Becerra Flores, project director at ENDE Andina. "It's going to

make the interconnected system highly reliable, and the availability of electricity means we will have the tools to facilitate the general socio-economic development of the country, thanks to the availability of a service and a resource such as electricity."

By playing an active role in the economic and social development of Bolivia, the project exemplifies Siemens' Business to Society approach. The company is also committing to the region with a new Service and Training Center in Warnes, where Bolivian technicians will be trained to maintain, monitor, and repair power plant turbines and other components. The center will serve as catalyst for maintaining and optimizing power plant performance in Bolivia and throughout Latin America. The country has embarked on a path that will enable the production and export of value-added products and the development of human capital – which in turn will lead to an improved standard of living for its citizens. ■