2019 POWER PLANTS OF THE WORLD

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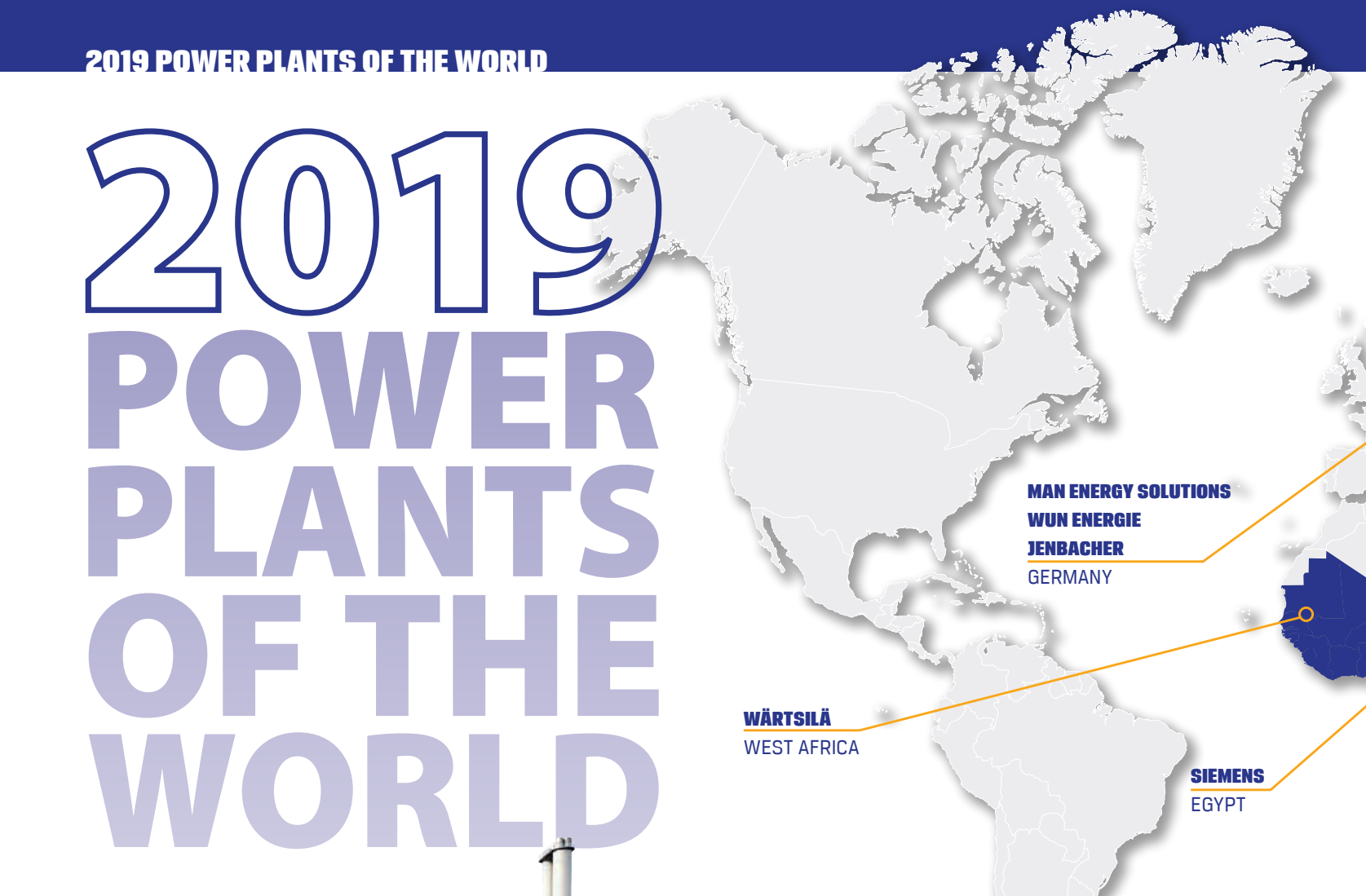


The Gaisburg power plant near Stuttgart, Germany, incorporates three MAN 20V35/44G gas engines.

EDITOR'S NOTE: *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.

The coverage is limited to plants commissioned during the 2018 calendar year. Here are this year's submissions.

MAN ENERGY SOLUTIONS

CHP solution

MAN lowers emissions with natural gas

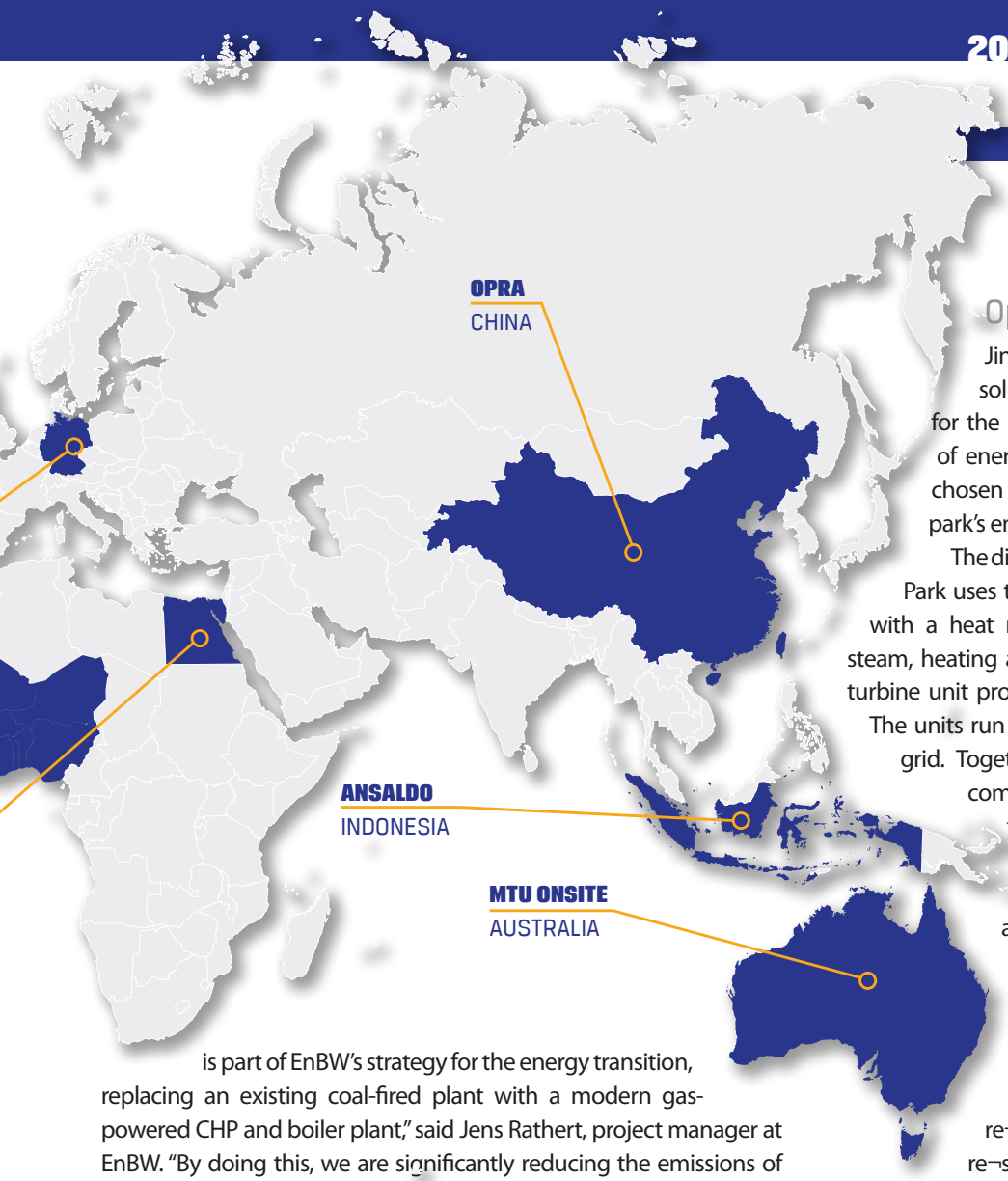
For over 60 years, the Gaisburg plant near Stuttgart, Germany, has been supplying electricity and heat for over 25 000 homes, 1300 companies, and 300 public facilities in the region.

Now, the existing coal-fired plant was replaced by a new highly efficient gas-powered thermal power plant – lowering carbon emissions by 60 000 tons per year while increasing the energy output and flexibility, compared to the old plant.

MAN Energy Solutions handed over the new solution for combined heat and power generation (CHP) to energy company EnBW Energie Baden-Württemberg AG in December 2018. At the heart of the 30 MW plant are three MAN 20V35/44G gas engines, which produce not only electrical energy but also 30 MW district heating. Operating at a total efficiency of up to 90%, the power plant makes particularly effective use of its fuel—gas, the company said.

The new power plant is part of an extensive modernization program for the cogeneration unit in Stuttgart Gaisburg. In addition to the 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. The existing coal power plant was decommissioned when the new facility commenced operations.

"The reconstruction of the cogeneration unit in Stuttgart Gaisburg



is part of EnBW's strategy for the energy transition, replacing an existing coal-fired plant with a modern gas-powered CHP and boiler plant," said Jens Rathert, project manager at EnBW. "By doing this, we are significantly reducing the emissions of CO_2 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 this as a blueprint for further fuel-switch projects and relish the opportunity for more projects along these lines."

The CHP plant is a core element of the modular concept of the new construction: While the gas boilers produce exclusively heat and are primarily designed to cover the peaks in demand over winter, the gas engines will ideally be run continually to provide both electricity and heat. By combining the facility with a district heating accumulator, EnBW can fully utilize 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. This flexibility is made possible by the high reaction speed of the MAN gas engines.

"This combined heat and power plant is a small, fast, efficient energy system that is perfectly tailored to local requirements. We can turn our engines off in less than five minutes, and ramp them back up to full load in three minutes. Other power plants of this size have much longer startup times," said Hajo Hoops, senior manager Power Plants at MAN Energy Solutions. MAN remains on the project even after the plant's successful commissioning in December 2018. The company's global after sales brand MAN PrimeServ will handle the engine's service and maintenance for a further 10 years.

OPRA

Efficiency key

Opra powers technology park

Jinan Linuo Technology Park power plant required a solution that would provide steam, heating and power for the park's own use especially during the peak season of energy usage. It was also important that the solution chosen made efficient use of ener¬gy while reducing the park's emissions.

The distributed energy project of Jinan Lin¬uo Technology Park uses two 1.8MW OP16-3B gas turbines and is equipped with a heat re¬covery steam generator to provide industrial steam, heating and partial power for the park. Each OP16-3B gas turbine unit produces 1850 kW electricity and 6 tons/h of steam. The units run con¬nected to the electric power grid and steam grid. Together with Energas, Opra engineers success¬fully completed the commissioning in record time making this project another fine example of Opra's success in China. Receiving strong support from the local power sector and attracting widespread attention from domestic distributed energy users, this grid-connected power generation solution successfully provides the owners with reliable and powerful energy making them independent of peak electricity prices.

By implementing this solution Linuo Park have re¬duced their coal intake by 15 000 tons per year, re¬sulting in a reduction of CO_2 emissions by 10 600 tons, and a decrease in both sulfur dioxide and ni¬trogen oxides by 320 tons and 160 tons per year. With the successful completion of the Linuo project, Opra said it continues to exert its strength in the field of distributed energy and contribution to the cause of energy conservation and emission reduction in Chi¬na.

Jininan Linua Technology Park in China.

WUN ENERGIE

Gas genset solution

WUN Energie relies on MWM gas gensets

In 2018, WUN Pellets GmbH built a modern pellet plant at the energy park in Wunsiedel-Holenbrunn, Bavaria, Germany, with a combined heat and power unit (CHP).

The company relies on the highly efficient gas gensets of the MWM brand. Three generator sets of the TCG 2032 series with an electrical output of 4.5 MW each were installed at the site. The natural gas-powered units ensure a decentralized supply of electrical and thermal energy. The advantage of combined heat and power generation over the separate generation of electrical energy and heat lies in the significantly better utilisation of primary energy, the company said.

The total maximum electrical output is 13 500 kW and corresponds approximately to the total output in the network area of SWW Wunsiedel GmbH. The electricity generated in the CHP can supply approx. 40 000 households.

What is special about the system is that every usable heat is also used here, MWM said. Thus, in addition to the waste heat from the engine, the mixture cooling heat is also used for the drying process of the pellet plant. This gives the plant a thermal efficiency of around 47.4%. The overall efficiency is up to 92%, an absolute top value in Germany, according to the company. The combined heat and power units round off the energy concept, consisting of photovoltaics, wind and biomass utilization.

In addition, decentralized energy supply will in future also be possible with synthetic CH4 (keyword power-to-gas) in addition to biogas use, thus describing a new era in energy supply.

The CHP unit is already equipped for the future - the extensive delivery package also includes SCR catalysts to meet the upcoming emission requirements (NOx=250 or 100 mg/Nm^3).

WUN Pellets GmbH relies on MWM gas gensets.

Kamojang Geothermal power plant was refurbished with an Ansaldo Energia steam turbine.

ANSALDO

Geothermal update

30 MW geothermal plant updated with Ansaldo Energia steam turbine

Indonesia Power in 2015 issued a call for a tender for the rehabilitation of Kamojan geothermal power plant 30 MW block 1, western Java.

Kamojang Geothermal power plant comprised three blocks, block 1 with 30 MW of output and block 2 and 3 with 50 MW output each. All three blocks were using Mitsubishi steam turbines. The block 1 was completely damaged by an uncontrolled over speed episode.

Ansaldo Energia-P.T. PP (Indonesian partner) was awarded as the winner of the tender. Acting as EPC, Ansaldo Energia supplied the geothermal steam turbine and relative air-cooled generator.

The results of this rehabilitation were:

- **Efficiency** increases about 2%
- **Emissions Improvements**: The gas extraction system provided a dispersion of SO_2 at a height that helped alleviate odors.
- **Environmental aesthetics** were improved using a new cooling tower which reduces the view impact of the power plant. The use of a combined demister and separator instead of two components reduced the number of big vessels, the company said.
- **Construction Principles**: The work was a rehabilitation, hence the construction was focused on adaptation of foundation and structures on the new comonents design and vice versa.
- **Operational Characteristics**: Baseload operation with no ancillary services given to the power grid.

Jenbacher Type 6 gas engines from INNIO are used at HanseWerk Natur's CHP plant.

JENBACHER

Climate-friendly

Jenbachers for modern CHP plant

Featuring several of INNIO's Jenbacher Type 6 gas engines, HanseWerk Natur's combined heat and power (CHP) plant was commissioned—after only eight months of total construction time and acceptance—near the Tivoli GlobalMalt in February 2018. Its 8.4 MW of electrical output is enough to power up to 20 000 households in the Hamburg region. Installed at Hamburg-Eidelstedt, it is Hamburg's largest and most modern high-efficiency CHP plant with more than 95% fuel utilization at 110°C flow temperature and almost 45% electrical efficiency. In addition, the waste heat generated supplies heat and hot water to 500 residential buildings and businesses.

"By generating both heat and power, the plant achieves a total efficiency of over 95%," said Thomas Baade, CEO of HanseWerk Natur GmbH. "With this extremely high efficiency and impressive operational flexibility, the CHP plant helps to achieve greater security in energy supply and is therefore another valuable part of the decentralized energy supply in the Hanseatic city of Hamburg."

The new CHP plant replaces the previous heat generation from the landfill plant while also generating power. The extremely high electrical efficiency can be achieved in combination with an ammonia heat pump and can be operated independently of the heat pump as well. Compared to the separate production of heat and power, the CHP plant consumes more than 30% less resources and emits almost 60% less carbon dioxide.

While the percentage of renewable energies in power generation is growing continuously both in terms of production capacity and volume, expansion of other innovative forms of generation will also continue for many years.

"INNIO's gas engine technology can make a key contribution to implementing the energy transition globally," said Carlos Lange, president and CEO at INNIO. "For example, INNIO's combined heat and power solutions are an efficient, climate-friendly, reliable and profitable approach to meeting the energy demand."

Not only are INNIO gas engines themselves innovative, but their predictive operation is too. The myPlant Asset Performance Management solution from INNIO actively collects all important engine parameters of selected Jenbacher gas engines for HanseWerk Natur. The service life of the various system components can be predicted with the analysis data obtained. This allows HanseWerk Natur to transition from a reactive to a proactive, condition-based maintenance strategy for the gas engines.

Over 50 climate-friendly Jenbacher gas engines are already in operation in other HanseWerk Natur power plants throughout Germany. HanseWerk Natur has also proven itself as a certified service partner for INNIO's Jenbacher gas engines since 2011.

HanseWerk Natur GmbH is one of the largest regional providers of heat and decentralized energy solutions in Northern Germany and has many decades of experience as a heat supplier. Combined, the company's local and district heating networks are roughly 800 km in length. With 1200 heat connection networks, cogeneration plants and heating plants, HanseWerk Natur supplies tens of thousands of private and industrial customers and public sector facilities 365 days a year.

> "INNIO's combined heat and power solutions are an efficient, climate-friendly, reliable and profitable approach to meeting the energy demand."
>
> **CARLOS LANGE**, president /CEO, INNIO

MTU ONSITE

Critical care

MTU onsite energy provides emergency backup for Adelaide's flagship hospital

The AUD 2.3 billion Royal Adelaide Hospital has been listed as the single largest capital investment project in the history of South Australia. Built to the world's best standards, it is the state's flagship hospital, providing a comprehensive range of the most complex clinical care for the people of South Australia. To deliver emergency power to the all-new hospital, the local MTU partner Penske Power Systems has supplied and managed the installation of six diesel-powered MTU 20V 4000 DS 2650 generators.

Located in Adelaide's West End, the Royal Adelaide Hospital (RAH) spans the equivalent of three city blocks with almost four hectares of internal and external green space. Its design blueprint is based upon some of the world's leading hospitals, combining cutting-edge health care technology with new standards in conservation and environmental management. Accordingly, the RAH will deliver the most technologically advanced and environmentally sustainable medical facility in Australia. The 800-bed hospital has the capacity to treat more than 400 000 outpatients and deliver overnight care to approximately 85 000 inpatients every year.

With 40 technical suites on a 10-hectare site, reliable power supply is critical. Nilsen Australia, a leading electro-technology company, was relied upon to power the large scale project, subcontracting all electrical and integrated communication services that are underpinned by MTU's reliable Series 4000 engine. As part of its work with Nilsen Australia, the local MTU Onsite Energy partner Penske Power Systems supplied and installed six 20V 4000 DS 2650 diesel generators that are instrumental in delivering standby power to the new hospital.

Specified for work in black start conditions, the innovative MTU Onsite Energy configuration features best-in-class load acceptance, delivering 100% capacity to the entire RAH site within 18 seconds. Importantly, the 3D-listed units deliver 2.08 MW each and boast fuel systems capable of extending to 72-hour intervals. Housed within the hospital's east and west plant rooms, each 21 tonne MTU Onsite Energy unit features integrated exhaust, controls and silencer systems, ensuring the delivery of a combined output of 12.48 MW when required. Additionally, the MTU Onsite Energy generator sets maintain critical operations at high ambient temperatures and also comply with detailed earthquake requirements as part of the RAH's Tier 1 disaster recovery hospital classification.

Due to the scope and size of the project, Penske Power Systems allocated a full-time site manager to service the project, providing complete engineering and project management to Nilsen. Penske's engineering team also completed a full equipment risk assessment and support for system integration, as well as building additional system protection features into generator set controls.

SIEMENS

Milestone in Egypt

Siemens' signature megaproject

The signature for what has been named Egypt Megaproject happened in June 2016, between Egyptian Minister of Electricity Dr. Mohamed Shaker and Siemens CEO Joe Kaeser which took place in Berlin with the attendance of Egyptian President Abdel Fattah El-Sisi.

Siemens and its consortium partners, Orascom Construction and Elsewedy Electric, announced on July 24, 2018, in the inauguration ceremony which took place in the New Capital power plant, the completion of the Egypt Megaproject in record time, with the

The Egypt Megaproject includes 14.4 GW of power capacity. Siemens supplied 24 H-class gas turbines and other equipment for the project.

commissioning of three combined-cycle power plants: Beni Suef, Burullus and New Capital.

All of them are in operation adding a total of 14.4 GW of power generation capacity to Egypt's national grid (enough power to supply more than 40 million people).

With this milestone, the Egyptian Ministry of Electricity and Renewable Energy, Siemens and the company's consortium partners have set a new world record for execution of modern, fast-track power projects, delivering 14.4 GW of power in only 27.5 months. A single combined cycle power plant block with a capacity of 1200 MW typically takes approximately 30 months for construction. For the Egypt Megaproject Siemens built in parallel twelve of these blocks in record time and connected them to the grid. Now, each of the three 4.8 GW-power plants has become the largest gas-fired combined cycle plant ever built and operated in the world.

For the three power plants, Siemens delivered 24 H-class gas turbines, 12 steam turbines, 24 heat recovery systems, 36 power generators and main transformers, and three gas-insulated switchgears. Included in the €6-billion contract supported by the German government were also the construction of eight substations and a nine-year long-term service contract for the Siemens equipment. In addition, Siemens was selected, last September, to provide comprehensive operation and maintenance services (O&M) for the Beni Suef, New Capital and Burullus power plants, for the next eight years. The agreement, which is the largest ever for the Siemens Power Generation Services, in terms of power generated, includes the implementation of the company's Omnivise digital service solutions.

The Beni Suef power plant was the first to be handed over to the customer– a consortium between Siemens and El Sewedy Electric – followed by Burullus and New Capital. Beni Suef is located in the south of Egypt in a remote and rural area. The construction site at Beni Suef utilized over 8000 people for a total man-hour count exceeding 45 million. Logistics and construction were a challenge as the location is on rocky soil on the bank of the river Nile with a non-homogeneous topographic nature. A customized plan was put into action in order to excavate on four levels to reach the required elevation. The difference between the highest level and the Nile is 72m.

The Burullus plant, in North Egypt, was also a demanding project. One of the vast challenges facing the Burullus power plant was the location's saline soil condition. This was overcome by the construction of 11 000 piles and 13 000 stone columns in all project structures using the latest subsoil geo-technical system design.

The plant is expected to deliver electricity to the industrial and urban areas in the North of the country, especially to the cities of Alexandria and Damietta. The configuration here is also a combined cycle with eight gas turbines and four steam turbines using sea water for the cooling system.

As for the site in the New Capital, the new administrative center of Egypt currently under construction, the challenge was mainly presented due to its desert location with no water available and a rocky soil substructure, a water treatment plant was constructed to meet the plant's requirements employing an air-cooled condenser, which is reported to be the biggest worldwide and the first in Egypt.

According to Siemens, the three plants in combined-cycle operation reach an efficiency of 61% and will allow to save US$1.3 billion in fuel per year.

The commitment of Siemens in Egypt though, does not end with the construction of new plants. In fact the company was one of the main players in a strategic alliance between the Egypt government and the German Federal Government or the construction of a Service and Training center in Ain Soukhna. The project's broader aim is to train 5 500 Egyptian youth over the next four years in advanced technical skills that are critical to the Egyptian economy.

The Zein El Abedeen technical school, in one of the most densely populated areas of Cairo, was also involved to become a technical school of excellence and was inaugurated in October 2018 by Siemens and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), on behalf of the Federal Ministry for Economic Cooperation and Development (BMZ). The school lab is equipped with 3D printers, Totally Integrated Automation (TIA) systems as well as Siemens' Product Lifecycle Management (PLM) software.

Six diesel-powered MTU 20V 4000 DS 2650 generators back up Royal Adelaide Hospital in South Australia.

The Iamgold mining company's power plant in Burkina Faso was hybridized to incorporate 15 MW of solar power.

WÄRTSILÄ

Grid partners

Wärtsilä helps with hybridization of power plant with solar panels

According to a report made by the European Commission in 2017, at EUR 0.21/kWh the cost of electricity in Burkina Faso in Western Africa was far higher than in its neighboring countries. Furthermore, since 2010 the average cost of electricity production was even higher than its selling price.

The high cost has been further aggravated by an unreliable grid supply. In 2016, for example, Burkina Faso had an average 9.8 power outages per month, each lasting approximately 9 to 10 hours. For these reasons, the Iamgold mining company's gold mine in the remote village of Essakane chooses to operate its own off-grid power plant.

However, until recently the 57 MW plant was completely dependent upon imported heavy fuel oil (HFO). Again, cost and risk associated with dependence on adequate and timely fuel supplies to this facility in the middle of the desert created the need for an alternative power solution. Consequently, Wärtsilä was commissioned to hybridize the mine's thermal plant by installing an additional 15 MW of solar photovoltaic (PV) power generation capacity.

It was a challenging 10-month project. Expert logistics planning was required since Burkina Faso is a landlocked country. The more than 170 container loads had to be first transported by rail to Ouagadougou, the country's capital, and from there by trucks to the remotely located mine site. The full solar plant delivery included solar panels, inverters, support structures, cables, switchgear, and control system.

To achieve the required output, 1440 'tables', the structure upon which the solar panels are mounted, needed to be manufactured locally, a major task, the company said. To be successful and within the specified extremely tight time-frame, the entire construction required an extremely high level of project management, with local labor and contractors being employed and supervised by Wärtsilä's on-site team.

Once the solar PV equipment was in place, it had to be integrated with the existing engine-driven plant. Wärtsilä said its experience and capabilities in designing, controlling, and optimizing the combined use of renewable energy and combustion engines was an essential factor in the success of this integration.

The result of this project is a highly successful hybrid engine-solar PV power plant, the biggest in Africa and the world's largest isolated hybrid power plant of this kind. The Wärtsilä technology is estimated to reduce the mine's fuel consumption by approximately six million L per year, while the decreased reliance on HFO fuel will lower the plant's carbon dioxide emissions by some 18 500 tons annually.

The real significance of the project, however, is in its implications for greater global use of renewable energy and hybrid power plants to meet the increasing demand for electrical power. As energy markets around the world are increasingly focusing on greater sustainability, and the dramatically decreasing cost of renewables, there is a global shift towards renewable energy sources. Wärtsilä envisions a 100% renewable energy future, and is actively promoting this transition.

The challenge is that large, conventional power plants were never designed to handle the flexibility needed to effectively integrate large amounts of renewable energy. Since solar and wind generation is inherently intermittent, variable in function of weather, fast stopping and starting capabilities are required to balance the load demand. Internal combustion engines have the flexibility to meet this need, being able to reach full output from start-up in a matter of minutes, and being able to shut down when sufficient renewable generation is available. In the future excess renewable energy will be shifted for later use by energy storage, the company said.