Cogeneration of heat and electricity with the Series 4000

GAS ENGINE GENERATOR SETS SUPPLY HEAT AND ELECTRICITY IN THE BALTIC STATES

Who	Baltic Marine Group, Estonia
What	Natural gas-powered combined heat and power plants, based on generator sets with MTU Series 4000 gas engines
Where	Daugavpils, Latvia

In order to ensure that the inhabitants of Daugavpils, Latvia, continue receiving reliable heat in the future, one municipal energy supply company has replaced several decentralized boiler houses with modern cogeneration plants powered by natural gas. Based on Series 4000 generator sets from Rolls-Royce, the new plants have a thermal output of a total of ten megawatts – while at the same time generating just under ten megawatts of electricity that is fed into the local power grid against payment.

Many long winter days and temperatures of down to -32°C mean that ensuring a reliable heat supply is an important task in Latvia. As a legacy of its Soviet past, the Baltic country has a very well-developed district heating network that delivers the much-needed heat to households.

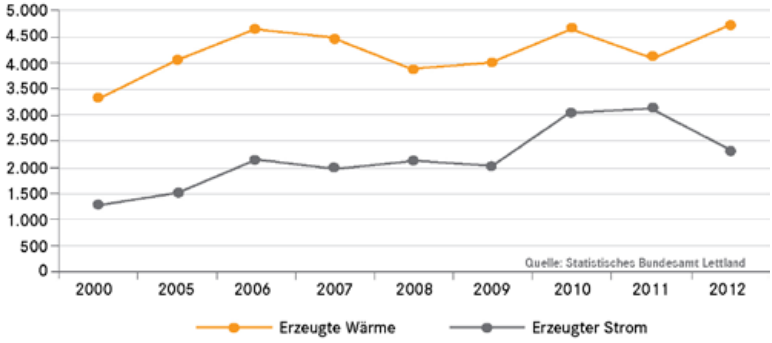
A Rolls-Royce solution

This network supplies approximately 65 to 70% of consumers with their heat energy and 30 to 35% with their warm water. Increasingly, this energy is now coming from efficient combined heat and power (CHP) plants that can produce electricity and usable heat at the same time. CHP plants with a combined output of 1,021 megawatts (MW) were operating in Latvia in 2012. A total of 2,339 gigawatt hours (GWh) of electricity was generated, together with 4,688 GWh of heat energy – just under two-thirds (62.9%) of the country's total heat supply.

High overall efficiency thanks to cogeneration of heat and electricity

The number of plants based on the principle of cogeneration has been increasing in Latvia since 2000. The Central Statistical Bureau of Latvia registered 71 CHP modules in 2009, and nearly twice as many (133 modules) just three years later. Eleven of these are located in the southwestern section of the country in the city of Daugavpils, where they are operated by the Estonian MTU distributor Baltic Marine Group (BMG). Their main task is to ensure the municipal heat supply for the city. One of the modules is also in service for an industrial customer from the railway sector, which uses the self-produced heat and electrical energy right in its own facilities. Planning and engineering services for construction of the plants were rendered by BMG, which also provided boilers to handle peak loads as well as heat exchangers for extraction of the exhaust heat. The heart of the plants came from Rolls-Royce: Each module consists of a MTU Series 4000 gas engine, a generator and an MMC module control unit (MMC stands for MTU Module Control). A heating module is used to draw heat from the engine cooling water, which can be up to 90°C, and then feed it into the district heating network.

In addition to heat, the modules are continually generating electrical energy via a generator driven by the gas engine. This energy can then be fed into the public power grid by the end customers. In order for this to occur, the Latvian Energy Act requires the system to have an efficiency level of at least 80% per year – a requirement that the power plants are easily able to fulfill thanks to their overall efficiency rate of nearly 88%.



Heat and electrical energy generated in combined heat and power plants, Latvia, 2000-2012 (in GWh). (Image: Central Statistical Bureau of Latvia)

1 **KWK-Anlage**
The new building for the CHP systems was constructed according to BMG's specifications. (Image: Baltic Marine Group)

2 **MTU Module Control**
Each generator set is connected to its own control unit, the MTU Module Control (MMC). It monitors the most important functions and provides a continual flow of operating data for the system. Maintenance staff can respond appropriately to messages via the central control system in the control office or decentrally from a laptop. (Image: Baltic Marine Group)

Reliable heat supply as a complete solution

As the general contractor, BMG supplied the entire cogeneration systems from a single source. The first two went to the municipal heat supply company Daugavpils Siltums in 2010. The company had its increasingly uneconomical boiler houses replaced by modern CHP systems based on MTU gas engines of Type 12V 4000. A total of eight such generator sets at two locations produce the energy necessary to supply some 4,500 households – 8,000 kilowatts of heat energy (kWth) and just under 8,000 kW of electrical energy (kWel). Rolls-Royce even electronically reduced the possible output of each engine from 1,165 kWel to 999 kWel in order to ensure the higher remuneration for systems with an output of under 1,000 kWel. Each of the generator sets has meanwhile run for over 10,000 operating hours. “The gas engines were developed and optimized by Rolls-Royce for continuous operation under full load,” explained Ivan Kilter, CEO of BMG. “They are particularly efficient and economical for generating heat and electricity in cogeneration plants. Our customers were equally convinced.”

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BMG commissioned two additional plants for the heat supply company in mid-September 2013. At a site outside of the city, two generator sets of Type GR 1999 N5 supply 2.2 MW of heat and 1,999 kW of electricity. The anticipated service profile made it worthwhile to equip the cogeneration plants with larger engines. In contrast to the systems with twelve-cylinder engines that do not always operate at full power – such as during the summer – and are turned off when less output is required, the larger generator sets operate around the clock throughout the entire year. In combination with peak load boilers, this enables BMG to respond more flexibly to the need for heat, such as when frigid subzero temperatures are replaced by a mild thaw during the heating period – which can happen within a single day.

Fuel-efficient and future-proof design

Because it lacks fossil raw materials, Latvia is dependent on Russia for imports. Low fuel consumption therefore plays a key role, especially in the energy supply. “The new plants require significantly less natural gas to generate the same amount of heat as the old boiler houses did,” underscored Ivan Kilter. Thanks to full heat extraction of exhaust gas and engine heat, the CHP modules make the most thorough usage possible of the energy contained in the fuel, which is the clue to their exemplary overall efficiency rate. “The solution pays off for our customers within just three to four years as a result of the high energy efficiency rate.”

Added to this is the fact that the new systems enable the heat supply companies to finally put an end to the safety risks posed by the aging heat boilers. Because that type of equipment is no longer made, competent maintenance staff is increasingly hard to find – as are the appropriate spare parts. In the case of an emergency with the new plants, BMG can rely on the expertise of the Rolls-Royce service staff. BMG handles simple jobs such as measuring oil levels or replacing certain components itself and leaves complex tasks – such as replacing wearing parts or checking and reworking engine components – to the team from Rolls-Royce. Plans are already in place for the general overhaul of the equipment in approximately eight years after some 63,000 hours in operation. Instead of completely removing, reconditioning and reinstalling the used engine – a process that can take up to three months, during which the equipment is inoperable – Daugavpils Siltums will sell it back to Rolls-Royce and receive a structurally identical MTU Reman engine. This is an engine that has been thoroughly examined and completely overhauled by Rolls-Royce following a standardized procedure, and is thus almost as good as new.

Daugavpils Siltums uses the exhaust heat from the generator sets to heat two additional water boilers. Holding 1,500 and 4,900 liters respectively, they are only operational in winter to handle unexpected peak loads. (Image: Baltic Marine Group)

The compact heat modules. At the first *Daugavpils Siltums* site, each of the four generator sets of MTU Type GR 999 N5 produces 1 megawatt of heat and nearly 1 megawatt of electricity. (Image: Baltic Marine Group)

The new building for the CHP systems was constructed according to BMG's specifications. (Image: Baltic Marine Group)

Industrial company saves up to 50% of energy costs

In addition to the CHP modules belonging to the heat supply company, BMG operates another system located on the grounds of a Latvian locomotive manufacturer. This system is based on an MTU gas engine of Type 16V 4000 and produces enough heat (1,719 kW) and electricity (1,560 kW) to cover the requirements for industrial processes, heating and lighting. The manufacturer relies on the public power grid only to cover unforeseen load variations. "The new equipment enabled our customer to significantly reduce its energy costs," explained Ivan Kilter. "Ultimately, the company pays only half as much for the electricity it produces itself."

Four additional MTU generator sets produce electricity and heat at the second *Daugavpils Siltums* site just 500 meters away. Like their counterparts, they are based on especially durable and fuel-efficient gas engines of Type 12V 4000. (Image: Baltic Marine Group)


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