

Skagen Varmeværk

District heating

Main CHP project indicators

Heat capacity (total)	kW _{th}	19,400
Electrical capacity (total)	kW _{el}	13,800
Technology	Motor engine	
No. of units	3	
Manufacturer	Wärtsilä	
Type of Fuel	natural gas	
Heat: yearly generation	MWh	
Electricity: yearly generation	MWh	
Year of construction	1998	
Total investment costs	EUR	
Financing	no specification	
State support	no specification	
Return of investment (payback period)	Years	no specification
Location	Skagen, Denmark	
Information	bent.iversen@wartsila.com	

Picture



General description of the case

The Skagen Varmeværk is responsible for operating district heating for the town of Skagen, the most northern town in Jutland, with 8,400 inhabitants. The Wärtsilä CHP plant (3 x W28SG) is equipped with efficient heat recoveries that reach total efficiencies of far above 90 %. The engines were upgraded a few years ago to give a higher output and improved performance.

In addition to its own production, a municipal waste incineration plant and a nearby industry are delivering heat to the common Skagen district heating network.

Success factors

The plant not only produces heat for the city and power for the distribution system operator, but also actively participates in the Danish electricity regulating and primary reserve/frequency balancing markets. To handle these simultaneous production requirements effectively, very flexible operation, short start-up and shut-down capability, as well as of course operator alertness, are essential. Besides the engines and in order to secure the production the plant is equipped with hot water boilers operating on natural gas and prepared for the possible use of bio-oils and fuel oils, an electrical hot water boiler operating in parallel with the gas engines, and of course with heat storage or an accumulator. All these units allow very flexible and environmentally friendly production.

Additional installations:

- 4 x Gas hot water boiler 46 MW_{th}
- Electrical hot water boiler 1 x 11 MW_{th}
- Heat storage capacity/Hot water accumulator 600 MW_{th}

The plant operates very much on the day-ahead estimates of the heat demand, and the regulating and frequency balancing markets. Depending on the balance between these two electricity markets, the running strategy is somewhat different and involves co-operation with the

dispatch centre for the area and the other power producers. The foreseen and prognosticated heat consumption is flexibly managed through the heat accumulators, and provides the framework as to how the gas engines could or should be run. The varying daily spot prices on the regulating and reserve markets have, of course, an impact on the running philosophy, and the goal is always to produce electricity when the spot prices are high. When operating in these two electricity markets, the gas engine – or Smart Power Generation (SPG) - characteristics prove to be very valuable. The primary reserve market demands fast starts and stops, and the engines can cope with that. In the regulating market, the engines are run at about 70-80 % load, where again the gas engines' high and constant part load efficiency is valuable.

If it is not worthwhile to run the engines, the corresponding heat can be produced by the gas boiler or even with the electrical boiler, provided that the electricity spot prices and the electrical network balances are favourable. The 11 MWe electrical boiler is designed to have a large operating window, and can in that way also participate in the electricity markets as a load. The excess electricity from the renewable energy production can, therefore, also be dumped into the electrical boiler and further into the heat accumulator. Electricity production is of course closely coordinated together with the electricity operator for the district or area.

Main barriers

Not identified.

Comparison: before and after

CHP engines not only can increase energy efficiency considerably. In actively participating in the electricity regulating and primary reserve/frequency balancing markets, they can additionally serve as flexible “partners” of fluctuation power supply from wind and solar energy and increase the economy of the plant.

Conclusions

CHP plant Skagen is one of the first flexible CHP unit in EU which proved that CHP units can offer high level energy ancillary services on the energy market and provide good support for RES electricity grid integration.