SUCCESS STORY:

Fossil free heating from a new biomass plant

INVESTMENT CASE
Title:
Brønderslev – 20 MW CHP wood chip fired plant with ORC and CSP
Year (commissioned):
2017/18
Location:
Brønderslev Forsyning, Brønderslev Varme, Brønderslev, Denmark

Stakeholders:
1. Lasse Riisgaard/Brønderslev Forsyning - Chairman of the Board
2. The rest of the Board (4 persons)
3. Thorkil B. Neergaard/Brønderslev Forsyning - CEO
4. Poul Vestergaard Jensen/ Brønderslev Forsyning – Head of District Heating

Authors:
Jan Depenau, Euro Therm
Allan S. Pedersen, Euro Therm
Thorkil F.B. Neergaard, Brønderslev Forsyning

District heating in Brønderslev dates all the way back to 1921 when a local school started to receive district heating based on the cooling circuit of a diesel engine (for power generation) installed in 1919. By 1976 the entire town had district heating, which initially was based on heating oil but from 1987 on natural gas.

In 2015 Brønderslev Forsyning decided to change from natural gas to biomass as heat source for their district heating system. A completely new plant based on ORC technology was planned in the vicinity of the existing gas fired plant in Brønderslev– contemplated to reach "the highest efficiency of any renewable energy based cogeneration plant in the world".

The project included three contracts:

- a new building with all facilities for the technical installations as well as the administration.
- a 16.6 MW concentrated solar power plant (CSP) for heating of thermal oil.
- a 20 MW wood chip fired ORC based boiler system for co-generation of heat and electricity – able to utilize the energy from the CSP plant for partial or full operation of the ORC

The wood chip fired plant started heat production towards the end of 2017 and started electricity production in the beginning of 2018. The plant was expected to be handed over to Brønderslev Forsyning in 2018.

The investment and its technology

Replacing existing gas fired boilers with a new plant that uses biomass and solar power is a huge step in Brønderslev Varmes transition towards a fossil free district heating system.

The complete wood chip fired boiler system was supplied by Euro Therm. It was supplied as two identical 10 MW boiler lines operating a common ORC generator. The CSP solar plant feeds into the same thermal oil system as the biomass boilers so the consumption of wood chips fuel is minimized particularly over the summer months.

By using flue gas condensation in three steps, including two heat pump cooled steps, together with heat recovery from the water-cooled ORC generator and recuperation of thermal losses through a third heat pump, the biomass plant produces up to 22 MW heating and 4.0 MW electricity.

Fuel type:
- Wood chips

Feedstock origin:
- Domestic silviculture residuals from thinning, tops, branches etc
- Domestic and imported forestry by-products/residuals: bark, wet wood chips, etc
- Domestic sustainable energy crop (agriculture or forest)

Conversion system:
- Boiler combustion, e.g. stand-alone boiler plant including co-firing and combined heat and power
- Both electricity and heat can be generated by the CSP solar plant as well

Co-fire:
- Heat generator (i e boiler) is 100 percent biomass-fired.

Heating system heat sources:
- Heat generator is part of a system with heat pumps
- Heat generator is part of a system with solar heat collectors

Replacing existing gas fired boilers with a new plant that uses biomass and solar power was a huge step for Brønderslev Varme.

The temperature of the flue gas is as low as 12- 15 °C when reaching the stock.

The gross electrical efficiency reaches nearly 20 percent while the total plant efficiency is up to 120 percent.

Factors behind the decision

Three main drivers are behind the decision.

1. Changes in framework conditions. A major financial subsidy from the state directed at the existing natural gas fired plant is to stop by the end of 2018. Without a new productions concept, the heat consumers would face a huge increase in the tariffs. Approximately 700 Euro per year.
2. Brønderslev wants to contribute to the green transition and hence wished to fade out the use of fossil energy.
3. The new plant will in combination with the existing production facilities provide a great flexibility in the planning of the production of heating as we now have five different production sources.
   a. The sun (Wvia the CSP-plant)
   b. Biomass
   c. Gasengine (seven big Bergen-motors)
   d. Gasboilers
   e. A powerbased boiler

Thus, the price towards the end-users is not only dependent on one source (gas).

Replicability potential:

- High local replicability
- High regional replicability
- High national replicability
- High international replicability

Comment:

Euro Therm commissioned the first wood chips fired ORC plant in Denmark 5 years ago, and the technology has proved successful for district heating. Similar conditions are found throughout Denmark and internationally.

Scale-up potential:

- High local potential
- High regional potential
- High national potential
- High international potential

Comment:

Similar technology can be applied to smaller as well as larger boiler systems.

Lessons learned

In the future we shall be even more cautious about the general risk analysis in order to evaluate the risk of changed framework conditions.

Success factors

The national policy on the energy-sector must be long-sighthed, more reliable and more transparent.

Good funding possibilities must be available (they are today).

Constraints

Clearly, the gravest obstacle was, that the Danish state / parliament during the erection period changed the law on renewable energy with retroactive effect and hence withdrew an already obtained commitment of financial support to the new ORC-power production. Today, however, a new solution has been found, but it caused a lot of "bad sleeping".

Relation to Sustainable Development Goals:

End poverty in all its forms everywhere

Ensure healthy lives and promote well-being for all at all ages

Ensure access to affordable, reliable, sustainable and modern energy for all

Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

Make cities and human settlements inclusive, safe, resilient and sustainable

Ensure sustainable consumption and production patterns

Take urgent action to combat climate change and its impacts

Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertif¬i¬ca¬tion, and halt and reverse land degradation and halt biodiversity loss

Comments:

- The annual CO_2-production is reduced by 25 000 tonnes.
- There will be more local workplaces generated – compared to the use of gas.

Web sites:
www.bronderslevforsyning.dk
www.ri.se
www.energimyndigheten.se/en/
www.iea.org/tcp/
www.ieabioenergy.com

Additional resources
Facebook Brønderslev Forsyning

Contact:
Jan Depenau, Euro Therm
E-mail: jd@eurotherm.dk
LinkedIn

Allan S. Pedersen, Euro Therm
E-mail: asp@eurotherm.dk
LinkedIn

Thorkil F.B. Neergaard, Brønderslev Forsyning
E-mail: tbn@bronderlevsforsyning.dk