SDH solar district heating

Case study : Nexoe - 100 % solar fraction for DH expansion in 3 towns

Name of the project: 100 % solar fraction for DH expansion in 3 towns
(100 % solvarmedækning - Solvarmebaseret fjernvarmeudvidelse til Svaneke, Aarsdale og Listed)

Adress of the project: Nexø Halmvarmeværk, Halmvænget 2, 3730 Nexoe, Bornholm, Denmark

Name and type of the owner: District Heating plant owned by the utility company Bornholms Forsyning A/S

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A/ Context of the study

A.1/ Motivations

There has been set up goals to reduce fossil fuel use in the heating sector on the island Bornholm. Besides these goals, a heat plan for the island has been carried out. This heat plan estimated that biomass and solar based district heating would be feasible in a list of towns. Therefore the utility are expanding their business in these towns and need to know how these areas can be supplied in the most feasible way. In the case study three towns are planned to be included in a larger DH network. In the report it is investigated how the heat demand of these three towns can be supplied by solar district heating.

A.2/ Description of the existing DH

Straw based district heating in three existing DH networks in the towns Nexoe (where the DH plant is located), Snogebaek and Balka all connected via transmission lines. Address of DH plant: Nexoe Halmvarmeværk, Halmvænget 2, 3730 Nexoe, Bornholm, Denmark. The plant consist of two 5 MW straw fired boilers and a 9 MW oil boiler for peak load and backup. However the utility has a transportable wood fired boiler which is mainly used in case there are need for backup or extreme peak load capacity. At the plant, there is also an old steel tank (~800 m³). Temperature level in DH network: Summer: 76 °C forward, 44/45 °C return. Winter: 78/79 °C forward, 40/41 °C return. Most users are single family houses. However some low temperature industry costumers (e.g. a supermarket) are also connected. The heat demand (at DH plant) including the expansion of the network is around 60000 MWh/year. The energy price is around 17.4 €/MWh (for the fuel). A new tax on biomass is gradually implemented from 2014 to 2020 where it will add around 14.2 €/MWh to the fuel cost.

A.3/ Environment data

Countryside location. Probably a flat landscape. Irradiation around 1050 kWh/m²/year on a horizontal surface. In most places there is hard rock just below the ground surface. However an old gravel pit might be used for a pit heat storage.

A.4/ Opportunities and barriers

The heat production will in any case be CO_2 neutral (biomass based). Thus the environmental benefit is that it can be partly CO_2 free (solar based). The percentage depends on the chosen solution for the size of collector area etc. Good opportunity for realising a SDH plant since there are a strong political will to include RE and especially more solar (and biomass). Besides this the calculations show that it is feasible! A barrier could be to find suitable land site, but since the plant could be placed near an existing transmission line, it should not be a "deal breaker". Greatest strength is that there is a potential for a really large scale SDH plant. Main weakness is that the alternative supply is quite cheap and CO_2 neutral (straw).

B/ Methodology and tools used in the study

B.1/ DH load profile

Based on monthly demand from the DH plant, a calculation is performed to generate the degree dependent percentage which fits this demand according to the weather data which is measured in the same period.

B.2/ SDH design and sizing, energy balance

TRNSYS software incl. weather data from TRNSYS library modified somewhat to the local conditions.

B.3/ Economics

Annuity loan is assumed for the investments. Since the goal for the utility mainly is get the lowest possible heat price (for themselves and thereby for the costumers), the optimisation has been made to find the lowest possible heat price calculated as (fixed annual costs + variable annual costs) / annual heat demand.

C/ Results of the study

C.1/ SDH system design, energy balance and performance

By means of a biomass driven absorption heat pump, heat from the pit heat storage can be utilized even at low temperatures. At the same time this provides low temperatures for the collectors. The annual yield thereby reaches 500 kWh/year.

C.2/ Heat production management at network level

If possible the solar heat (in the pit heat storage) is at a high enough temperature, it is sent to the DH network (up to the level of the demand) via a heat exchanger. Extra solar heat is stored for later use in the seasonal storage. If the temperature is not high enough, the absorption heat pump will ustilize the medium level temperature heat in the storage. The preconditions for the operation of the heat pump is included. The boilers supply the remainder of the demand.

C.3/ Economics at SDH level and at network level

The study has been carried out from the point of view of the DH plant since this is where the solar collectors will most likely be located. The study concludes that there is a good financial basis for a large scale solar district heating plant incl. seasonal storage. The optimum collector area is in the first estimation calculated to be around 30000 m², but it is also reveiled that further investigations may increase this optimum area significantly (e.g. up to 60000 m²). The average total heat price is calculated to be around 40-42 €/MWh.

C.4/ Overview of possible business models

The utility will take a loan with very low interest rates where the municipality guarantees that the money will be paid back even if the utility goes bankrupt. The investments will then be spread out over the coming years and forwarded to the costumers. However the investment should also include some savings for the utility and ideally make it possible to lower the cost of the heat for the costumers.

Authors

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