Case study : FlexCities (Denmark)

Name of the project:	FlexCities
Adress of the project:	Horsens Varmeværk, Østergade 14, 8700 Horsens
Name and type of the owner:	Horsens Varmeværk, District heating utility
Owner contact person:	Christian Niederbockstruck, tel +45 75627233/20992536, CHN@hfvv.dk

A/ Context of the study

A.1/ Motivations

During the work with a new heat plan for Horsens municipality it was discussed if a connection of the existing district heating utilities could be a possibility and also a connection to district heating companies in Hedensted municipality was discussed. The district heating companies in the two municipalities therefore started to co-operate. The idea with the cooperation was:

- To utilize excess heat from industries
- To add large scale solar thermal plants at the transmission pipes outside the cities
- To add large scale heat storages at the transmission pipes
- To supply villages which today have individual heating and are situated by the transmission pipes with district heating
- To supply biogas plants with process heat and/or utilize heat from biogas CHP
- To convert areas with individual gas heating with district heat

The district heating utilities have calculated prices for connection pipes, prices for renewable energy production (solar, storages, heat pumps, biomass plants, biogas plants and geothermal energy) and for utilization of excess heat from industries. Scenarios for connection of the district heating utilities, conversion of individual heating, supply with 100 % RES and co-operation models has been analyzed. Seven district heating utilities are connected in the analyses.

The following scenarios have been analyzed:

1. Reference
2. Reference + 80 % of individual heating potential to district heating
3. As 2 but the 7 district heating utilities are connected with transmission pipes
4. As 2 but a new Biomass fuelled CHP-plant is implemented
5. As 2 but an existing natural gas fired combined cycle plant is converted to wood chips
6. As 2 but an existing waste incineration plant is closed
7. As 5 but excess heat from industries and 23 MWheat or 49.5 MWheat pumps are added
8. As 5 but 20 % solar thermal or 40 % solar thermal with long term storages are added
9. As 5 but biogas CHP is added
10. As 5 but a combination of excess heat, 20 % solar thermal biogas and 39.5 MWheat h3q5 pumps are added

A.2/ Description of the existing DH

Company	Production system	Production MWh/year
Horsens Fjernvarme	Waste incineration CHP 27 MW_{heat} Natural gas fired combined cycle 22.5 MW_{heat} Gas boilers 75.3 MW_{hear} Steel tank	269,545
Dagnæs-Bækkelund Fjernvarme	Gas boilers 27 MW_{heat}	66,900
Hedensted Fjernvarme	Natural gas fired CHP 8.6 MW_{heat} Gas boilers 14 MW_{heat} Steel tank	46,400
Løsning Fjernvarme	Excess heat, 3 MW_{heat} Gas boilers, 12 MW_{heat}	27,400
Brædstrup Fjernvarme	18,600 m^2 solar themal 1.5 MW_{heat} heat pump 7,500 m^3 steel tank 19,000 m^3 borehole storage Natural gas fired CHP 8.2 MW_{heat} Gas boilers, 15.3 MW_{heat}	39,576
Østbirk Fjernvarme	Wood chip boiler, 5 MW_{heat} Oil boilers, 6 MW_{heat}	14,100
Hovedgaard Fjernvarme	Wood chip boilers, 7 MW_{heat} Oil boilers, 4.5 MW_{heat}	13,200
Individual boilers		310,635
Total		**787,756**

A.3/ Environment data

CO_2 emission for the reference system is 135,000 tons/year

A.4/ Opportunities and barriers

Opportunities

In Hedensted industries have app. 100,000 MWh of excess heat not utilized.

Horsens wants to change to other fuels than natural gas and can utilize solar thermal, if the plants are connected to transmission pipes outside the city.

Brædsteup wants to extend the borehole storage and the solar plant to 50,000 m2 but they will get buffer capacity from the transmission system.

Barriers

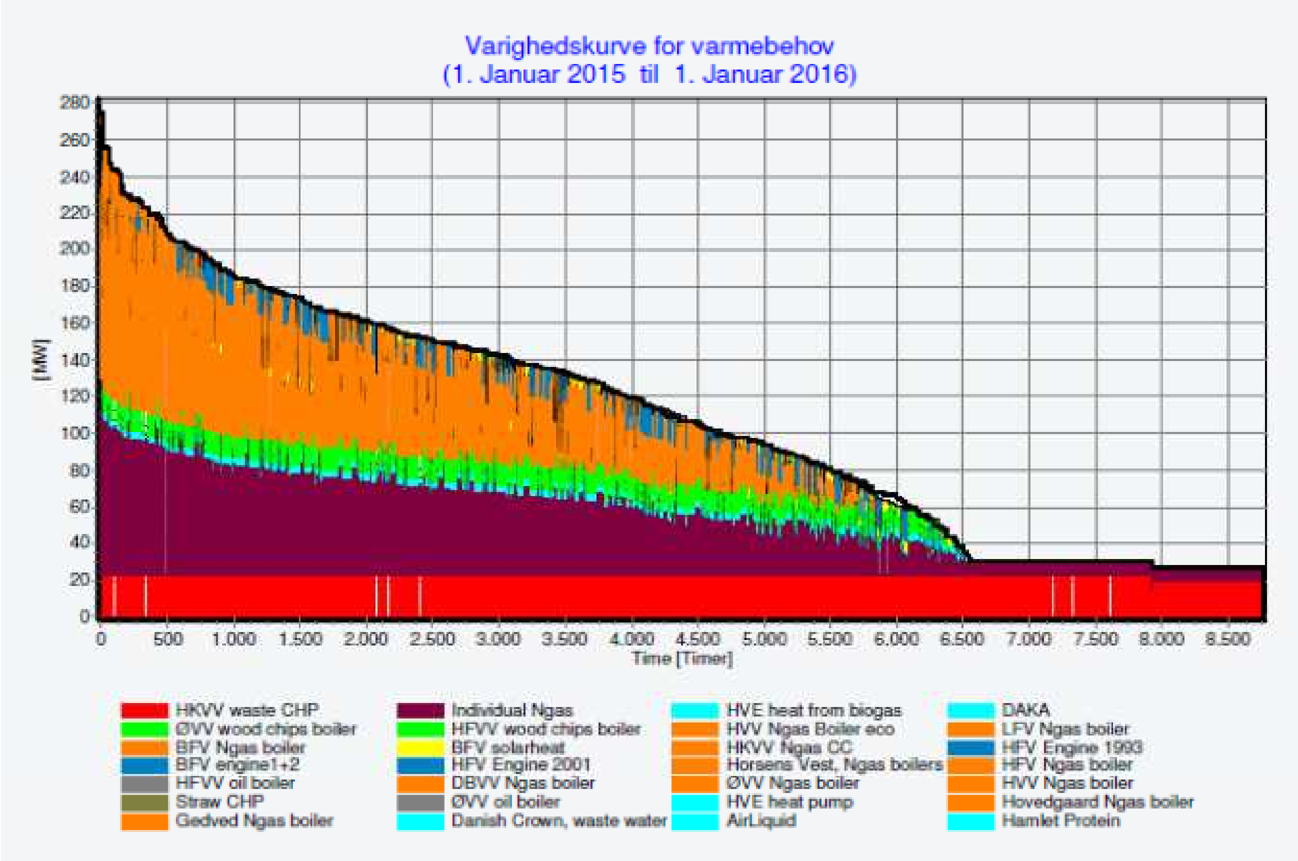
Co-operation between 7 independent district heating utilities is complicated and will need a new co-ordination structure (transmission company) to implement transmission pipes or fusion of the companies.

Also the socio economy and the consumer economy when connecting district heating plants with transmission pipes have to be positive.

B/ Methodology and tools used in the study

B.1/ DH load profile

Figure 1: Duration curve, reference system



B.2/ SDH design and sizing, energy balance

All design calculations are carried out in the calculation software EnergyPRO.

SDH plant

In alternative 7 two alternatives are calculated: 7a with a solar production of 200,000 MWh (app. 20 % of the production). If this is devided in 5 plants, each plant will be 85,000 m2 and need a water storage volume of 21,000 m3 and 7b with a solar production of 400,000 MWh (app. 40 % of the total production). To this 1,000,000 m2 solar collectors and 1,7 mio. m3 water storage is needed.

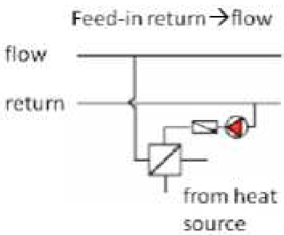
SDH system

The water storage directly connected to the plant must be able to equalize the feed in from the solar collectors in a 24 hours period. That means a storage capacity of at least 10,000 m3/plant. The system concept is very simple since the only solar collectors pipes to accumulation tank and feed in system is needed.

SDH technical data

The feed in temperature will be adjusted by matching the flow volumes to the required flow temperature. The feed in pump has to overcome the pressure difference between return and flow.

Figure 2: Feed in system



B.3/ Economics

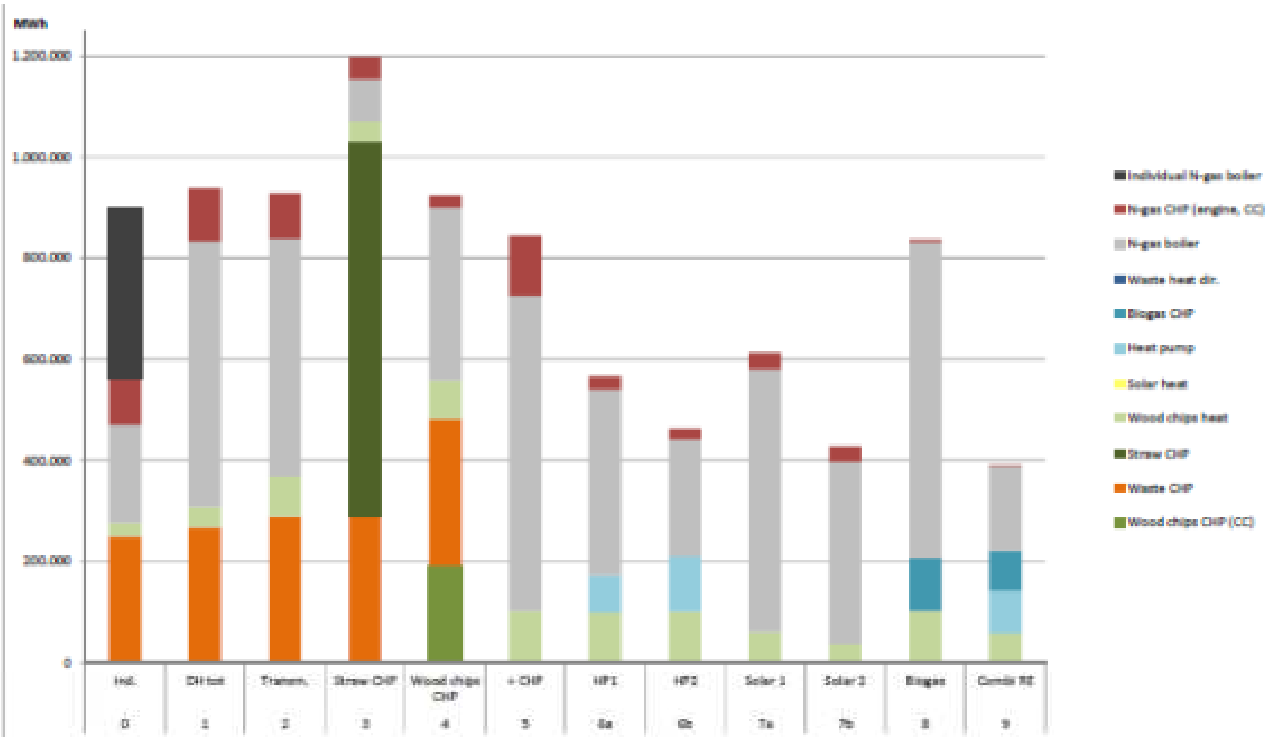
Investments for alt. 7a are expected to be 95 mio. €. No subsidies. Price for solar heat is calculated to 28 €/MWh (4 % real investment, 30 years lifetime).

Investments for alt 7b are expected to be 240 mio. €. No subsidies. Price for solar heat is calculated to be 36 €/MWh (4 % real interest, 30 years lifetime)

C/ Results of the study

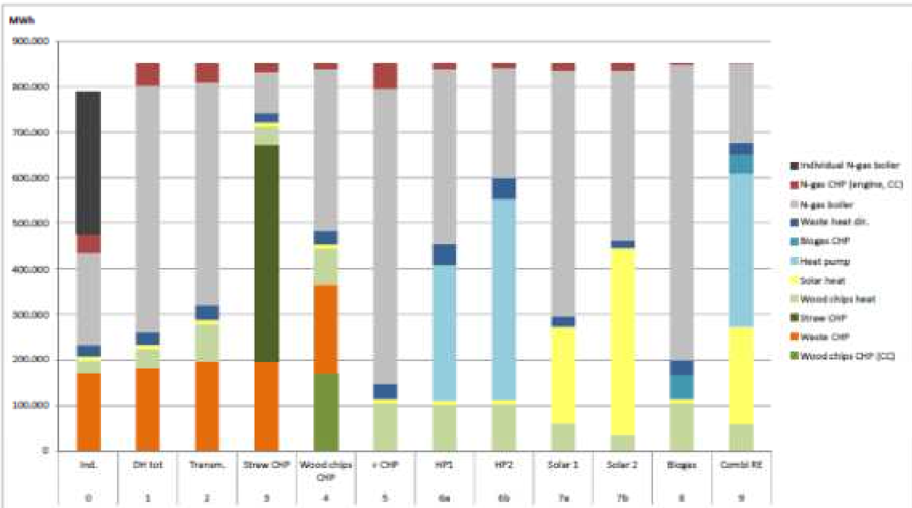
C.1/ SDH system design, energy balance and performance

Figure 3: Fuel consumption in reference and 11 anternatives



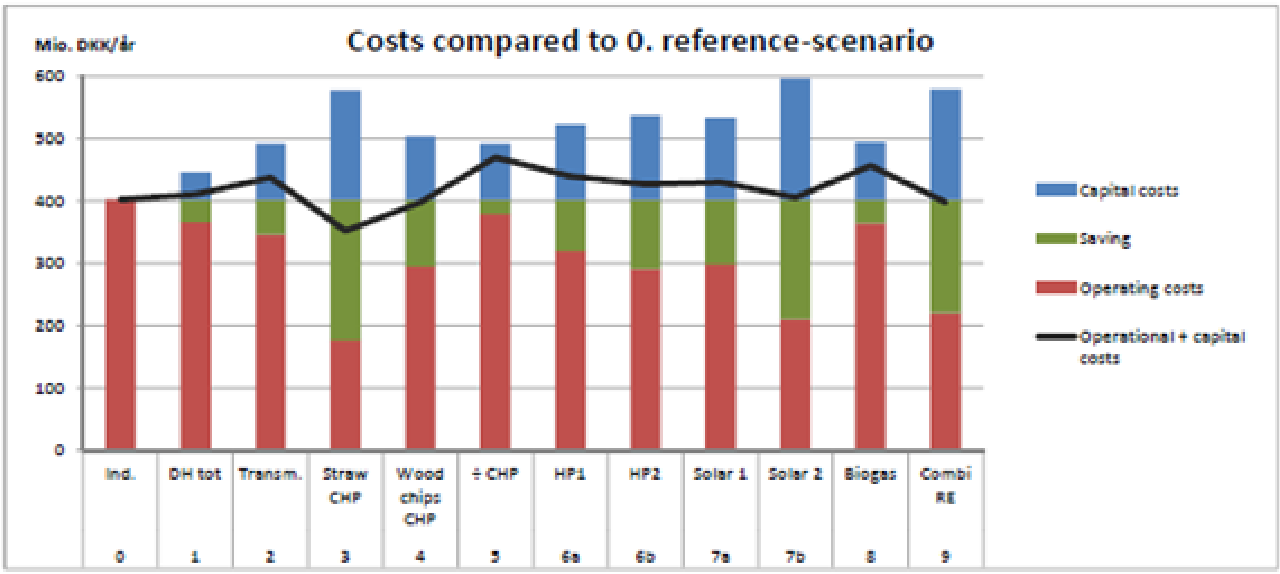
C.2/ Heat production management at network level

Figure 4: Heat production in reference and 11 alternatives



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

Figure 5: Total yearly production costs for the alternatives



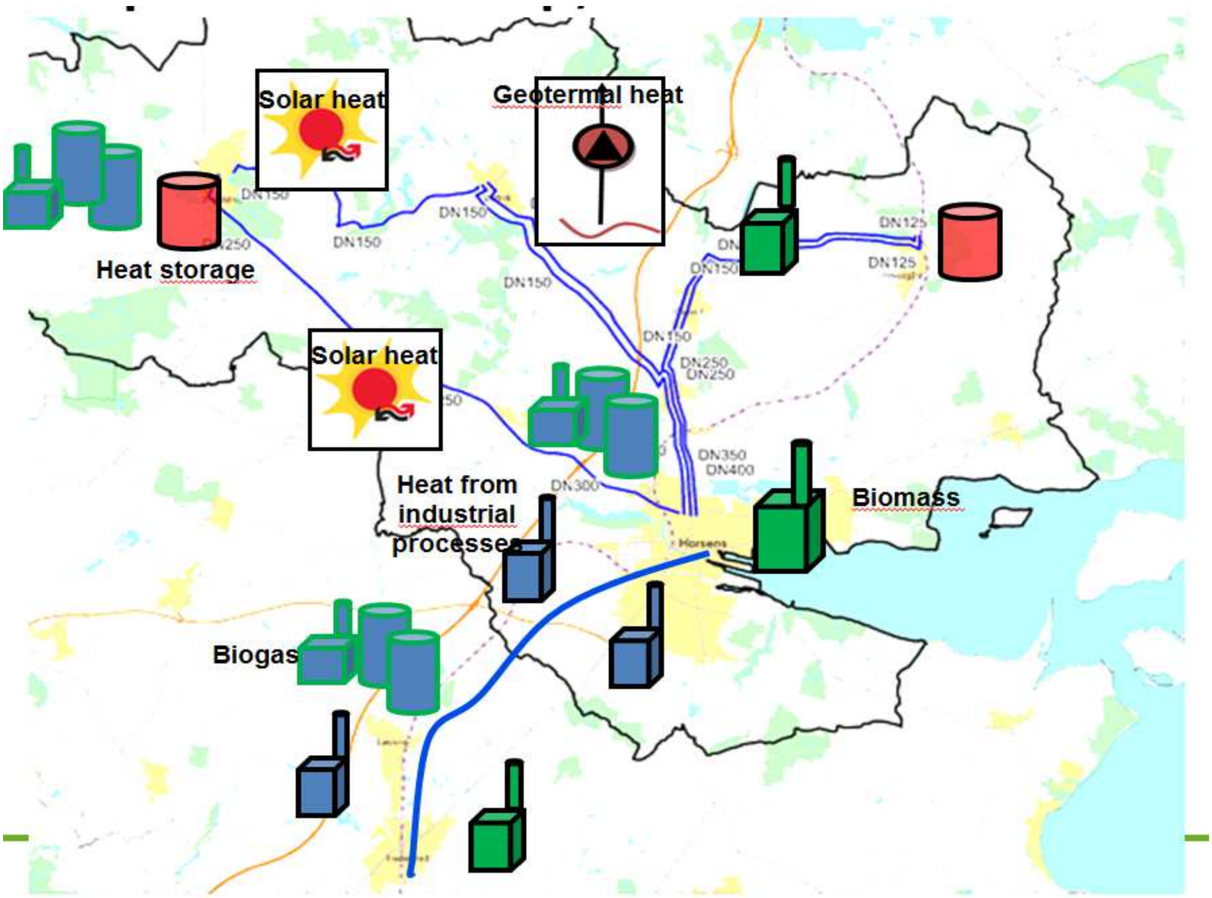
C.4/ Overview of possible business models

The 7 district heating utilities have decided to set up a business model, where the co-operation will be formalized and future development takes place in this formalized framework. These activities are:

- Design and implementation of the transmission pipe between Hedensted and Horsens
- Further development and implementation in a manual for conversion of individual heated buildings.

This formal co-operation unit is expected to develop into an implementation unit for transmission pipes, solar thermal and storages along the transmission pipes and conversion of individual heated villages along the transmission pipes to district heating.

Figure 6: Illustration of the project



Authors

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