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ÆRØ – THE DANISH SOLAR ISLAND

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Abstract:

Since 1988 thermal solar power has been used in the district heating plants, on our island Ærø, the three local district heating companies all in all have installed 26.000 m² solar collectors, which gives the island an average of 3,8 m² solar collector per inhabitant.

Rise District heating, a "bare field project", has been in operation since 2001. The heat production is budgeted to 3,500 MWh per year. 50% of the energy production comes from a 3,575 m² thermal solar plant and 50% from a wood pellet boiler.

Ærøskøbing District Heating, in 1998, built a 4,900 m² solar plant. Ærøskøbing District Heating covers 17 % of its sale through thermal solar heating. 63 % is derived from a straw boiler and the remaining 20 % is obtained from a pellet boiler. The total heat demand in Ærøskøbing and Rise District Heating Companies is now covered 100 % by Renewable Energy sources.

Marstal District Heating has in 2002 extended the old solar plant from 9.000 m² solar collectors to 18.365 m² solar collectors, and now 30 % is covered by solar energy.

The Island Ærø

Ærø is a small Island situated in the southern part of Denmark. The number of inhabitants is app.7.000. Unfortunately this number has decreased with app. 5000 people within the last 100 years and is still decreasing. 25% of the population are old people.

The inhabitants on the island make their income from agriculture, shipbuilding, tourism, education, seafaring and craftsmanship working all over the world. But the numbers of jobs are decreasing every year.

The island is 90 km² of which 60 km² are used for farming. The countryside is flat and open with only a few ha of forests. The farmland is rich and most of the population live in 3 small towns or in villages.

RISE DISTRICT HEATING

In Rise a new small plant was set into operation in 2001. 115 consumers, including a nursing home, a primary school, church etc. The annual sale of heat is 2.650 MWh.

For district heating the following is of importance.

- Small pipes. (Cheaper and lower heat loss than bigger)
- Low temperatures. (Lower heat loss)
- High performance of heat storage. (More kWh pr m³)
- Power for pumps. (Lower flow gives lower demand)

A special effort is made to get as low a return temperature as possible. 30 deg. C is obtained during winter, rising to 36 – 40 in the summer period, due to necessary opening of bypasses in the net. The flow temperature to the network is 73 in the winter and 80 in the summer.

The main parts of the connected installations were ordinary central heating installations with an oil-fired boiler.

To obtain the low return the following was done:

- Directly connection of the radiators without heat exchangers.
- Each radiator mounted with a new flow-regulating valve, which reduces the flow to the necessary. (In the range of 1 litre / m² room / hour)
- Connected via a pressure regulation valve.
- New hot-water tank (110 litre) – low-temperature type.
- All large installations is strictly balanced and installed with control devices.
- 1-pipe systems in single-family houses were installed with a control system for regulation of flow temperature to radiators acc to ambient temperature.

3.575 m² solar heaters and an 800 kW wood pellet boiler do supply all the heat needed. 4000-m³ heat-storage

Also in Rise the strategy for controlling the flow in the solar circuits is based on variable flow. The higher solar fraction is the more important it is to use variable flow.

In this case the outlet from the panels is set to 95 degrees C from primo May to end of September.

The rest of the year it varies between 40 and 80 degrees.

For 2002 the solar heating plant, delivered and installed by GJ Teknik, Marstal, has given the following:

- | | |
|--|-----------|
| - Total from solar heating plant: | 1.563 MWh |
| - Total from pellet boiler: | 2.160 MWh |
| - Heat loss at plant incl. active cooling: | -445 MWh |
| - Delivered to network | 3.278 MWh |

ÆRØSKØBING DISTRICT HEATING

Ærøskøbing District heating was founded in 1963 as a consumer owned company. The energy source then was heavy fuel oil. Today 600 consumers are connected to the district heating in the town of Ærøskøbing.

The 80'es were the period of the pioneers on Ærø: Solar collectors were built in the garages, local smiths tried to start a wind turbine production.

The pioneer-period culminated on Ærø with the erection of Ærøskøbing Energy Plant in 1989, a test and demonstration plant where some of the elements were straw boiler, solar absorbers, heat pump and flue gas condensers. The company also owned three windmills.

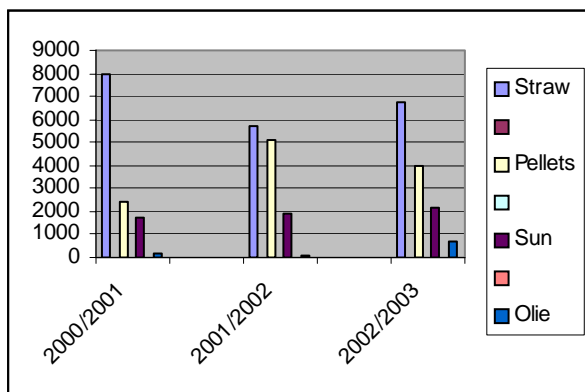
Heat was produced on a straw boiler, a diesel generator and a heat pump.

In 1992 Ærøskøbing District Heating Company took over the Ærøskøbing Energy Plant, which went bankrupt.

Because of the disastrous harvest in 1993, the idea of establishing a solar plant came about in 1994.

In 1998 Ærøskøbing District Heating Company were ready to establish the first stage, which was a plant on 2040 m². In the following year the plant was expanded to 4898 m². The plant covers 16 % of the annual demand for heating.

In the autumn 2000 a wood pellet boiler was installed in the central on Lerbækken. This way the use of the boilers running on fuel oil could be avoided. The 1.6 MW straw boiler from 1988 is replaced by a 3.2 MW straw boiler. The boiler was put in operation in October this year.



Like Marstal Ærøskøbing District Heating also run their solar plant with a variable flow, which means that the plant can keep a high temperature in the summer so the water can be sent directly to the consumers. During the winter time the temperature will be kept at a low temperature. The production on the solar plant is sent either in the straw boiler or in the wood pellet boiler.

The production and the three forms of production can be followed at homepage WWW.aeroe-varme.dk, in the menu choose solfangeranlæg.

MARSTAL DISTRICT HEATING

In 1996 Marstal District Heating established 8038 m² ground mounted solar collectors and a 2.100 m³ water storage (steel tank). In 1999 another 1005 m² were added and also a storage tank with water pipes in wet sand (2000 m³ water equivalent) were established together with a heat pump making it possible to cool the solar collectors in the evening. Marstal District Heating has nearly no maintenance costs for the solar system and the heat production from the solar collectors is in average 7% more than guaranteed. The production from the solar collectors and the consumption in Marstal is updated on the address www.solarmarstal.dk.

The solar heat production covers 15% of the consumption, but Marstal District heating wants to raise the solar fraction to 30% because of the good experiences with solar energy. Therefore a new project, SUNSTORE 2 was started in 2000. The SUNSTORE 2 project, which is supported by European Commission (5th Framework) and the Danish Energy Agency, will add another 10,000 m² of solar collector and 10 000 m³ pit heat storage to the plant. Solar energy will then cover 30 % of the annual consumption.

8000 m² of the solar collectors will be a new type of "more efficient 12.5 m² HT collectors" from ARCON, Denmark.

The **development of the more efficient collector** has been a part of the project. The best competitive to the ARCON collectors (compared on heat production price/kWh) will also be demonstrated in our solar collector field with minor areas.

Marstal District Heating therefore designed an expansion of the present solar system including

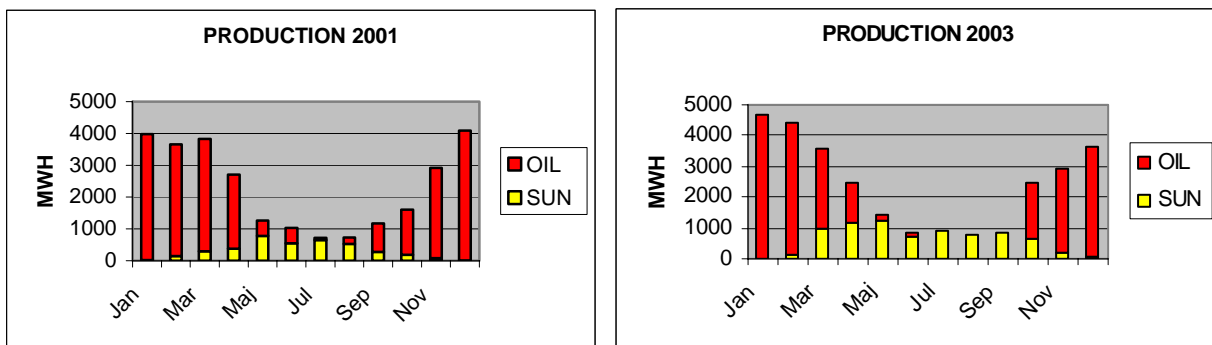
- 8000 m² of a new and more efficient ground-mounted ARCON-HT collector.
- A demonstration site with the most competitive collector types to the HT-collector including flat-plate collectors, roof-modules, and evacuated tubes and focusing collectors.
- A 10.000 m³ pit heat storage.

The project is supported by the European Commission (5.th Framework) and the Danish Energy Agency and will be established in 2002 and 2003. Project partners to Marstal District Heating are Ramboll (Denmark), ARCON (Denmark), CIT Energy Management AB (Sweden), Universität Stuttgart (Germany) and PlanEnergi (Denmark). The total budget for the project is 3.44 million EURO of which Marstal District Heating pays 1.62 million EURO.

The project is now ad the end and will be reported to The European Commission in the end of this year.

Operations experiences

The plant is now entering its eight year of production and it has fulfilled the guarantied production numbers, and our expectations. It was our intension that the solar plant alone should be able to cover our consumers demand during the summer months. As shown at the chart below this demand could not be reached in 1997.



The SUNSTORE 2 project, in 2003, enlarges the old plant with 9.320 m² of solar collectors.

To day Marstal District Heating has the following types of solar collectors installed:

- 103 m² roof mounted solar collectors
- 211 m² solar focusing solar collectors
- 122 m² solar evacuated solar collectors
- 17.929 m² flat plate solar collectors

All in all there are now installed 18.365 m² of solar collectors in Marstal.

WHY IS ÆRØ – THE DANISH SOLAR ISLAND?

The Island of Ærø has in 2000 year been selected as “Danish Sun Island” instead of the yearly selected “Sun City”. We have 10 % more sun than the rest of Denmark, and we have today 3,8 m² of solar collectors per inhabitant, which very well might be a World record. Solar heating and large storage tanks are important technologies of tomorrow’s complex energy systems.

On the island of Ærø we continuously build and test these solutions.