



Solar island in Denmark's South Sea

With a total of more than 33,000 m² of solar collectors, the district heating system in Marstal covers 55 % of the town's heat demand.

Photo: Marstal Fjernvarme

In all three towns on the small but sunny island Aeroe, citizens obtain a large portion of their heating energy from the sun. In the town of Marstal, solar now covers more than half of their requirements.

The weather on Aeroe Island was not at its best in June 2011. Pouring rain filled the excavation site for the heat storage reservoir of Europe's largest solar heating plant with muddy water. The ground was soaked and one day the northern wall of the dig site collapsed. "This delayed the work about two months," Lasse Kjaergaard Larsen from Marstal Fjernvarme said. The situation did not improve over the following months, either: winter came and a thick layer of ice covered the reservoir, causing further delays. Summer 2012 was so short that the reservoir could not heat up sufficiently.

Finally, 2013 brought the sun back. It heated the top layer of water in the storage reservoir to a temperature of 74 °C, and the solar plant is now also catching up. "The plan is to reach 80 to 85 °C, and depending on the weather we will achieve that next year," Kjaergaard said. Nevertheless, it will take two to three years before the storage reservoir reaches its optimal performance level. For this, the ground around the water reservoir needs to heat up as well.

Wood chips, solar, heat pump and ORC in one project

Sunstore 4 is the name of the project in Marstal, which includes the new heat storage, a wood chip boiler, an extension of the solar collector field and an electrical heat pump. Together, these technologies provide 100 % renewable energy for the district heating system in the town of Marstal.

The Danish island Aeroe was already famous for its three district heating systems with large solar plants: the district heating system of Ærøskøbing, the island's second largest town after Marstal, has a 7,090 m² solar collector field, and the village of Rise has 3,750 m² of solar collector area. Marstal already had more than 18,000 m² of solar collectors in operation, which were installed between 1996 and 2003.

But since August 2013, Marstal has Europe's largest solar thermal installation by far, with a total collector area of more than 33,000 m². Of this total, 15,000 m² were added as part of the Sunstore 4 project. Solar heat will cover 55 % of the heating requirements of the 1,500 customers. "With the new plant, we will be able to supply our customers with 100 % solar heat for six to seven months of the year," Kjaergaard said.

As the project name indicates, the storage reservoir is an important feature of the expanded plant. With a water volume of 75,000 m³, it is more than seven times larger than the old heat storage pit. The new system can either work independently or together with the existing system.

All-solar heat for six months a year

The new storage reservoir is equipped with a new type of insulation cover that reduces heat loss through the cover by 60 %. This is particularly important because the top layer is the hottest part of the storage. Natural stratification is supported by an electric heat pump (1.5 MW thermal output), which transfers heat from the bottom of the stratified storage tank to the middle layer, so the bottom is always cool. In contrast to the old system, the new one supplies the exact temperature required. The buffer tank provides additional flexibility. As wind energy generation in Denmark frequently exceeds the demand, the heat pump runs mostly on surplus green electricity. In this particular case, this does not affect the electricity price. For changing from bio-oil to the heat pump, the Danish government guarantees Marstal District Heating a fixed electricity price of 1.0 DKK/kWh (€ 0.13), which equates to 0.28 DKK per kWh of heat (€ 0,04).

For the months from September to April, Marstal Fjernvarme has installed a 4 MW biomass boiler, which currently runs on wood chips from the Baltic.

MORE ENERGY

absorptive and reflective solar surfaces:
mirotherm® | mirosol® TS | sunselect® | MIRO-SUN®



EFFICIENCY.
SOLAR.
SURFACES.



www.alanod-solar.com



“We were planning to fire it with locally produced energy willow, but when the food prices rose, the farmers decided to grow food crops instead. However, food prices are now falling and some farmers are showing interest in growing willows again,” Kjaergaard said.

An integrated Organic Rankine cycle generates electricity from it and feeds it directly into the national grid. The remaining heat coming out of the Rankine cycle is transferred straight to the district heating feed line.

Politics can change economics quickly

The budget for the entire project is € 15.1 million. The project has received € 6.1 million in grants from the EU's 7th Energy Framework Programme. Although Marstal has achieved their ambitious cost goals of 3 to 6 €-ct/kWh of solar heat and 33 €/m³ of heat storage, the economics of the non-solar heat sources soon proved to be tricky. Recently, the Danish government began discussing a tax on wood chips. “This came as a big surprise for us,” Kjaergaard said. In addition, Britain's largest power plant, Drax in Yorkshire, is planning to switch from coal to wood-chips. This will affect prices worldwide. On the other hand, heat pumps suddenly became more economical in January 2013, when the Danish government cut the taxes on heat pump electricity consumption in half. “If we were calculating the business case right now, I would probably opt for a heat pump instead of a wood chip boiler,” Kjaergaard said. He adds: “At least we can count on the solar heat staying free of charge.”

An island with a renewable energy tradition

Many of the people and companies involved in the development and construction of the new plant are

long-term members of the solar district heating community. Consultant Per Alex Sørensen of PlanEnergi, who was responsible for the technical design, planned Marstal's first solar thermal plant almost 20 years ago for the municipal swimming pool. The supplier of the collector area, Sunmark, has implemented many turn-key solar district heating projects all over Denmark. Leo Holm, who now represents Sunmark for the project, is the former Manager of Marstal Fjernvarme. Engineering company Solites from Germany has provided expertise based on their experience with long-term storage systems in Germany and also assisted in creating the measurement programme.

The official Sunstore 4 project, which is part of the 7th European Framework Programme, will end in June 2014. So far, no follow-up EU project is in sight. However, work will definitely continue in Aeroe. Marstal Fjernvarme will measure different types of performance data while the storage is heating up, and the knowledge gained from this will be shared with the solar community. Also, the “energy island” Aeroe is not just about heating. There are also plans to supplement the existing wind parks with a local offshore wind farm and use the electricity for battery-powered ferries.

Altogether, the three plants now add up to more than 44,000 m² of solar collectors on an island with 6,500 inhabitants. This is equivalent to 7.3 m² of collector area per person. This makes Aeroe the island with the largest share of solar heat per capita in Europe by far, even beating Cyprus, which has an installed collector area of around 1 m² per capita.

Chances are good that the huge new collector field will achieve the solar yield that Marstal Fjernvarme is expecting next summer. Aeroe is one of the sunniest places in Denmark, which is why the region is called the Danish South Sea.

Eva Augsten



**Reliable
Innovative
Customized**

www.ritter-xl-solar.com

Large scale solar thermal systems