TOMORROW’S DISTRICT HEATING IN DENMARK

In cooperation with Ramboll, three Danish municipalities in S. Jutland are converting to new flexible district heating solutions.

Denmark’s goal to become independent of fossil fuels, together with an unstable market for electricity has encouraged three Danish district heating plants, Logumkloster, Vojens and Gram, to think big and far-reaching to ensure a cost-competitive and environmentally friendly heat supply to local consumers in the future.

First step in Logumkloster was a strategic plan

In Logumkloster, a CHP plant for approx. 1500 consumers, the cooperation with Ramboll started with the formulation of a strategic plan for Logumkloster’s future heat production. In the process, a series of heat production technologies were studied, including different types of electric heat pumps, absorption heat pumps, solar heating and thermal storage of various sizes, biomass boilers, electric boilers as well as optimisation of existing gas engines. The many technological alternatives were combined into real-life scenarios where Ramboll simulated operations and analysed the output of each scenario.

The result was a strategic master plan with the most interesting and feasible combination for the future provision of heat in Logumkloster. The plan also includes building an entirely new heat central and administration alongside the existing plant. This will make it possible for Logumkloster district heating to gather all activities on the outskirts of the town and be able to close down the old plant in the centre of the city. The new heat central will accommodate a wood pellet boiler, an absorption heat pump, an electric hybrid heat pump as well as a heat exchange station for one of the world’s largest solar heating facilities at 50,000 m2 with a 150,000 m3 heat storage pond.

Solar heating

The analyses indicated that it would be a wise economic move for Logumkloster to make a substantial investment in solar heating. In addition to being a renewable energy source and cost competitive in relation to the current production, solar energy would provide heat at stable prices for the entire plant lifecycle of an expected 30 years. Operations and maintenance costs are low and thus the main cost would be depreciation, at a known level in upcoming years, as opposed to the risk of ever-changing fuel prices affecting other energy production.

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Excavation for a solar heating plant of 71,000 m² and an adjacent heat storage pond of approx. 200,000 m³ is well underway in Vojens. Vojens already has a solar heating plant, and initial years of operation have shown such convincing results from this technology that work has begun to establish the world’s largest plant with a solar heat storage pond in an abandoned gravel pit, close to the solar heating plant.

**Optimising output**

Heat pumps will enhance output from the solar heating plant and the existing gas engines where an extra flue gas cooler has been installed on one of them. With this heat pump, the flue gas from the engine can be cooled to approx. 20 degrees Celsius and the heat yield increased, raising the overall rate of efficiency to exceed 100%. This will make the gas engine more cost competitive and able to run for more hours in an electricity market characterised by periods with low electricity prices. The heat pumps can also lower the temperatures in the solar heating plant and thus reduce heat loss and increase the annual output by up to 15%.

**Absorption heat pump**

An absorption heat pump is run by heat, which from utilisation of a concentrated saline solution can absorb humidity and thus maintain an evaporation process in a vacuum.

The resultant heat then returns at a lower temperature, so that the absorption heat pump does not consume any energy other than the modest amount of electricity used in the circulation pumps. Combined with a heating unit which can deliver heat at an excessively high temperature, the absorption heat pump can thus practically extract energy for free from the low temperature source. This principle will be applied at Logumkloster, as the wood pellet boiler can produce super-heated water at 150 degrees Celsius to run the absorption heat pump, which can then deliver 75 degrees Celsius to the district heating network, and at the same time cool down the flue gas in the gas engine and the entry water leading to the solar heating plant.

**Hybrid heat pump**

The electric hybrid heat pump works using a coolant which is a mixture of ammonia and water. The hybrid heat pump also uses an absorption process to achieve a substantial temperature shift and an expected high coefficient of performance (COP) value of 4.5, which makes it advantageous for a district heating network such as in Logumkloster.

**Solar pond for heat storage**

Construction of the heat central is in full swing and moving steadily forward on schedule. The planned solar heating plant is expected to meet 50% of the demand for heat. This requires storing the heat produced during the summer for the fall and winter, in a seasonal thermal storage. That is why there are plans in Logumkloster to create a solar heat storage pond for 150,000 m³ water, involving an enormous excavation where the dug-up soil is used to make an embankment around the hole, forming the sides of the storage chamber. The pond will then be filled with water and covered with a fluid insulation cover.

Gram is starting work from a flat field instead, to establish a 110,000 m³ solar heat pond. Gram is tripling the size of its solar heating facility, with assistance from Ramboll, to cover a total area of 44,000 m². At the same time, the town is establishing a central heat exchange for the solar heating plant and is expanding its district heating central with a 10 MW electric boiler, which will participate in the power regulation market, and with a 900 kW electric heat pump to optimise the output from the solar heating plant.

The best managed and optimised solar heating facility can utilise more than 45% of the annual solar radiation and convert this to district heating. When the upcoming Danish facilities are established in 2015, the total solar heating to district heating will amount to more than 600,000 m². We in Ramboll are proud to have contributed to an extensive number of these plants.