

ENGINEERING
TOMORROW



VLT® Drives

Danfoss VLT® Drives run The world's smartest district energy system

Taarby Municipality within Greater Copenhagen is the first to integrate the production of district cooling and district heating in combination with ground source cooling and chilled water storage in one facility that also exploits surplus heat from a nearby wastewater treatment plant. This symbiosis allows the utility company to provide building owners in the district with competitive and environmentally friendly cooling – while generating more cost-effective heating to the district heating network.

13MWh
energy storage

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As cities across the world are looking for cost-effective, greener and lower CO₂ footprint solutions for thermal energy supply, the issue is not so much the availability of green technologies as it is to find ways of exploiting and combining existing technologies to their full potential. One example is the challenge of absorbing all the electricity actually available from renewable sources. Wind turbines idling, when they could be generating megawatts of clean energy, are an only too common sight on wind farms, simply because the demand for electricity doesn't follow weather conditions. Strategies for optimizing the use of energy from fluctuating renewable sources are either to store the power or to create a flexible demand. Sector coupling, as in the case of Taarnby's combined district heating and cooling facility, provides a way to use green renewable electricity when prices are low and avoid electricity consumption during peak hours with high prices.

A smart consumer

In the new Taarnby facility, surplus green electricity is channeled into a combined heating and cooling system that stores the energy in hot or cold water. Thanks to a chilled water storage tank, that can hold 2,000 m³ of cold water, Taarnby Utility is able to respond

to the fluctuations of the electricity market and produce cooling when electricity prices are low. Moreover, the tank can provide peak capacity and stabilize the operation of the heat pumps. In Denmark, where more than 45% of the electricity production derives from renewable sources, low electricity prices are usually an indication of surplus supply from wind power. From the point of view of the power system, Taarnby Utility becomes a smart consumer. Offering a much-needed energy demand response, Taarnby can purchase power at the times when the power supplier needs to sell it, eg. when the weather

conditions are optimal for generating wind power and/or outside of peak hours on the grid. Likewise, production can be disrupted in case of shortage of capacity for power generation or distribution.

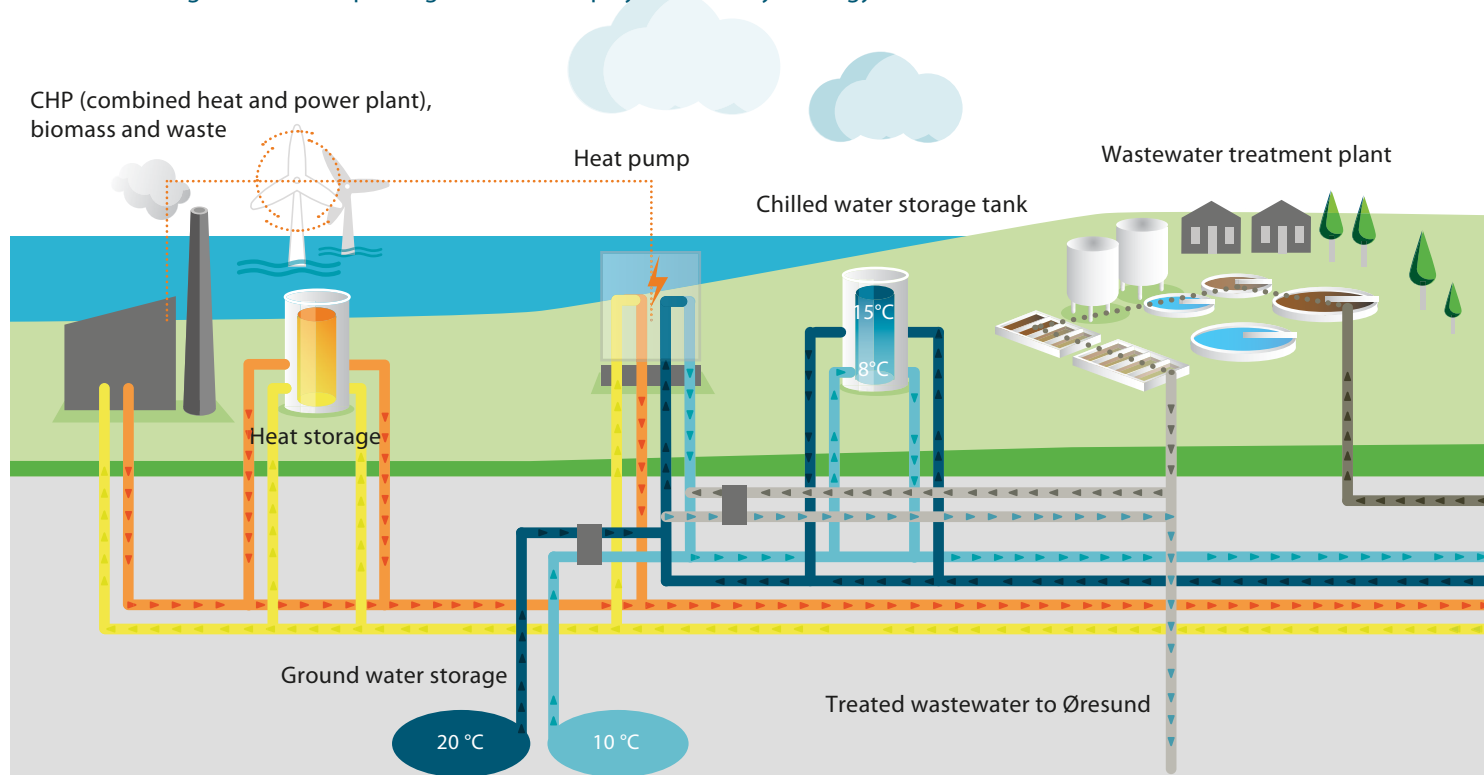
A highly cost-effective solution

With the new Taarnby district cooling facility, the ambition is not only to deliver an environmentally friendly cooling alternative to private roof-top chillers, but also a more economical solution. Combining the production of district heating and district cooling in one and the same facility was one step. But placing the energy plant and



The entire plant is powered by 27 Danfoss VLT® drives in the range from 0.75 to 400 kW.

District heating in Greater Copenhagen - a natural player in the city's energy infrastructure of tomorrow



storage tank actually at the wastewater treatment facility to save expensive land and to exploit the energy of the treated wastewater was the element that really made a difference because it allows for the production of heating all year round – independently of the demand for cooling.

Anders Dyrelund, energy planner at Ramboll and senior developer of the Taarnby project, explains: "It wouldn't have been a satisfying business case for the investment to only be able to produce heating during the few summer months of the year where there is a need for cooling. The heat pump has to compete with efficient heat production from large biomass fueled CHP plants in the Greater Copenhagen district heating system and heat has a very low cost in the summer. The heat pump can be optimized with respect to electricity prices and heat prices hour by hour, as it has access to the thermal storage tanks, ground source cooling and wastewater. The synergy that is created between all these different sectors is unique and makes this solution the world's smartest.

Joining forces

The new Taarnby facility is located in an area close to Copenhagen Airport and has been operative since

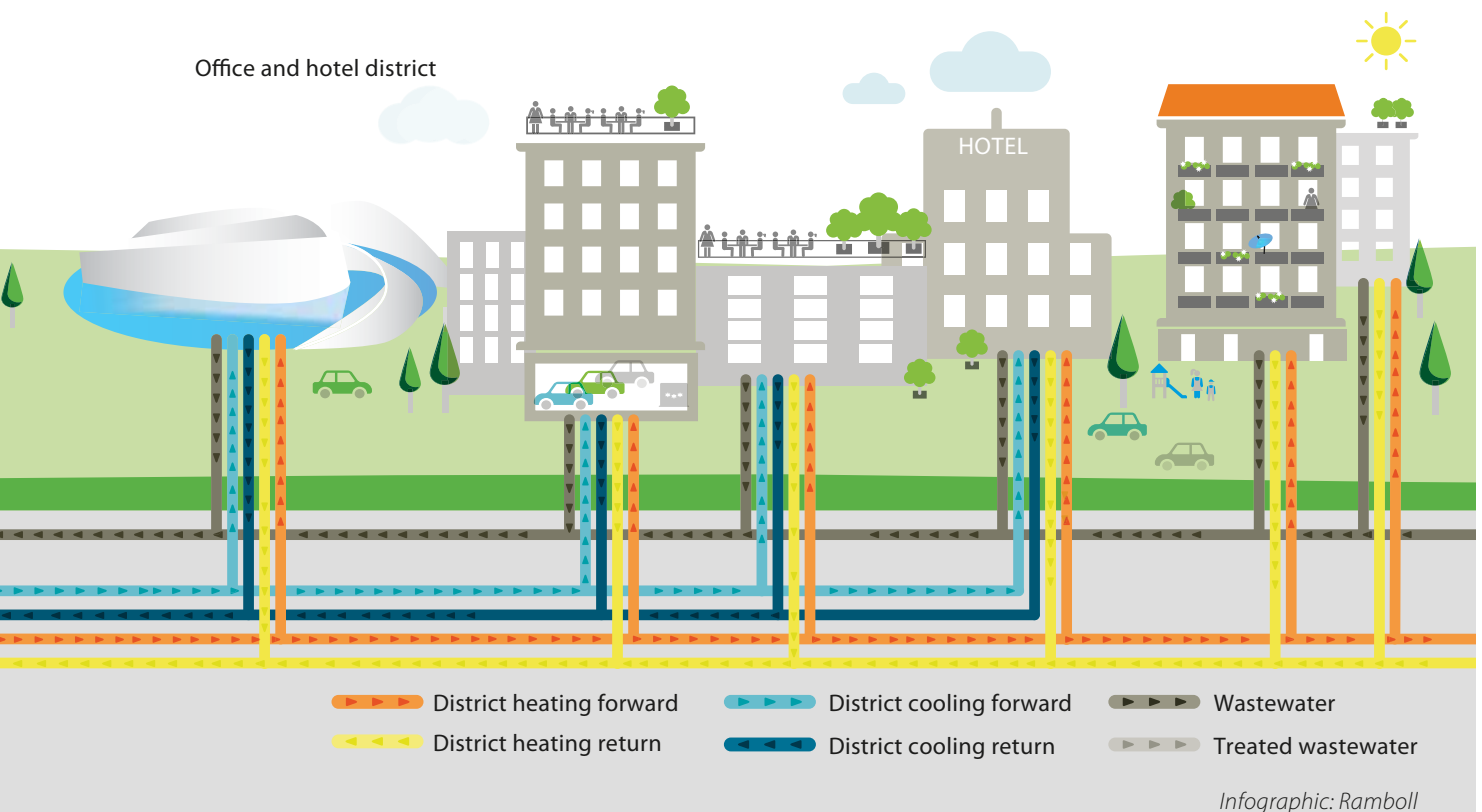


The Taarnby district energy plant is located in the outskirts of the Taarnby waste water treatment plant

Mid 2020. Director of Taarnby Utility, Raymond Skaarup, explains the reasons for establishing the district energy plant here; "There's a lot of new office and business development in the area, which creates a new demand for cooling – as well as offering an opportunity to incorporate green solutions into the new buildings. The location of a wastewater treatment plant in the area was not a barrier against new urban development, as we covered the water basins and established facilities to eliminate bad

smell. This paved the way for the idea of using surplus capacity of the heat pumps to increase the heat production with the ambient heat of the treated wastewater. Finding a location for the energy plant at the outskirts of the wastewater plant was important for the first step of the project, as space for an energy plant in the new urban development area was sparse."

The project is devised by Ramboll consulting engineering company and the main stakeholders are local





The variable speed controlled Sabroe® heat pumps supplied by Johnson Controls

building owners, Taarnby Public Utility and the heat transmission company CTR. Cooperation between these stakeholders and a mutual ambition to seek out an environmentally friendly and cost-effective solution has been key to the development and implementation of the Taarnby facility.

How does it work?

Combined production of district cooling and district heating is becoming standard in many energy facilities around Denmark. But a facility that does this, while utilizing treated wastewater has never been seen before. Project manager at Taarnby Utility, Hasmik Margaryan explains how it works:

“The first priority of the four heat pumps is to generate cooling to the district cooling network and heating to the district heating network in a combined production, which is optimized by a chilled water storage tank and ground source cooling. The second priority is to deliver cooling to the ground source cooling in winter and to the wastewater and thereby extract heat.

Heat from this process is channeled into the district heating system including large CHP plant and heat storages. Serving as a 13 MWh ‘virtual battery’, the 2,000 m³ chilled water storage tank provides flexibility to

interact with the heat market and use electricity when electricity prices are good, or to stop consumption in case of large prices or capacity constraints.

During the first stage of the project, the new facility will have a capacity of 4.5

MW cooling and 6.5 MW heat from four heat pumps and 2.5 MW cooling from the storage tank. When the demand for cooling grows, the second stage of the project will be implemented: adding a ground water source to extend cooling capacity to 9.3 MW.

What is sector coupling?

Sector coupling is a smart way of reducing greenhouse gases and contributing to reaching the Paris agreement in a fast and cost-efficient way. Innovative industries can improve their resource efficiency and reduce greenhouse gas emissions in a sustainable way by improving re-use and recycling through sector coupling.

Ensuring a cost-effective and energy-efficient way of linking the different sources of energy in transport, building, water and industry sectors, sector coupling also improves the penetration of renewable energy sources and decarbonization. With sector coupling you can avoid expensive overinvestments in grid and battery storage.

Stabilizing the power grid is a precondition for the transition to full electrification with a high uptake of renewable energy. Power grid stabilization can be achieved with electricity storage or flexible demand. One way of achieving this is to combine large heat pumps with large chilled water tanks and hot water storage reservoirs in the district energy system, as is implemented in Taarnby. This has proven to be a very cost-effective solution for absorbing surplus green electricity and utilizing excess capacity locally.



What is district cooling?

District cooling is a central facility with a distribution network that supplies building owners in the local area with cooling as an alternative to private installations, such as roof-top chillers. In addition to being a very noisy installation, a private air-condition system with a compressor and a cooling tower on the roof top typically occupies 200 m² of space, where a receiver facility for district cooling makes no noise or vibrations and only takes up 10m². Hooking up to the district cooling network frees up a lot of space that can be used for much more value-adding purposes, such as roof-top terraces or parking spaces, and there will be no refrigerants in the building. To most building owners the gains in terms of saved space are extremely valuable, as are the savings on installing, running, maintaining and renewing their own system.

Danfoss AC drives control pumps and fans

Danfoss Drives has supplied 27 AC drives for phase 1 of the new facility – from small drives for building ventilation to large drives up to 400 kW for controlling the capacity of the heat pumps. The main selection criteria were high energy efficiency and high reliability. Other Danfoss products are also applied at the plant: Danfoss SONDEX® heat exchangers transfer the thermal energy and Danfoss refrigeration controls are used in the heat pump system.



The key team members: From left to right: Antoni Trumulis, Ramboll; Anders Dyrelund, Ramboll; Hasmik Margaryan, Taarnby; Raymond Skaarup, Taarnby.

Key suppliers

Ramboll

Ramboll has supported the utility company in Taarnby in establishing one of the smartest and most advanced district heating and cooling systems in the world. Ramboll has been a trusted consultant for Taarnby since 1980.



Tjæreborg Industri

Tjæreborg Industri is a leading Danish turnkey supplier of district energy plants and systems. They are energy experts and have a large reference list of climate friendly district energy projects.



Johnson Controls

Johnson Controls is one of the world's leading suppliers of commercial and industrial heat pumps. The Sabroe® brand with the famous polar bear logo is well known and respected all over the world as a symbol of strength and integrity.



Grundfos

A global leader in advanced pump solutions, Grundfos develops sustainable water technologies to the world. Our solutions provide safe drinking water for remote villages, treat and remove wastewater, and secure heating and cooling where needed.



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