

Case study: VLT® AQUA Drive FC 202

An **energy-efficient** solution with many benefits: **district cooling** in Copenhagen

Using sea water in its cooling system, the district cooling network in Copenhagen provides buildings in the capital of Denmark with an energy-efficient and practical alternative to individual air-conditioning facilities. Danfoss VLT® drives control the capacity of the district cooling network and contribute to an impressive security of supply.



70%
less CO₂
emission



This building in Tietgensgade, previously the Venstre Elektricitetsværk power plant, is now converted to a cooling central for HOFOR. It supplies businesses and institutions in Copenhagen with energy-efficient and environmentally friendly cooling, based on seawater pumped up from Copenhagen Harbor.

City dwellers trend towards high-efficiency cooling

District cooling is a relatively new concept in Copenhagen. Although district heating was already being supplied to Copenhagen households in the beginning of the 20th century, the first district cooling central was not established until a decade into the new millennium.

The Greater Copenhagen Utility, known as HOFOR, supplies both heating and cooling in Copenhagen: District heating is delivered as a public supply service, but district cooling is a business run on normal commercial terms. In a country located in the cooler parts of the Northern hemisphere, the focus on district heating certainly makes sense. But the demand for cooling is on the increase and the number of customers has been growing steadily every year since HOFOR began to offer the service.

District cooling with sea water

HOFOR's first district cooling central was established in 2008, in a former power station in Adelgade near Kongens Nytorv. Since then, two more cooling facilities have been added to the network; one in Tietgensgade

opposite Tivoli and one in Ørestad, close to Copenhagen Airport. HOFOR are also planning to further expand capacity with new cooling centrals in the North Harbor and South Harbor.

The two cooling centrals in Adelgade and Tietgensgade use sea water from Copenhagen Harbor for their cooling systems. Between them, the two centrals have a capacity of around 65 MW. During the winter, when sea water temperature is below 5.2 °C, the system pumps sea water through a heat exchanger and the treated water on the output is sent out to customers as free cooling. During the warmer months of the year, the passive sea water cooling is combined with active compressor cooling. HOFOR pumps 6 °C cooling water out to the end users and 6 °C water is returned. But customers are advised to scale their systems to a supply temperature of 8 °C, as the cooling water may warm up slightly on its way through the heat exchangers.

For their cooling centrals, HOFOR have chosen to install Danfoss VLT® drives to control the capacity of all pumps

and compressors. So far, the facilities have been running with impressive stability, with minimal downtime and a security of supply of 99.9803%. During the first seven years, HOFOR have only experienced a couple of hours in total, where they were unable to deliver cooling water at the prescribed output temperature.

VLT® drives also contribute to ensuring very high energy efficiency due to an efficiency of more than 98%. From November to April, where sea water can be used directly as free cooling, the system's COP (Coefficient of Performance) is double-digit while, on average over a year, it is approx. 7.

Located too far away from the sea to use sea water, the facility in Ørestad is based on an air-to-water pump. This setup cannot compete with the outstanding COP from sea water cooling, and the facility is only intended as backup in emergency situations and during periods of peak demand.

More discover the benefits

HOFOR's district cooling customer list includes hotels, shopping malls and real-estate companies, as well as public institutions such as The National Museum, The National Gallery of Denmark, Copenhagen University and National Hospital. More new customers are joining all the time. This steady intake is partly due to customers discovering the benefits of not having to run their own air-conditioning facilities, and partly because the demand for cooling is actually going up.

Business developer at HOFOR District Cooling, Admir Omeragic explains that 50% of his customers use district cooling for comfort cooling, 40% are using it for process cooling and 10% for freezing facilities. This means that around half of the district cooling capacity is used to maintain a comfortable indoor climate in offices, shops and other places where many people share facilities. The 40% used for process cooling applies to server rooms, processing facilities or hospital equipment. Admir Omeragic explains:

"There are so many machines running in our surroundings that we don't really notice them on a day-to-day basis. CT-scanners, postal sorting machines, servers – they all need cooling to function. Over recent decades, we have also become much better at insulating our buildings to reduce heating consumption. This means that the demand for cooling goes up during warm weather. And these days, where most new offices are built with

lots of glass, the indoor temperature rises much faster when the sun is out. On top of that, there's an increasing tendency to spend more time at work. All of this means that the demand for cooling has increased."

Customers save money, space and hassle

Receivers of district cooling in Copenhagen enjoy a number of benefits – it costs less, it takes up less space and it makes no noise. Where traditional roof-top chillers, with a compressor in the basement and a cooling tower on the rooftop, typically occupy around 200 m² of space, the receiver facility for district cooling takes up only 10 m².

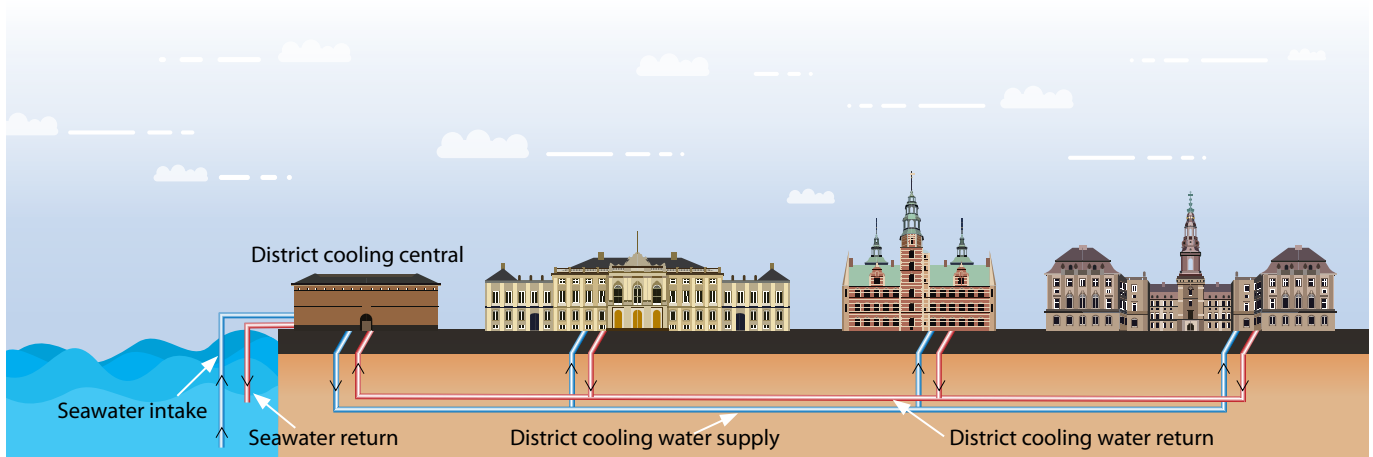
Buildings that are connected to energy-efficient district cooling can achieve cost savings of up to 40%, also eliminating all the operational and maintenance unknowns in an

air-conditioner budget. A traditional roof-top condenser typically has a life expectancy of 10-15 years, but a major part of the city's existing air-conditioning facilities needs to be replaced during the next couple of years, because they are using refrigerants that are damaging to the environment and are in the process of being phased out due to stricter legal requirements.

"We are getting a lot of feedback from customers who are so happy to have got rid of their noisy roof-top chillers. And customers who have replaced their old air-conditioning facility with the much smaller receiver setup can now put the freed-up space to better use. We have seen several places where the square metres they have gained have been transformed into a roof terrace, which is very attractive for residents, and increases the value of the property," says Admir Omeragic.



VLT® drives regulate the capacity of all pumps and compressors with impressive stability. Uptime is optimized and there is 99.98% security of supply.



Schematic diagram of the HOFOR seawater district cooling (SDC) system in Copenhagen



*Business developer at HOFOR District Cooling, Admir Omeragic:
"Even during this extremely hot summer we've just had, where everything has been running at full power, everything has worked perfectly"*

And contrary to what is usually the case when running your own facility, district cooling is also more flexible, as the cost of upscaling is considerably lower compared with having to rebuild your own system if you need more capacity.

Why HOFOR prefers Danfoss

Contributing to high energy efficiency in HOFOR's district cooling facilities, VLT® drives also ensure an impressively high security of supply of 99.9803%. "Right from the beginning we chose to go with quality products from Danfoss in our facilities and we have never regretted that. It was easier for us to get an overview over the specifications and, on all parameters, such as maintenance, standards, efficiency and running costs, they have turned out to be optimal. We have had no problems whatsoever, even during this extremely hot summer we've just had, where everything has been running at full power, everything has worked perfectly," says Admir Omeragic.

Everybody wins: one technical challenge

District cooling with sea water is a win-win story, not only for the environment but for everyone – financially as well as operatively. The only technical challenge is that mussels and dirt grow and build up on filters, pipes and pumps, clogging up the system. The problem cannot be solved with fine mesh filters because the water cannot be pumped through them fast enough. Instead, the answer is a cleaning pig – a plastic sponge that moves through the pipes, cleaning them on its way. The cleaning pig is sent through the system three or four times a year, then it is retrieved out of the harbor when it drops out with the return water.



The Greater Copenhagen Utility, known as HOFOR, supplies drinking water and manages wastewater treatment for several municipalities in the Danish capital region. HOFOR supplies district heating, district cooling and natural gas, as well as investing in renewable energy, contributing to the climate goals of Copenhagen Municipality, which aims for CO₂ neutrality in 2025.