

# District cooling

Keeping the city cool during summer periods



# Introduction

The need for cooling down buildings in Copenhagen has increased in the last many years. Server rooms need to be cooled down in all months of the year. Offices and shopping malls require a comfort temperature even outside the summer, even though the summer in Copenhagen can be warm and local peaks very hot. Therefore many large commercial buildings and office buildings (e.g. data centers, server rooms) and public buildings (e.g. hospitals, libraries etc.) have cooling today, and the demand is expected to increase in the future. Traditionally, buildings are cooled down with local electricity consuming compressors, but the ineffectiveness and CO<sub>2</sub> emission of the local production is not supporting Copenhagen's ambition to become CO<sub>2</sub> neutral in 2025. Therefore the building owners demand more environmental friendly cooling production as for example District cooling.

## District Cooling

### What is district cooling?

District cooling is the distribution of cold water to buildings in need of cooling. The water is cooled at a cooling plant, primarily based on the use of cold seawater. The production of cooling itself can be done CO<sub>2</sub> neutral from October to May. The cold water is distributed through pipelines directly to customers, delivered in the basement through heat/cool exchangers, which use the cold water to cool the water in the buildings own systems. The water is then sent back to the central cooling system, where it is cooled again.

In principle district cooling works like district heating because the production is handled centrally. The supply of cooling takes place through a coherent system of pipes, similar to the existing system for the distribution of heating. The concept is illustrated below:

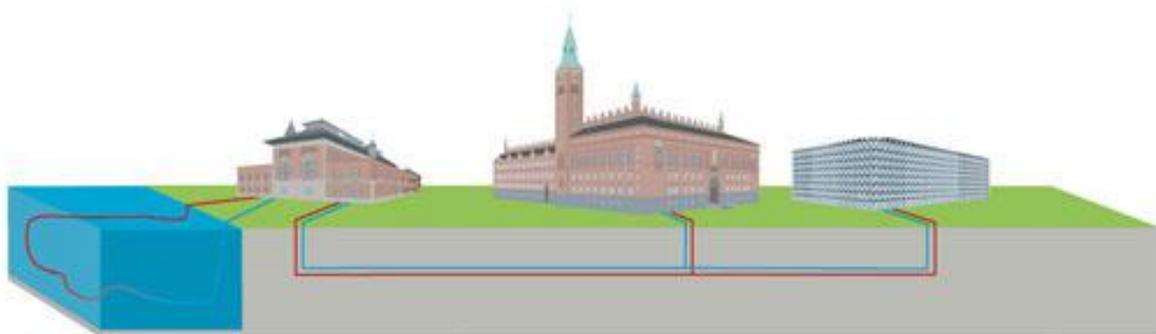


Figure 1. The concept of district cooling. Source: HOFOR Fjernkøling A/S.

Essentially cooling in the City of Copenhagen is produced centrally in three different ways:

- During the winter months cooling is produced using sea water that is brought into the cooling plant

through a pipe between the port and the cooling central. This production of cold water from seawater is completely carbon neutral and is called free cooling. However, a small amount of electricity is consumed when the cold water is pumped to customers.

- During summer months, the sea water is not cold enough to be the only source to be used for cooling production. During this period cooling is produced using waste heat from power plants. This method is called absorption cooling.
- When the demand for cooling is very large, and enough waste heat is not available, the heat production is supplemented by electric compressors. This cooling form is the most CO<sub>2</sub>-emitting. However, huge and efficient compressors are used in the cooling plant, so the electricity used for cooling is less than for local compressors.

Since approximately 30% of the production of cooling is based on free cooling, the total CO<sub>2</sub> emission from the district cooling production is lower compared to local cooling production. Therefore it is a better alternative than local, decentralized plants.

## **Advantages of district cooling**

There are many advantages to switch from decentralized cooling to district cooling, and by using water from e.g. the Copenhagen Harbor for cooling natural resources are used more sustainably. In this way CO<sub>2</sub> emissions are reduced as well as the customer's operational and space problems, since all operations and distribution takes place centrally in a professional cooling center.

The benefits of district cooling include:

- Environmental benefits - significant CO<sub>2</sub> reductions (up to 70%)
- Easy operation and high security of supply
- Flexible power requirements - with district cooling, the cooling demand can easily be increased
- Reduced investments and operation costs
- Phasing out environmentally harmful refrigerants (e.g. CFC-gases)
- A wide range of production methods and always the latest type of equipment
- Less noise and space requirements
- Simple payment methods

## **The political context**

For many years no regulation was in place to allow for district cooling. The first regulations were passed in 2008 to make it possible for companies to invest in district cooling systems.

## **Planning regulation**

The current regulations for municipal district cooling companies are based on the "Act on municipal district cooling", which is an implementation of the Danish Energy Agreement of 21st February 2008. The purpose of the regulation was to allow municipalities to establish and operate district cooling

plants, in such a way that private district cooling companies are not exposed to unfair competition, and heat consumers will be protected against economic risk.

The district cooling in Copenhagen “HOFOR Fjernkøling A/S” is a municipal company part of the HOFOR group, which is owned by the City of Copenhagen. The law limits the activities of the municipalities to invest and finance capital to guarantee or provide subsidies for cooling activities. If a municipality wishes to establish a cooling company the financing has to be included in the municipal budget. In addition, the cooling system is placed in an independent company with limited liability.

The City of Copenhagen requires a project approval in order to expand the cooling business further than already planned.

Currently the “Act on municipal district cooling” applies to central cooling production based on two types of cooling: absorption cooling and free cooling. Absorption cooling uses hot water to produce chilled water and free cooling is based on local resources (water from the sea, ports, etc.).

## **Financial incentives**

In principle the financial incentives of district cooling are the same as for district heating. By connecting to a district cooling net ongoing operating and maintenance costs are avoided at consumer level.

When replacing a decentralized cooling system with district cooling, it means that maintenance costs for chillers, free cooler, components and control panels disappear for the customers. Furthermore, the consumer saves the costs of consultants, service, operation and maintenance and not least his own time consumption.

Some of the financial incentives of district cooling are:

- The cheapest way to a green profile (related to fulfilling a cooling demand)
- Lower energy costs
- Lower capital costs
- Lower operating and maintenance costs
- Easy payment of utility bills, which leads to increased transparency of costs
- Future-proof investment
- Leases become more attractive

By the end of 2014, many companies will have to change their decentralized cooling systems because of ban on CFC-gases. Economically, it may be advantageous to replace old decentralized cooling systems with district cooling. In most cases (depending on the overall cooling demand), district cooling is cheaper over a 20-year period.

## **Organisation**

In the City of Copenhagen district cooling is being supplied by the company HOFOR FjernkølingA/S.

HOFOR Fjernkøling A/S is part of the HOFOR group, which is supplying cities with water, sanitation, district heating, city gas and district cooling and electricity from wind turbines.

HOFOR provides the cities of Albertslund, Brøndby, Dragør, Herlev, Hvidovre, Copenhagen, Rødovre and Vallensbæk with water - and is also responsible for the discharge of wastewater and rain water in the same cities except Brøndby and Vallensbæk.

In addition to water supply, the company also supplies Copenhagen with district heating, city gas and district cooling - and is involved in several wind projects both inside and outside Copenhagen.

HOFOR has been given the English name "Greater Copenhagen Utility", which can be used when it is referred to in English.

HOFOR's vision is to create sustainable cities based on climate and environmentally friendly supply solutions. Co-operation is one of the cornerstones of HOFOR's philosophy. This applies to co-operation across municipalities, with the industry and customers.

Co-operation is particularly important for water and waste water, because water routes do not respect municipal boundaries, and because the water circuits in the metropolitan area are linked. Therefore the establishment of HOFOR is a result of a recent merger of water and wastewater companies in Albertslund, Dragør, Herlev, Hvidovre, Copenhagen and Rødovre and water companies in Brøndby and Vallensbæk.

HOFOR Fjernkøling A/S began its district cooling activities in the middle of 2008 and its principal activity is the production, distribution and sale of district cooling for customers in Copenhagen. The company meets the demand throughout Copenhagen and has strong competencies within the value chain from sales process to the daily operation of the plant.

The two district cooling centrals one near the City Hall (Cooling plant, Tietgensgade) and the other near the King's Square (Cooling plant, Adelgade) in Copenhagen, is the first step in the company's efforts to ensure environmental friendly cooling to Copenhagen businesses. The plan is to introduce district cooling in several places in the capital city and to expand the network in step with the influx of new customers.

The cooling central at the King's Square (Adelgade cooling plant) in the heart of the city currently has a capacity of approx. 18 MW and supplies some of the properties in the inner city.

Some of the upcoming projects suggested by the company are estimated to save the atmosphere for up to 30,000 tons of CO<sub>2</sub> per year. The customer base is expected to increase from almost 8 MW in 2010 to 53 MW in 2015.

# Sustainability

District cooling provides clear environmental benefits and is better for the environment than the cooling produced in decentralized local units. Local cooling systems produce cooling less efficient and use electricity from the grid based on a larger share of fossil fuels. District cooling systems can, however, use CO<sub>2</sub>-free or nearly CO<sub>2</sub>-free energy sources a large part of the year.

HOFOR's cooling plants are the first steps to ensure environmental friendly cooling in the metropolitan area.

In the future, HOFOR's goal is to make the production of cooling completely CO<sub>2</sub> neutral. This is done by optimizing the production of cooling. If there is wind energy in excess, cooling will be produced on electric cooling systems. If there is much excess heat, absorption cooling systems, which use steam in the process of producing cooling, will be used. This flexibility is unique to district cooling, and will in the short term lead to significant savings in CO<sub>2</sub> emissions. The implementation of CO<sub>2</sub> neutral production will be adjusted to the market situation.

HOFOR's vision is to save the atmosphere of 30,000 tons of CO<sub>2</sub> per year when all upcoming cooling centers and distribution networks are established.

The idea behind district cooling is the use of local resources for cooling purposes, which would otherwise be wasted. The use of these local resources will make cooling competitive with conventional cooling solutions. Some specific environmental benefits are:

- Reduced CO<sub>2</sub> emissions (up to 70%)
- Electricity savings (up to 80%)
- Cooling centers use CO<sub>2</sub>-friendly sources of energy
- Beautification of the cityscape - no split units on the roofs and facades

The City of Copenhagen's ambition is to become CO<sub>2</sub>-neutral by 2025. HOFOR has therefore developed a climate action plan, which will help to drive development towards a CO<sub>2</sub>-neutral future.

In addition to contributing to a better environment, business can by connecting to district cooling also reap economic benefits, increased reliability and space savings.

# How to get started?

In order for district cooling to be implemented in a larger scale, the policy and the regulation must be somewhat conducive and help reduce risks associated with district cooling. Major risks include uncertainty regarding fuel price developments and technological developments.

A good first start would be to:

- Co-operate with existing district heating companies regarding know how
- Identify customers with a potential cooling demand
- Estimate the cooling demand of the customers
- Analyze production possibilities and estimate production cost and CO<sub>2</sub> emissions
- Measure the price of a district cooling system against geographical location and cooling demand in order to assess, if the cost reductions compared to the establishment of a decentralized facility justifies the founding of a district cooling system



Figure 2. Mapping of district cooling potential. Source: HOFOR Fjernkøling A/S.

This analysis would be useful in order to evaluate the district cooling potential and the business case before proceeding into the implementation phase.

## Getting the organisation right

District cooling systems involve long-term investment of considerable volume. In order to acquire this capital a strong organization should be built with capacity to establish and run a district cooling business. In practice most district cooling systems are owned and run by local authorities as in Copenhagen. Even if the local authorities are not directly involved in the organization, close ties are needed to secure a coherent long-term planning, where grid expansion plans tie into major urban development or re-development plants.

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