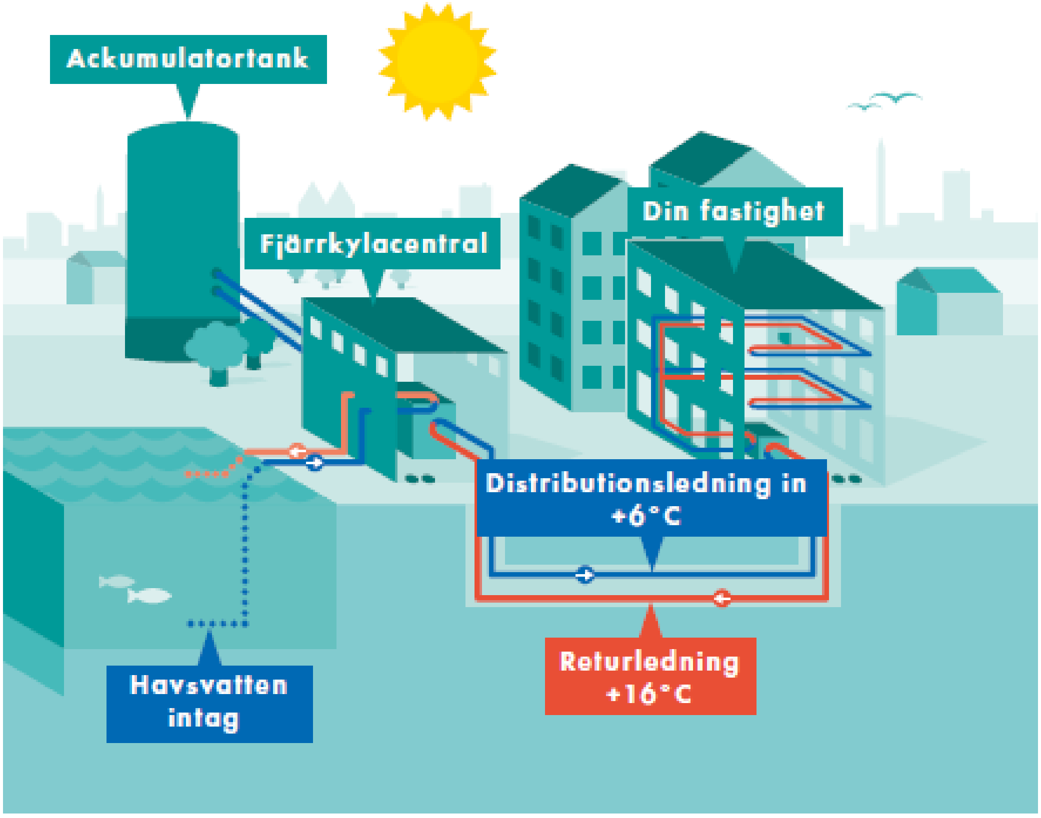
Description and Summary Helsingborg District Cooling Expansion and reengineering



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Project information

Project name: District Cooling Expansion & Reengineering in Helsingborg

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Summary

In the city of Helsingborg in Sweden, the municipal energy company Öresundskraft supplies District Cooling to a variety of customers in the downtown area. Customers include large users such as a pharmaceutical production facility and a major hospital together with an array of offices and other commercial buildings. The system that has been in operation since 1999 has now been reengineered to allow for an expansion to 30 MW (thermal) cooling capacity and to significantly improve energy efficiency and environmental performance. The new production mix includes the use of cold sea water and absorption chillers powered by surplus heat from industrial processes and waste incineration. It is this reengineering project that is now nominated for the Global District Energy Climate Awards.

District Cooling is based on central production of cold water which is distributed to customers in a closed loop under-ground pipe network. Production of cooling can be based on various sources and technologies including Not-In-Kind (NIK) chillers. In some cases, the cooling is obtained from natural sources such as seas, lakes, rivers and ground water. Where excess heat from industrial production or electricity generation is available, NIK absorption chillers can be used to produce cooling. At the customer end of the system, the cooling is transferred to buildings in energy transfer stations (ETS).

District cooling can be introduced both in existing building populations and in green field developments. Introduction in existing building populations require an amount of retrofitting to existing building air-conditioning and ventilation systems to adapt to DC. Furthermore, constructing of the underground distribution system normally requires careful planning and additional cost compared to green field areas.

The project in Helsingborg includes the construction of a new cooling production station housing industrial scale absorption chillers, sea water heat exchangers and large sea water pumps to mention a few pieces of main equipment. Another essential part of the project is the construction of a sea water intake and outlet pipe system with various filters and strainers. All designed to have a minimum impact on the underwater flora and fauna. The project has undergone an extensive environmental impact assessment and has obtained all necessary permits.

The project was initiated in 2015 to meet the increasing customer demand for District Cooling and to further improve the environmental benefits of the service. It was found that the combination of using sea water and absorption cooling technology for the expansion rendered the highest energy efficiency and obviated the use of environmentally hazardous refrigerants such as HFC. The design was completed in 2016, construction commenced by mid-2017 and the facilities have been fully operational since the second half of 2018.

Motivation

The main reasons for nominating the District Cooling expansion project for this award are that: Öresundskraft by this initiative makes a superior, sustainable and competitive cooling service available to customers on a city-wide scale; it addresses both the phasedown of hydrofluorocarbons (HFCs) and improved energy efficiency at the same time; it utilises sources that are renewable or that otherwise would be wasted; the project can act as a show case in demonstrating the concept to others.

Öresundskraft is one of the largest Swedish energy companies supplying electricity, district heating, district cooling, natural gas and biogas. The company has very high sustainability ambitions and the energy strategy is built on four pillars: minimising end use of energy; minimising losses in all stages; making use of rest products and recovering energy; adding renewable energy.

Under the Kigali Amendment of the Montreal Protocol, 197 countries committed to drastically cut the production and consumption of hydrofluorocarbons (HFCs), which are potent greenhouse gases used in refrigeration and air conditioning. The amendment also calls for increased focus on energy efficiency to further reduce the increase in global warming. Not only the global society, but also the EU focuses on energy efficiency, and the EU Energy Efficiency Directive states that district cooling has significant potential for saving primary energy. Such focus on energy efficiency makes a lot of sense since the vast majority of the global warming impact from air conditioning and refrigeration is due to indirect emissions related to energy use.

District cooling in general is a powerful tool in HFC phase-down through the following mechanisms: city or district wide centralization reduces refrigerant charge even if conventional chiller technology is adopted for producing district cooling; the large-scale nature of district cooling allows for utilization of energy sources otherwise not available minimizing the need for chillers of any kind; use of natural refrigerants is highly feasible in central district cooling production units where flammable and hazardous substances can be effectively managed and controlled.

The district cooling expansion project in Helsingborg is a very good example on how phase down of HFCs and increased energy efficiency can be achieved at the same time and on a city-wide scale. Expanding the system not only improves the climate, but also reduces noise in the downtown area by the avoidance of building individual cooling towers and fans.

In an international workshop on District Cooling and Not-in-Kind technologies with participants from the private sector, international organisations and academia arranged by the Swedish Environmental Protection Agency in September 2016 one of the conclusions was that a first step in capacity building is to increase awareness of how NIK and District Cooling can contribute to the global environmental targets by informing about successful cases. The project in Helsingborg is one such case that will contribute to further dissemination of knowledge and outreach activities.

Project results

System Energy Efficiency

The reengineered system, in its first expansion step, delivers 19 GWh/year of cooling to customers using 2,4 GWh/year of electricity for production and distribution of the cooling. Hence the annual system energy efficiency ratio is 7,9 in this first step. Fully built out the reengineered system will have an efficiency ratio of 16,4.

The base load production is free cooling from the sea and absorption cooling based on surplus heat from industrial processes and waste incineration. These sources have the primary energy factor 0.

Using the default primary energy factor for electricity of 2,6 the primary energy factor of the first step district cooling expansion is 0,3. For the fully built out system and with the use of renewable sources for electricity production the primary energy factor will be as low as 0,09.

Greenhouse gas emission reduction

Emission reductions achieved by the project are due to increased energy efficiency and to using technologies avoiding the use of hydrofluorocarbons as refrigerants. To quantify the emission reductions, the results of the first 5 MW expansion phase of the project have been calculated.

The basis for the calculations are that by adding sea water cooling and absorption cooling technologies to the district cooling production mix, the system becomes more energy efficient. On top of that, more customers can be connected due to the expansion and thereby relatively inefficient building individual chillers can be avoided. Avoiding such local chillers results in further reduced energy demand and that the use of hydrofluorocarbons is avoided since the district cooling expansions takes place without using such substances.

The overall improved energy efficiency results in less electricity generation and thereby less emissions to the atmosphere. The reductions of carbondioxide emissions have been calculated based on the emission factor 336 g/kWh of generated electricity, as recommended by the Swedish heat market committee.

The avoided use and leakage of HFC have been calculated based on the assumptions that the charge of HFC in the omitted local chillers are 0,3 kg R-410a/ kW installed cooling capacity, that 7 MW such capacity is avoided and that the annual leakage is 2%. The total annual reduction of CO_2-equivalents is 1173 tonnes of which energy efficiency accounts for 92%.

Benefits for the climate are achieved by the direct and indirect emission reductions described above, i.e. annually reduced emission of 1173 tonnes CO_2 equivalents.

Environmental benefits

Energy efficiency of the project results in avoided electricity generation and thereby reduced emissions to the atmosphere caused by such electricity generation. However, the emissions of pollutants other than CO_2 have not been calculated.

The expansion of district cooling in Helsingborg brings with it a couple of major benefits to human well-being. By avoiding building individual chillers and cooling towers, many sources of noise and vibrations are also avoided to the benefit of those working and living in the downtown area.

Avoiding local cooling towers also brings the benefit of reducing the risk for spreading Legionnaires' disease, which is a form of atypical pneumonia caused by any type of Legionella bacteria.

Innovation and replicability

The combined use of natural and domestic sources to produce energy efficient and sustainable district cooling is one of the major benefits of the project. Part of the innovation is also that the expansion is based on absorption and other technologies not using HFC or other hazardous refrigerants.

District Cooling can be implemented at different scale and in various built environments such as airports, resorts, campuses and entire cities, why the potential is truly global.

District Cooling as implemented in Helsingborg demonstrates how natural and domestic energy sources, that would otherwise be lost, can be used to supply competitive and sustainable cooling in smart urban developments. The solution used in Helsingborg can be an inspiration to others and can be implemented in full or in part depending on local conditions and sources.

Community involvement

Several parts of the community have been engaged in the development of the expansion and reengineering. Region Skåne, which is the regional organisation responsible for health care and public transport, business development, culture, infrastructure, social planning and environmental and climate-related issues in Skåne, have together with Öresundskraft provided a strategic directing through a letter of intent aiming at energy efficient solutions. The environmental permit process has been open to public review and comments. The private sector has been essential in providing demand for a sustainable service and by the supply of surplus heat to the district heating and cooling systems.

Supporting documents

Energy and emissions calculation