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5 Unitop® 50FY heat pump / chiller units simultaneously generate 90 MW heat energy and 60 MW chilled water

Client

Helsinki Energy
00090 HELEN, Finland

Helsinki is a fast growing area

With a population of about 560,000 inhabitants (Greater Helsinki area approx. 1.0 mil.), Helsinki is located at the sea in the southernmost part of Finland. In winter, ambient temperatures drop as low -25°C for longer periods. In the summer, the climate is relatively warm and temperatures rise up to 25°C or even higher.

Helsinki Energy

Helsinki Energy is one of the largest Finnish service companies in the energy sector. Customers are industrial and business enterprises, energy companies, municipalities, real estates and private consumers using electricity, district heating and district cooling.

Helsinki Energy supplies electric energy to over 300,000 customers in different parts of Finland. Among the services provided are the design, projecting and maintenance of energy production and distribution systems. It produces and supplies district cooling energy and provides IT services to business buildings. With annual district heating sales exceeding 6,000 GWh and serving 13,000 customer premises, most of which are residential buildings, Helsinki Energy is the largest energy company in Finland producing, distributing and selling district heat.

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Helsinki Energy is a leading company for combined heat and power (CHP)

Helsinki Energy produces district heat effectively with combined heat and power production. Thus, the plants produce both electricity and heat with the highest possible efficiency, as opposed to separate electricity production, where the heating energy generated as a by-product is lead to the sea and lost.

The CHP solution also offers a number of environmental benefits, including lower fuel use and controlled emissions. In Helsinki, CHP use typically results in a fuel consumption efficiency rate exceeding 90%.

By comparison, an equivalent quantity of fuel used solely for generating electricity would result in a maximum fuel consumption efficiency rate of 40–50%.

Helsinki Energy is one of the world's leading CHP specialists, and Finland one of the leading countries in this field. Helsinki's CHP-based district heating system was awarded the United Nations Environmental Prize in 1990 – and Helsinki Energy's CHP and district heating expertise has been used in Korea, China, Japan, Canada, Britain, and Russia.

Significant reduction of emissions

Most of the heat energy in Helsinki is produced with natural gas. The use of natural gas creates no particle or sulphur emissions, and its carbon dioxide emissions are considerably lower than with other fossil fuels.

The emissions from the power plants in Helsinki have reduced significantly since 1990. Dust emissions have been cut down by 89%, sulphur dioxide emissions by 82% and nitrogen oxide emissions by 72%. Emission reductions have been achieved mostly with combined production, use of natural gas and constantly refined production techniques.

District heating...

The move from individually heated buildings to centrally generated district heat began in the 1950s, and district heat now covers over 90% of the city's infrastructure. Low individual chimneys have almost vanished from the urban landscape.

The reliability of the district heating network is very high in Helsinki. It is

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designed with loops allowing distribution to customers via several alternative routes, if required. Looped networks increase distribution reliability considerably.

The operation of Helsinki Energy's district heating network is constantly monitored, limiting interruptions to a minimum.

...and district cooling

Since the late 1990s, Helsinki Energy is also constantly developing its district cooling system.

One of the main reasons for the growing popularity of district cooling is seen in the increased concentration on core business activities of companies and subsequent outsourcing of building services. Another reason for the growing popularity of the service is its environmental friendliness and cost-effectiveness compared to conventional technology with local installed small air conditioning units.

From Helsinki Energy's point of view, district cooling also enhances the energy efficiency of CHP production even further. Along with electricity and district heat sales, district cooling constitutes a new form of energy service.

Development of district cooling

The capacity of the first district cooling plant located at the Salmisaari power plant is 10 MW. It consists of two absorption chillers and a 1,000 m^3 chilled water storage tank to cope with peak loads. Between the years 2002-2006 another district cooling plant was built in the Salmisaari power plant area. The total capacity of this plant is 28 MW.

The chilled water is distributed via the underground district cooling network to office and business buildings connected in the district of Ruoholahti. Since the year 2002, district cooling has been supplied to office buildings in the district of Hermanni and Vallila. Transportable cooling units produce the required cooling energy until a cooling plant and corresponding distribution network for district cooling are constructed in the area.

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Energy distribution tunnels

Helsinki Energy operates close to 30 km of multi-utility tunnels excavated in bedrock. They contain water-, district heating- and district cooling pipelines, electric cables up to 110 kV as well as electric and telecommunication cables for domestic purposes. The size of the tunnels allows travelling by car.

Due to the growing demand, Helsinki Energy has increased its district cooling production capacity significantly with the new Katri Vala installation.

A distribution network is built to connect the city centre of Helsinki and the district of Sörnäinen to the new plant.

Katri Vala combined district heating and district cooling plant

In a rock cavern excavated beneath the Katri Vala Park in the Sörnäinen district of Helsinki, the heat-pump plant is generating district heat of 88°C and simultaneously chilled water with a temperature of 4°C for district cooling purposes.

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Excavation work for the installation started in summer 2004 and the plant has been in commercial operation since autumn 2006.

The Katri Vala installation is connected to the Suvilahti seawater pumping station via a 600 m long multi-utility tunnel.

"First, the seawater pumping station will only serve the Katri Vala heat-pump plant. By 2020, the pumping station will also serve the future Suvilahti and Pasila district cooling plants" says Mr Veijo Noponen, who is a process designer and installation supervisor at Helen Engineering, a business unit of Helsinki Energy.


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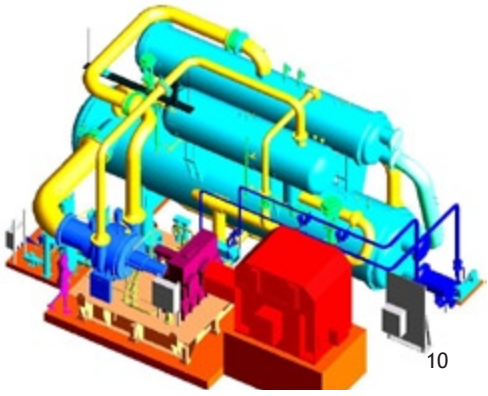
"In winter, the energy for district heating is extracted from treated domestic sewage flowing through the evaporators of the heat pumps, downstream of the Viikki sewage works and cold seawater is used for producing district cooling in free-cooling mode. In summer, the heat pumps produce heat continuously also in cooling mode. While the chilled water is completely absorbed by the district cooling system, the surplus heat energy is discharged into the sea water", explains Mr. Noponen.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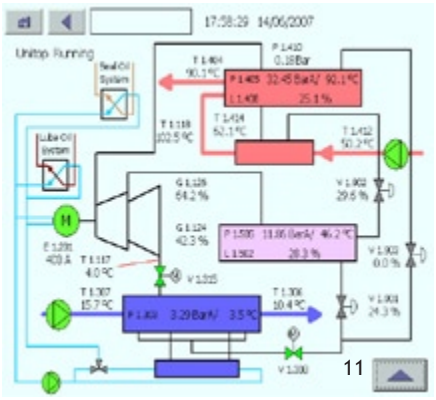
New 10,000 m³ chilled water storage facilities connected to the multi-utility tunnels are planned in the city centre. They are charged during the night when cooling energy sales are generally lower. The energy stored is used during the next day at peak load hours. The storage process enables the operation of the heat pumps at maximum efficiency.

Five Unitop® 50FY heat pumps

The Katri Vala installation comprises five electric-driven Unitop® 50FY heat pumps leaving space for a sixth unit. Each heat pump consists of the Uniturbo® 50FY compressor with integrated lube- and seal oil systems, all factory assembled, completely piped and wired up and delivered to site as a single lift package. The high-efficiency heat exchanger package is also pre-assembled in the works. It consists of evaporator, condenser, subcooler and intermediate pressure vessel. Dismantled again, the package is supplied to site in various parts of still impressive size.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Enhanced finned tubes of the latest design are used for optimal heat transfer and highest performance of the heat exchangers. Materials are selected to perfectly match the requirements of the heat transfer fluids.

Advanced plant control system

The control and logic system is based on the latest Siemens PLC equipment designed especially for use in industrial environments. Each Unitop® 50FY heat pump is equipped with its own PLC, touch screen, and is connected to the field components like pressure- and temperature sensors, actuators, electric motors, contactors and switches.

The control and logic system is designed for fully automatic operation of the heat pump plant. For remote operation, a link is provided via Modebus to Helsinki energy's main control room where operators monitor Helsinki's whole district heating and district cooling networks.

Flexibility for high energy efficiency

Unitop® 50FY chillers offer all imaginable flexibility regarding use of heat sources. Picture no. 12 shows the integration of the Unitop® 50FY heat pump at Katri Vala.

Winter operation
The temperature of the sewage is higher than the seawater temperature, resulting in a favourable COP of the heat pump. (Valves B, C+ D open, Valve A closed). The district heating water is preheated only by the heat pump to 62 °C, thus further enhancing the overall COP. The heat energy generated is completely absorbed by the district heating network, while the district cooling demand is covered by using cold seawater in "free cooling" mode. (Valves G open, valves E, F + H closed).

Summer operation
There is a considerably smaller demand of heat energy during the warm season.

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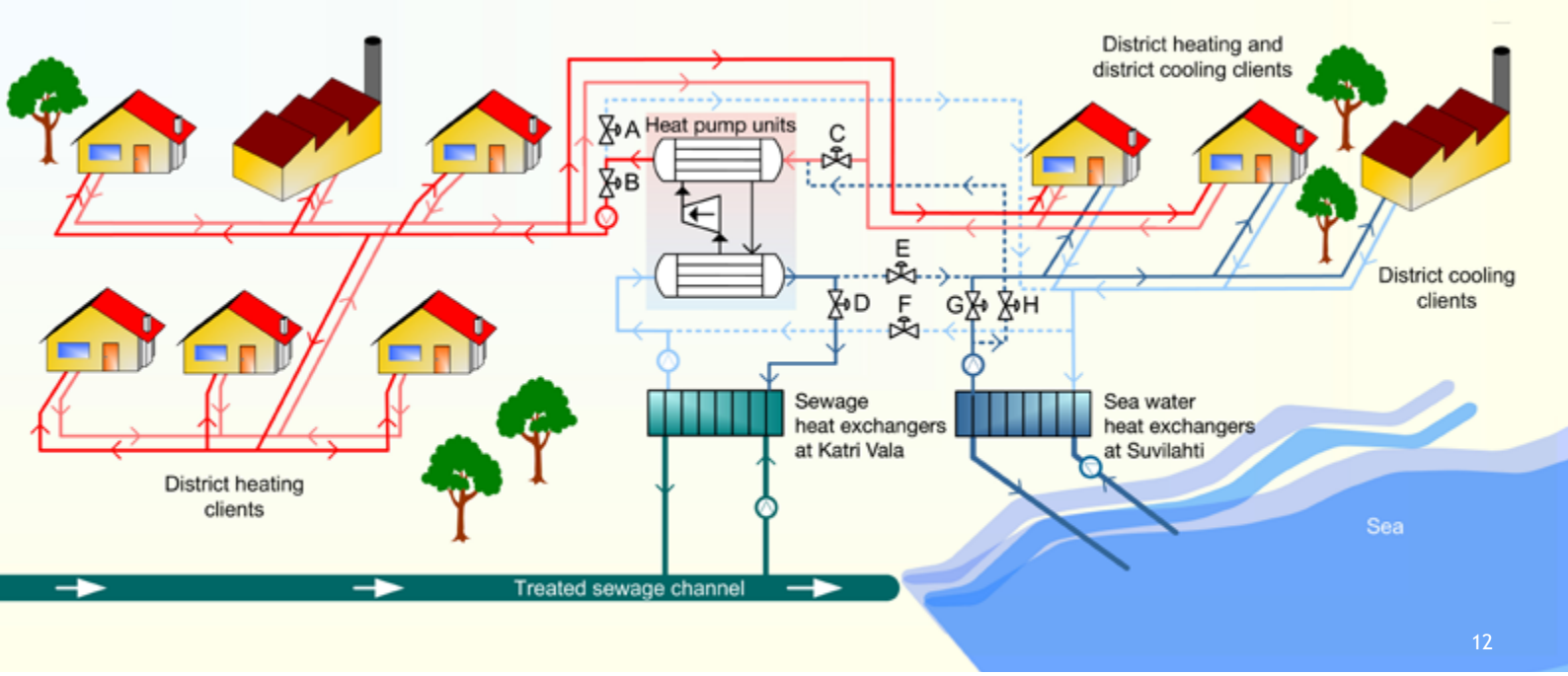

Thus, the Unitop® 50FY heat pumps are able to produce the full temperature lift required. The chilled water produced is absorbed completely by the district cooling system. During times without heat load, the condensing temperature is lowered to match with sea water conditions and the heating energy is rejected to the sea, resulting in a very high COP. (Valves A + H open, Valve B + C closed, Valves E + F open, Valves D + G closed).

Main features of the Unitop® 50FY

- Open-type two stage compressor
- Refrigerants: halocarbon / hydrocarbon
- Tough industrial design with vertically split casing for easy maintenance
- Suited for all drive systems
- High efficiency across the entire operating range
- Operating temperatures -40°C / +90°C
- Operation in series or in parallel
- Large capacity, small floor space

Service and maintenance

Specialists of Helsinki Energy are maintaining the Unitop® 50FY heat pump during normal operation. Under a special agreement, Friotherm carries out the regular service works on the five heat pumps.

Technical data:

5 Heat Pump Unitop® 50FY, each

Winter operation:	
Heating capacity	16,770 kW
Heating water flow	1,221 m³/h
Inlet/outlet temperature	50/62 °C
Power absorbed	4,770 kW
Electric motor	6,500 kW
Voltage	11 kV
Heat source (cooling) capacity	12,000 kW
Sewage in/out temp.	10/4 °C
Summer operation:	
Heating capacity	18,113 kW
Heating water flow	370 m³/h
Inlet/outlet temperature	45/88 °C
Power absorbed	6,113 kW
Electric motor	6,500 kW
Voltage	11 kV
Heat source (cooling) capacity	12,000 kW
District cooling in/out temp.	20/4 °C

Legend

1 View of the harbour area and the city centre of Helsinki.

2 The Hanasaari combined heat and power plant. The Suvilahti seawater pumping station is located in the flat roofed brick building on the left.

3 The only smoking chimneys on a cold winter day are the ones of the Helsinki Energy's power plants. They cover more than 90 percent of the heat demand of the capital city with district heat

4 A Unitop® 50FY heat pump unit at right, with district heating pumps and piping in the centre, towards the end of erection.

5 Helsinki Energy is developing its networks for district heating and district cooling at great speed to match with the increasing demand.

6 The Katri Vala park is located between the city center and the harbour area with the Hanasaari power station.

7 Main entrance door to the district heating / cooling plant located below the Katri Vala park.

8 One of the three service tunnels of the Katri Vala plant. Each Unitop® 50FY is placed in a cavern, isolated from the other units.

9 Operating staff member next to a Unitop® 50FY heat pump unit. Right: Compressor and motor; centre: the seal oil package; back: the heat exchangers.

10 3D-view of the Unitop® 50FY. Left: motor, gear, compressor and oil system. Right: the heat exchanger package.

11 Sample screen of the touch panel with user friendly setup of the control system for each Unitop® 50FY heat pump unit.

12 Simplified functional diagram of the Katri Vala district heating / district cooling systems, utilising sewage and sea water as heat sources.

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