Keeping cool in Helsinki

Photo: Gavin Hellier/Robert Harding World Imagery/Corbis

For more than fifty years the combination of power generation with district heating has been the norm in Helsinki. A few years ago Helsinki Energy decided to integrate district cooling into the system, with great success. 'Helsinki is an excellent example of how the efficient use of fossil fuels can be environmentally friendly.'

by Reiner Gatermann

Katri Vala Park is located in the Helsinki suburb of Sörnäinen. As with much of the Finnish capital it sits on solid granite. From the Sörnäistenrantatie, it is impossible not to see the large gate below the park which blocks the way into an extensive system of tunnels. If you walk straight ahead, you will come upon the Katri Vala power plant, the largest plant in the world which simultaneously produces district heating and district cooling using cleaned wastewater as a heat source. In addition to using wastewater, the plant also uses water from the Baltic Sea. It has a production capacity of 90 MW for heating and 60 MW for cooling.

District cooling is one of the fastest growing forms of energy supply in Europe. According to figures from business association Euroheat in Brussels, district cooling (known for short as DC) grew by 22% over the last five years in the EU-15. France has the largest capacity, followed by Sweden, but Finland belongs to the countries with the highest growth. With the growing use of airconditioning in Europe, the use of DC is important as a way of to save energy. DC tends to be much more energy-efficient than stand-alone airconditioning systems.

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Overseas visitors

In Helsinki, more than 90% of all buildings are connected to the district heating (or DH) system and an even higher percentage of new buildings are. Helsinki's DH distribution network is now about 1300 km long and has a connector heating load of some 3250 MW. By contrast, district cooling is still in the development stage in Helsinki. In 2009, 80 MW will be connected and this is expected to grow to 250 MW by 2020. The DC supply network is about 40 km long and currently services 115 buildings, but it is being expanded by 5 to 10 km every year.

In terms of DC capacity, Helsinki Energy is in third place in Europe behind Paris and Stockholm. However, the Finns have broken new ground by extending combined heat and power generation to include cooling. During a visit to the Katri Vala plant, Marko Riipinen, who is in charge of district heating (DH) and an enthusiastic supporter of district cooling (DC) at Helsinki Energy, explains that he gets a lot of visitors from overseas. 'The main point of interest for them is in the combination of DH and DC. What we have here is the result of our own technological development, which cost nearly €40 million.'

There are 5 heat pumps on the 7,000 m below the Katri Vala Park which are supplied mainly by wastewater. Seawater is available as an alternative. A sixth heat pump, following expansion of the capacity of the sewage treatment plant, will be installed for use. Wastewater and seawater are brought up from a tunnel which runs 65 m under the plant. The seawater pump station is 300 m away from Katri Vala. The multi-utility tunnels lie 40 m below the surface. They total 1,300 km in length of which 50 km are in spacious 'energy-tunnels' where main distribution lines, pumping stations, cooling plants and many other supply equipments are located.

The temperature of the cooling water is 8 degrees when it leaves the plant and 16 to 18 degrees when it returns. For DH the respective numbers are 88 and 40 degrees. In winter, the returning water is even used again to heat pedestrian zones. In winter, the plant produces only district heating and uses wastewater as a heat source because at 16 degrees, it is significantly warmer than seawater, which is 2 degrees on average. On the other hand, in summer the returning cooling water is used for warm water production. All five units can supply either warm or cool water as required.

Around 80% of the DC system's energy supply is based on sources which would otherwise remain as unused waste and for half the year, water from the Baltic is cold enough to be used. Cold sea water provides one third of the production. Another third comes from converted heat pumps. Their capacity will be increased along with the expansion of sewage treatment plants. The final third comes from absorption chillers witch run on unused heating energy from the power production in summer. The use of sea water is an advantage that Helsinki has over Paris, which mainly relies on compressors or heat pumps.

600 million kilometres

In comparison with the current situation in which buildings predominantly have their own individual cooling systems, Helsinki Energy calculates that in 2020 the DC supply of the capital will lead to annual savings of about 300,000 MWh of fossil fuels, 30 million litres of oil, and a reduction of 100,000 tons of carbon emissions, which equates to approximately 600 million automobile kilometres. The Finns have made a further calculation: by 2020 Europe will require an additional cooling capacity of 500 TWh. If 30% of this could be covered through DC, which currently provides a meagre 1%, fossil fuels for the production of 150 TWh could be saved per annum, which is approximately equivalent to the electricity needs

of the Benelux countries. It would also save 60 million tons of carbon emissions, roughly the amount currently emitted by Sweden.

Despite the high efficiency of Helsinki's energy system, it does still rely for a large part on the burning of fossil fuels. Of the 7,900 GWh of power supplied last year, 54% was derived from natural gas, 19% from coal, 18% from nuclear power and 9% from renewable resources. Of the 6,583 GWh of district heating supplied, natural gas provided 60%, coal 35%, heat pumps 3% and oil 2%. Martti Hyvönen, environmental director, defends the resource mix: 'We're in favour of the responsible use of all forms of energy.' Finland has almost no energy resources of its own and neither does it have the natural conditions for large scale storage of natural gas, which is why it is still not possible to get by without coal. The use of renewable energy sources is expected to climb from 9% to 20%. To this end, 80 wind turbines are to be built offshore.

Hyvönen says that the carbon emissions caused by Helsinki Energy have fallen since 1990 from 400 g/kWh to 240 g/kWh. The business aims to be carbon neutral by 2050. If electricity and district heating were produced separately, fuel use and carbon emissions would be 40% above current levels. DC delivers an additional contribution to the improvement of air quality in the capital as its performance is 80% higher than that of traditional cooling systems such as compressors or fans. Marko Riipinen is convinced that 'Helsinki is an excellent example of how the efficient use of fossil fuels can be environmentally friendly through the combined production of electricity, district heating and district cooling.'

The various awards which Helsinki has received prove that Riipinen's claim has merit. In 2008, Helsinki Energy won the regional championship award in the European parliament regional awards competition. Helsinki Energy was designated as world leader in co-generation efficiency. The International Energy Agency (IEA) awarded Finland 5 out of 5 possible points for the highest honour in the field of CHP/DHC and concluded: 'Finland is a global leader in CHP/DHC'. Denmark is the only other country which got the maximum of 5 points in this category.

Katri Vala heat pump plant 2. Photo: Helsinki Energy

Not unimportantly, DH and DC have been profitable activities, both for the city of Helsinki and for the residents. 'The prices we charge for DH are about half of those in Stockholm, Berlin or Copenhagen', says Riipinen. 'And we have never received any financial support from our owner, the city of Helsinki. We have always been a profitable business for the city.' Indeed, before extraordinary items and provisions for capital reserves Helsinki Energy last year made a profit of €275 million on turnover of €694 million. ■

Development DC Energy sales

GWh per year	2003	2007	Increase
France	1,054	1,114	5.69%
Sweden	642	882	37.36%
Germany	324	383	18.39%
Italy	65	95	46.78%
Finland	13	60	346.08%
Norway	50	58	15.91%
Netherlands	10	55	468.75%
Portugal	48	48	0.00%
Monaco	33	36	10.69%
Luxemburg	23	23	0.00%
Spain	21	21	0.00%
UK	7	10	40.46%
Denmark	5	19	285.71%
Austria	3	3	0.00%
Total	2,298	2,806	22.14%

Development Connected load

MW	2003	2007	Increase
France	622	719	15.59%
Sweden	557	697	25.13%
Germany	173	267	54.37%
Italy	97	138	42.47%
Finland	20	101	403.98%
Norway	25	30	20.41%
Netherlands	8	38	375.00%
Portugal	40	50	25.00%
Monaco	27	30	10.99%
Luxemburg	19	19	0.00%
Spain	16	16	0.00%
UK	3	5	62.50%
Denmark	1	11	1176.47%
Austria	4	21	393.02%
Total	1,613	2,143	32.88%

Source: Euroheat & Power