APPLICATION FOR THE INTERNATIONAL DISTRICT ENERGY CLIMATE AWARD

Helsingin Energia's smart CHP/DH system – the most energy-efficient solution for heating Finland's capital



1.1 Helsingin Energia's smart CHP/DH system

- the most energy-efficient solution for heating Finland's capital

1.2 Helsingin Energia is a public energy utility owned 100% by the City of Helsinki. It produces diverse energy services and meets the energy needs of its customers in an energy-efficient, secure and economic way.

1.3 Further information to the application

Marko Riipinen, Director, Helen District Heat Helsingin Energia FIN-00090 HELEN Tel. + 358 50 502 3908 marko.vj.riipinen@helen.fi

2. Helsingin Energia's smart CHP/DH system

2.1. Our application comes under the category of **Municipal scheme with more than 10,000 users.** Helsingin Energia's district heating system covers more than 90% of the heating need of the buildings in Helsinki. The connection capacity of the network is 3,244 MW and there are 14,010 customer connections.

2.2. Our application comes under the series of **Modernization of existing scheme.** Helsingin Energia has extensively operated its energy-efficient smart CHP/DH system in Helsinki since 1957. The operations have been improved in terms of their climate impact and efficiency throughout the years.

2.3. Why and how the programme was implemented? What has been achieved?

• Combining district heat and district cooling in production and energy use is a globally unique solution, with significant climate impacts on a global scale and in terms of air quality in Helsinki. The Helsinki solution creates an example globally recognized.

• Energy efficiency is implemented throughout the energy chain – heat consumption, transmission and distribution, production control, production.

• The energy efficiency of the district heating system is constantly developed in accordance with ecological targets: Light district heat as a solution for low-energy houses, heat produced by computers into district heat, waste heat from purified sewage water into district heat, advice and reporting on energy use to aid target-oriented energy saving, a clear development programme in carbon-neutral energy production is implemented project by project.

• The quality of climate impacts throughout the chain of the district heating system is constantly monitored, and quality of operations has been recognised by the nationwide Excellence Finland, which has granted us several awards over the years.

• The district heating system has an environmental certificate, and production is developed to have increasingly low emissions. All CHP plants producing district heat in Helsinki have environmental certificates, and their operations are monitored and developed accordingly.

• The energy-efficient system is expanding in Helsinki as the city grows and the urban structure becomes denser, which means that the positive climate impact will increase further.

3. Summary

• Helsinki's solution combines CHP, district heating (DH) and district cooling (DC) in the most energy-efficient way in the world.

• In CHP DH is produced concurrently with electric energy with an efficiency rate of more than 90%. Fuel is turned into energy in the most extensive way possible. DH covers over 90% of Helsinki's heating need. CHP accounts for over 90% of DH production.

• Produced in the same processes with DH, DC is the most energy-efficient form of cooling properties by far. In Helsinki, the heat gathered from properties with rapidly expanding DC is used fully in DH.

• DH and DC are produced from the waste heat of purified sewage water and from sea water in the Katri Vala heating and cooling plant.

• The data centre concept: The heat produced by computers cooled with DC is conducted to the DH network to provide heat to buildings in Helsinki.

Light district heat is a heating solution for low-energy houses built in the extremities of the DH network. The building automation of these houses supports the concept of lower temperature of the circulating water in the smart DH system.
In accordance with Helsingin Energia's development programme towards a carbon-neutral future 2050, increasing use of

bio-renewable energy is being introduced in the DH system project by project.

4. Helsingin Energia's smart CHP/DH system

- the most energy-efficient solution for heating Finland's capital

• Helsinki is the northernmost and coldest capital city on the European continent, as well as one of the leading users of district heat in the world.

• District heat enables combined heat and power (CHP) generation in Helsinki. CHP is a superior alternative in terms of the climate. CHP combined with a district heating system minimises the climatic effects of operations and enables clean urban air.

• Helsingin Energia produces district heat primarily with CHP. In CHP, heat produced in connection with electricity generation is utilised in the production of district heat with an efficiency rate of more than 90%, which is among the best in the world.

• Over 90% of district heat production is implemented with energy-efficient CHP.

• Over 90% of the entire heating need of Helsinki, including hot tap water, is met with district heating.

• Air quality in Helsinki is among the best in the world. The main reason for this is energy-efficient district heat, which has eliminated building-specific heating. We have succeeded in minimising sulphur dioxides, nitrogen oxides and fine particles in energy production.

• New district heating customers are constantly connected to the network along with urban construction. District heating competes in the free heating market in Helsinki, and it is a desirable alternative especially due to its reliability, price level and positive environmental impacts.

• The district heating system is constantly developed. It also enables renewable energy use in the most eco-efficient way.

• District heating customers use heat in an energy-efficient way and are committed to take advantage of Helsingin Energia's reporting and advisory services that comply with the Energy Services Directive.

• The price level of district heat in Helsinki is among the lowest in Finland, and in relation to purchasing power, Finland has the most favourably priced district heat in Europe.

• The waste heat of office, residential and business buildings and data centres cooled with district cooling is utilised in full in district heat production.

• As a business area district heat is very profitable.

4.1. District heat is the answer to Helsinki's heating needs and energy-efficiency targets

Helsinki is located at 60 degrees North latitude and is among the northernmost capital cities in the world. Helsinki has approximately 600,000 residents whose homes and workplaces are heated with energy-efficient district heat. More than 90% of the housing stock in Helsinki is connected to district heating.

The district heat for Helsinki is produced in four CHP-power plants and ten peak-load and reserve heating plants situated in different parts of Helsinki. The CHP-power plants have been constructed in the years between 1970 and 1990 and the peak-load and reserve power plants in the years between 1960 and 2000. The Katri Vala heating and cooling plant is the largest in the world producing heat and cooling from sea water and from waste heat of purified sewage water. The Katri Vala plant was taken into commercial use in 2006. Helsingin Energia modernises its production plants continuously as a part of the company's energy efficient and pro-climate operations.

Energy-efficient district heat was selected as the heating solution for the capital city as early as the late 1940s when a farreaching decision on producing electricity and heat from the same fuel (CHP) and district heating was made in Helsinki. The Helsinki districts started utilising district heat at a rapid pace. This solution clearly improved the air quality in the city when building-specific chimneys became unnecessary. In terms of the climate, the decision was sustainable and good. The fuel efficiency of CHP in Helsinki is among the best in the world, over 90%, when in separate production it can reach just over 40% even in the best conditions. Currently, we can even talk about trigeneration in Helsinki when also district cooling is produced in the same processes with heat and electricity.

4.2. CHP and district heat - a sustainable solution for the climate and air quality



The principle of 90 + 90 + 90 is realised in today's Helsinki: over 90% of the fuel is utilised in energy generation, over 90% of the heated housing stock in Helsinki is connected to district heating, and the share of cogeneration of the produced district heat is over 90%.

Due to CHP and district heat, Helsinki saves the same amount of energy that would be consumed in the heating of 270,000 single-family houses each year.

The average share of CHP of produced DH Due to cogeneration and district heat, Helsinki is one of the cleanest capital cities in the world in terms of air quality. Cogeneration and district heat are the primary means of climate change mitigation.

CHP of produced DH Measured by energy efficiency, district heating is clearly the best heating solution in urban areas. In Helsinki, energy efficiency is present in all solutions throughout the energy chain, including the users, distribution and production. District heating combines clean urban air and comfort and easyness of living.

Helsingin Energia produces district heat in its power plants located in Hanasaari, Salmisaari and Vuosaari in Helsinki. A total of 10 heating plants operate as peak-load and stand-by production plants. The energy reserves (accumulators) located in connection with the power plants provide flexibility in production. Moreover, district heat is produced in the Katri Vala heating and cooling plant, which is the largest plant in the world using the waste heat of sewage water as a heat source. The main fuel used in CHP in Helsinki is natural gas with a share of over 60%.

At the end of 2010, the connected heat load of district heating was 3,244 MW, and there were 14,010 district heating customers (buildings). Over 90% of the entire city's heating need is met with district heat, and the majority of all Helsinki residents live and work in premises heated with district heat.



Over 90% of Helsinki's heat demand is covered by district heating. The green areas represent parks and forests.

4.3 Emissions have remained low





The amount of fuel saved by using CHP

Emissions from Helsingin Energia's energy production clearly fall below the constantly tightening limit values of the licensing regulations.

The specific carbon dioxide emissions from Helsingin Energia's energy production have followed a steadily falling line in the long term, and this was also the case in 2010 despite the growth in energy production due to a 10% colder than normal winter period. The specific carbon dioxide emissions from Helsingin Energia's energy



Helsingin Energia's nitrogen oxides emissions, tNO₂/a



production remained between 240 and 330 g CO₂/kWh in the 2000s.

Long-term measurements show that sulphur dioxide and nitrogen oxide emissions in the Helsinki region have clearly fallen. Particle emissions have also clearly reduced and are currently at a very low level despite increased energy production.

Helsingin Energia is carefully monitoring the emissions trend of its energy production and takes into account the impacts on both local air quality and the climate. In the monitoring of fine particles, Helsingin Energia carries on close co-operation with the University of Helsinki, the Finnish Meteorological Institute and the Ministry of Transport and Communications, studying the number, quality and origin of fine particles in urban air in Helsinki. The monitoring station is



located in Kumpula in Helsinki. Measurements have indicated that energy production accounts for a very small proportion of the fine particle contents in urban air. The main sources of fine particles are traffic, small-scale wood burning, long-distance transmission, and construction.

In the mandatory monitoring of the sea areas, the thermal load has been relatively low as a result of district heating, ranging between 180 and 2,200 GWh. The thermal load of sea water in 2010 totalled 260 GWh.

The fly ash produced in Helsingin Energia's production processes is utilised in the production of cement and concrete. Bottom ash is used in earth construction. When dismantling pipes or structures, we direct the materials primarily for recycling or reuse. For example, over 90% of the materials of the CHP plant of the Hanasaari A plant, which was dismantled in 2009, were recycled. In the similar way, hazardous waste is directed to appropriate processing.

4.4 Developing smart DH system



different heating solutions

In Helsinki, district cooling and district heat produced in the same processes complement each other in an excellent way. District cooling enables environmentally friendly and efficient cooling for customers, and district heat in its heating system enables efficient use of the heat gathered from properties in the cooling process. This entity is extremely efficient and pro-environmental, implemented in Helsinki by maximising the energy efficiency.

The world's largest plant producing district heat and district cooling with a heatpump technology operates in a facility excavated into a rock cave under the Katri Vala Park in Sörnäinen, Helsinki. The district heating capacity of the Katri Vala heating and cooling plant is 90 MW and its district cooling capacity is 60 MW. This capacity is enough to heat a small town. The plant produces district heat and cooling from the waste heat of purified sewage water and from sea water.

In 2009, Helsingin Energia implemented a data centre excavated in a rock cave under the Uspenski Cathedral in Katajanokka in Helsinki. The data centre is described as the most eco-efficient in the world. The computers in the data centre are cooled with eco-efficient district cooling, and the heat produced by the computers is transferred into the district heating network. The capacity of the data centre meets the heating needs of about 500 single-family houses. Helsingin Energia will also offer its facilities for eco-efficient data centre operations in the future. The next data centre utilising district cooling and producing district heat will be opened this year in the facility of a former substation in Suvilahti in Helsinki. The heat output of this data centre will meet the heating needs of about 2,000 single-family houses. We are further developing the energy-efficient use of data centres by expanding the current centres and opening new ones in safe and functioning facilities in the vicinity of cooling and heating networks. The data centres implemented by Helsingin Energia are operated by Academica Oy.

Helsingin Energia is developing its district heating system in a diverse way for the needs of Helsinki's expanding housing stock and users, also for low-energy houses. Light district heat is a product offered to the extremities of the network in areas where it is not justifiable to extend the conventional district heating system and where eco-efficient low-energy houses suitable for lower temperatures are being built, with their building automation supporting the district heating solutions of the smart energy system.

In 2010, the City Council of Helsinki approved the development programme towards a carbon-neutral future 2050, drawn up by Helsingin Energia. The programme clearly outlines the measures to be implemented in separate projects that will help Helsingin Energia's gradual transition to carbon-neutral energy production.

On the path of constant improvement

The energy-efficiency of Helsingin Energia's district heating system is based on combined heat and power generation, CHP, which accounts for over 90% of district heat production. Achieving fuel efficiency of over 90%, the energy efficiency of CHP is among the best in the world. District heat with its superior energy efficiency covers over 90% of the heated housing stock in Helsinki.



The 90 + 90 + 90 energy-efficiency principle of Helsingin Energia's district heating system creates a basis for constant improvement in compliance with sustainable development. Fuel efficiency is constantly refined at the environmentally certified power plants located in Helsinki, aiming for as few climate impacts as possible. In heating plants producing reserve and

peak load, constant power upgrades that increase energy efficiency are carried out, and the feasibility of new solutions aiming for emissions reduction are investigated. In all productional modernisations and new investments, the possibilities of using biorenewable fuels are investigated, and investments enabling the use of bioenergy are carried out or preparations are made to implement them.

In Helsinki, district cooling and district heating complement each other perfectly. District cooling enables the best possible cooling solution in terms of its environmental impacts, and district heat enables ecological use of the heat gathered by the cooling system. District heat and district cooling in Helsinki have been implemented in a splendid way with respect to the climate. All heat gathered through cooling is utilized in district heating network.

In the district heating system, the cityscape is promoted with underground distribution solutions and by taking the requirements of urban architecture into account in the design of every production plant.

Network condition management is part of the smart DH system

Helsingin Energia is monitoring the operation of its district heating system in real time with the aid of its unique Webmap system. The system searches real-time data on the status of the network from various databases, enabling proactive and efficient condition management. The system includes, e.g. street information, technical information and owner data of buildings, other connections built into the street network including their locations, 3D aerial photos with the desired angle of view, and structural, condition, identification, sluicing, outage and damage data of the district heating network. All of these are gathered from the databases of various operators, to be available on a single map base.

The structure of the district heating network is looped, which means that the distribution connection to users is ensured from various directions. Almost 60 kilometres of the district heating network is located in energy tunnels in the Helsinki bedrock, providing excellent security of supply. The length of the district heating pipeline in Helsinki totals almost 1,300 kilometres.

The energy-efficiency, reliability and security of supply of Helsingin Energia's district heating system are manifested in the extremely small amount of leakage waters and progressively small heat losses, only about 6% per year. In district heat distribution, the average annual outage time, 2.8 hours per customer, is at an excellent level on the international scale.

4.5 Efficiently used district heat is part of a good way of life

District heating customers in Helsinki are committed to using sensible and ecological heat, which is in evidence, for example, in annual increase in the efficiency of specific consumption in buildings.

Efficiently used district heat brings comfort to homes and workplaces and has a positive effect on indoor air quality. A suitable heating method for all buildings, district heat is easy and effortless. Helsingin Energia delivers 100% district heat to homes, and therefore there is enough heat for all customers regardless of the weather. District heat enables an optimal and recommended indoor temperature of 21 degrees at home and at work all year around.

In its own operations, Helsingin Energia is strongly committed to implementing the voluntary energy-efficiency targets in the EU Energy Services Directive in its entire district heating system. This is also the requirement of the two energy efficiency agreements that Helsingin Energia has signed with the Ministry of Employment and the Economy concerning the efficiency of energy production, district heating and energy transmission.

Helsingin Energia provides its customers with support and instructions for energy-efficient use of heat. Helsingin Energia offers its customers free, continuous monitoring and reporting on energy consumption, instructions on the use of heating appliances, dimensioning, planning and quality control of the installation of district heating equipment, and condition monitoring of district heating equipment, including metering data and seal tests. In consumption monitoring, changes, deviations and technical faults are identified, and information and advice about these are sent to customers.

Residents are given energy-saving advice in customer magazines, residents' events, through the media, in trade fairs, in residents' association events, and in connection with visits. We have close co-operation with nationwide Motiva, which promotes energy saving, the Finnish Real Estate Federation, the Finnish House Owners' Association, and various environmental organisations.



Specific energy consumption of district heated buildings in Helsinki

Reporting and advice to various customer groups

Helsingin Energia provides its customers with advisory services in sensible energy use in the Energy Advisory Centre, which is located in the company headquarters, on its website and, when necessary, in the properties of heat users. The Energy Advisory Centre has disseminated information on energy use to the Finnish people free of charge for over 30 years.

Over 60% of district heating customers are within the sphere of remote reading, which enables hourly metering, and remote reading will be expanded to all customer connections in Helsinki by 2013. Along with remote reading, the reporting services on energy use will be expanded and diversified further. Helsingin Energia's website has a free Sävel Plus reporting service aimed at all customers. In the service, heat users can monitor their consumption virtually in real time and set energy-saving targets for themselves.

Helsingin Energia gives advice to heat users, property maintenance personnel, housing managers, and residents' associations interactively in residents' evenings and various real estate meetings, in the customer magazine, and in the social media (energy adviser in Twitter).

The Energy Advisory Centre provides information on energy saving for schoolchildren in Helsinki with a variety of events. All primary school sixth graders in Helsinki make an excursion to the Energy Advisory Centre. Especially young people have given positive feedback on the energy-saving video, in which an award-winning mime artist introduces the viewers to energy efficiency with the aid of comedy.

Helsingin Energia has several on-going customer projects promoting energy efficiency:

- The MET project (The MET group project for improving energy economy in Maunula) 2008–2011: A study on the improvement of energy efficiency in a developed area. The housing stock in the area was built between the 1950s and the 1970s. The project includes several companies, the residents' association of the area, and a group of housing companies
 The KIMU project (climate change and blocks of flats) 2009–2012: A development study on the technical solutions for diminishing climate impacts and improving the indoor climate of residential buildings. The project involves several companies and a few pilot suburbs.
- The ATT low-energy building in Helsinki: Implementation of a new low-energy apartment block as a district heat solution. The block was completed in 2011. The City of Helsinki is involved in the project.
- 'Heat log' product development project (2010–): Development of an extensive energy-efficiency and condition monitoring system and an energy maintenance log for customers.

4.6. The smart CHP/DH -system of Helsingin Energia is developed together with the DH clients

The Helsingin Energia CHP/DH –system is all in all a success story that continues and develops through constant dialogue with the clients to become all the more energy effective

The system was launched as a solution to the need of the nordic capital to produce heat efficiently and in an environmentally benign way. The system is constantly being developed by searching and inventing new pro-environmental production and consumption methods.

4.7. The smart CHP/DH system of Helsingin Energia is business based and the product price is on a competitive level

The Helsingin Energia CHP/DH system has from the very start been business based with a competive price level. Due to the efficient production, transmission and consumer solutions the price level of the Helsinki CHP/DH system is one of the most competitive in all of Finland. Related to the purchasing power the DH price in Finland is the most competitive in Europe. The investments made to improve operations are financed according to the free competition through profits gained in free DH market.

Awards and recognitions given to Helsingin Energia's district heating system

- The environmental award to Helsinki's DH/CHP system granted by the United Nations in 1991
- The European Regional Champion Award in the category of Energy Champion awarded to Helsingin Energia's ecoefficient cogeneration and district heating by the European Parliament's Committee of the Regions in 2008
- Certification of Merit awarded by the International Energy Agency IEA for the superior solutions for climate change mitigation in 2009
- The Fair District Heating award granted by Finnish Energy Industries for commitment to the development of district heating, openness of pricing, increased customer safety and open interaction with stakeholders, 2009
- Green Enterprise IT Award for the eco-efficient way of utilising the heat produced by computers in district heating, Data Center Efficiency & Green Enterprise IT Symposium, 2010
- The quality award granted by the Mayor of Helsinki for long-term, customer-oriented and energy-efficient operations, 2010
- Special distinction awarded by Excellence Finland for customer-oriented operations, 2010