Helsingin Energia

APPLICATION FOR
THE INTERNATIONAL DISTRICT ENERGY CLIMATE AWARD

District cooling in Helsinki – The Most Advanced Cooling Solutions

1.1 **Name and location of the system:**

District cooling in Helsinki (“Helen District Cooling”)

1.2 **Name of the owner and type of ownership:**

Helsingin Energia (“Helen”), a municipal energy company that is 100% owned by the city of Helsinki

1.3 Name, address, phone number and e-mail of the person submitting the application:

- *Niko Wirgentius, Director* / Helen District Cooling
- Kampinkuja 2, Helsinki, Finland
- Mobile: +358 50 33 000 43
- niko.wirgentius@helen.fi

2.1 a) Municipal scheme with more than 10,000 users

2.2 We are applying for the d) district cooling award.

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

District cooling business in Helsinki started some 10 years ago. The decision to start the business was based on an estimate that cooling demand will grow quite rapidly in Helsinki despite of the Northern climate. At the same time, it was obvious that building owners will take more seriously into account environmental issues, especially climate issues. The aim was to provide a reliable, economical and eco-efficient cooling solution for all type of property owners. However, the key was to offer outsourced cooling solution that helps the building owners to concentrate on their key business and therefore boost the productivity of their business. Another benefit for the building owners was related to energy efficiency and CO_2 savings. It was noticed that district cooling provides the easiest way to improve energy efficiency and reduce the CO_2 emissions for a building located in Helsinki. However, Helsinki Energy already had a lot of experience and knowledge about successful district energy business that made the barrier to start a business much lower.

Since the start of the operation, the growth of the business has been really rapid. Customer’s connected capacity is already more than 100 MW. At the same time market share has risen up to 30%. In the last three years, the connected capacity has grown about 50 MW and about 100 new buildings have been connected to system. The total amount of connected buildings is nearly 200. It is estimated that growth will continue as rapidly as it has done in the last couple of years. The growth has taken place in 100% free cooling market. Every customer has had its own willingness to connect to the district cooling system. Therefore district cooling has been the customers’ preferred solution in every single case.

District cooling has had its own profit and loss account from the very beginning of the business and its own balance sheet as well. District cooling in Helsinki has generated profit in the last several years without any subsidies from the owner or the government. The economic success has been the key to rapid enlargement and therefore it has been the key for the environmental benefits as well. The growth of district cooling has been the greatest single factor for lowered CO_2 emissions in the Helsinki downtown area. It is also the most cost efficient way for generating CO_2 savings in the area.

Yearly primary energy savings by district cooling in Helsinki is nearly 100 000 MWh compared to the alternative cooling solutions. Annual CO_2 reduction is about 25,000 tons – an equivalent to almost 200,000,000 km of driving with a passenger car. District cooling has generated nearly 150,000 tons CO_2 savings during its lifetime despite of short history of the business. Connection capacity is estimated to grow up to 200 MW by the year 2015, which means about 60% market share in the Helsinki city center. In 2015, district cooling in Helsinki will save some 60,000 tons of CO_2 emissions every year. Without district cooling it would be nearly impossible to achieve same amount of savings.

Helsinki district cooling system is a great example of a market based tool for improving energy efficiency and reducing remarkably CO_2 emissions. It is a win-win-win-win activity that generates benefits for climate, customer, energy company and for the whole society as well.

3. Summary

Helsingin Energia has the third largest and one of the most rapidly growing district cooling systems in Europe. It has been an outstanding success story since 2000 when the business started. Helsinki has the most innovative and versatile cooling system in Europe with relatively most significant results for the climate. However, Helen District Cooling has changed the whole market by re-defining cooling business. It is not defined as cooling production but as heat delivery from the surplus to the demand instead. A new way of thinking has created new potential customers by developing new types of innovative district cooling products. Therefore, district cooling has generated larger savings potential and outstanding results for climate.

Heat delivery from the surplus to the demand has been the way to avoid production that has been the key for significant primary energy and CO_2 savings. Actually, heat delivery benefits are not limited to district cooling itself. It has an impact in district heating and electricity production as well. Yearly primary energy supply has reduced nearly 100,000 MWh and CO_2 emissions has lowered about 25,000 tons. If the impact of refrigerants would be calculated, the greenhouse gas reduction would be much larger. District cooling has been the most significant single factor for lowered CO_2 emissions in Helsinki city center area. It will generate the greatest benefits in the future as well. CO_2 savings is estimated to be more than double in 2015. District cooling is also the most cost efficient way for achieving remarkable CO_2 savings.

District cooling in Helsinki is a great example of a market based system that reduces primary energy supply and CO_2 emissions without any financial support from the owner or the government. District cooling in Helsinki is a win-win-win-win system that generates benefits for climate, customer, Energy Company and for the whole society as well.

4. Written description of the system:

4.1 District cooling business in Helsinki started in the year 2000. Current number of connected buildings is nearly 200. Customer's connected capacity is more than 100 MW and nearly 10,000,000 square meters has been cooled by the district cooling.

The length of the distribution network is 46 km and the volume of it is equal to 18,000 m^3. More than 10 km of distribution pipelines are located 40 m under the ground in tunnels.

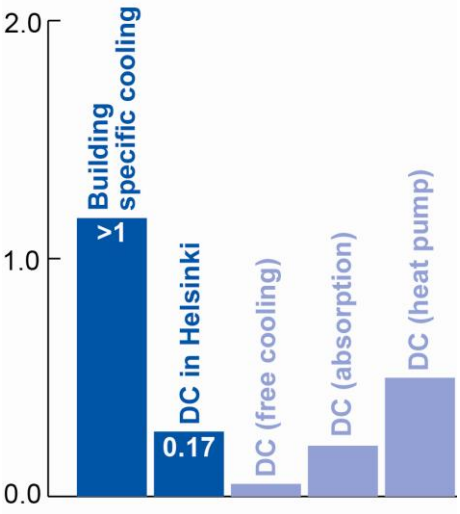
Production consists of 5 heat pump and 10 absorption units. Production is distributed to three different production plants. Every heat pump produces 12 MW of cooling and therefore total heat pump cooling capacity is 60 MW. Absorption units are designed for 3.5 MW and total absorption capacity is 35 MW. There is one cold accumulator in operation and an additional 10,000 m^3 accumulator will be completed this year. The average age of production capacity is about 7 years.

4.2 System overall efficiency is measured by standards EN 15603 and EN 15316-4-5. Same calculation is shown in Ecoheatcool WP 3. Primary energy factor based on measured data from the year 2010 is equal to 0.17. Key measured data are following:

- Energy sold to customers is 83,850 MWh (measured at customers substation)
- Electricity in to DC system is 12,950 MWh (including el. to pumps and other additional)
- Heat as a fuel to DC system is 36,850 MWh (heat from natural gas CHP)
- Heat delivered to district heating system is 35,700 MWh (by heat pump plant)
- Free cooling delivery is 32,100 MWh (Sea water cooling from Baltic Sea)

Primary energy factor: <u>0.17</u>

CO_2 emission factor based on calculated PEF: <u>62 g/kWh</u>



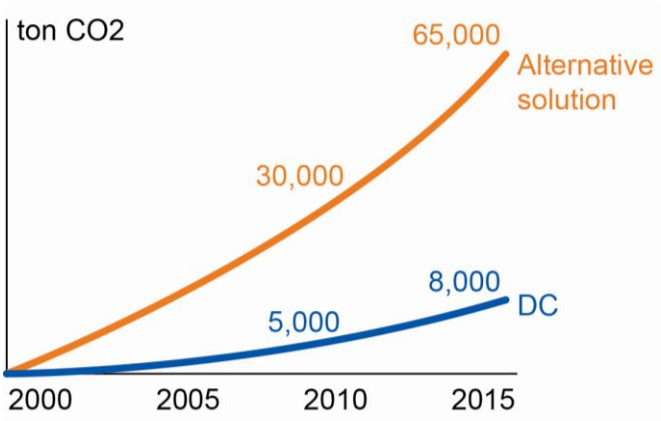
Primary energy factors for cooling solutions

4.3 CO_2 emission factor for district cooling in Helsinki is calculated in chapter 4.2. CO_2 emission factor for alternative solution is calculated based on standard EN 15603. CO_2 savings by district cooling is difference between district cooling emissions and emissions of alternative solutions:

Cooling demand for alternative solutions:	83,850 MWh
Difference between CO_2 factors:	307 g/kWh
Difference between CO_2 emissions:	25 800 tons
CO_2 savings by district cooling:	**25 000 tons**

In the year 2015 customer's connected capacity is estimated to reach 200 MW. In 2015, district cooling in Helsinki will save about 60,000 tons CO_2 emissions. Without district cooling there would be nearly impossible to achieve same amount savings.

During the year 2010 about 35,000 MWh worth of surplus heat was delivered to the district heating system in Helsinki. Heat delivery continued around the year both in winter and in summer. It replaced other heat production and therefore lowered primary energy supply. For example, during July 2010, the surplus heat delivery was equal to monthly domestic hot water demand for 100,000 people. However, there is always a possibility to use surplus heat as a fuel for absorption. Therefore absorption and heat delivery to customers are options for each other which enables a selection of a more energy efficient alternative every single hour. Same type of option occurs between free cooling and heat delivery to customers during the winter. Heat is delivered to the end customer whenever it replaces production with greater primary energy supply. Therefore, primary energy factor for district cooling in Helsinki is negative during the winter. Actually, primary energy factor during the summer will be negative in the future as well. Therefore, district cooling system in Helsinki will be carbon negative in the future.



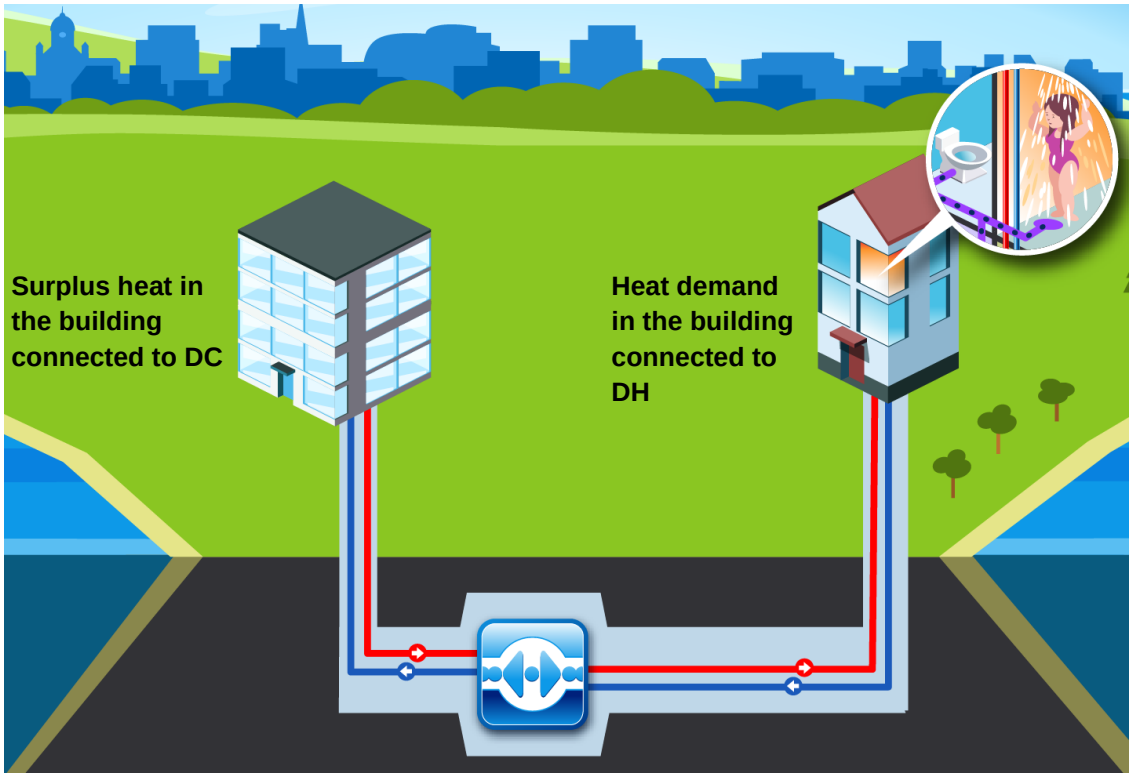
CO_2-emissions with and without District Cooling

4.4 What makes your programme outstanding and innovative?

Helsinki district cooling system is an outstanding cooling system because of the largest variation and very advanced nature of the cooling products. The variety and level of available cooling products increase the potential market significantly and therefore allows relatively greatest primary energy savings and CO_2 reductions in whole Europe and presumable in whole world as well. The key of the progress has been the re-definition of the whole district cooling business. Traditionally, district cooling has been defined as cooling production but the current definition in the Helen District Cooling is a heat delivery from the surplus to the demand. The fundamental idea behind re-definition is the fact that there is always enough heat around the world but it is typically in a wrong place, at a wrong time and in a wrong form. The whole business has to be based on an idea to deliver heat in a right form at a right time without additional primary energy supply.

This new way of thinking has generated new types of innovative district cooling products, enlarged market potential for district cooling and at the same time changed the whole market as well. The most significant benefit of the re-definition of the business is related to the greater primary energy and CO_2 savings. The innovative cooling production has generated CO_2 savings in sectors and industries that have not been traditionally potential customers for the district cooling. However, this re-definition will generate penetration to new sectors and industries in the future as well because the world is full of heat – the only thing that has to be concentrated on is the right type of product that fits to the customers demand and deliver energy in a right form to a right place with a right timing.

The principle of heat transfer from surplus to demand



The priciple of "Helen-IT"

The best known and the most remarkable example of a heat delivery from the surplus to the demand is related to a product called "Helen-IT". It is an innovation that meets the increasing cooling demand of data centers that otherwise produce a lot of waste heat around the year. Traditionally, there has been cooling for servers but now this is replaced by "Helen-IT" that deliver heat to the district heating system or other activities where it replaces production and therefore generates remarkable primary energy savings.

"Helen-IT" has been such a great innovation that it has been awarded several times around the world. Perhaps the most remarkable award is the Green-IT 2010 award by Up Time Institute that was given in New York in May 2010. "Helen-IT" has been a big story in media around the world as well. It has been in the national news at least in Japan, Sweden and Russia. The latest story was in CNN in January 2011.

Helen already has a dozen of data centers connected to district cooling. They generate annually some 15,000 MWh primary energy savings and 4,000 tons CO_2 savings. However, the future savings potential is really large because only one large-scale data center may generate annually 15,000 MWh and 4,000 tons CO_2 savings. What makes "Helen-IT" even more remarkable is the fact that it is not limited to data centers only. It is suitable for other type of processes as well. For example, Finnish Broadcasting Company has already connected its TV and radio technology to district cooling by "Helen-IT".

Another example is "Helen-Condensing" that has been created to generate electricity savings for fridges in department stores and supermarkets. Traditionally surplus heat from condensing has dumped up to roof but "Helen-Condensing" delivers heat wherever demand occurs in current moment. The idea of "Helen-Condensing" is suitable for any other processes with condensing as well.

Success story is also the “Helen-chill”. This product is developed mainly for the residential buildings, and has already more than 10 customers. It was created to fit residential area demands both technically and financially, and so far market response has been very positive. “Helen-chill” is basically the same district cooling that is provided to the other buildings too. Still there are three main reasons why it is a win-win-win-win product:

1) Partners, meaning both engineering consulting companies and device creators, have been heavily involved in creating the product. They see “Helen-chill” as a major business enabler in residential buildings, and residential buildings get a product that fits better their need. Therefore a win to our partners and residential building owners.
2) Product has a simplistic approach from technical perspective, making it cheaper to produce. Cost for Helen is lower, therefore a win to Helen.
3) We are already seeing a major uplift in cooling demand within residential buildings. If majority of the new demand starts using “Helen-chill” then significant savings in CO2 emissions are achieved. Hence a win situation to the environment.

A major uplift in demand for the “Helen-chill” is anticipated within a few years once Helsinki’s new residential regions are built. However, “Helen-chill” fits to existing residential buildings as well.

The future product will be “Helen-melt” that is to be designed for melting snow in the city center area. Snow is a large logistic problem in Helsinki and “Helen-melt” will avoid snow transportation and therefore save fossil fuel and CO_2 emissions. Snow is a good free cooling source as well. However, “Helen-melt” fits the fundamental idea of district energy: Use a local resource that otherwise would be wasted or unused.

4.5 How has the programme improved the quality of life of your community?

Traditional building specific systems generate much noise, but this noise has now mostly disappeared and the rest of it will disappear in the future because of the district cooling. City center area is much more comfortable without noisy and ugly condensers.

New products like “Helen-IT” make business environment in Helsinki more attractive for foreign investment. “Helen-condensing” gives freedom to building designers to make shopping centers more efficient for the commercial activities. District cooling enables a creation of new business opportunities in the area. Helen District Cooling helps to generate welfare for the area by versatile and innovative cooling productions.

The greatest benefit of district cooling is related to accessibility for cooling. Especially, “Helen-chill” will make cooling barrier for residential buildings lower and therefore indoor climate will be appropriate year around. Indoor climate has a great impact on health and quality of living. Without district cooling, there would be greater number of buildings that have poor indoor climate all year long.

4.6. What were the challenges you faced and how were they overcome?

During the early years of business, some building owners did not trust this new type of cooling solution but quite soon they were convinced because of the good experiences in the first connected buildings. However, especially HVAC design companies were really skeptic about district cooling. Despite of the good experiences, some designers in nearly every single case explained why district cooling is not a suitable solution for a particular building. Traditional and old-fashioned HVAC industry has been the main obstacle of the district cooling. Now good experiences have changed the general opinion. Hardly no-one challenges the suitability of district cooling for all types of buildings.

Some technical difficulties have been related to district cooling production but generally system itself has not been a challenge.

4.7. How was the programme financed?

District cooling business has had its own balance sheet from the very beginning of the business. It means that business has had its own financing as well. Heavy investments in the early period of the business required a lot of capital and therefore debt in balance sheet is relatively large and equity ratio is relatively low. District cooling has to pay market price for money. District cooling business in Helsinki is financed as any other business in any industry.

Helsinki Data Center Solution

Energy efficient
Innovative
Eco-friendly

Helsinki Solution for Secure Data Center

Freedom to execute the most effective da

Looking for the best-in-class solution for your data center operations?

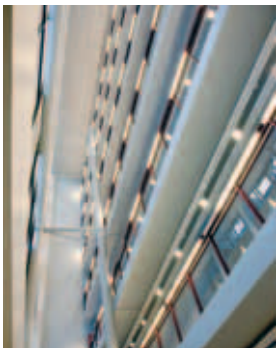
You will find it in Helsinki, Finland.

The energy provider for the City of Helsinki, Helsingin Energia, and a leading construction company, YIT, have joined forces and created a unique infrastructure for building a data center with the best possible Energy Performance Certificate (EPC) rating.

Helsinki is located on a peninsula surrounded by the sea. The natural conditions are ideal for energy efficient and low costs data centers.

Top class speed and flexibility

- Turn Key solutions
- One-Stop Shop for project management
- Freedom to execute your own Data Center Concepts
- Existing planning and environmental permits
- Existing district heating and cooling networks
- Low execution and running costs
- Top-level security for data stream and energy supply
- Fast data links to Central and Eastern Europe and to Russia



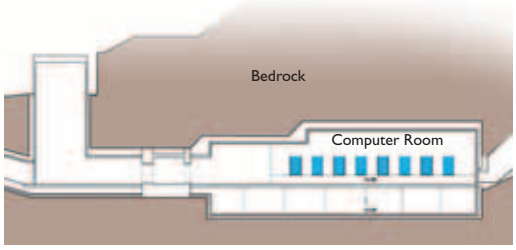
With its ready high-quality infrastructure, **Helsinki** is a location favoured by international corporations. The Helsinki metropolitan region with a population of one million provides active business connections and fast data links to Central and Eastern Europe and to Russia.

The existing energy and IT infrastructures allow considerable savings in execution costs and time. Helsingin Energia provides a cost-effective energy supply with the possibility of starting with no capital outlay by the data center owner.

Large range of solutions for different data center types

Helsinki lies on solid granite bedrock.

Existing premises excavated into bedrock ensure the highest possible physical security. The energy tunnel network under the City of Helsinki provides a secure route and an unbroken supply for connections.

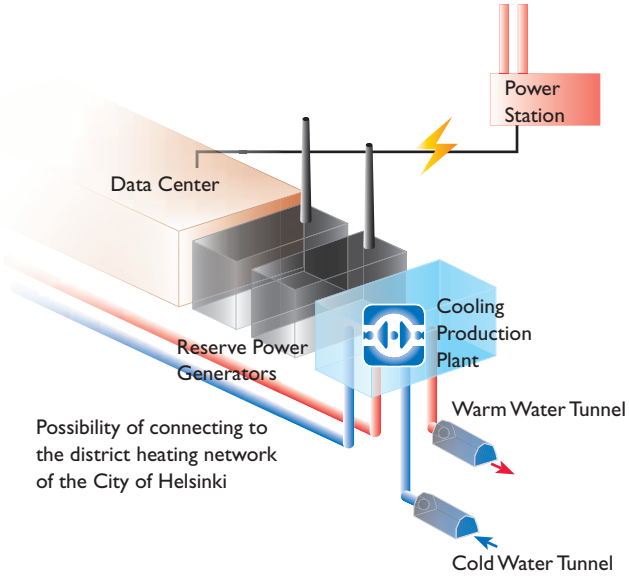


Safely underground

ta center concept with highest EPC rating

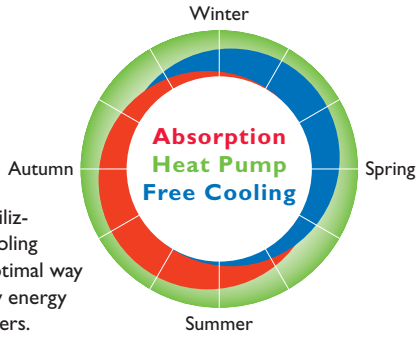
The best technical solutions tend to be innovative ones

There will be increasing interest in data center energy efficiency and publicly reported Power Use Effectiveness (PUE) values. Target values for new data centers will be around PUE 1.2 – or even better with fully outsourced cooling production.



World-class innovative eco-efficiency and cooling solutions

- The Helsinki solution is based on utilizing sustainable district cooling and allows the thermal energy produced by the computers to be recovered
- The carbon footprint is only a fraction of that of alternative solutions
- Possible to use 100% of the capacity and electric energy of the electrical connection for computing
- Excellent Water Use Efficiency (WUE) and Carbon Use Efficiency (CUE) ratings
- Best-in-class values that raise Data Center eco-efficiency to a new level



The method of utilizing the district cooling network in the optimal way offers eco-friendly energy usage in data centers.

Recycling the energy

The smart combining of cooling methods enables 80% of the cooling to be provided by energy that would otherwise be wasted. The client choosing district cooling reduces CO_2 emissions radically.

Innovative and energy-efficient solution in a former gas holder

An exceptionally affordable and eco-friendly solution in a former shipyard close to the power station

We provide world-class expertise in energy efficiency and re-use

Finland is a safe Scandinavian country where the population's level of education is one of the highest in the world. Finland ranks as the best country in the world in the 2010 Newsweek survey based on health, economic dynamism, education, political environment and quality of life. Finland has also been ranked the second most stable country in the world.

Helsingin Energia

As one of the largest energy companies in Finland, Helsingin Energia supplies electricity to approximately 400,000 customers, and its district heating network covers over 90 per cent of the heat demand of the capital city area. Among the services provided by Helsingin Energia are the design, project management and maintenance of energy production and distribution systems. The company also produces and sells district cooling. Helsingin Energia was founded in 1909.

IT sector Green Enterprise IT (GEIT) Award in May 2010 to Helsingin Energia

Helsingin Energia received recognition for its most energy-efficient solution. The award was granted for the innovative technology at the Uptime Institute 2010 annual Symposium.

YIT

YIT Group offers services in over 15 countries covering the Nordic countries, Russia, the Baltic countries and Central Europe. The roots of our company go back to 1912.

YIT Group offers solutions for all sectors concerning technical building systems, construction, and industry services. In all sectors of operation, the services cover the entire life cycle of the projects.

Your partners: a leading energy provider with an internationally experienced building corporation

Further information:

Juha Sipilä
Tel. +358 40 334 6663
juha.sipila@helen.fi

Janne Johansson
Tel. +358 40 522 5145
janne.johansson@yit.fi

Helsingin Energia

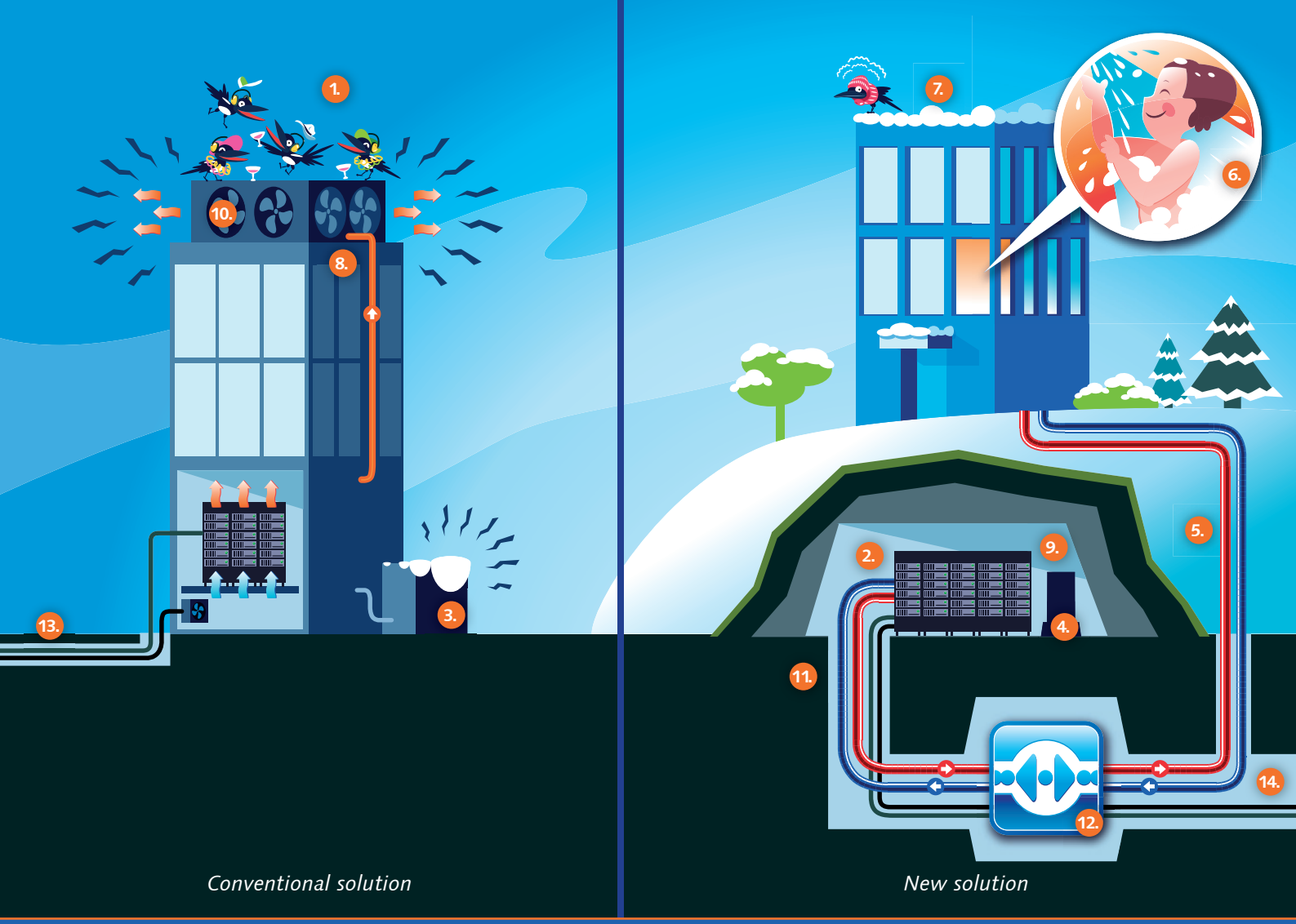
Helsingin Energia
Kampinkuja 2
FI-00090 HELEN
www.helen.fi

YIT

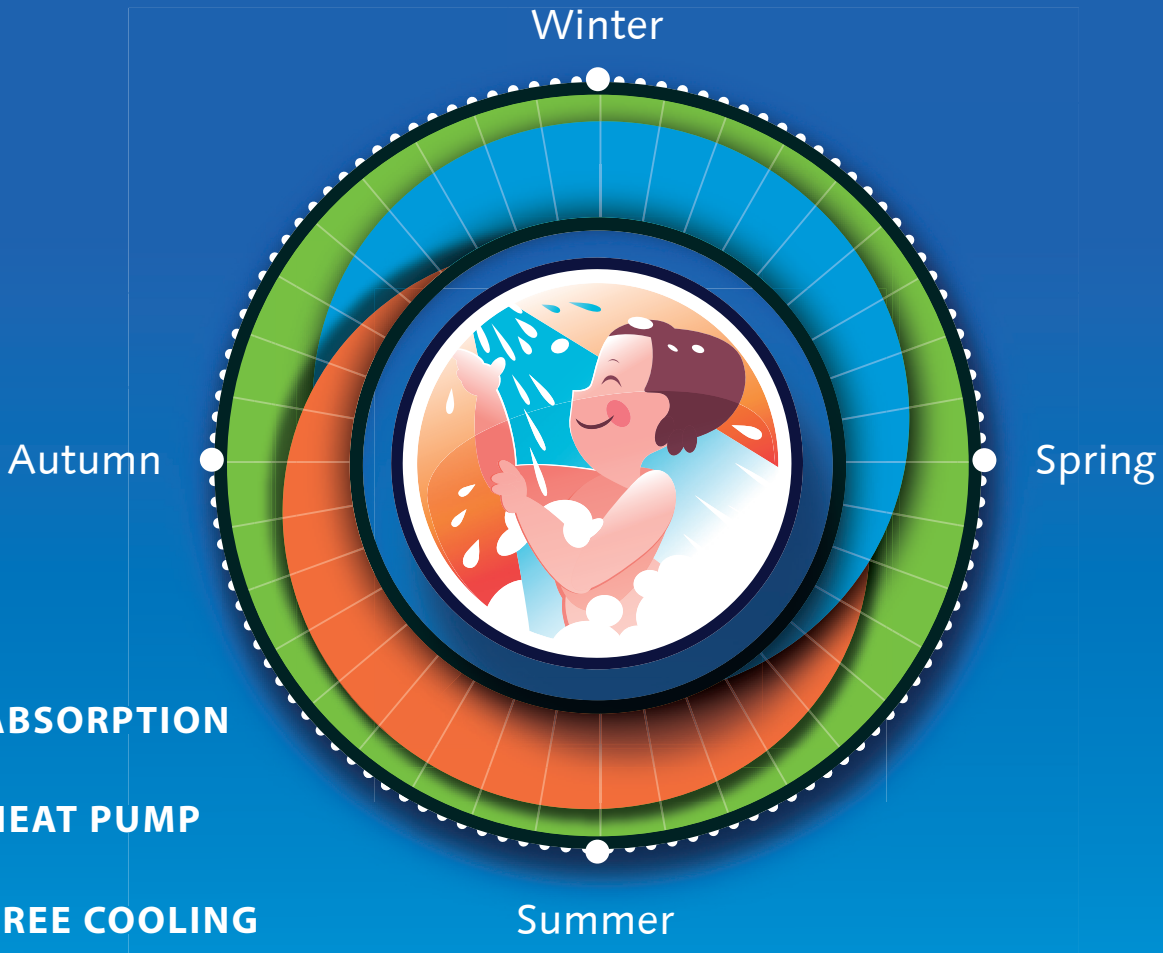
YIT Construction Ltd.
P.O.Box 36, Panuntie 11
FI-00621 HELSINKI
www.yitgroup.com

Helsingin Energia

The world's most eco-efficient computer hall from Helsingin Energia



District cooling production methods



Eco-efficiency for computer halls

Helsingin Energia's new solution takes computer halls into an eco-efficient age: the computers are cooled by district cooling, and the heat produced by the machines can be piped into the district heating network to heat buildings in Helsinki and to provide them with hot water.

If all the computer halls in Finland operated on this principle, up to 500 MWh of energy could be saved every day. At the same time, a medium-sized town's worth of buildings could be heated.

Beneath central Helsinki lies a ready-made district cooling and -heating network and plenty of subterranean spaces for eco-efficient computer halls.

1. A conventional cooling solution consumes a lot of electricity, and the thermal energy goes to waste. The equipment is also very noisy. The roof structures of buildings are not usually designed to take the loads of condensing units, so they may need to be reinforced. A condensing unit on a roof does not add beauty to the facade of the building, and it also requires a lot of room.

2. The computer hall solution that Helsingin Energia offers allows the thermal energy produced by the computers to be recovered, while being totally silent and unobtrusive. The carbon footprint is only a fraction of the alternative solution. The district cooling equipment to be installed in the client's premises takes up much less room than traditional cooling devices. The need for servicing and maintenance is reduced, and the risks and worries of the client's own cooling provision are eliminated.

3. The reserve power generator container must often be installed outdoors. A container reduces people's enjoyment of the yard.

4. The reserve power generator container can be placed underground adjoining the computer hall.

5. The recovered thermal energy can be transferred to the Helsingin Energia district heating network covering the whole city area.

6. District heating is used to heat buildings and domestic hot water.

7. The heat produced by the computer hall is recycled and not wasted to warm up the air outside. The carbon footprint of the computer hall is substantially reduced.

8. Compressor-operated cooling devices have used cooling agents, such as HCFC compounds which are classified as destructive of the ozone layer in the atmosphere.

9. No cooling agents are used in a district-cooled computer hall.

10. Compressor-operated cooling equipment increases power consumption considerably. The output of a conventional cooling system cannot be increased, but a second unit must be installed on the roof, if increased output is required.

11. With the Helsingin Energia cooling solution, output is never inadequate and can be raised steplessly at any time. Our production capacity already exceeds 100 MW and more is being built to respond to growing demand. One hundred percent of the capacity and electric energy of the electrical connection can be used for computing. None of the client's electricity is used for cooling.

12. District cooling is produced by a total of 15 mutually independent production units in three separate plants. Two of the production plants are in Salmisaari, and the third is the Katri Vala Heating and Cooling Plant in Sörnäinen. The Katri Vala plant and one of the Salmisaari plants are situated in premises excavated underground.

13. In a conventional solution, power transmission lines and data communication links run along the street network, subjecting them to external risk factors, such as diggers etc.

14. Underground energy tunnels provide a secure route and an unbroken supply for important connections. Helsingin Energia has a tunnel network of almost 60 km in Helsinki. Premises excavated into bedrock ensure the highest possible physical security.

District cooling production methods

The absorption technique is employed to produce district cooling using thermal energy that is otherwise wasted in energy generation. The absorption machinery operates in summertime, when sea water is too warm for free cooling.

A heat pump is used to recover thermal energy obtained from district cooling. The heat is transferred to the district heating network for heating buildings and domestic hot water in Helsinki.

Free cooling produces district cooling from cold sea water between November and May, when its temperature is below 8°C. The cooling is produced direct from sea water whenever possible.

Helsingin Energia

Additional information:
Juha Sipilä
Tel. +358 40 334 6663
juha.sipila@helen.fi

www.helen.fi/energy/tietokonesali.html

Helsingin Energia
00090 HELEN
Tel. +358 9 6171
www.helen.fi