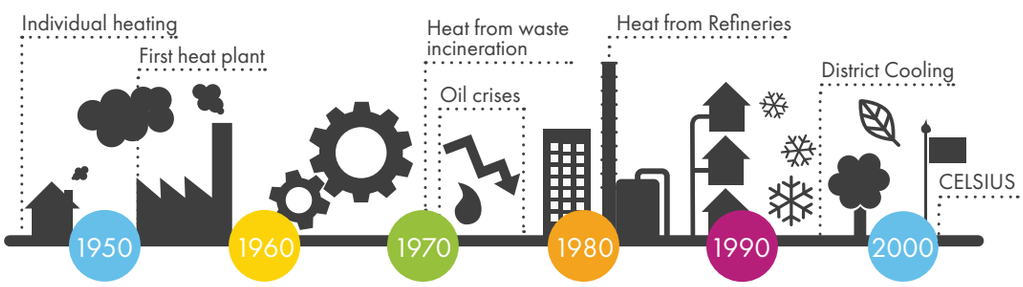
THE DEVELOPMENT OF DISTRICT HEATING AND COOLING IN GOTHENBURG

Learn from our challenges and progress!

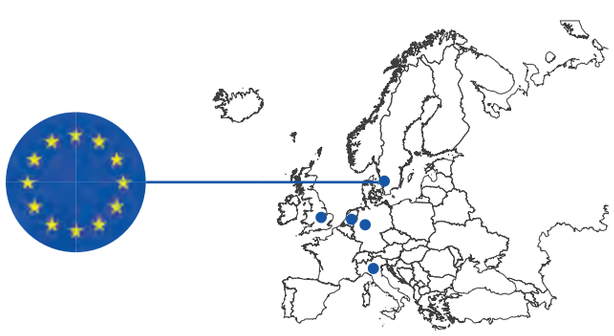
celsius
smart cities

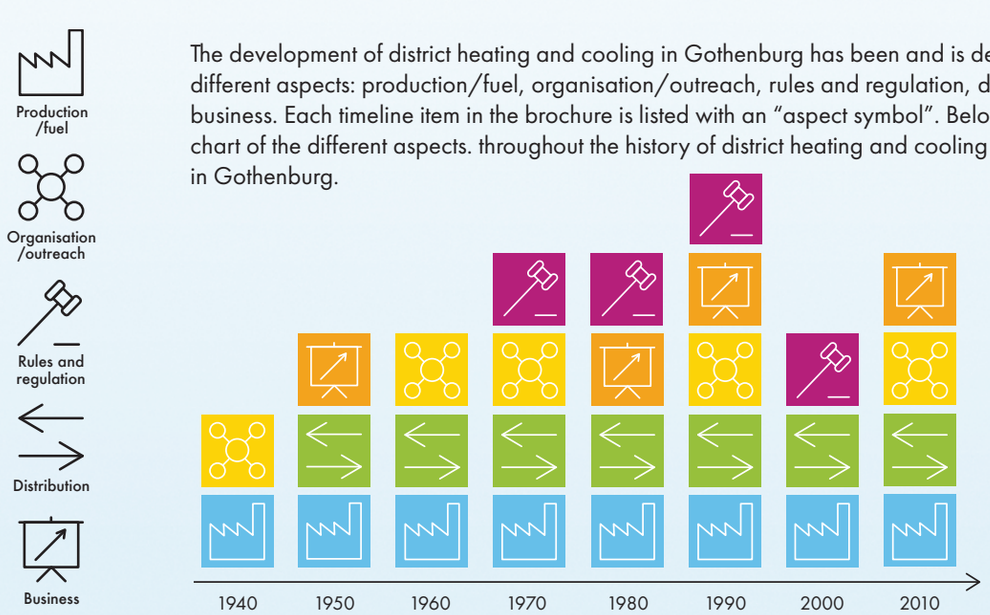
THIS IS THE STORY of how a city developed its district heating and cooling system, which provides its citizens with secure, affordable and low-carbon heat and cooling. By sharing this story, we would like other cities to be inspired, or better, learn from our challanges and progress.

As the development of the district heating system in Gothenburg shows, it is not only a story of generating and distributing heat, it is a story of a city and a society in change.



Gothenburg is the lead partner of CELSIUS, an EU-funded project demonstrating and assisting other European cities to plan, implement and optimize smart district heating solutions. The other partner cities are Cologne, Genoa, Rotterdam and London & Islington Borough.





The development of district heating and cooling in Gothenburg has been and is dependent on different aspects: production/fuel, organisation/outreach, rules and regulation, distribution and business. Each timeline item in the brochure is listed with an "aspect symbol". Below is a simple chart of the different aspects. throughout the history of district heating and cooling development in Gothenburg.

TIMELINE

Maintenance tools for the district heating system were transported with mopeds in the 60's

1946
Investigating

The old boiler generating electricity needed replacement so the city investigated the integration of district heating in the new solution. This solution would increase energy efficiency and also help getting rid of the smog created by individual heating boilers which were considered a local environmental issue. At this time, district heating already existed in big cities in Europe and the US, predominantly using steam instead of water to distribute the heat.

1948
Conference

Gothenburg organized a district heating conference, which resulted in the founding of the Swedish district heating association.

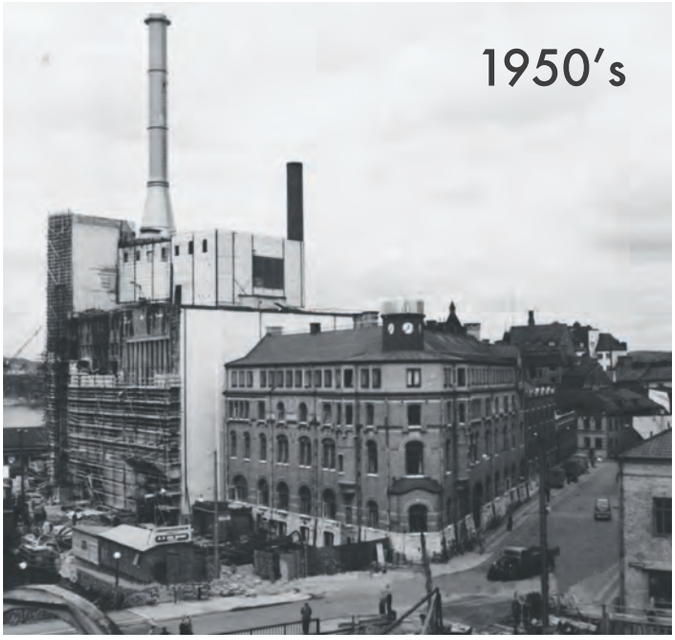
What is DH?

1. District heating can be generated from waste heat, heat pumps, waste combustion, biofuel etc.
2. Water is heated in a centralised location and then distributed in pipe networks.
3. The end user has a seprarate heat exchanger which facilitates heating the building and the tap water. Once the water is cold, it returns to the central plant.

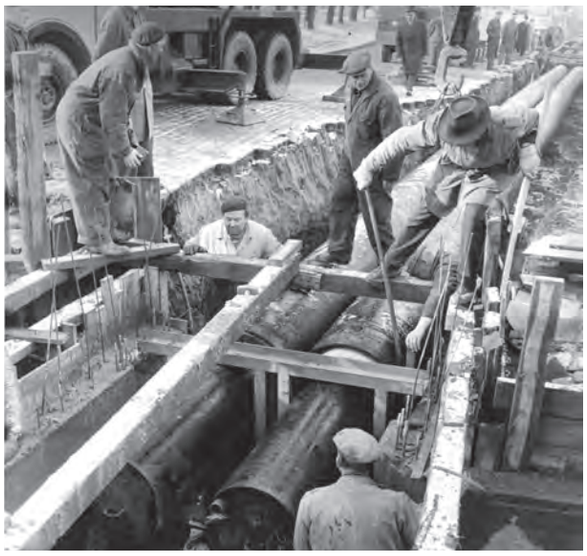
1953

It begins

In Gothenburg, district heating was introduced with two simultaneous projects: one plant (Rosenlund) to supply the inner city with heat and one (Sävenäs) to supply a new residential area, Kortedala. Both plants were constructed to generate electricity and heat from fossil fuels; coal and oil were both used initially, but eventually the use of oil dominated because it was easier to handle and less expensive. At first district heating was organized under the electricity department in the city.



The Rosenlund plant, situated centrally in Gothenburg



Building the main pipes running through the city

1950's

Network expansion

A big pipe for distributing district heating was built running through the inner city from Rosenlund. Initially the response from other potential clients was limited because of concerns to get locked into a system in which the monopolistic situation would result in unreasonable prices. This viewpoint changed and as more end-users were connected, the pipe turned out to be a fundamental structure for the whole district heating network.

1950's

Connection technology

The substations were built with two-step or three-step connections, which allow the systems to preheat the tap water and secure a lower return temperature.

1959

Target Price Tariff

At first district heating pricing was decided separately with individual agreements, but the customers advocated a more predictable system. The Swedish District Heating Association heeded the request and developed the Target Price Tariff, which was agreed upon with the Property Owners Association. Based on oil prices, the new pricing system was dependent on the customers' heat consumption.

Construction of Sävenäs, one of the first plants, 1952 and 1953

1960's

Short-term solutions

When customers increased by signing district heating contracts before the main network was extended to each residential area, the short-term solution was to generate heat with mobile or electrical plants.

1960's

Oil-fired boilers

Because the oil price was very low, the City of Gothenburg purchased several large oil-fired boilers.

Casting culvert covers

Finished concrete culvert

Network construction in the Haga Kyrkogata and Bellmansgatan intersection

1960's and 70's

Unfruitful negotiations

With the national energy company Vattenfall, the City of Gothenburg had ongoing negotiations to collaborate in the construction of a combined heat and power plant. Since Vattenfall had nuclear power plants which generated a surplus of electricity, nothing came out of the negotiations.

The plant in Angered – initially supplying a separate district heating network with heat

1960's and 70's

District Heating in Small Islands Small

Separate district heating islands were built to supply housing companies' apartments with heat. The large expansion of the city during this time sped up the development of district heating.

1965

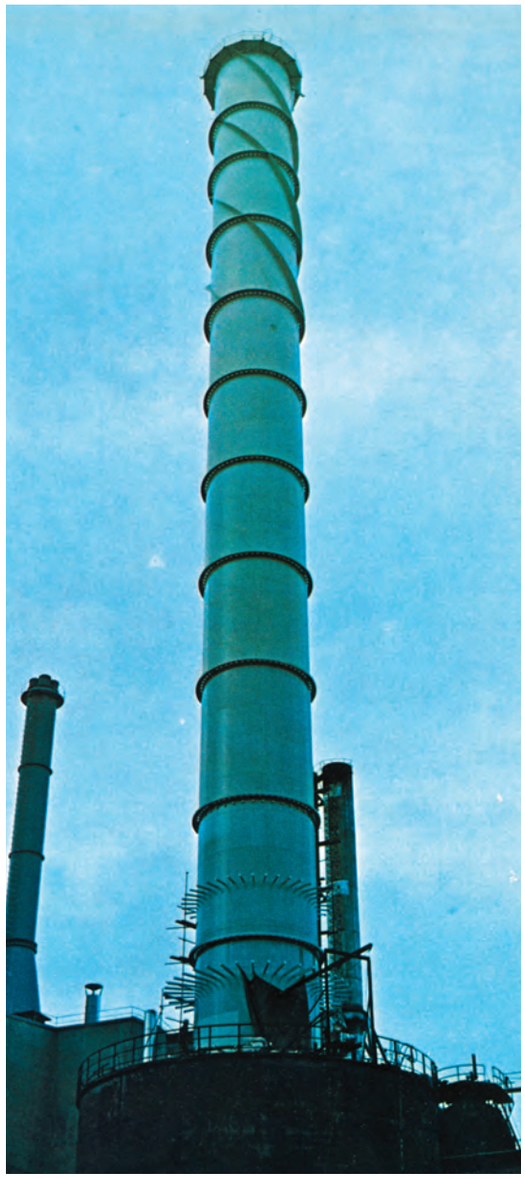
Organisational change

When the district heating activities increased, the need of a detached organisation grew. A separate district heating department was established in the city.

1967

A higher chimney

The oil used for district heating was a low-grade and dirty rest product that resulted in smog, which was a health hazard for the citizens, so a higher chimney was built to disperse the pollution.



The waste incineration plant (1971)

1972

Waste to heat

The city waste had been burned in small local burners without purification of the emissions, and this was not considered a viable option any longer, nor was depositing garbage at a landfill site. Discussions with adjoining cities resulted in the construction of a regional waste incineration plant. The heat from the waste incineration was used in the district heating network.

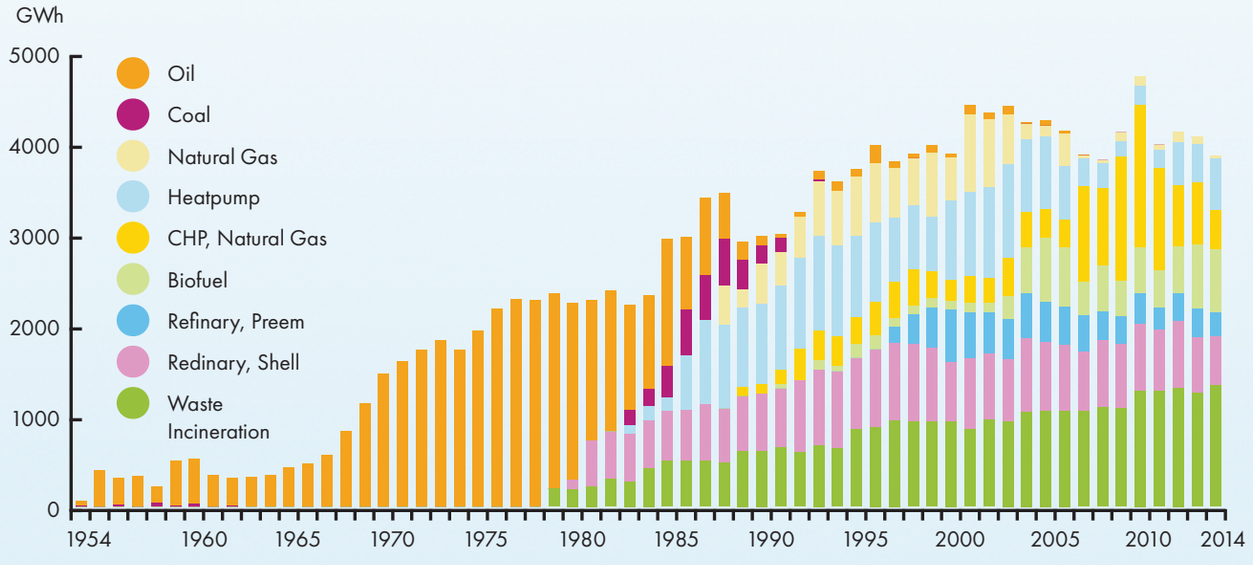
Another determining factor to build the waste incineration plant was the construction of a new hospital that needed hot water to sterilize equipment. The network was extended to the hospital with a separate line delivering extra-hot water. Later a big industry was also connected to the extra-hot water line. (Today the line delivers normal district heating temperatures, and the small increase that at times is needed is fulfilled via electricity.)

1973

The first oil crisis

With the oil crisis, Swedish politicians realized that dependency on oil made a society vulnerable and made several decisions to end the dependency.

Fuel mix of produced heat



1976

Substation ownership

City of Gothenburg offered to take ownership, operation and maintenance of the district heating substations. Both the municipal real estate companies and private real estate companies made the transfer. Today most substations are owned by Göteborg Energi.

1979

New material test

One of the material research tests during the years was the PEX project. With 77 houses as recipients, the PEX project tested plastic pipes in the district heating network with a reduced water temperature. This project was unsuccessful because oxygen permeated the pipes and corroded the heat exchangers. (Today the system has regular distribution components.)

1979

The second oil crises

A large portion of the Swedish GNP was still used for oil consumption, so with the second oil crisis it became a national political interest to decrease the oil use to protect the Swedish economy. "Oil Investigation Committees" came up with "Oil Replacement Plans," and district heating became an important component in many oil reduction strategies. To replace individual oil burners with district heating substations was nationally subsidised. In Gothenburg the oil reduction strategy was to utilize more waste heat.

The turbines at Rosenlund, one of the Combined Heat and Power plants (1973)

1980

Industrial waste heat

The Shell refinery in the Gothenburg harbour needed to get rid of waste heat and consequently dumped it into the river. A thesis made by a university student suggested that Göteborg Energi could collaborate with the refinery for a reliable heat supply. And in 1977, the decision was made. In a unique cooperation, the refinery increased their incomes and the energy company added the waste heat to the district heating network.

In 1980, a tunnel was completed 140 metres under the water level of the Göta Älv river to connect the refinery to the district heating network; to help realize the project, the government partially financed both companies' investments.

1982
City Council decision

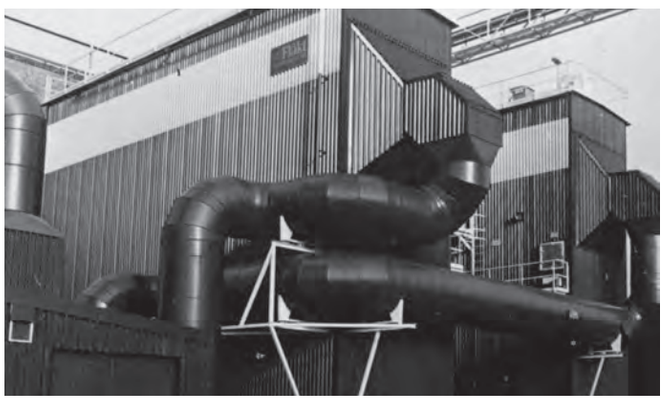
Based on two reasons, the City of Gothenburg made a decision in the the City Council to expand the district heating system. The reasons were to protect the environment and to reduce the oil dependency, and the way to do this was to use waste heat.

1983-1985
Retrieving heat content in sewage water

Heat from cleaned sewage water was used in combination with heat pumps to increase the district heating capacity. Large heat pumps were installed to retrieve the heat in cleaned sewage water from the regional water plant. The heat from the sewage water contributed with approximately 15% of the delivered district heating in the city.

1983
Switching to coal

Due to the oil crisis and rising market price, an old coal boiler was revived at Sävenäs and another one was built. Better filters were used to purify the emissions.



When coal was revived as fuel, a better filter was installed

The new Sävenäs chimney, 80 m high

Rosenlund, control room (1974)

Mid 1980
Union of networks

The two original and biggest combined power and heat plants in Gothenburg were connected and many of the smaller district heating islands were added to the system. This allowed for a greater flexibility in the system.

In the "Bump project," the district heating islands were connected to the central network by removing oil burners and upgrading pipes.

As district heating expanded, customer acceptance grew because of an awareness of energy resources, a better air quality in the city and a more reliable system both financially and operationally.

1985
Category Number Tariff

With a growing awareness among customers of energy use and pricing, a new pricing system was developed. In the Category Number Tariff, the pricing was based on the energy utilization time the previous two years, adjusting to normal climate conditions. The customers paid for used capacity divided by a category number (which represented the number of hours the service was used). The pricing changed monthly based on oil prices.

1990
Incorporation

To be able to grow and to be more competitive, the energy department in the City of Gothenburg was converted into a municipal company – Göteborg Energi. The goal with the newly incorporated organisation in the municipality was to have the ability to act faster and more independently.

1990's
Internationalisation and market focus

The management of the energy company decided to expand the organisation perspective by networking in Europe and the US. At the same time, a more market-focused organisation was introduced. An energy consulting company focusing on the international market was established with special expertise in district heating. The company resided within Göteborg Energi for 10 years, after which it was sold to a consulting company.

1990's
New installation technology

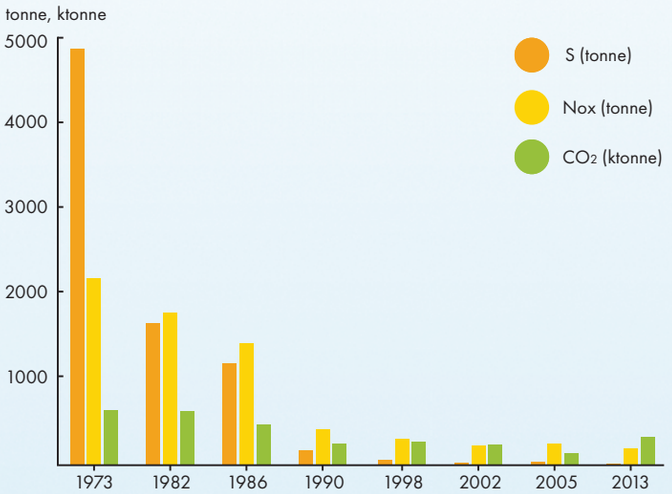
Dimensions of the district heating equipment decreased. Brazed plate heat exchangers, prefabricated pipes and smaller valves were installed and older technology phased out.

1995-2000
Regional collaboration

District heating collaboration was initiated with four neighbouring municipalities through commercial supply agreements, acquisition and merger.

Mid 90's
District Cooling

Cooling was initially supplied to through absorption cooling connected to the district heating system. The first cooling was delivered to a hospital.



Emissions for Gothenburg Energy AB including emissions from electricity generation. Use of waste heat is considered without emissions.

1996
Electricity market deregulation
The Swedish government deregulated the electricity market, which meant that Göteborg Energi had to operate on a commercial rather than cost-recovery basis.

1997
Choice of connections
Extensive research during the 90's showed that one-step connections in substations were the most efficient solution. Göteborg Energi phased out two-step and three-step connections and used one-step connections primarily.

1997-2005
Adding district cooling areas
Ten district cooling islands were built in Gothenburg.

1998
Adding another refinery
A refinery, that was already distributing heat to a nearby car factory, decided to also distribute the heat to the city's district heating network.

2003
Alternative fuel sources
Motivated by environmental concern, one of the biggest hot water boiler and power plants converted two of their boilers from using gas and oil to using pellets as fuel.

2004
More Alternative Fuel
Another Sävenäs coal burner was converted to use wood chips as fuel.

2006
A new Combined Heat and Power plant (CHP)
With installed capacity to supply Gothenburg with 30 % of its electricity and 35 % of its heat, Rya CHP was constructed.

2007-2011

Heating residential homes

Approximately 12 000 single family houses were connected to district heating in Gothenburg after a program was initiated by the City of Gothenburg.

2007

District cooling in one system

District cooling developed similarly to the district heating system. First small islands of district cooling were developed and in 2007 most of them were integrated in a centralised system.

2010

Pricing based on capacity

A new pricing system for district heating was developed in Gothenburg based on the average of the three days per year with the highest consumption.

2008

The District heating Act

The District heating Act was introduced in Sweden to increase the transparency in the sector and to protect the customers from unfair price settings.

2012

Adding electricity

A turbine was installed in the Sävenäs biomass burner to also generate electricity.

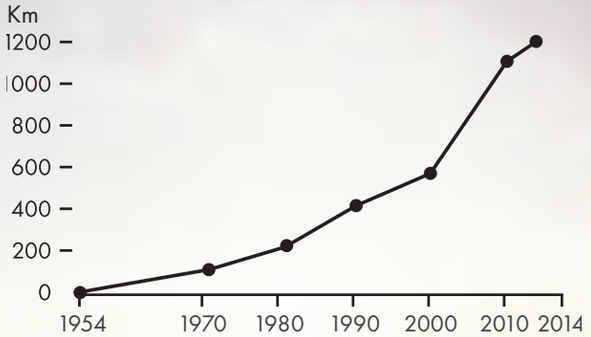
Fun Facts

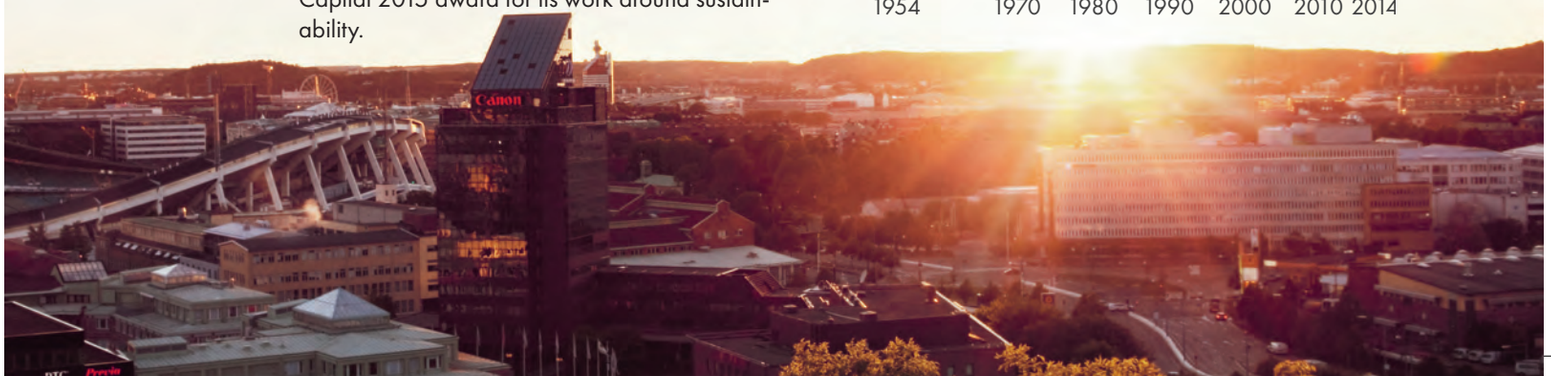
The topography in Gothenburg has been a challenge for the district heating network; there is 280 metres in altitude difference measuring from the lowest to the highest point.

In 2011 the City of Gothenburg and Göteborg Energi won the Global District Energy Climate Award.

Gothenburg won WWF's Swedish Earth Hour Capital 2015 award for its work around sustainability.

District Heating Network, length





2013
CELSIUS

Gothenburg is chosen lead partner in an EU project to demonstrate district heating and cooling and assist other European cities to implement and optimize smart solutions. With a district heating network covering 90 % of multi-family residential buildings in Gothenburg, Göteborg Energi has three innovative demonstration projects in CELSIUS showing how to use short-term storage in buildings, connecting a ferry in port to district heating and using district heating to white goods.

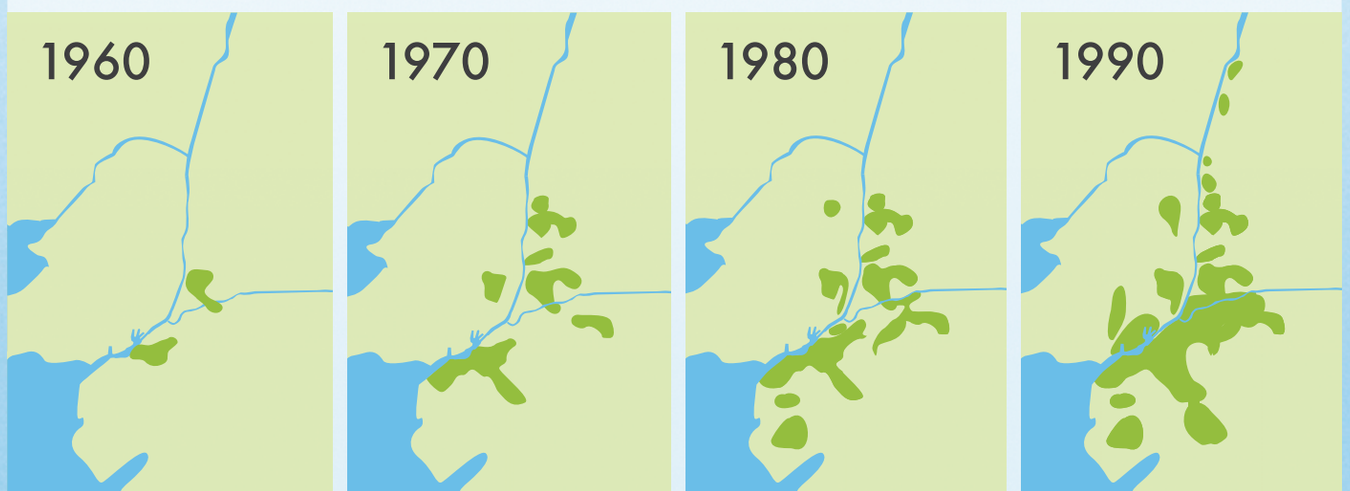
2014
Today's society favours two-step connection

Because of changes in house construction methods and living habits, suggestions were made to go back to two-step connections in heat exchangers. House construction has become more complex, and previously there was little use of hot water between 12 PM and 4 PM and between 12AM and 5 AM, but now hot water is used during the whole day, and sometimes apartments are not used for several months during the summer. To go back to the two-step connection would result in a more even hot water supply and less maintenance.

2014
The Price Dialogue

Göteborg Energy joins The Price Dialogue (Prisdialogen), which is a national system for communicating changes in district heating prices. The system is an open dialogue between district heating suppliers and their customers to create a predictability of district heating prices and a transparency in pricing and price changes.

District heating network development




GOTHENBURG 2014
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CELSIUS is an EU project that demonstrates and promotes integration of smart district heating and smart district cooling. CELSIUS supports committed European cities to maximize the utilization of its primary and secondary energy resources in an integrated way that minimizes its operational costs and carbon emissions while maximizing its energy efficiency. The CELSIUS project supports EU's aspiring energy efficiency goals.

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no 314441.