ENVIRONMENTAL BENEFITS FROM DISTRICT HEATING IN THE NORDIC CAPITALS

ENVIRONNEMENT AVANTAGES AVEC LE CHAUFFAGE URBAIN DANS LES CAPITALES NORDIQUES

ROSENBERG, Mats
Norwegian District Heating Assoc., Norway
KOIVISTO, Heikki
Finnish District Heating Association, Finland
STÅLEBRANT, Rolf
Swedish District Heating Association, SWEDEN
GUNNARSDOTTIR, Maria
Icelandic District Heating Association, Iceland
PETERSEN, Erling
Danish District Heating Association, Denmark

1. Introduction

1. Introduction

The increase of district heating has resulted in a better environment in the Nordic capitals and greater efficiency in fuel utilisation.

If you compare the development of district heating in the Nordic capitals with the decreasing pollution of sulphur dioxide, nitrogen oxide and particles, the quality of the air has constantly improved. The content of sulphur dioxide in the air, which mainly emanates from energy production, has for example greatly diminished because of the increased use of district heating and new technologies in the heat (and power) production. Figure 1 shows the development of district heating in Helsinki, Oslo and Stockholm and the decreasing content of sulphur dioxide in the air at the same time.

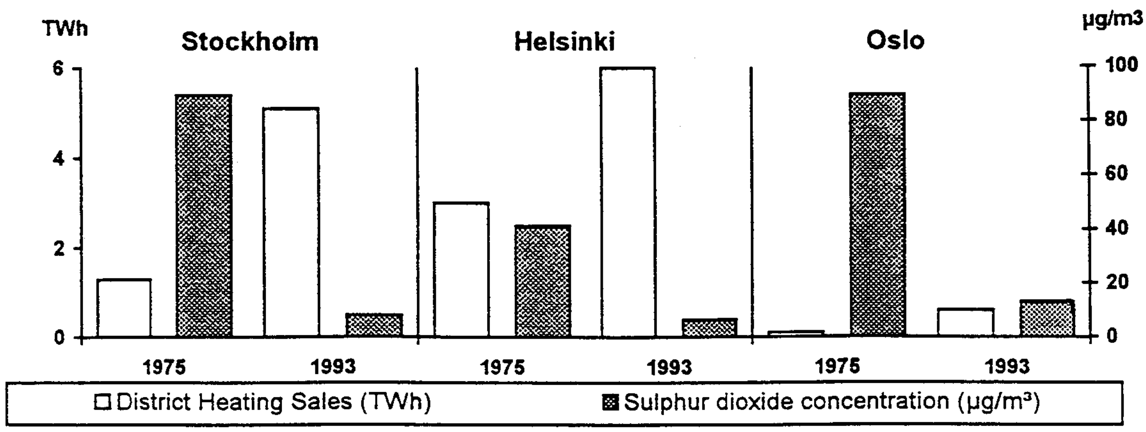


Figure 1 District heating sales and SO_2 concentration in Stockholm, Helsinki and Oslo.
Tableau 1Vente de chauffage urbain et concentration d'anhydride sulfureux a' Stockholm, Helsinki et Oslo.

2. District heating and the Nordic Countries
2. Le chauffage urbain dans les pays nordiques

2.1 NORDVÄRME
2.1 NORDVÄRME

This paper is produced as a report from NORDVÄRME (Nordic heat). NORDVÄRME is an association for co-operation between the national district heating associations in Denmark, Finland, Iceland, Norway and Sweden. If you would like more information, clear facts or results of district heating and environment in the Nordic countries, you are welcome to contact one of the associations belonging to NORDVÄRME.

2.2 Environment and energy
2.2 L'environnement et l'energie

During the last 20 years environmental questions have received a higher priority in industrial countries. In order to come to grips with these problems, international agreements on common measures have been reached in a number of countries. Where we formerly spoke of national or local problems, we now speak of global problems.

Only if the industrial nations «clean their own door-step», will their environmental and energy policies be given credibility. Only then will they be able to take an active and effective part in the on-going environmental debate. Every industrial nation must take inventory of the realistic possibilities of reaching a more rational energy usage and of their methods of producing the needed energy with a minimal effect on the environment. This means, apart from the efforts to reduce energy consumption, investments in a more judicious use of technology and a more effective use of fuel.

Today it is not the large «point-emissions» which are responsible for the major effects on the environment, but instead such diffuse emissions as:

- «Importation» air pollution
- The increasing traffic
- Many small local heating sources

In cities and urban areas, district heating is one of the best economically and the best environmental competitive alternative to individual heating from oil or gas. When coupled with generation of electricity in CHP (combined heat and power), district heating is beyond comparison.

The World Commission on Environment and Development has explained the problem in the extensive report «Our Common Future» also known as «The Brundtland Report». In chapter 7 about energy it states: «An important method of heating buildings is by hot water produced during electricity production and piped around whole districts, providing both heat and hot water...the cogeneration of heat and electricity could revolutionize energy efficiency of buildings world wide.»

2.3 District heating
2.3 Le Chauffage urbain

District heating may be defined as space and water heating of a number of buildings from a central plant. The plant can either be a combined heat and power plant or a plant that only produces heat. The heat produced in this plant is delivered to the consumers as hot water through an insulted, double pipeline system (in some system steam is used instead for water). Figure 2 shows the different parts in a district heating system. The heated water is carried in the forward pipe distribution system and having given up its heat, the cooler water returns to the plant in the other pipe for reheating. Any fuel or any source of surplus heat that can heat the water to approx. 100 °C may be exploited in district heating systems.

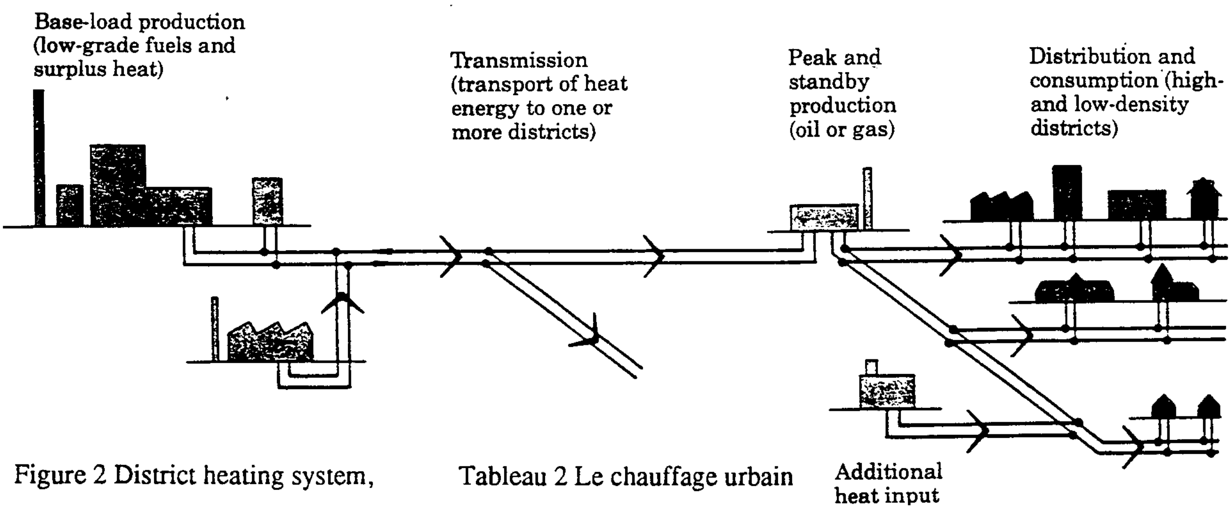


Figure 2 District heating system, Tableau 2 Le chauffage urbain

District heating meet the diverse thermal energy needs of residential, commercial and industrial users. Thermal energy needs or demands include space heating for maintaining human comfort, domestic hot water requirements, manufacturing plant process heating, etc.

District heating can be combined with electricity to create a more efficient total energy utility. Conventional condensing power stations generally utiliz e less than 40% of the fuel they burn for electricity generation (over 60% is lost in flue gases and in cooling tower or cooling water). Much of this waste energy can be reclaimed by recirculating hot water or steam to buildings, for space heating or industrial processes giving an overall efficiency of about 85%. Waste heat can also be used to drive chillers for cooling.

The difference in fuel efficiency between combined heat and power plants and condensing power plants can be illustrated with the following example:

For each EIGHT «barrels of energy» consumed in a combustion plant.

- ONE «barrel of energy» is lost throughthe chimney or in the plant.
- THREE «barrels of energy» is generated to electricity.
- FOUR «barrels of energy» is wasted in cooling systems *or*
  FOUR «barrels of energy» is used for district heating.

Combined production of heat, power and cooling has enormous potential. The technology is proven, it would be relatively simple to satisfy a substantial part of energy demand and its basic efficiency means reduced pollution, especially for high population density areas. Once established, the system can also be connected to other efficient sources of heating or cooling such as industries or cool water sources.

2.4 The Nordic countries
2.4 Les pays nordiques

The Nordic countries, embracing Denmark, Finland, Iceland, Norway and Sweden, cover a total area of approx. 1,300,000 square km, corresponding roughly to that of Spain, France and Italy combined, figure 3. While the latter three countries have more than 150 million inhabitants, there are only about 23 million in the Nordic countries.

The Nordic climate is dependent on the Gulf Stream, the world's largest carrier of district heat. The Gulf Stream transports huge amounts of heat from the Equator to the most northern parts of Western Europe, thereby making it possible to inhabit areas at the same latitudes as Alaska.

In the Nordic countries, District Heating has developed into an important source of heat supply for homes, offices and factories. The role played by district heating varies from country to country, influenced by such factors as climate, geography, economic and political considerations, and appropriate techniques have developed in the various ways to meet specific demands. In general, however, district heating is today an essential element in the overall heat supply situation in the North.

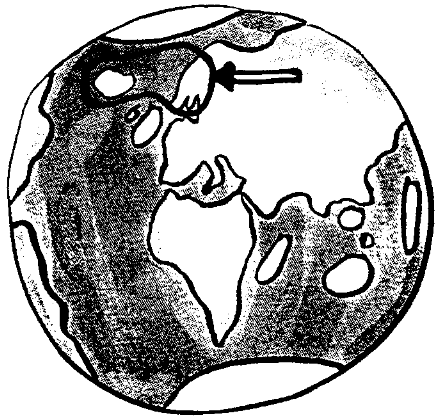


Figure 3 The Nordic countries
Tableau 3 Les pays nordiques

Lacking hydraulic power and close to the district heating system in Germany, Denmark was the first country to establish district heating in the early 1920's. The system was mainly in order to utilize heat from electricity generation. With the excellent communication channels between the Nordic countries, Denmark paved the way for district heating in the North during the first decades.

Today the Nordic energy utilities delivers approx. 100 TWh (360 PJ) district heat every year to space heating and domestic hot water. This is more than 35 % of the market for heat and domestic hot water in the Nordic countries. District heating is a heating systems that is most efficient and profitability in regions with high energy demand per square km.

A condition to get a successful district heating system is that you have a heating market and a «cheap local energysource». A «cheap local energysource» can be waste heat from power generation (common in Denmark and Finland), geothermal energy (Iceland), waste heat from incineration (Norway) or a mixture of several energysources (Sweden).

3. District heating in the Nordic capitals
3. Le chauffage urbain les capitales noriques

3.1 Copenhagen, Denmark
3.1 Copenhague, Danemark

With surrounding cities the greater Copenhagen area has altogether more than 850,000 electricity consumers with a total annual sale of electricity of approx. 8 TWh. The City of Copenhagen has used cogeneration of heat and power for more than 50 years, mainly based on supply of steam.

In 1983, the 16 municipalities which are to receive heat from exciting and new power plants, started planning and engineering of the interconnected transmission network in accordance with guidelines laid down by the authorities. Two transmission companies have been established for this purpose. VEKS in the area west of Copenhagen and CTR in central Copenhagen as well as north and south of Copenhagen. This two systems are linked to Vestforbrændning incineration in the northern part. Together these three systems make up one of Northern Europe's largest transmission systems. The heat sale is around 7 TWh/year (25 PJ/year), depending on weather conditions. Nearly 100 % of the heat is produced in combined heat and power stations or in incineration plants.

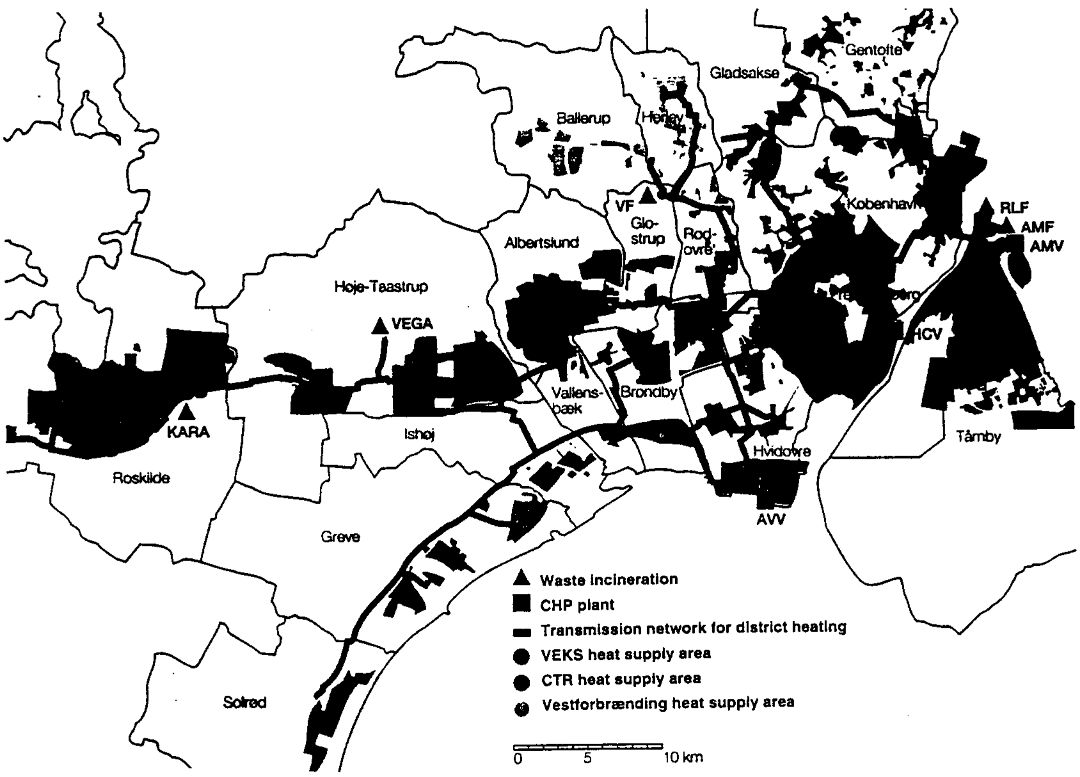


Figure 4 District heating and combined heat and power generation in Copenhagen
Tableau 4 Chauffage urbain et les centrales chaleur-électricité a' Copenhague

The transmission network to supply approx. 63 local district heating networks via heat exchanger stations, figure 4. Most of the local district heating networks are existing networks established in the 1960s and 1970s based on oil firing or incineration.

Due to the complicated composition of the combined heat and power systems, it is important that the load dispatching should be co-ordinated by ELKRAFT in co-operation with the two transmission companies. An agreement has been made to effect that the production shall be arranged at any time, so the total production costs of the power system and the heat system will be as low as possible.

While convenience, profitability, and energy conservation have been the major considerations for introducing and extending district heating schemes in the past, environmental protection has now become to the forefront. It is clear that it is more feasible to control emissions from a few large plants than from thousands of house hold boilers spread over a city. Also, if less energy is consumed through combined heat and power and utilisation of waste heat, the emission per delivered unit of heat is reduced. Increasing political demands as to environmentally acceptable disposal of waste products such as garbage, chemicals, straw, etc. now give district heating a new dimension, as energy from almost any combustible material can be exploited.

During the last 10 years the SO_2 emission per TJ energy produced from Danish CHP stations have decreased with 50 %.

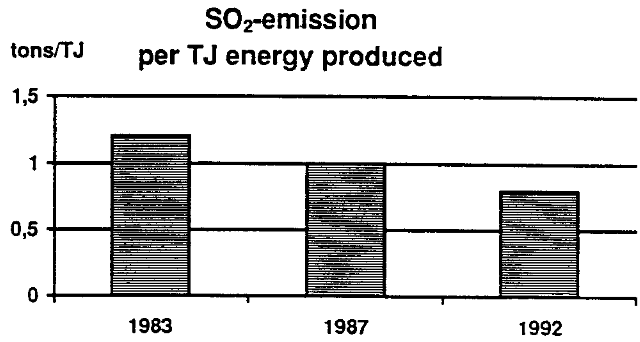


Figure 5 SO_2 emission per TJ energy

Tableau 5 SO_2 rejets par unité d'énergie

3.2 Helsinki, Finland
3.2 Helsinki, Finlande

Helsinki, the capital of Finland, is situated by the gulf of Finland at 60° Northern latitude. The annual mean temperature is +5.3 °C. The lowest ever daily mean temperature, -32.5 °C, was recorded in January 1987. The population is slightly more than 500,000 in 1994. With surrounding cities the greater Helsinki area has altogether more than 900,000 inhabitants.

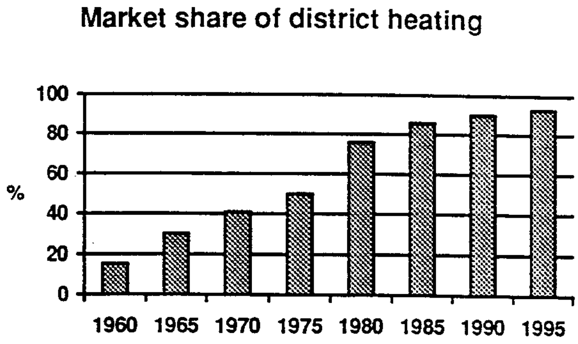
Networks

After the Second World War fuel was expensive and difficult to obtain. Efforts were needed to improve the efficiency of fuel utilisation, so district heating was introduced in Helsinki in 1952. The spread of district heating has resulted in greater efficiency in fuel utilisation. At the same time the self-sufficiency in electricity production has increased to nearly 100%.

Fuel is now required, 33% less than if electricity would be generated in condensing power plants and heating provided by individual heating boilers. This energy saving corresponds to 460 thousands tons of oil per year.

District heating distribution now covers practically the whole city area. The market share of district heating is 92%, figure 6. The heat sale is around 6 TWh/year (22 PJ/year), depending on weather conditions. In 1993, the sale was 6.0 TWh (21.6 PJ). In the same year, the electricity sale was 3.1 TWh. According to heat sale, the Helsinki Energy Board is the biggest district heating company in western Europe.

Figure 6 Market share of district heating
Tableau 6 Marché du chauffuge urbain



The heating energy consumption per cubic meter of space showed a slight increase until the energy crises of 1973, but has since shown a proportional continuous decline. The declining trend is expected to continue even in the future. The heating demand diminished by 33% between 1971 and 1993. It is estimated, that the heating demand will still decrease by 1% per year until the year 2000.

From the beginning the district heating tariff was set at an economically competitive level. District heating had to be cheaper than other sources of heating. Consequently, district heating spread very quickly, and resulted in full investment utilisation and good profitability. The good profitability ensured the financing of further investments.

Production

Modern technology offers a possibility of forestalling a number of potentially harmful effects on the environment. Nevertheless the final result will always be a compromise. We can however say, that the new energy plants of Helsinki fulfil the environmental requirements quite well. The coal power plants Salmisaari and Hanasaari B are both equipped with desulphurisation and will be equipped with low-nox burners.

Ecology

Sulphur dioxide mainly emanates from energy production. In 1993 the sulphur dioxide emissions originating from centralised energy production amounted to some 5600 tons in Helsinki. The total emission within the city area was about 6500 tons.

The sulphur dioxide content in the air has greatly diminished because of the increased use of district heating.

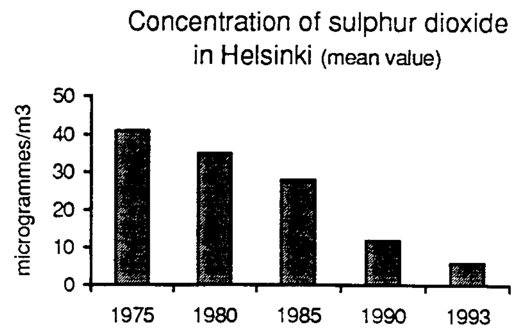


Figure 7 SO_2 concentration in Helsinki
Tableau 7 SO_2 concentration a' Helsinki

Research showed a sharp decline of sulphur dioxide content in the early 1970s, when district heating achieved a market share of 50%. Meanwhile, the share of longe-range sulphur dioxide has increased, and nowadays accounts for about one-third of the annual average of 5...10 $\mu g/m^3$ in the air in the city centre. Daily levels seldom reach above 100 $\mu g/m^3$.

It has been predicted that the insignificant amounts of sulphur will continue diminishing in spite of increased energy production. This decrease will be due to the gradual change-over to desulphurisation of flue gases. According to plans, the last coal boiler without desulphurisation will only be used as reserve capacity from 1997. Coal will still remain as a main fuel in Helsinki, even though natural gas has been utilised for CHP production since 1991. The increasing use of natural gas will also contribute to lower sulphur dioxide emissions. It is estimated, that the sulphur dioxide emissions in Helsinki then will be about 2500 tons annually, which is around 90% lower than the emissions in 1981.

The nitrogen oxide content in the air of Helsinki has been measured and investigated since mid-1980s. As district heating has become more common, the average emission heights have increased, and the nitrogen oxide content originating from energy production has decreased. The increase of traffic has strongly affected the nitrogen oxide content. In Helsinki the estimated nitrogen oxide emissions emanating from energy production were 8400 tons in 1993, whereas nitrogen oxide emissions from traffic were estimated at some 7500 tons expressed as NO_2.

Future development

It has been estimated that in 1995 the nitrogen oxide emissions from the Helsinki power plants will only be about 7500 tons of NO_2. The lowering of NO_x - emissions is due to the NO_x - reduction measures coming into use at Helsinki Energy Board before 1995. The prognosis for the year 2000 is 6500 tons of NO_2, which is around 50% less compared to the situation in 1988. The use of natural gas and new power plants will also contribute to lower emissions.

Only the old power plants contribute to the emissions of energy-production-based airborne particles. As new technology is utilised, it is likely that the air particle content from energy production will be insignificant compared to that of traffic. In 1993 about 550 tons of particles were emitted from power plants. It is estimated that in 2000 the dust emissions from energy production in Helsinki will be about 250 tons/year.

The storing and transfer of coal at the power stations causes emissions of coal dust. According to the measurements the downfall is limited mainly to the power plant area. The coal dust emissions are largely dependent on weather conditions and climate, which effectively reduce the amount of airborne dust in Helsinki during most of the year.

Helsinki was awarded the United Nations Environmental Prize in 1990 for its district heating program, which has used cogeneration to reduce energy demand in Helsinki. The award was given to the city of Helsinki "in recognition of its dedication, leadership and commitment to the enhancement of the quality of the urban environment".

3.3 Oslo, Norway

3.3 Oslo, Norvège

Christiania Elektrisitetsverk installed the first electric streetlights in the Capital of Norway in December 1892, thus introducing electricity and at a later stage district heating. Upto the year 1900 steam and direct current was the only source for electricity production. In the summer of 1900 started the first hydro power station producing alternating current. Today Oslo Energy solely and jointly with other companies, own hydro power stations with a production of about 7.7 TWh. Oslo City with its 470,000 inhabitants, is the main receiver of the produced electricity. Oslo Energy has about 300,000 electricity customers.

Since 1937 The Town Hall and a few buildings near by, were supplied by district heating: The main point was to utilize waste heat from a centrally located steam turbine. In 1980 four different district heating projects were started within Oslo City. Today to of the systems are interconnected, og total delivery is about 560 GWh yearly (2 PJ/ year).

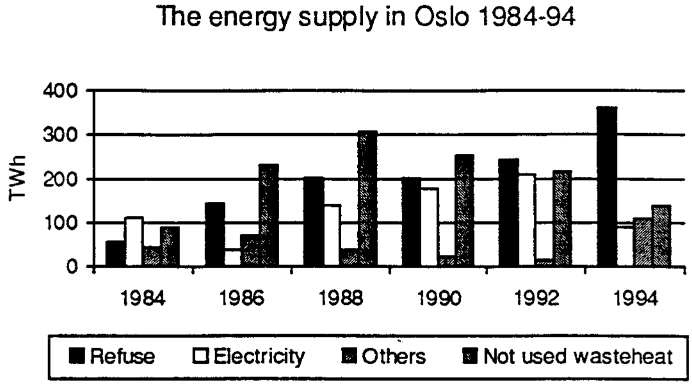


Figure 8 Fuels used for district heating in Oslo
Tableau 8 Combustibles utilisés pour la production de chaluer Oslo

Referred to as «others» in the figure 8 are 10 GWh annually from heatpumps, the rest is oil. Oil is used for peak and standby production.

District heating was introduced after oil prices roared in 1979. Increase in use of electricity during these years was over 10 percent annually and new hydro power projects declined due to extensive costs. In addition two waste combustion plants were built in Oslo with the possibility to use reasonable inexpensive waste heat for hot water heating. In addition there were certain gain to the environment.

District heating has given extensive environmental gain due to reduction of fuel oil. In 1994 the estimated gain is 45 million litres fuel oil annually, meaning 160,000 tons less CO_2 into the atmosphere.

Ecology

In the beginning of the 1960 several cities in Norway struggled with high levels of airpollution due to release of CO_2 from stokers and industry. The levels of CO_2 and soot in Oslo was on top in 1963. Due to less coal firing and better combustion, were reduced in the following years.

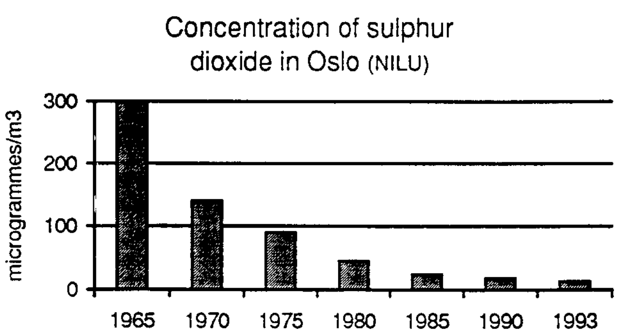


Figure 9, SO2-concentration in Oslo
Tableau 9, SO2-concentration a' Oslo

In the winter of 1963 the mean value was 380 ug/m^3 and in 1993 13 ug/m^3 (figure 9). The problem was gradually reduced due to lower contents of sulphur in fuel oils, a transition to electricity for heating, purifying plants and use of better technology during the 1970s. In the 1980s and 1990s the increase of district heating has been a main part of the improvement.

A few years ago a project in Oslo had as its main target the priority of different tasks to improve the levels of airpollution after costefficiency calculation. Almost 40 different measures were evaluated and among these, rated as number five, increase in district heating from 500 GWh to 1500 GWh (figure 10).

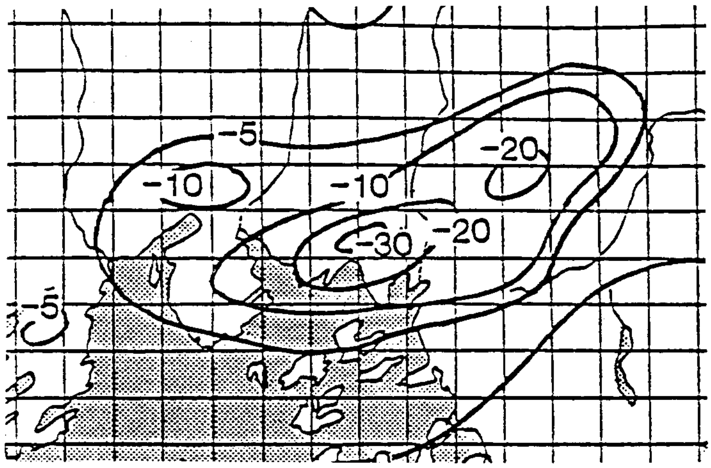


Figure 10. Change of concentration of SO_2 in Oslo from 1980 to year 2000 if district heating is increased by 1 TWh (SFT/Municipal of Oslo).

Tableau 10. Changement de concentration d'anhydride sulfureux a' Oslo. Le dévelopment du chauffage urbain avec 1 TWh

The first four attempts to reduce airpollution was against motor vehicles in a realtively small scale effecting only few people. The project showed that district heating is an efficient way of reducing airpollution in a city.

In the last years the media has mentioned airpollution as a cause for reduced health, especially by small children. A reacent examination from Transport økonomisk concludes that the inhabitants are willing to pay up to NOK 8,500 per year to reduce by 50 percent a release of health damaging pollution into the air. For release of NO_x transport is the most important factor. Release of NO_x from heating is today relatively modest.

Future development

District heating is increasing in Oslo. Primarily it is important to get new customers for the already existing systems, and thus utilise accessible heat from waste disposal plants. 30 million tons depositing metane gas from a large wastedeposit can further replace an annual consumption of about 3 million tons of oil with a release of 10,000 tons of CO_2. In the district heating system there will be a surplus of heat from incineration plants during summer months. Oslo Energy analyses the use of such energy for district cooling in the center of Oslo. District cooling can eliminate or better control chloroflourcarbons (CFCs) that contribute to atomospheric ozone depletion.

District heating is expanding with approximately 10% annually in the City of Oslo. For the next 10 - 15 years the annual district heating sales will increase to approximately 1.0 - 1.2 TWh (3.6 - 4.3 PJ). Consequently, the air quality in the city will improve to be a benefit to people as well as buildings when district heating has replaced burning of fuel oil for heating.

2.4 Reykjavík, Iceland
2.4 Reykjavik, Islande

Reykjavík, the capital of Iceland, is situated by the south west cost of Iceland at a Northern latitude of 64°. The population is 103,000 and with the surrounding cities it amounts up to 145,000. The annual mean temperature is +4,3 °C.

Geothermal heat is one of Iceland's greatest natural resources. About 85% of the inhabitant of Iceland have there houses heated with geothermal energy. Reykjavík has enjoyed the use of this treasure for more than 60 years. Geothermal heat is proven an inexpensive and safe source of energy for space heating without polluting the environment.

Networks

In November 1930 the first building in Reykjavík, a school, was connected to district heating, with 3 km long pipe from geothermal area in Laugardalur. In the next few years more public houses and 60 dwellings were connected, and served about 2,7% of the population of the capital. The inhabitants saw immediately the advantage of district heating and were impatient for more hot water. But the geothermal resource in Laugardalur was limited and in 1933 boring began at Reykir in Mosfellsbær, a geothermal area some 18 km away from Reykjavík. Work began in 1939 on bringing the pipeline from Reykir to Reykjavík and laying the distribution system in the city. World War II delayed operation so that it was not before 30 November 1943 that the first house was connected from the new municipal system. By the end of the year, 1300 houses were connected and the following year the number reached 2850 which then served 73% of the population.

Everybody wanted hot water and from 1949 until 1963 drilling was continued. Nevertheless, the population of the city was growing very fast and there was enough water for only half of the city in the 40s and 50s. Just before 1962 operation began with the goal of developing more boreholes, installing pumps and research for new geothermal areas, to be able to serve all the inhabitants of the city. At the end of 1972 97% of Reykjavík had hot water. After 1972 pipelines were laid to nearby towns, Garðabær, Kópavogur and Hafnafjörður, which are all now connected.

At the end of 1993 Reykjavík District Heating (RDH) provided hot water to 144,600 residents in ca. 37,000 houses in the capital and three nearby cities, which is 99,7% of the inhabitants in this area and about 55% of the inhabitants of Iceland.

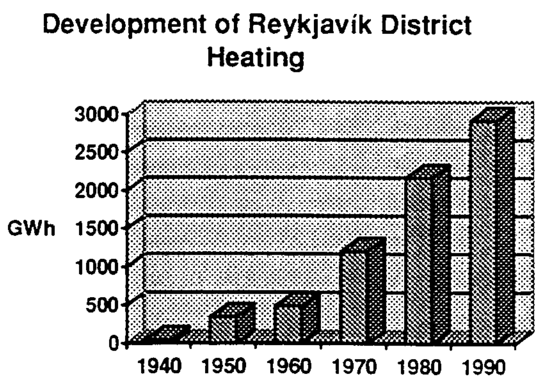


Figure 11 Development of District Heating

Tableau 11 Le développement du chauffage urbain

In the coldest periods the residents of the capital area consume about 3800 l/s for space heating. In 1993 RDH sold about 57 million cubic metres of hot water. Heat sale is around 2.7 TWh (9.7 PJ) per year. Installed capacity is now 640 MW.

In 1993 Reykjavík District Heating had 1120 km of pipelines, including both distribution system and main lines from geothermal areas. RDH uses either a single or a double distribution system. In the double system the return runs back to the pump station but in the single system the backflow drains directly into the rainwater severs in the street. After the hot water has been used in building it is 25-40 °C. In recent years it has become increasingly common to use this backflow to melt snow of pavements and now there are about 200 thousand square meters of such in the capital area. This adds to the better environment in winter time and results in fewer accidents on slippery pavement and less hospital cost. It is also increasingly common to build garden conservatories in connection to dwelling houses. This gives a prolonged summer season for man and vegetation.

Production

The first drilling for hot water in Reykjavík took place in 1928 and has continued since. All the water for space heating in the capital area comes from the more than 70 boreholes in geothermal fields in Reykjavík, Mosfellsbær and Nesjavellir. The boreholes are 150 to 230 mm in diameter and 500-2000 m deep, with the deepest over 3 km.

Geothermal fields are divided into low temperature areas were water temperature is below 150 °C at a depth of 1000 meters and can be used directly for space heating, and high temperature areas were temperature is above 200 °C at a depth of 1000 m. Such areas are found in active volcanic zones. The gas and mineral content is too high for such water to be used directly for space heating and instead cold water is heated with steam. The geothermal field in Reykjavík and Mosfellsbær are low temperature fields whereas Nesjavellir some 28 km from Reykjavík is a high temperature field.

Atmospheric pollution

Before the establishment of the District Heating in Reykjavík a pall of coal smoke over the city was a daily sight. There were drastic changes in atmospheric condition following the change to hot water. The absence of smoke is especially noticeable on bright winter days. Yet people hardly realized how important clean air is for human health, the term air pollution was really not known in those days in the same sense as today, when air pollution in densely populated areas is a global menace, causing increasing worry. The largest contributor to this is the burning of coal, oil and petrol in industry, dwelling houses and automobiles. In the early days of district heating, coal smoke lying over the city was a daily sight. Figure 12 shows a picture from 1940.

Figure 12,
Reykjavik 1940
Tableau 12,
Reykjavik 1940

The total heating load in 1993 correspond to the burning of 440.000 metric tons of fuel. It has been estimated that the pollution resulting from burning this amount of oil in domestic burners would produce about 1760 tons of sulphur dioxide, 1860 tons of nitrogen oxide and 470 tons of ash and soot. The town is certainly healthier now to live in.

The measurement of air pollution parameters on a regular basis just started in Reykjavík in 1990. It is known that the sulphur dioxide emission has greatly diminished because of the increased use of district heating. The highest mean value in January in traffic areas is around 20 $\mu g/m^3$ whereas just outside of Reykjavík highest mean value is 1-2 $\mu g/m^3$.

In high temperature areas acid gasses (CO_2, H_2S, etc.) are admitted to the atmosphere, likewise in Nesjavellir. It has not been detected that this H_2S is converted into SO_2, but reserch is continued. This amount of exhaust gasses from geothermal areas are small compared to thtat of oil burners. It has been estimated that the total amount of CO_2 from all natural geothermal sources and geothermal station in Iceland is 146,000 tons per year and of SO_2 is 14,000 tons per year.

3.5 Stockholm, Sweden
3.5 Stockholm, Suède

Stockholm is the capital of Sweden. The number of inhabitants is 8.5 millions in Sweden and about 650,000 in the City of Stockholm.

District Heating was introduced in Stockholm in 1953. Since then the network has expanded every year and the total deliveries today are over 5 TWh/year (18 PJ/year), figures 13 and 14, corresponding to about 60% of the space heating market in Stockholm.

The total district heat deliveries in Sweden amount to 40 TWh/year (145 PJ/year).

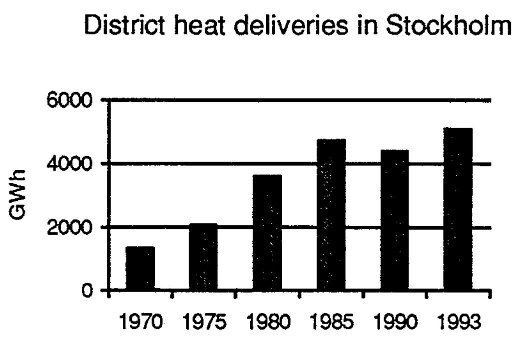


Figure 13 Development of District Heating
Tableau 13 Le développement du chauffage urbain

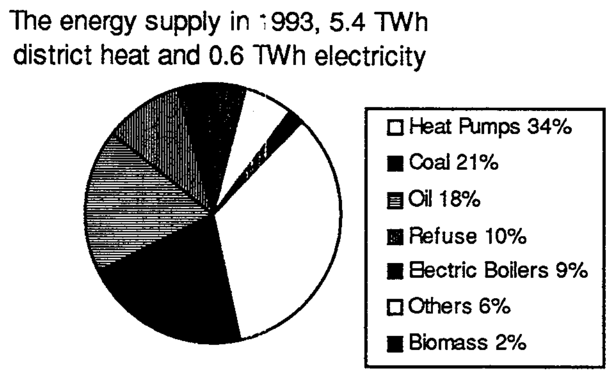


Figure 14 Fuels used for district heating
Tableau 14 Combustibles utilisés pour la production de chaluer et electrictie

Networks

The district heat in Stockholm is generated and distributed from five different locations. The reason for this is that the City of Stockholm is situated on water and built up from a number of islands. To build separate networks is therefore a natural way to start a district heating business under these circumstances. From the beginning there were several networks but some of them have been interconnected.

Three connections to district heating networks in neighbour municipalities exist today. A regional co-operation body have been established for many years and one of the aims is to get a rational energy supply for the Greater Stockholm area.

Production

In the 1950s, the district heat was mainly produced by coal and oil fired boilers. Stockholm Energy, which is the producer and distributor of district heat in Stockholm, has a well composed production mix today to spread the risks and to have a good production economy.

Today, over 30% of the Stockholm Energy production comes from electrically operated heat pumps. Even electrical boilers are used. Other important production installations are the CHP plants - one oil-fired and one coal-fired unit, one oil and biomass-fired unit and one unit operated on waste. In total, these CHP units deliver around 35% of the produced district heat.

Stockholm Energy has good possibilities of installing more fuel efficient CHP (combined heat and power) units. This is because the district heating network allows such an installation to produce electricity as well, especially if the separate networks should be connected within the City. Of course, more connections to the surrounding networks would allow still more CHP units to be installed.

Ecology

The ecological impact is considered very thoroughly. Many steps have been taken to minimize the outlets from the district heating production plants. Types of fuels as well as production methods have been changed, and exhaust gas cleaning devices have been installed.

The total outlets from the district heating production in Stockholm show a very favourable development. A decreasing sulphur content programme has also been introduced in Sweden and deNO_x devices are nowadays installed in all new cars.

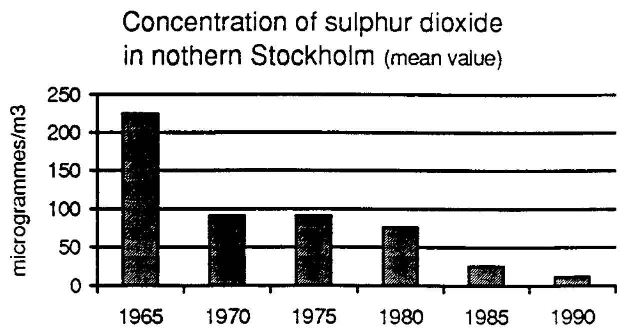


Figure 15, SO2-concentration in Stockholm
Tableau 15, SO2-concentration a' Stockholm

Figure 15 is an example of the results of this development for Stockholm and its inhabitants. It shows the concentration of sulphur dioxide in the northern part of the City of Stockholm.

The next figure 16 shows the emissions of sulphur dioxide from the Stockhnolm Energy production units for CHP and heat only.

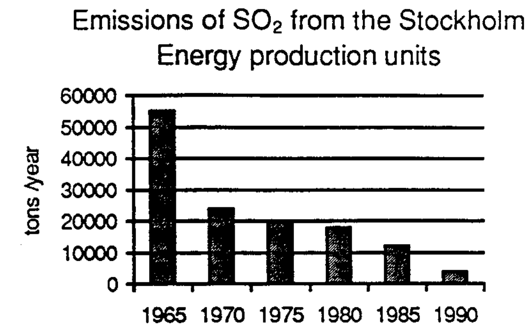


Figure 16, Emission of SO_2 from Stockholm Energy
Tableau 16, Rejets SO_2 de Stockholm Energie

Future development

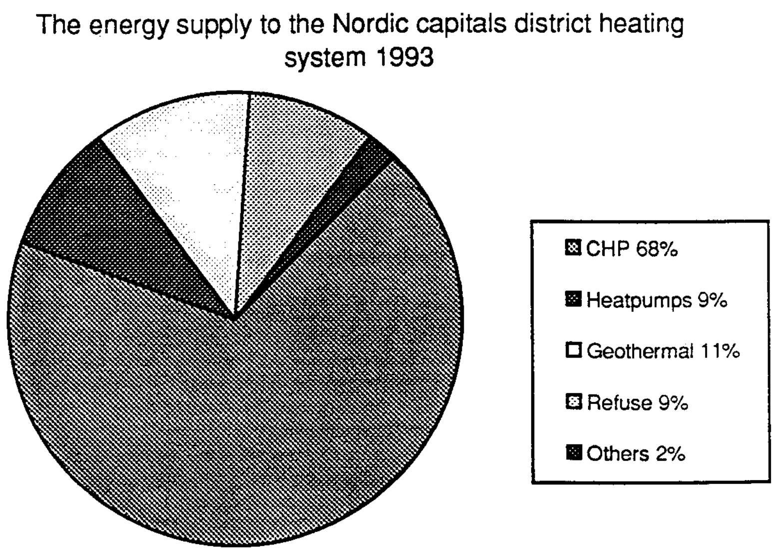
District heating is still expanding in the City of Stockholm. This means that the total outlets from space heating production in the area will decrease more. Consequently, the air quality will increase in the city and be of benefit to both people, buildings and environment. At the same time it gives new opportunities to generate more electricity and district heat in CHP units.

4. The Nordic Capitals
4. Les capitals Nordiques

The Nordic capitals with surrounding cities has altogether more than 3 million inhabitants. This is about 15% of the total inhabitants in the Nordic countries, but the population is concentrated at a quite small region. The condition for district heating is then good. The total heating market in the capitals is approx. 35 TWh (125 PJ) and nearly 2/3 of this demand 22 TWh (80 PJ) is supplied from district heating. District heating have a very strong positions in the Nordic capitals.

Figure 14 Fuels used for district heating in the nordic coutries

Tableau 14 Combustibles utilisés pour la production de chaluer les pays nordiques



The Swedish professor Ulf Högström at the University of Uppsala, has made some interesting research about the pollution situation in an area. Space heating is shown to contribute very much to the local pollution situation. In the main case the normalised SO_2 concentration is determined to a great degree by population size, approximately to a curve. A lowering of the SO_2 level can be achieved by two means: by lowering the sulphur content of the oil and by alter the energysource to for example electricity, natural gas or district heating.

The positive effect on the local air pollution situation of district heating is illustrated by this report. For the Nordic countries district heating is a well known, well established and widely used type of heating. Furthermore, there is absolutely no doubt that the positive results shown by investi- gations into the effects of district heating will lead to continued expansion in the use of this type of heating in towns and cities.

Nonetheless, much remains to be done to make district heating even more efficient. This efforts to improve and develop district heating will continue. This applies particularly to research into such areas as smoke and gas purification, combustion engineering, etc. Progress in these areas will lead to a dramatic improvement in our environment.

16eme CONGRES DU CONSEIL MONDIAL DE L'ENERGIE
Résumé

Titre du rapport: **ENVIRONNEMENT ADVANTAGES AVEC LE CHAUFFAGE URBAIN DANS LES CAPITALES NORDIQUES**

Auteurs: ROSENBERG, Mats
Norwegian District Heating Association
KOIVISTO, Heikki
Finnish District Heating Association
STÅLEBRANT, Rolf
Swedish District Heating Association
GUNNARSDOTTIR, Maria
Icelandic District Heating Association
PETERSEN, Erling
Danish District Heating Association

Résumé

Le développement du chauffage urbain a eu pour effet d'améliorer la qualité de l'environnement dans les capitales nordiques et d'accroître l'efficacité du fuel utilisé.

Si l'on compare le développement du chauffage urbain dans les capitales des pays nordiques a la baisse de la pollution causée par l'anhydride sulfureux, les oxydes d'azote, et les particules, on s'apercoit que la qualité de l'air n'a cessé de s'améliorer. À titre d'exemple, la teneur de l'air en anhydride sulfureux, qui est essentiellement généré par la production d'énergie, a sensiblement diminué du fait de l'utilisation accrue du chauffage urbain et de l'application de nouvelles techniques de production de chaleur et d'électricité.

La prodution d'électricité dans les centrales chaleur-électricité a augmenté et, à l'heure actuelle, quelques-unes de ces grandes villes sont auto-suffisantes dans ce domaine. Si le chauffage urbain est associé à la production d'électricité qui, en tout état de cause, doit être produite, nous estimons que cette production conjointe présente de grands avantages écologiques. Le volume total de rejets thermiques par unité d'énergie produite s'en trouve réduite. Les rejets sont pratiquement les mêmes sans production de chauffage urbain.

Le chauffage urbain s'impose en force dans les pays nordiques (Danemark, Finlande, Islande, Norvège et Suède). Il détient des parts de marché très importantes. Dans ces pays, en matière de chauffage urbain, les services publics responsable de l'énergie fournissent annuellement environ 100 TWh (360 PJ) destinés au chauffage ambiant et à l'eau chaude a usage domestique. Cela représente plus de 35% du marché du chauffage et de l'eau chaude domestique dans les pays nordiques. Dans les cinq capitales nordiques, les services publics de l'énergie fournissent annuellement environ 22 TWh (80 PJ) destinés au chauffage urbain, ce qui représente plus de 62% du marché du chauffage. Une grande partie de la production de chauffage urbain s'effectue dans des centrales chaleur-électricité.

16TH CONGRESS OF THE WORLD ENERGY COUNCIL

Summary

Titel of paper: **ENVIRONMENTAL BENEFITS FROM DISTRICT HEATING IN NORDIC CAPITALS**

Authors: ROSENBERG, Mats
Norwegian District Heating Association
KOIVISTO, Heikki
Finnish District Heating Association
STÅLEBRANT, Rolf
Swedish District Heating Association
GUNNARSDOTTIR, Maria
Icelandic District Heating Association
PETERSEN, Erling
Danish District Heating Association

SUMMARY

The increase of district heating has resulted in a better environment in the Nordic capitals and greater efficiency in fuel utilisation.

If you compare the development of district heating in the Nordic capitals with the decreasing pollution of sulphur dioxide, nitrogen oxide and particles, the quality of the air has constantly improved. The content of sulphur dioxide in the air, which mainly emanates from energy production, has for example greatly diminished because of the increased use of district heating and new technologies in the heat (and power) production.

The electricity production from combined heat and power (CHP) stations has increased and today some of the cities are nearly self sufficient with electricity produced within the cities. When district heating is produced combined with electricity (which must in any case be produced) then we find large ecological advantages in the common product. The total emission per unit of produced energy is reduced. The emissions are nearly the same even without the production of district heating.

District heating has a very strong position in the Nordic countries (Denmark, Finland, Iceland, Norway and Sweden). The market shares are very high. Today the Nordic energy utilities deliver approx. 100 TWh (360 PJ) district heat every year to space heating and domestic hot water. This is more than 35 % of the market for heat and domestic hot water in the Nordic countries. In the five capitals of the Nordic countries the energy utilities deliver annually approx. 22 TWh (80 PJ) district heat. This is more than 2/3 of the heat market. A large part of the district heating generation is produced in combined heat and power (CHP) stations.