

Why district heating?



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All over the world, the Northern European countries are distinguished for a highly developed and energy efficient district heating infrastructure. Denmark in particular is known for its district heating, which has doubled its share of the whole heat market from 30% to 60% during 20 years. In the same period, the efficiency of the district heating production has swelled, with an increase of the use of surplus heat sources and combined heat and power (CHP) up to 90% of the total heat production.

In most of the old democracies it is difficult to establish district heating, while the district heating that exists is insignificant. In most of the new democracies district heating is still the dominating

heat form, but its general reputation is poor and the district heating is in crisis.

Therefore many politicians and technicians from all over the world come to Denmark to see with their own eyes and ask the question: why district heating?? And how?? In this special issue, we will try to offer some arguments and ideas from the point of view of the main players in the sector, namely the international and national politicians, the local politicians and the consumers. In addition to that, we will focus on some of the obvious advantages of the district heating systems compared with individual heat sources such as security of supply, increased competition and the utilisation of the energy efficient heat sources and low-grade domestic fuels.

District heating is a precondition for substantial energy savings and CO₂ emission reductions in cities. Typically more than 50% of the fuel used by heat only boilers can be saved if the heat is produced by CHP plants, thereby replacing electrical generation from condensing plants operating in the power system.

District heating is a precondition for an efficient use of local surplus heat sources, e.g. from industrial processes and low-

grade heat sources, e.g. geothermal energy and solar hot water heating.

District heating is a precondition for an environmental safe use of low grade domestic fuels.

District heating is a precondition for real competition between all sorts of heat sources and fuels and therefore an important element in a liberalised energy market, in spite of the fact that the network itself is a heavy natural monopoly.

District heating may, with the appropriate planning and management, provide the consumers with high quality heat supply at a low competitive price in case of consumer or municipal ownership. Likewise, it may be a profitable business for a private investor with the license to supply district heating at a competitive price. However, it implies also a risk of higher prices and economical losses if some of the essential assumptions for the investment change. Therefore district heating has to be handled with care and attention by all parties from national politicians to investors.

International energy and environmental policy

All over the world the Kyoto Conference has initiated an increasing awareness of the risk of global warming and the importance of energy efficiency and CO₂ emission reductions. Most countries have now signed the agreement. In countries with cold winters the heating sector contributes significantly to the national CO₂ emission and therefore it is natural for the national governments in these countries to look at potential savings from this sector.

In this search for potential savings, politicians in many countries are "lucky". They can observe 1) that their big cities are supplied with heat from gas or oil-fuelled heat-only boilers, mostly at building level, and 2) that electricity is produced by large fossil-fuelled condensing power plants emitting huge amounts of thermal energy (even very visible) from large cooling towers or more secretly through sea water cooling channels. This is a potential for huge CO₂ savings. If a district heating system is developed in such a city to replace the heat from the boilers with heat from large CHP plants, the fuel consumption for the heating can easily be a factor 2 lower than the fuel consumption using boilers, and the cooling losses will be reduced correspondingly. If one could imagine that all buildings instead shifted from boilers to electric heating, the fuel consumption at the condensing plants for producing this electricity would be at least 2.5 times the fuel consumption using boilers.

The front page picture illustrates a rather simple district heating system. The boiler plant is based on biomass, and the distribution system is operated manually. Also the consumer side is manually controlled and includes a metering system. The entire operation is overlooked by the public regulator.



The politicians may also observe that their towns are supplied with heat from fossil fuel boilers, while at the same time huge biomass resources are wasted in the nearby forests, and the farmers around the city burn agricultural waste products, like straw on the fields.

In the EU countries these potential savings are recognised as is the necessity for international co-ordination to support the utilisation of this potential. The issues of CHP and biomass are now on the agenda in the EU policy and it is being recognized that in fact district heating is a precondition for utilising these potentials efficiently and on a large scale.

An issue that should also be addressed at international level is that CO₂ savings from CHP, end-user savings and conversion to CO₂ neutral energy are real and sustainable, whereas national CO₂ savings deriving from coal to gas conversion are not "real." Such conversion merely moves the emission to another country or it postpones it from one decade to the next.

National energy policy

Up until 1976, Denmark had no energy policy at all. With the market forces alone, district heating had gained 30% of the market and oil was almost the only fuel available. Denmark was therefore vulnerable during the first oil crisis in 1973 and this situation initiated the development of a strong Danish energy policy, starting with the first national heat plan in 1976 and the first heat supply law in 1979.

It became clear that district heating should be a cornerstone in the national energy policy, meeting the objectives of least cost solutions, reduction of the dependency on oil, security of supply at national level and an environmental improvement. More specifically, the aim was:

- to increase the share of CHP
- to utilise free waste heat
- to utilise domestic fuels
- to increase fuel flexibility
- to improve the trade balance by reducing imports
- to improve the local environment
- to reduce CO₂ emissions
- to minimise the long-term costs of heating for society and the consumers

It was realised that the market forces alone could not do it. Like wild horses, the market forces had to be regulated (reins) and encouraged (carrot and whip) to keep the wagon of energy policy on the track and at full speed.

Local heat supply policy

Is energy an issue in the local policy? It depends on the local politicians and the special conditions of the city. In Denmark many municipalities have a very strong energy and environmental policy and do their utmost to meet the national and international objectives on energy and en-



Today straw is widely used as fuel for the Danish district heating sector.

vironment related aspects. These municipalities set up objectives, implement them and monitor the implementation, e.g. in municipal Agenda 21 plans. The municipality of Albertslund is an example of this. (See article in this issue). Other municipalities only do what they are obliged to do according to the legislation.

In countries having little or no national energy policy we often see that local authorities, at their own initiative, develop their own heat supply policy and do what is possible to implement it.

Typical heat supply objectives for a city council could be:

- to work for a least cost development of the heat supply for the municipality as a whole (municipal budget plus the budget of all citizens)
- to guarantee the city buildings security and quality of heat supply
- to minimize the heat supply costs for all buildings in the city and thereby make the city more competitive
- to improve the local environment and air quality in the city
- to reduce costs of imported energy and
- to increase local employment and activity

District heating is an important element when meeting these objectives, but only in those parts of the city where the heat density is sufficient to make district heating economical. In some countries, e.g. Denmark, district heating may be economical even to new semidetached houses, due to the high level of taxation of fuels and the efficient production of heat. In countries with low fuel prices, district heating is only an option to supply large apartment buildings and similar buildings.

In other words: one of the advantages of having a dense urban structure is that such a structure opens for efficient heat supply forms like district heating, which can improve the economic and environmental conditions for the citizens.

In their endeavour to make the best out of district heating, city councils often do the following:

- The city analyses the option of heat supply in urban planning.
- In districts suitable for district heating, DH is made a part of the urban infrastructure to all buildings, like it is the case with sewage, water and roads. Thereby all new buildings are connected to the network, and existing connections remain.
- If possible, all publicly owned buildings are connected to the district heating network.
- The city council takes the responsibility of ownership of the district heating system, or at least of the core business of the natural monopoly network.
- The city council guarantees for loans to the consumer-owned district heating company, in order to minimise the financial costs for the citizens.
- The city council use other powers provided by the national legislation, e.g. in Denmark, to ensure the most economical development of the heat supply for the citizens as a whole, e.g. force the remaining buildings to connect to the network in order to minimize costs for all the consumers.

To the benefit of the consumer

District heating is a natural monopoly and therefore the relations between supplier and consumer might be poor. In Denmark, traditionally we have good relations, first

of all because the consumers mostly have a direct influence on the company as owners or an indirect influence via local politicians (in case of municipal ownership), but also because the companies provide good services. Moreover, in accordance with the newest heat supply law from 2000, the district heating companies must offer the consumers advice on how to use the district heating in the best way and save resources.

This obligation is fully in accordance with the main objective of the companies - to serve the consumers with heat at the lowest possible costs.

In the search for profitable savings, the companies target consumers with a relatively large heat consumption per m² and with a relatively low temperature difference (high return temperature). Often a high return temperature indicates that the heating system is badly regulated and therefore uses too much heat.

It is an old tradition that district heating is sold to the building and that both the substation and the internal network is owned and operated by the building owner. A new trend is, however, that the district heating companies offer the consumers to operate and even to own the substation at a competitive price. In this way, the building owner will be released from this burden and will be able to concentrate on the core business of administrating the building. Moreover, the buildings can be provided with reliable and safe heat supply using only a little space and without any environmental problems.

In some cases even large professional building owners prefer to accept a good offer from their district heating company (see article in this issue).

Energy efficient heat supply

When talking about energy efficiency, the required temperature level of the energy is an important parameter. Buildings can be provided with an indoor temperature of 20 dgr.C and the temperature of cold fresh water can be increased to 55 dgr.C using energy resources at low temperature levels. Most of these low temperature level heat sources are CO₂ neutral or they cause only a little CO₂ emission compared to the heat energy. Only few low-level temperature resources are available

for individual buildings at a reasonable cost, whereas the district heating system can have access to most of these sources and at a much lower cost.

It is therefore a challenge to develop district heating systems that efficiently utilise low temperature sources in the region and to deliver them to the end-users via efficient distribution systems and building installations. Efficient heat exchangers, transfer of heat at low temperature loss, temperature regulation and control, efficient heating installations and incentive tariffs reflecting low costs of low temperature heating are all essential for the success.

Low temperature district heating, with return temperatures around 30-40 dgr.C can utilise the following heat sources:

- Efficient use of CHP by extracting steam at low temperature levels, at low CV values, e.g. 0.10 kWh lost electricity/extracted kWh heat.
- Efficient use of biomass or gas boilers by condensing steam in economizers, increasing the efficiency from 90% up to 110% (based on lower calorific value).
- Efficient utilisation of geothermal energy.
- Direct utilisation of excess low temperature heat from industrial processes.
- Efficient use of large scale solar heating plants.

Many district heating companies regard a high return temperature from the consumers as fixed, which means that it cannot be changed and thereby remains a barrier against the utilisation of low temperature sources. Our experience in Denmark shows that tariffs, which encourage the consumers to save the consumption of circulated flow and thereby lower the return temperature, can create miracles, in particular if accompanied by professional advice to the consumers.

Use of local fuels

It is often a political priority to utilise the local fuel resources of solid fuels, such as biomass, peat, lignite and coal for heating. Unfortunately these fuels are difficult and sometimes even impossible to utilise efficiently in small stoves and boilers, and if they are, the emissions are enormous

compared to the useful heat. In large boilers, however, these fuels can be utilised very efficiently and in an environmentally safe way. Therefore district heating is an important precondition for implementing this policy. In Denmark we have a large number of projects demonstrating this technology.

Economical benefits

Is district heating economical for the consumers? Yes, but only if it has been carefully planned, and the main preconditions have developed as expected. The costs of district heating depend on numerous local factors, such as the sale of heat per km pipe, the necessary investment in pipes related to the heat sale, the availability of efficient and cheap heat sources, the historical development, the connection rate of consumers etc. We can say that district heating makes low heating costs possible, and also that it opens up the prospect of independency of increasing oil prices, as most of the heating costs are fixed (e.g. to pay back the investments).

Due to the fixed costs, district heating also implies a risk of higher costs in case that some of the assumptions for the investments develop in a negative way. Therefore it is important for investors in the sector - may it be consumers themselves, municipalities or private investors - that the authorities have an eye on the development of the main conditions, e.g. the alternative fuel prices and the fuel taxes, and take necessary actions to compensate for possible unforeseen and unfavorable changes.

To give an example, in the mid-eighties the Danish Government increased the oil taxes to compensate for lower oil prices. Likewise some of the uncertainty for small-scale CHP plants created by the opening of the electricity market has been taken care of.

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