

Best practice in Danish district heating



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District heating experts come from many countries to study the Danish District Heating sector. Many are taken by surprise and are eager to learn about Danish experience. They find it unique compared to experience in other countries. We are often asked to point out the most interesting and important characteristics of Danish district heating. This is possible, but only with difficulties, as it all seems natural to us. It is also difficult because there are many opinions about what is most important. The following 10 characteristics are our suggestions. They are based on feed back from hundreds of visitors. Please forgive us, if you feel that we have omitted some of the more important ones.

Increasing market share of DH and CHP

District heating, being a cornerstone of Danish Energy Policy, now supplies almost 60% of the heated floor area, and this figure is increasing. The majority of the heat is produced by CHP plants fuelled by coal, gas, waste incineration and other renewables. The market share of the electricity from combined production is increasing too.

The main reason for the importance of District Heating is that it forms an integral part of Danish energy policy, thus ensuring:

- National least-cost solution
- Security of supply at a national level
- Energy efficiency
- Low level of emission of CO₂ and other pollutants
- Low level of local pollution
- Suitable thermal comfort



Gas fuelled combined cycle CHP plant 55 MW_{elec}/55 MW_{heat} with heat accumulator, owned and operated by Hjørring District Heating Company, a consumer owned cooperative.

It is important to note that the objectives of the energy policy can only be achieved if all cities are more or less fully supplied with district heating.

Strong support from central authorities

The central authorities strongly support the development of district heating through a wide range of measures, including:

- National least-cost energy planning
- Monitoring of the least-cost urban heat planning
- Monitoring of strict zoning of district heating and other sources for heating
- Encouragement of local authorities and utilities to implement least cost projects
- Implementation of legal measures which enforce building owners to connect and remain connected to district heating
- Ban on electric heating in new buildings
- High taxation of fossil fuels for heating
- Investment subsidies to utilities which rehabilitate and complete networks

- Investment subsidies to consumers who install central heating and connect to district heating.

These measures, which combine the advantage of strong regulation and controlled use of market forces are very important; however, they are far from sufficient.

Strong support from municipalities

The role of the municipalities in the implementation of the national energy policy is very important, as the municipalities have a natural interest in developing a good local district heating system for the benefit of the inhabitants in the urban areas.

The district heating network is regarded as a natural part of the urban infrastructure, through which all buildings in districts with sufficient heat density (ie. sufficient population density) are supplied. Similarly, heat planning is an integral part of urban planning. Urban development areas are therefore provided with district heating as well as water, sewage and other services. Less densely populated districts are supplied directly with gas, whereas buildings, which are supplied with gas, might shift to district heating in the course of

time, as the urban heat density increases.

Democratic consumer ownership

Almost all district heating companies are owned by the consumers, either directly as consumer co-operatives or indirectly as municipally owned companies. Thus the consumers elect members for the board of directors directly or indirectly through public elections. This gives certain benefits:

- All company profit is given back to the consumers at the end of the year or is transferred to the next year to lower the heat price
- Management will be encouraged to work for good consumer services at the lowest possible price
- All budgets and prices will be transparent for the consumers
- Consumers will be more motivated to pay the bills
- No others than the consumers will make profit on the heat supply – or take possible losses

Some municipal companies have established directly elected consumer advisory boards, thus benefiting from the advantages of both the co-operative and the municipal ownership. Other municipal companies have privatised the company by transforming it into a consumer co-operative.

It is equally important that all apartment buildings are properly organised. Privatised apartment buildings must, in accordance with the law on privatisation, have established a condominium with a home-owners association, which is the legal owner of the building envelope and thus the legal district heating consumer. The home-owners association is responsible for all internal installations and for distributing all costs among the apartment owners, including costs of heating. Likewise, many housing companies in the rental building sector have established local advisory

boards elected among the tenants. These have been asked to take part in managing the local budget, thereby gaining some of the obvious benefits of private ownership.

Efficient financing

Financing is a problem in many countries, but not in the district heating sector in Denmark. Most companies finance their investments in networks and CHP plants 100% by international credits at the lowest market based interest rate (for the time being around 5% p.a. in USD). Banks compete to offer the best conditions so long as they can see that the security is high. And security is high, due to following reasons:

- The national energy policy is stable
- The municipalities guarantee for loans, also to the consumer co-operatives
- The consumers are obliged to remain connected and to pay at least the fixed tariffs
- The proven technology and maintenance management ensure long lifetime
- The consultants provide know-how on feasibility studies and project implementation
- There are clear roles of responsibility and efficient decision-making in the companies.

Therefore other private investors, ESCO's, BOOT concepts and the like offer no real competition.

Variety of technical solutions

You may find a district heating system, which, one could say, is typical for the Danish approach today; however, there are no obligatory norms and standards that specify detailed technical solutions and design criteria which have to be followed. On the contrary, the technological development is very dynamic and you will find a huge variety of technical solutions. Installations which are more than 30 years old and which still

operate are, of course, different from the new installations, but even new installations may be based on different solutions adjusted to the local conditions and the opinion of the local decision makers.

We could, for example, list the following variety of existing technical solutions:

- System design: steam, super-heated water, normal hot water (maximal 120 °C) or low-temperature systems
- Pipe construction: preinsulated steel pipes, steel pipes in concrete ducts, steel pipes in steel or plastic pipes (in small dimensions)
- Indirect connection: via heat exchangers or direct connection
- Meters: Energy meters or flow meters only
- Preparation of domestic hot water with storage tank or with heat exchanger, but absolutely no open systems (tapping hot water from the district heating circuit).

The district heating company will, often assisted by its consultant, select the concept which gives the consumers the best value for money in the long run. After all, the consumers are the only ones to pay for the costs.

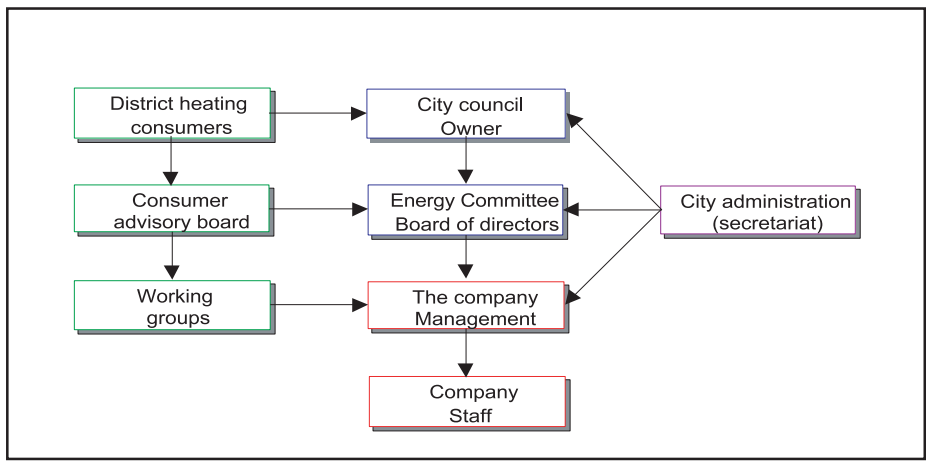
Dynamic development and co-operation

It is a surprise for many that the preinsulated pipes and other components in the heating systems (as well as modern wind turbines) have been invented and developed in a little country like Denmark. What is the secret?

It's difficult to pinpoint one specific reason, but the following factors have been important for this development:

- Norms and standards are based on prescribed functions (not on specific details) and therefore they allow a huge variety of solutions (as described above) which stimulate a competitive development
- This development creates a good environment for co-operation between district heating companies, suppliers of equipment and consultants.
- Many small enterprises in the private sector work in a competitive environment
- The government support the development of energy efficient technology by investment subsidies to individual projects in the initial phase
- The Danish District Heating Association gives support and advice to all its member-companies and acts as interest-organisation for the sector.

Generally speaking, one could say that decentralisation of activities and responsibility might be the secret.



Organisational chart of a municipally owned district heating company with consumer advisory board, like the municipality of Albertslund, uniting the benefits of municipal ownership with the benefits of a democratic consumer co-operative.

Large integrated systems with optimal load dispatch

The Danish district heating systems are normally not considered to be the largest in the world. Denmark is probably more known for small and simple local systems, even in villages. One reason for this is a modest heat load due to a modest climate. Another reason is the very high degree of building insulation.

However, if we compare the heated floor areas which are supplied from the same integrated system, then the systems can be quite large. For example, the District Heating system in the Copenhagen region is one of the world's largest.

In total around 50 million m² of heated floor area is supplied from one pool-operated system and the total heat production is around 30,000 TJ annually. The project provides an interesting example of:

- Technical solutions combining old and new installations,
- Institutional solutions,
- Operation management, and
- Tariffs

The heat is supplied from 4 CHP plants, 4 waste incinerators and more than 50 peak boiler plants to more than 20 distribution networks by 3 interconnected transmission companies, CTR, VEKS and Vestforbrænding – but still, it is **one single pool** of optimal load dispatch.

Heat accumulation

Many visitors have never seen a heat accumulator before, but by now almost all district heating systems in Denmark have installed a heat accumulator. This has been done for several reasons:

- To optimise production from small-scale CHP plants
- To optimise production from large extraction CHP plants

- To optimise operation of solid fuel boilers
- To level daily heat load variations
- To serve as pressure maintenance
- To serve as water storage
- To provide the peak hour load on the coldest day.

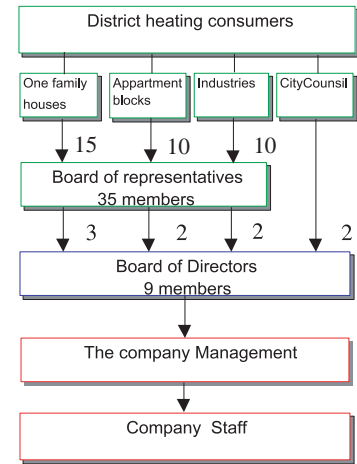
The most normal and simple pressureless tank with direct connection can be found in sizes ranging from 500-50,000 m³. A few accumulators of a more complex type (with temperatures up to 120 °C and separate connection via pumps and throttle valves), e.g. the tanks in the Copenhagen system, have capacities of 2 x 20,000 m³.

Also simple technical solutions

Obviously the advanced solutions often attract most attention. This is not fair, since one could, based on Danish experience, design small simple systems with the following main characteristics:

- Maximal design temperature 95 °C
- Variable flow and operational supply temperature down to 60 °C in the summer
- Network of the preinsulated bonded system without expansion loops, compensators or pre-stressing. For further lowering of costs, curved pipes can be installed in a new optimised trench only 60 cm below ground
- Substations with direct connection and differential pressure valve in each building complex
- Production of domestic hot water in each building substation
- Flow meter in each substation to distribute costs among the buildings (or heat meters if buildings are large),
- Closed heating circuit and water treatment

Such simple and cheap solutions could be more important than the advanced ones for the further market develop-



Organisational chart of a large district heating co-operative, with democratic election of representatives in each consumer group, like Høje Taastrup District Heating co-operative, the largest consumer owned district heating company in Denmark.

ment of district heating in the western countries and for the survival of the small local distribution systems in the Central and Eastern European states.

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