Energy efficiency and energy audits in the District Heating Sector in Denmark

Henrik Steffensen

State Property Fund of Ukraine & INOGATE Technical Secretariat, UA-136 CWP.07.UA

Kiev, Ukraine, 22 March 2016

BUILDING PARTNERSHIPS FOR ENERGY SECURITY

www.inogate.org
Energy efficiency in the district heating and cooling sector
Content

• Some historical development – from the very beginnings to the future
• Danish District Heating Association
  – Benchmarking
• Chapter III Art. 14 of Dir. 2012/27/EU
• Energy Audits
• The Danish Model – a summary
Historical development – from the very beginnings to the future
District heating and cooling is not energy – It is using multiple energies in a smart way
Energy efficiency in the District heating and cooling-sector
Developing Smart Energy Systems

- National power grid
- City-wide district heating grid
  - storage for CHP and RES
- City district cooling grid
  - storage and optimal cooling
- National natural gas grid
  - storage, CHP and small houses
- Buildings and other end-users
  - Optimized building envelope
  - Low temperature heating
  - High temperature cooling
  - Micro DC grid electronics
  - Adjust consumption to dynamic prices
Historical development – in Denmark
The Guardian wrote recently

When the oil crisis hit in the winter of 1973 the price per barrel quadrupled, and countries that were heavily dependent on oil were in dire straits. Denmark was one such nation: more than 90% of its energy came from imported oil. Danish citizens shivered in their homes while factories were forced into temporary shutdowns, alternate street lights were switched off and driving was banned on a Sunday.

After that long and painful winter Denmark vowed to wean itself off oil imports, determined to improve its energy security. Ever since it has invested heavily in renewables, energy efficiency and “district heating”.

District heating is exactly as it sounds: colossal boilers provide heat for entire districts through a network of heating pipes. While in the UK households buy gas, which is piped into individual boilers to provide heating, Danish neighbourhoods do away with individual boilers and instead have their hot water piped directly into their houses from one larger, and much more efficient, shared boiler.
Selected incentives which has been used to implement the heat plans since 1976

- High level of energy tax on fossil fuels – filled up the gap when oil prices dropped after the energy crisis
- Around 1976-1996: some investment subsidies to DH grids and to central heating installations if connected to the planned DH
- Tool box in the Heat Supply Act:
  - All heat supply plants > 250 kW are of public interest and must prove that projects are cost effective for the society
  - Around 1993 the government asked all municipalities to force plants > 250 kW to connect to the planned supply of DH or gas within one year
- New buildings can be obliged to connect to DH and pay fixed fee
- Old buildings can be obliged to be connect to DH and pay fixed fee
- A ban on new oil boilers in DH- and gas-zones
- No gas boilers to new buildings
Municipal or consumer ownership is the key to efficiency

• The technical efficiency is large, as the owners have an interest in long-term investments to the benefit of consumers and the society.

• The institutional efficiency is large, as the municipal and consumer owned companies co-operate in an open way to find the least cost solutions for the local society.

• The financial efficiency is large, as projects can be financed 100% by the most competitive loans on the market, due to:
  – Stable energy policy
  – Good bankable feasibility studies and project documents
  – Municipal guarantees for loans
Danish District Heating Association
Danish District Heating Association
Danish District Heating Association (Dansk Fjernvarme)

• Founded in 1957 with the aim of organising Danish district heating companies; facilitate cooperation between these members and to promote their interests towards authorities and other organisations. Today it covers 99 percent of district heating production in Denmark.

• The association counts a little more than 400 members all over Denmark. 40 are municipally owned district heating companies, which deliver around 50% of all district heating. The other half is predominantly 350 consumer owned cooperatives. In addition, approximately ten private companies which provide very little district heating.
Danish District Heating Association (Dansk Fjernvarme)

- Members supply 63% of Danish households (1.63 million) with district heating, covering around half the demand for space heating demand in all buildings.

- 52% of delivered district heating is green, sustainable heat.

- Danish District Heating Association is financed by member’s fees, which are calculated on the basis of members heat sales. Income from member’s fees was €3.1 million in 2014.

- Further income is generated by meetings, training courses, publishing, projects etc. Total turnover in 2014 was almost €6.8 million.
Danish District Heating Association promotes the interests of the members in a visible and efficient manner, aiming for:

- Environmental protection
- Energy efficiency
- Security of supply
- With due consideration to the economy and the district heating consumers.
Danish District Heating Association (Dansk Fjernvarme)

- That is done by:
  - Influencing rules and conditions of production, transmission, distribution and sales of district heating in Denmark
  - Ensuring development of the district heating sector
  - Gathering knowledge about district heating
  - Disseminating knowledge through meetings, training courses, etc.
  - Information activities (issuing a magazine)
  - Inspiring members to develop strategies and act strategically
  - Uniting district heating stakeholders in Danish District Heating Association
  - Solving common problems among members
  - Providing service to members
As a supplier to 3.6 out of 5.7 million Danes, Danish District Heating is an organisation, that politicians, media and other opinion makers listening to.

Danish District Heating has a good contact to the Parliament and continuously works for that both ministers and energy rapporteurs have the best possible basis for making decisions related to the District Heating Sector.

• The Vision:
  Danish District Heating Association is an active and visible stakeholder in the Danish Energy Sector - a Sector who invest more than 670 million Euro per year in new pipe networks, boiler plants and Solar thermal plants.
Danish District Heating Association (Dansk Fjernvarme) Benchmarking

Benchmarking 2014 key figures for web - 2.xlsx - Shortcut.ink
Chapter III Art. 14 of Dir. 2012/27/EU
CHP – directive
a foundation for the new Directive

CHP = less fuel + less carbon dioxide + more energy efficiency
Figures show net calorific value

The overall objective is to encourage the identification of cost effective potential for delivering energy, principally through the use of cogeneration, efficient district heating and cooling and recovery of industrial waste heat.
Chapter III Art. 14 of Dir. 2012/27/EU

Member States are required to:

**Identify the potential for high-efficiency cogeneration and efficient district heating and cooling** and to analyse the costs and benefits of the opportunities that may exist.

take adequate measures to ensure these are developed if there is cost-effective potential.
Chapter III Art. 14 of Dir. 2012/27/EU

Efficient heating and cooling encompasses principally the use of:

- heat from cogeneration and renewable energy sources.
- recovery of waste heat from industrial processes

Options that achieve primary energy savings compared to a baseline scenario.

A comprehensive concept that covers all heating and cooling options in line with the general definition of energy efficiency provided in the Directive.
Chapter III Art. 14 of Dir. 2012/27/EU

Member States are required to comply with the following main obligations:

- **Carry out and notify by 31 December 2015** to the Commission a **comprehensive assessment of the potential** for the application of high efficiency cogeneration and efficient district heating and cooling **based on a country-wide cost-benefit analysis**

- **Take adequate measures** for efficient district heating and cooling infrastructure to be developed and/or to accommodate the development of high-efficiency cogeneration and the use of heating and cooling from waste heat and renewable energy sources, **where the comprehensive assessment identifies a potential whose benefits exceed the costs** for the application of high efficiency cogeneration and efficient district heating and cooling.
• **Adopt policies in relation to local and regional levels** that encourage the due taking into account of the potential of using efficient heating and cooling systems, including the potential identified in the comprehensive assessment.
Chapter III Art. 14 of Dir. 2012/27/EU

• **Adopt authorisation or permit criteria and procedures** for operators of electricity generation installations, industrial installations and district heating and cooling installations ensuring that they carry out an installation-level **cost-benefit analysis** on the use of high-efficiency cogeneration and/or the utilisation of waste heat and/or connection to a district heating and cooling network when they plan to build or refurbish capacities above 20 MW thermal input or when they plan a new district heating and cooling network.

• The procedure and criteria must also lay out the conditions for exemption from the obligation to prepare a cost-benefit analysis, if the Member State decides to use the exemptions allowed.
Chapter III Art. 14 of Dir. 2012/27/EU

What it can lead to:
Point out and focus on the Best Places to Start/Refurbish District Heating in the EU
Chapter III Art. 14 of Dir. 2012/27/EU

- This and the former CHP directive is deeply rooted in Danish Heat Plans.
- All most all utilities are owned by the regions and municipalities – *in the end by the consumers*.
- The responsibility for the Energy Auditing in the DH-sector is stated in the National Heat Plans.
- Through the ownership the regions/municipalities carry out supervision and energy follow-up on environmental and emission impacts.
- The plants carries out the cost effective solutions from in the Heat Plans and carry out annual status and statements.
- The National Energy Supervision Board is the legal entity/authority. Here all disputes and uncertainties are settled. E.g. questions about Tariffs – and other legal aspects and boundaries between supplier and consumer.
ENERGY AUDIT – an Iterative Process
ENERGY AUDIT – an Iterative Process

- REVIEW
- DATA GATHERING
- PRESENTING
- DATABASE STRUCTURING
- DATA PROCESSING
ENERGY AUDIT – an Iterative Process

• The energy supply company do the energy auditing themselves – they have the certificated staff
• The energy supply company has an energy managing department with skilled analysts
• The energy process are monitored 24/7.
• The meters at the consumers are online and can be reached on Call-Up
• Detailed and overall efficiency can be gathered and presented on demand and are always stored.
• Recommendations for change towards higher performance comes through experience and benchmarking.
• Best practice solutions are evaluated with respect to cost effectiveness whenever it make sense.
The Danish Model – a summery
Heat Plan Denmark 2010, statistics and forecast – confirmed by DEA analysis in 2015
Heat Plan Denmark 2010, statistics and forecast – confirmed by DEA analysis in 2015

District heating load dispatch
Modest development

Historical
Projection

Heat Production in TWh

Boilers, fossil fuels
Boilers, biomass
Large-scale solar heating
Geothermal
Electric boiler
Large heat pumps
Biogas CHP, engine
Biomass CHP, steam turb.
Dec. CHP natural gas
Central CHP, fossil fuels
Waste-to-energy CHP
Industrial surplus heat
Share of CHP

Curve: share of CHP

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

The Danish Model – a summery

• Long-term majority energy policy agreements in the Parliament
• Least cost solutions for the society, including environmental cost
• Municipalities take responsibility for their infrastructure to the benefit of the population and local industries
• Municipalities co-operate and establish municipal co-operatives to own and operate large facilities (waste to energy, regional)
• Consumers co-operate and establish co-operatives
• Home-owners co-operate and establish home owners associations and housing co-operatives
• This ensures maximal
  – Technical efficiency for long-term solutions
  – Institutional efficiency (ability to find least cost solutions)
  – Financial efficiency (to provide 100% financing at lowest interest)
• To the benefit of
  – The energy consumers and
  – The society as a whole, including our export industry
  – The CO₂ reduction
Дякуємо за увагу

Хенрік Стеффансен
Senior Technical Expert
hst@ramboll.dk
Rambøll Energy Denmark