Integrating renewable energy sources and thermal storage

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Outline

- Fundamental idea of district heating
- Heat supply to European district heating networks the last twenty years
- Renewable examples: Biomass, Geothermal, Solar, and Wind
- Conflict between energy efficiency and renewables in the district heating systems
- Heat and cold storages in DHC systems
- Conclusions

Fundamental idea

Today, the fundamental idea of district heating is to use
- local fuel or heat resources that would otherwise be wasted,
- in order to satisfy local customer demands for heating,
- by using a heat distribution network of pipes as a local market place.

Currently, five strategic local heat and fuel resources for district heating

- Usable upgraded excess heat from thermal power stations. This method is called *combined heat and power* (CHP) or *cogeneration*.
- Usable heat obtained from waste incineration. This method is used in *Waste-to-Energy* plants.
- Usable *excess heat from industrial processes* and fuel refineries.
- Fuels those are difficult and bulky to handle and manage in small boilers, including most *combustible renewables*, such as wood waste, straw, or olive residues.
- Natural *geothermal heat* sources.

Diversity in heat supply

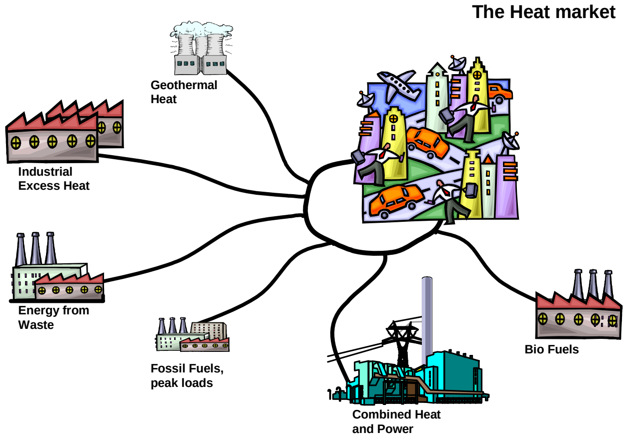


Figure 2-2. Example of illustration of the fundamental idea of district heating with respect to diversity in heat supply. Illustration source: Svensk Fjärrvärme. Another more elaborated example can be found in (NCG on DHC/CES 1985)

Sweden 2008

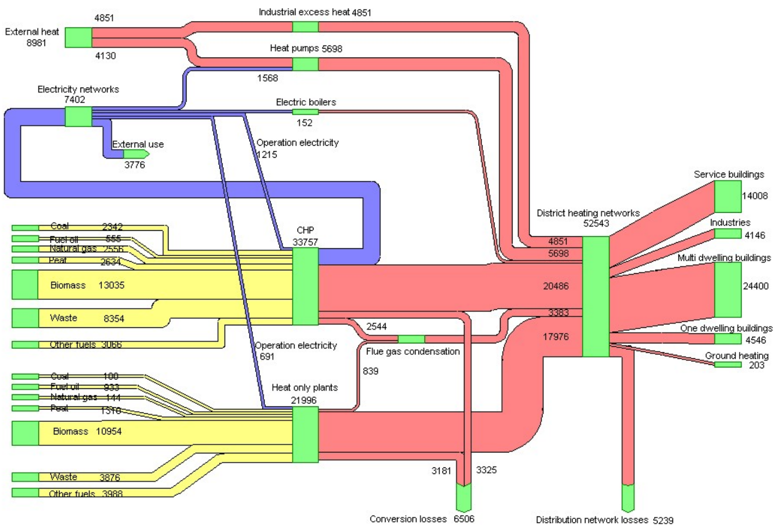


Figure 2-3. Sankey diagram for the Swedish district heating balance during 2008 with input data according to Statistics Sweden. Values represent energy flows in GWh, while yellow bars denote fuel flows, blue bars correspond to electricity flows, and red bars present heat flows. Green rectangles represent various nodes in the energy balance. Source: Henrik Gadd, Halmstad University.

Basic energy flows in district heating systems

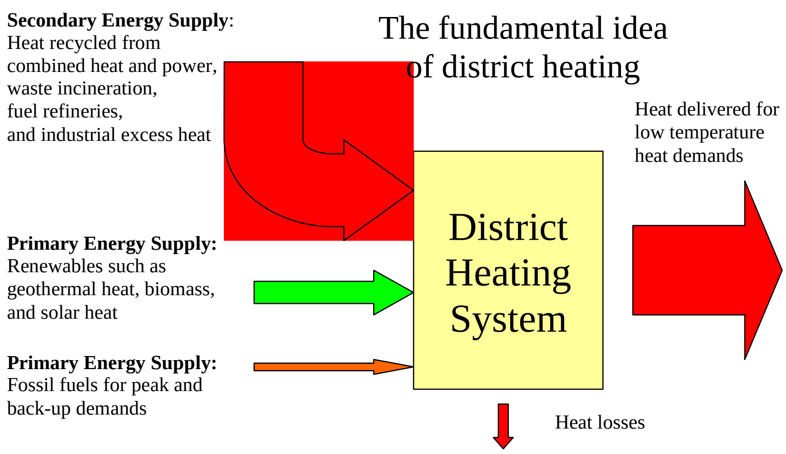
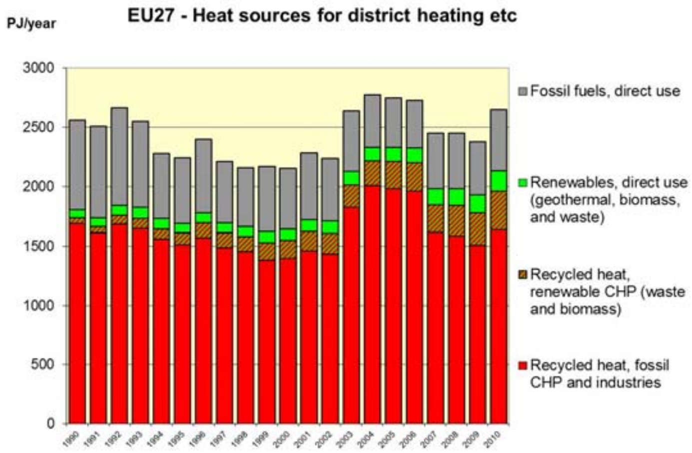
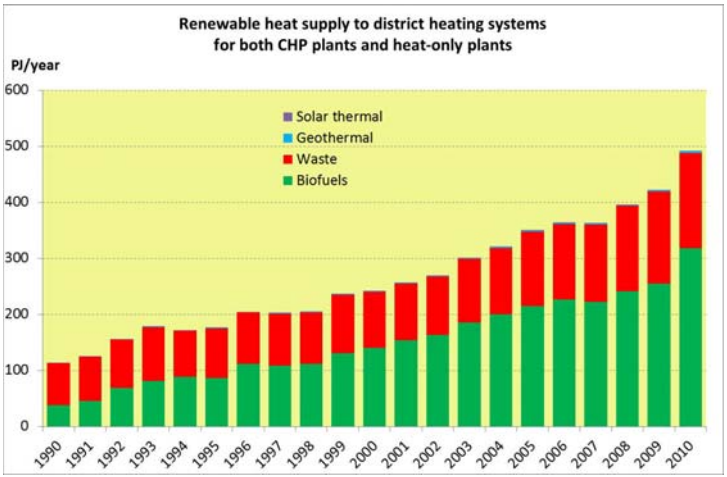


Figure 2-1. The basic energy flows in a district heating system designed according to the fundamental idea.

DH heat supply in EU27



DH-Renewables in EU27



Forest biomass availibility

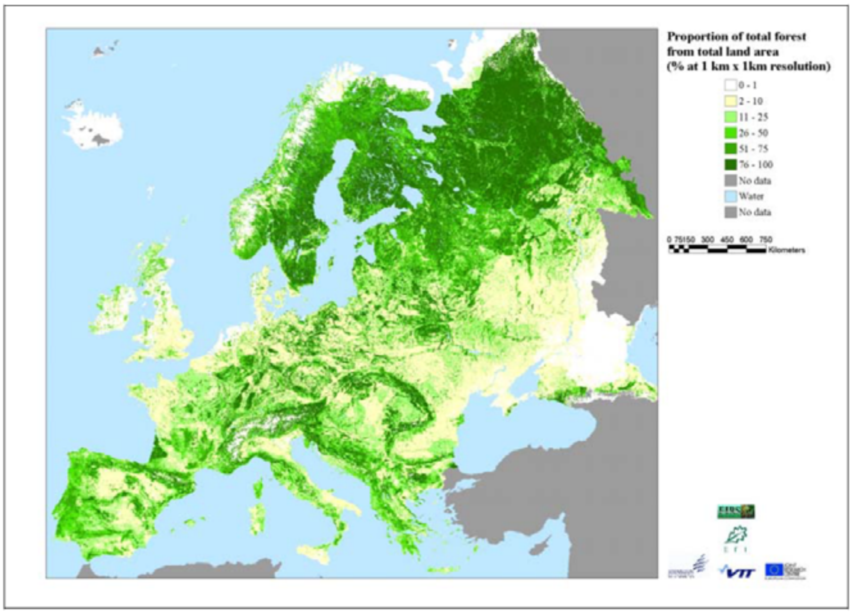
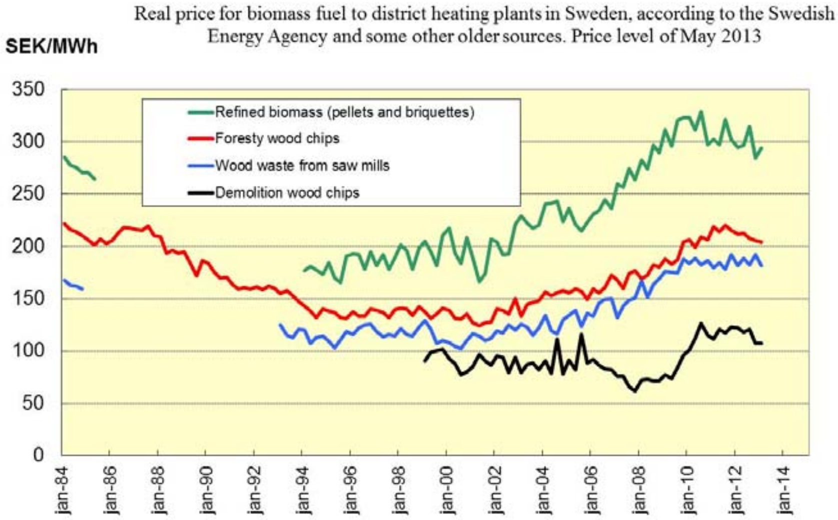


Figure 44. Proportion of forest area in various parts of Europe. Source: European Forest Institute.

Swedish biomass prices



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Biomass CHP in Södertälje, Sweden:
Igelsta: 85 MW electricity och 200 MW heat

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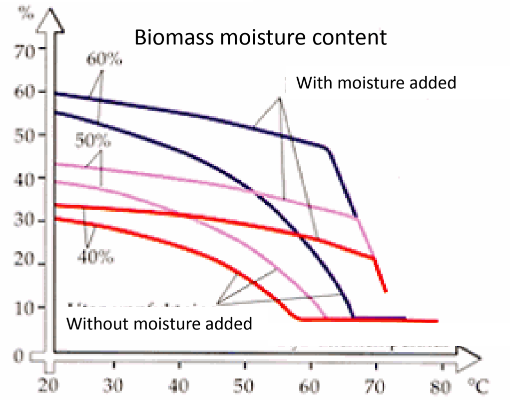
Flue gas condensation from biomass and waste

Boiler capacity increase from flue gas condensation



Return temperature in the distribution network

Location of geothermal possibilities

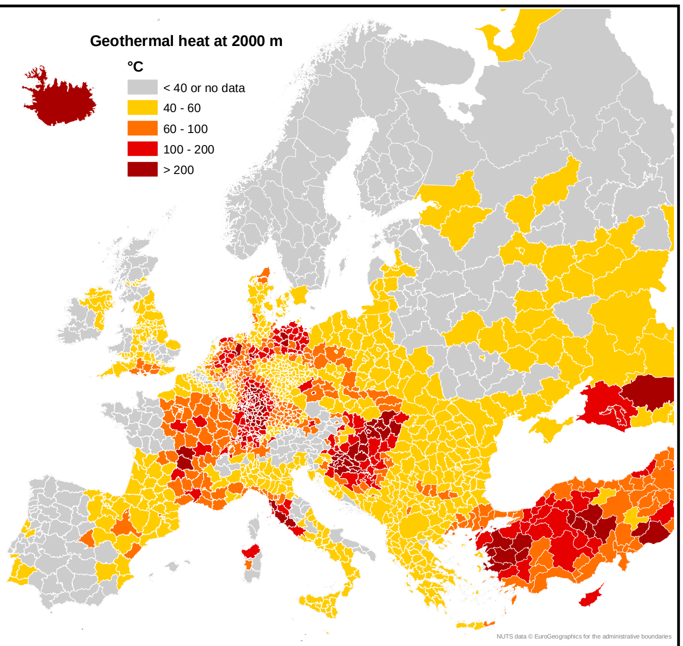


Figure 43. Identified geothermal heat resources by temperature at 2000 m depth by NUTS3 area. Source: European Commission, Atlas of Geothermal Resources in Europe. Publication EUR 17811, Luxembourg 2002.

Geothermal district heating systems in Europe

Location of Paris Basin geothermal district heating doublets
2006 status (source ADEME)

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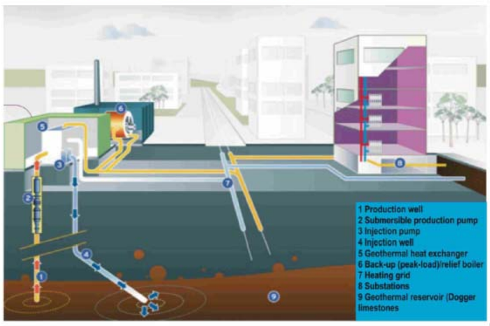
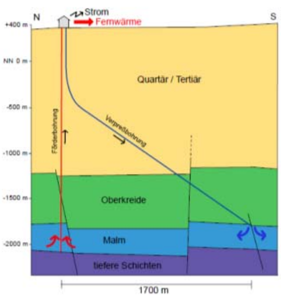
Geothermal boreholes:

PARIS BASIN GDH SCHEME





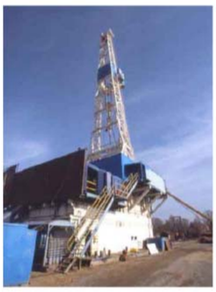


Figure 23: Geothermal power plant in Altheim, Austria. Left: geological cross-section, simplified. Right: drilling rig for the re-injection well (deviated) (photo: O. Joswig).

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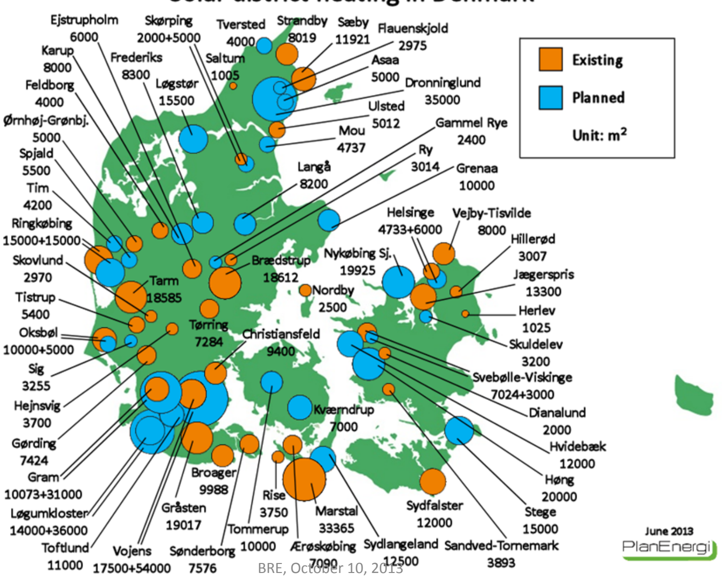
Solar district heating



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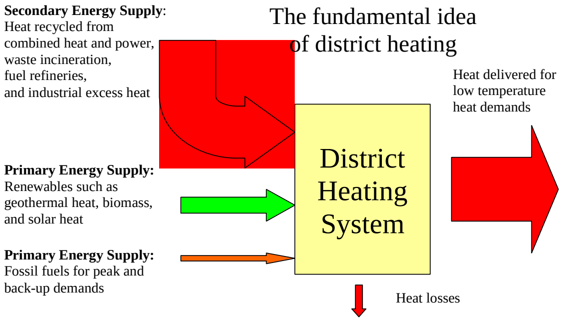
The Marstal district heating system 2013

Surplus wind power

Future variable power generation from wind and solar power will generates many hours of power surpluses for heat generation in
- Large electric boilers
- Large heat pumps

Conflicts between energy efficiency and renewables

Many examples were renewable heat supply (primary energy) is chosen instead of existing heat recovery from primary processes using fossil fuels or waste (secondary heat)



Heat storages

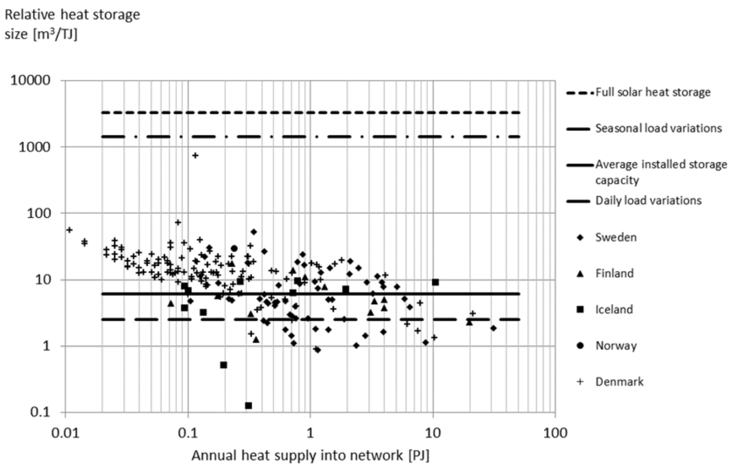


Figure 2. Specific heat storage sizes with respect to annual heat supply into networks in 209 Nordic district heating systems.

Pit heat storage 10000 m^3, Marstal

I princippet er et damvarmelager blot et hul i jorden der fyldes op med varmt vand fra solfangerne. Men det har krævet års udvikling og test at finde frem til en løsning, der fungerer i virkelighedens verden. Billedet er fra det 10.000 m³ store sæsonlager i forbindelse med udvidelsen af solfanger-feltet på Marstal Fjernvarme.

Cold storages

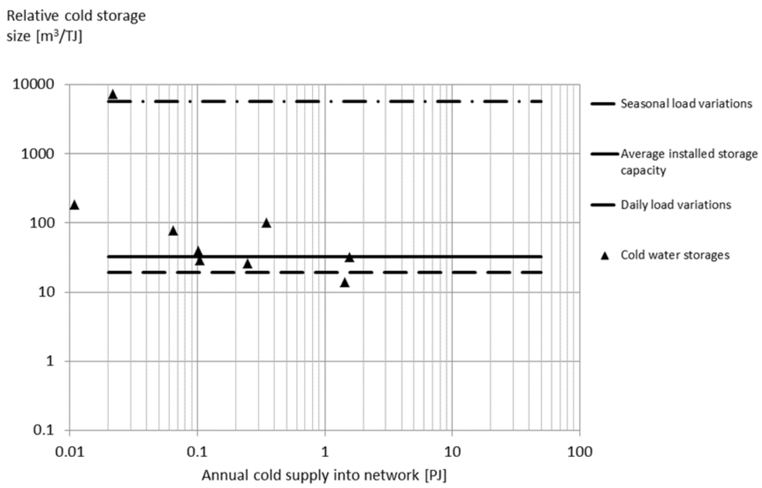


Figure 4. Specific cold storage sizes with respect to annual cold supply in seven Swedish district cooling systems, one Finnish system and one French system.

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Cold storage example from Halmstad, Sweden

Figure 5.27. The district cooling plant in the Halmstad University campus area is owned and operated by Halmstad Energy and Environment. The plant contains 3.6 MW of absorption chillers, mainly fed by heat from waste incineration. The cold storage cylinder to the left has a storage capacity of 24 MWh.

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Conclusions

- Renewable heat exists in district heating systems today
- Renewable heat supply is growing year by year in the European district heating systems
- Sometimes a conflict between heat recycling from fossil primary processes (as coal CHP) and renewable heat supply

The End

Any questions?