Global Challenges for District Heating and Cooling

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To be discussed

0. Introduction

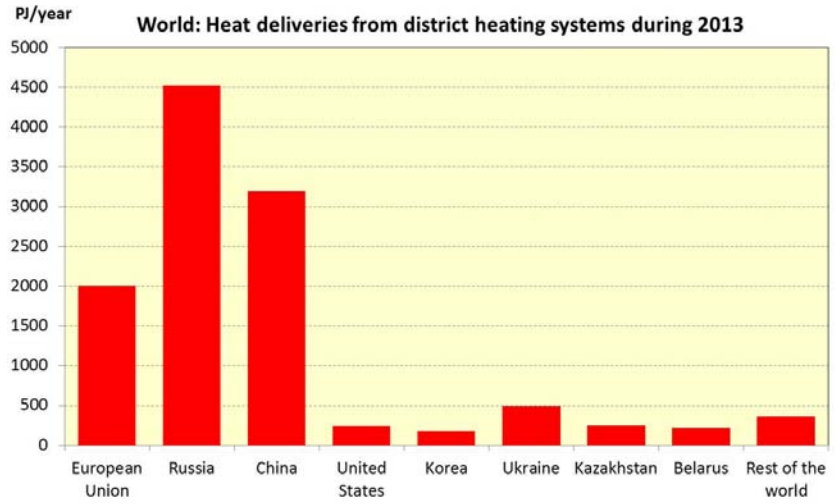
The four global challenges for District Heating and Cooling (DHC):

1. Obtaining full recognition of the DHC benefits within the global warming context
2. Introducing new non-fossil heat sources
3. Harmonizing the district heating technology with lower future heat demands
4. Introducing an enhanced district heating technology for meeting the future market conditions

Conclusions

0. Introduction

Global situation for district heating



0. Introduction

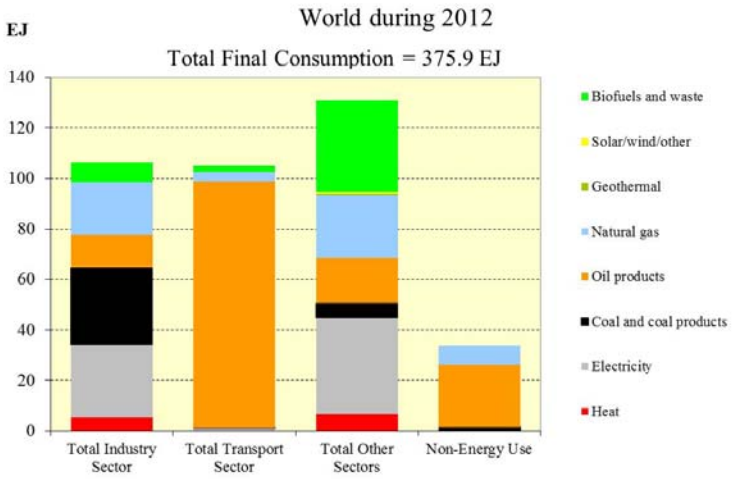
Global situation for district cooling

- Europe, 10 PJ/year
- Japan, 14 PJ/year
- USA, 80 PJ/year
- Middle East, 100-400 PJ/year

FIGURE 8.52 Installation of district cooling pipes in Dubai. Source: Logstor.

0. Introduction

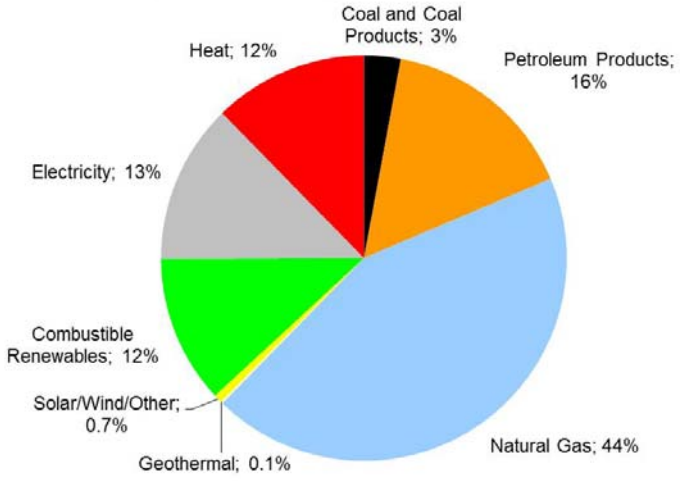
DHC is small in global energy use



0. Introduction

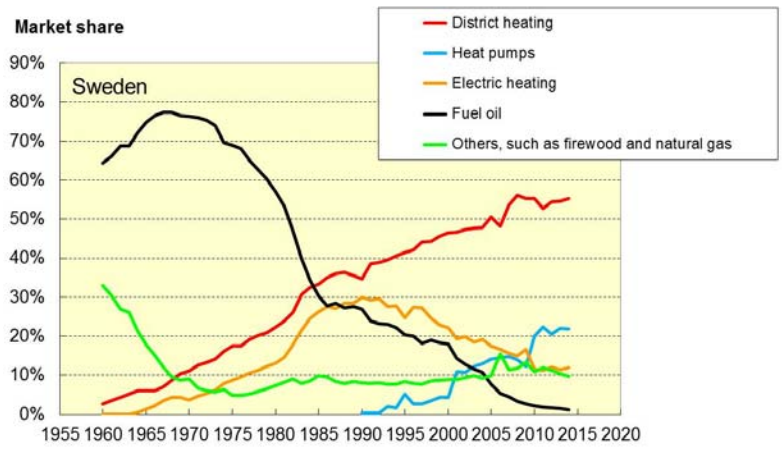
EU28 during 2012, Proportions of heat supply for heat demands in residential and service sector buildings

Total heat supply was 11.0 EJ for 507 million inhabitants, not including indirect heat supply from all indoor electricity use



0. Introduction

Heat supply to Swedish buildings



0. Introduction

European space cooling demands

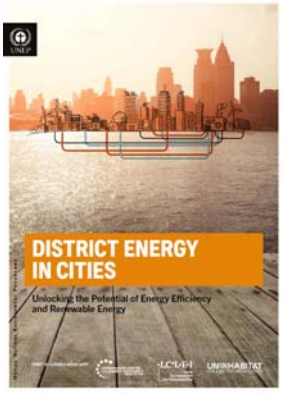
- Currently, about 700-900 PJ cold are annually used in European residential and service sector buildings
- European district cooling systems delivers about 10 PJ annually
- Hence, the market share for district cooling is about above one percent

Challenge 1

RECOGNITION

1. Recognition

Recent recognition actions



UNEP action:
District Energy in Cities


EUROPEAN
COMMISSION

Brussels, 16.2.2016
COM(2016) 51 final

COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS

An EU Strategy on Heating and Cooling

{SWD(2016) 24 final}

European Commission:
An EU Strategy on Heating and Cooling

1. Recognition

Further recognition actions

- Communicate the fundamental idea of district heating (heat recycling)
- Communicate district heating and cooling as useful tools for combating climate change
- Facilitate efficient planning of district heating and cooling (Heat Roadmap Europe as example)

1. Recognition

Basic heat flows in current district heating systems

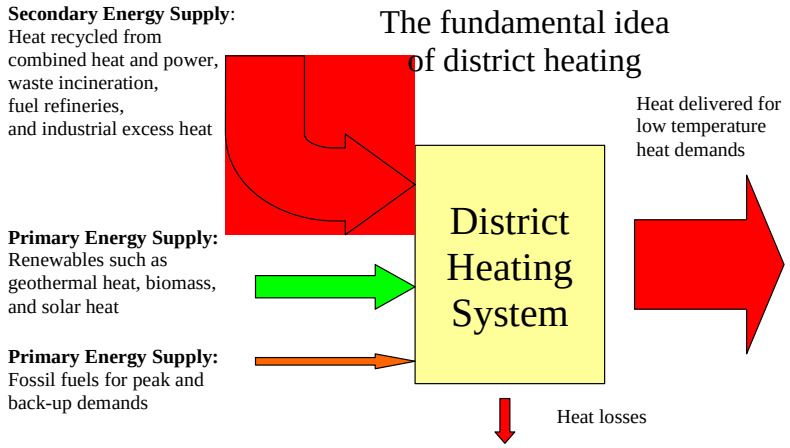
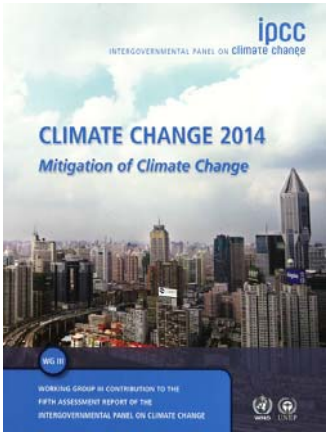


Figure 2-1. The basic energy flows in a district heating system designed according to the fundamental idea.

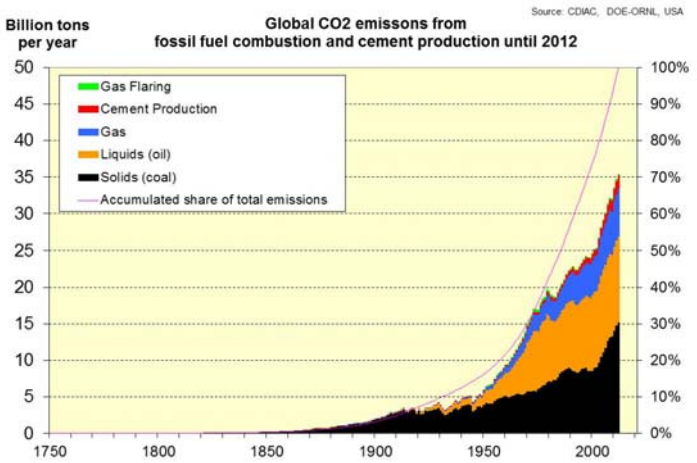
1. Recognition

IPCC has not yet fully identified DHC as efficient tool for combating climate change



1. Recognition

World carbon dioxide emissions from energy supply



1. Recognition

Specific carbon dioxide emissions from the Swedish district heating systems

1. Recognition

Heat Roadmap Europe projects

- 1st Heat Roadmap Europe pre-study 2012 about the future conditions for district heating in a business-as-usual scenario. Benefit of lower costs with 14 billion EUR in 2050.
- 2nd Heat Roadmap Europe pre-study 2013 about the future conditions for district heating in a strong energy efficiency scenario. Benefit of lower costs with 100 billion EUR in 2050.
- Stratego – HRE3, European project between 2014 and 2016 with several partners. Detailed studies of five European countries.
- Heat Roadmap Europe 4, European project between 2016 and 2018 with several partners. Detailed studies of further ten European countries.
- Outputs and corresponding maps are available at www.heatroadmap.eu

1. Recognition

Main results from Heat Roadmap Europe

A. **Forecast: District heating will be suitable in dense urban areas, while local heat pumps and biomass boilers will be suitable in other areas.**
B. **News:** First ever estimation of the district heating benefits in the future European energy system.
C. **Less costly:** We can avoid the most expensive end use energy efficiency measures in buildings by using district heating as an energy efficiency tool.
D. **Paradox:** District heating will have a higher competitiveness in a future more energy efficient Europe.

1. Recognition

Heat Roadmap Europe methodology

We sliced EU into about 1300 pieces (NUTS3 regions), and estimated what was possible in each region.

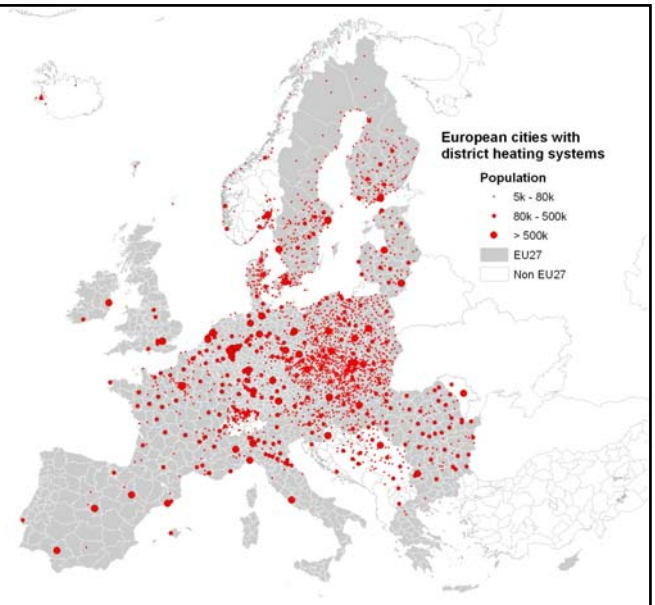
Other energy modellers just cut EU into 27 pieces (the national energy balances)

Figure 11: The NUTS3 regions of Europe, of which 1289 are located within the EU27 European territory and 14 are located overseas. (from the second pre-study)

1. Recognition

District Heating

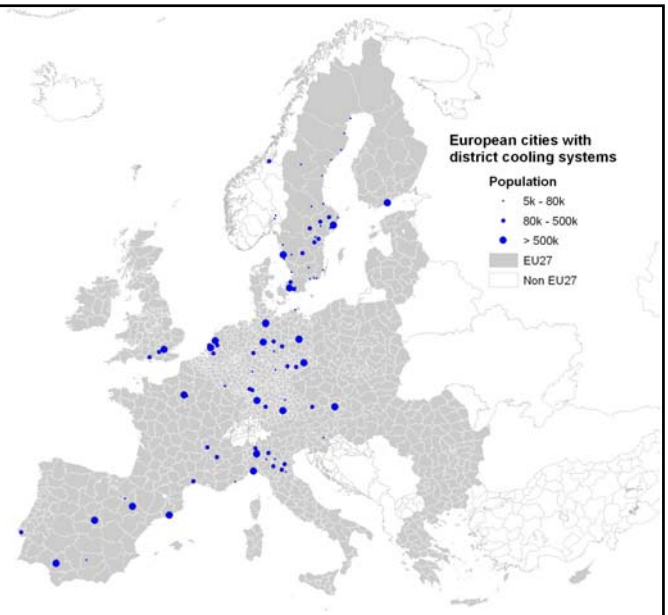
Figure 12-2. Map showing district heating systems in Europe in 2011. Systems have identified in 2779 cities and towns having more than 5000 inhabitants. Further 1395 district heating systems have been found in smaller towns and villages, mostly in Denmark, Sweden, Switzerland, Austria, the Czech Republic, and the Slovak Republic. According to national statistics, further about 1500 systems are in operation. Source: The European DHC database at Halmstad University (Urban Persson).



1. Recognition

District Cooling

Figure 12-4. Map showing European district cooling systems in 2011. Source: The European DHC database at Halmstad University (Urban Persson).



1. Recognition

The European heat density map

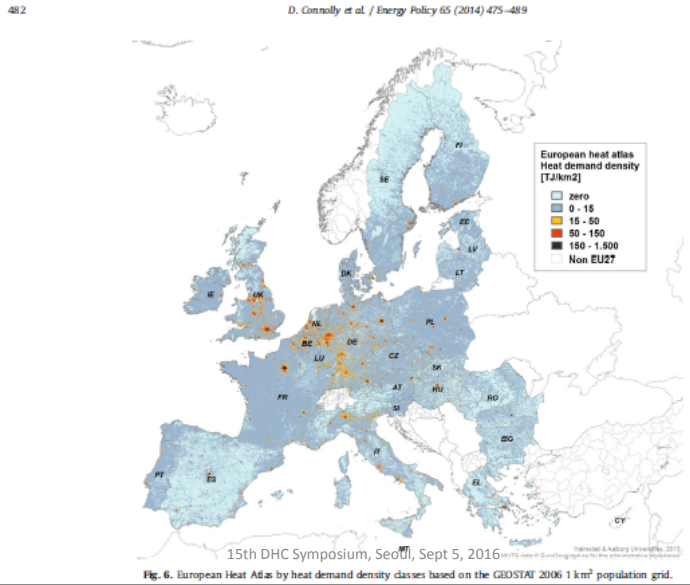
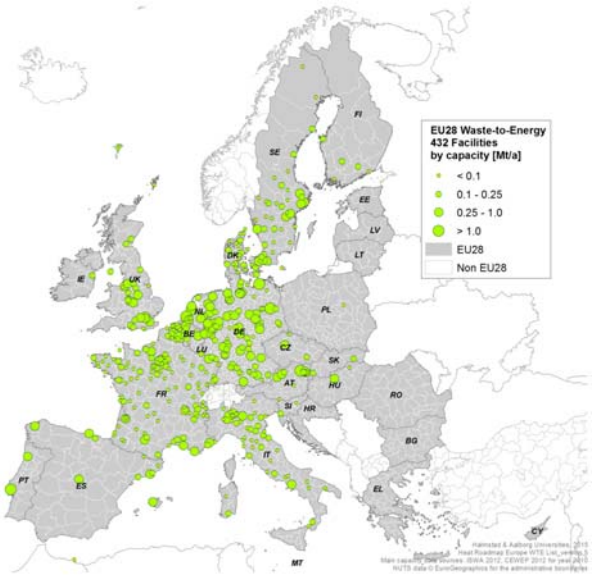


Fig. 6. European Heat Atlas by heat demand density classes based on the GEOSTAT 2006 1 km² population grid.

1. Recognition

Examples of heat sources: Waste incineration

All waste incineration plants within EU with respect to size and location as example of available large central heat sources.



1. Recognition

Heat synergy regions

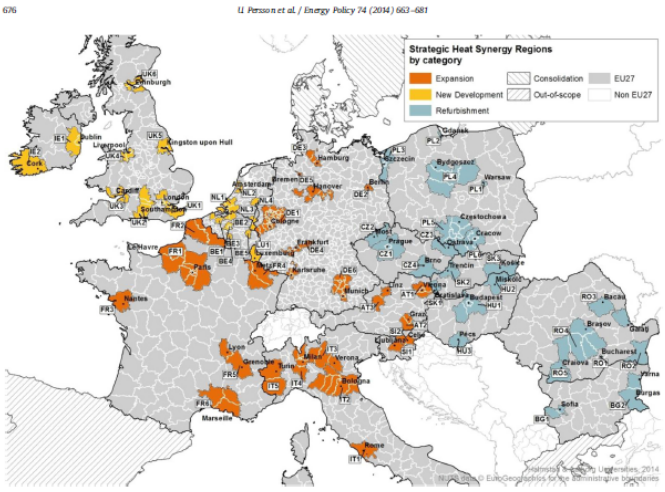


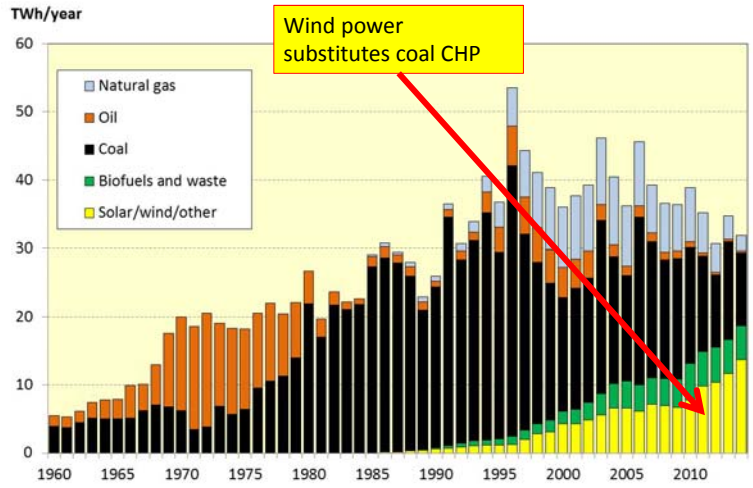
Fig. 9. 63 Strategic heat synergy regions in 16 selected EU27 Member States, by categories Expansion, New Development, and Refurbishment.

Challenge 2

NEW HEAT SOURCES

2. New heat sources

Less heat from coal CHP: Transition from fossil fuels in the Danish power system



2. New heat sources

Some biomass-fueled steam CHP plants in Sweden

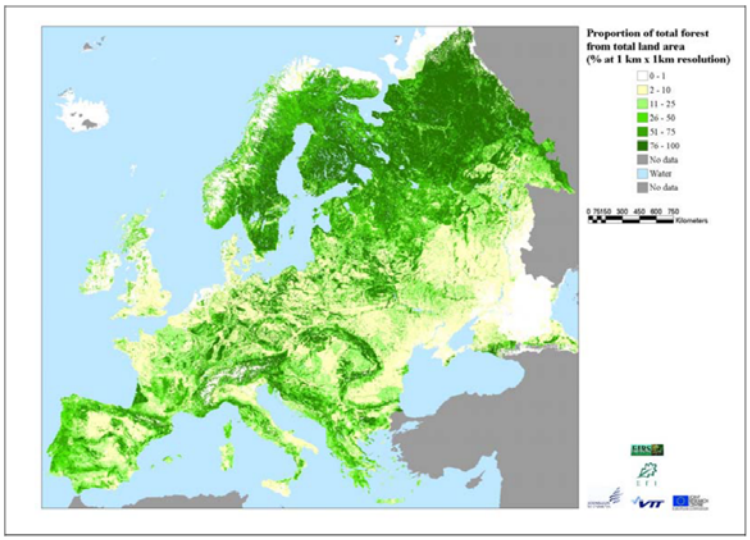
Lund: 38 MW_{el} and 88 MW_{heat}, including 16 MW flue gas condensation

Stockholm: 130 MW_{el} and 280 MW_{heat}, including 80 MW flue gas condensation

Södertälje: 85 MW_{el} and 200 MW_{heat}, including 56 MW flue gas condensation

2. New heat sources

Forest biomass availablity



2. New heat sources

European Directive 2008/98/EC on waste (Waste Framework Directive)

Most favoured option

Reduce lowering the amount of waste produced

Reuse using materials repeatedly

Recycle using materials to make new products

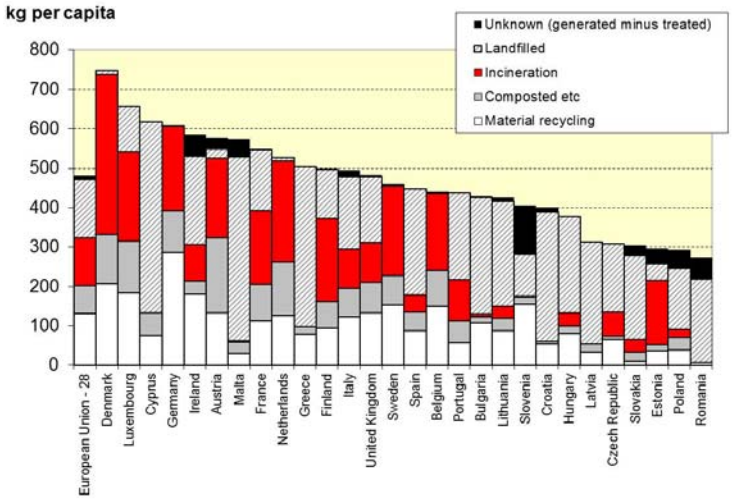
Recovery recovering energy from waste

Landfill safe disposal of waste to landfill

Least favoured option

2. New heat sources

EU – municipal waste management



Current Waste Management for Municipal Waste during 2013 in the EU28 countries. Source: Eurostat online database.

2. New heat sources

Some European Waste-to-Energy plants

Linköping, Sweden

Vienna, Austria

Brescia, Italy

Copenhagen, Denmark

2. New heat sources

One example of industrial heat recovery in Germany

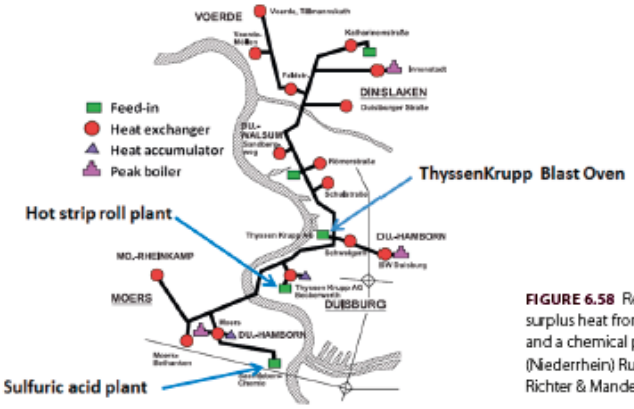
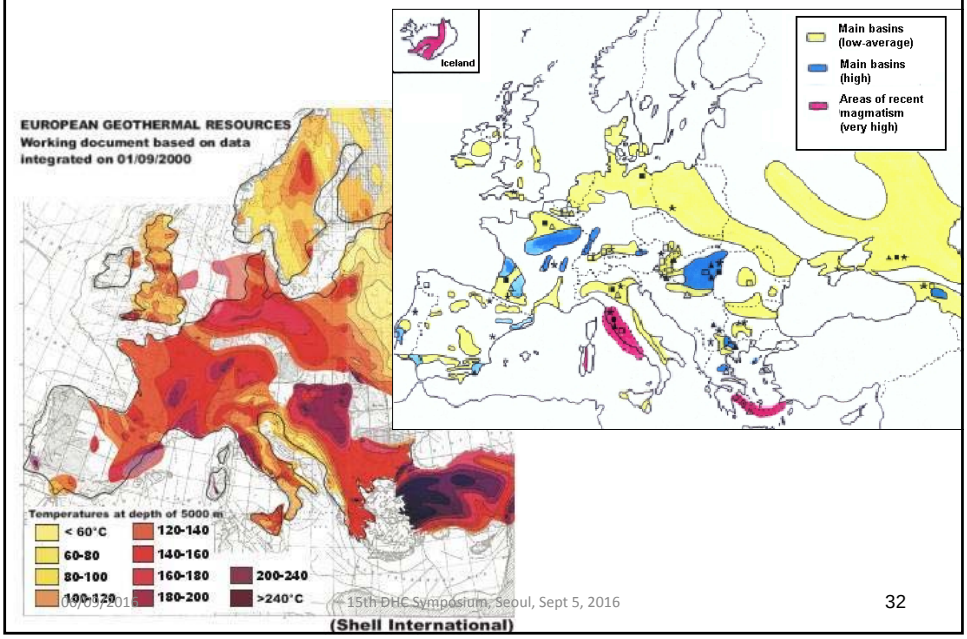


FIGURE 6.58 Recycling of industrial surplus heat from two steel works and a chemical plant in the German (Niederrhein) Ruhr region. Source: Richter & Mandelfeld 2007.

2. New heat sources

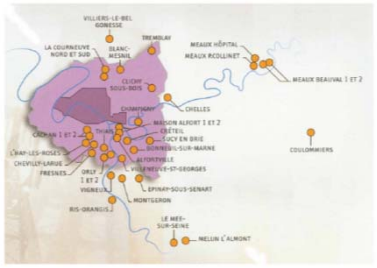
Geothermal conditions in Europe



2. New heat sources

Geothermal district heating systems in Europe

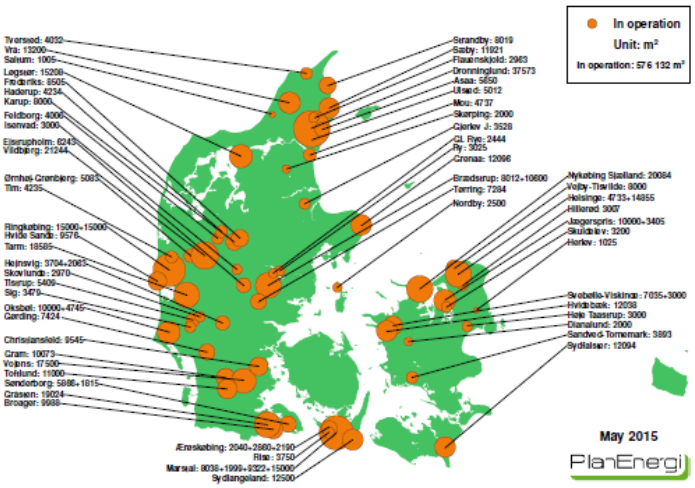
Location of Paris Basin geothermal district heating doublets 2006 status (source ADEME)



One quarter of the EU population lives in urban areas where geothermal heat is available.

2. New heat sources

Solar district heating in Denmark



2. New heat sources

Vojens, Denmark

Construction of the large thermal storage during 2014

2. New heat sources

Other future heat sources

- Large data centres (Stockholm, Helsinki, Mäntsälä, Viborg etc.)
- Large heat pumps (Sweden - sewage, lake, or sea waters)
- Large electric boilers (Denmark/Germany - taking care of surplus wind power)
- Local heat sources as bakeries, air conditioning chillers, electric transformers etc.

Challenge 3

LOWER HEAT DEMANDS

3. Lower heat demands

Current temperature demands

- Fossil fuel resources can easily deliver the high temperatures required to distribute heat to buildings with high heat demands
- Hence, the current district heating technology was once developed for fossil based heat supply and for buildings with high heat demands

3. Lower heat demands

Future temperature demands

- Renewables, heat recycling, and heat storage becomes more efficient when the temperature demands is lower
- Buildings with lower heat demands requires lower temperature demands
- Hence, lower heat demands is a possibility to obtain more efficient district heating systems.

3. Lower heat demands

Conclusion, temperature demands

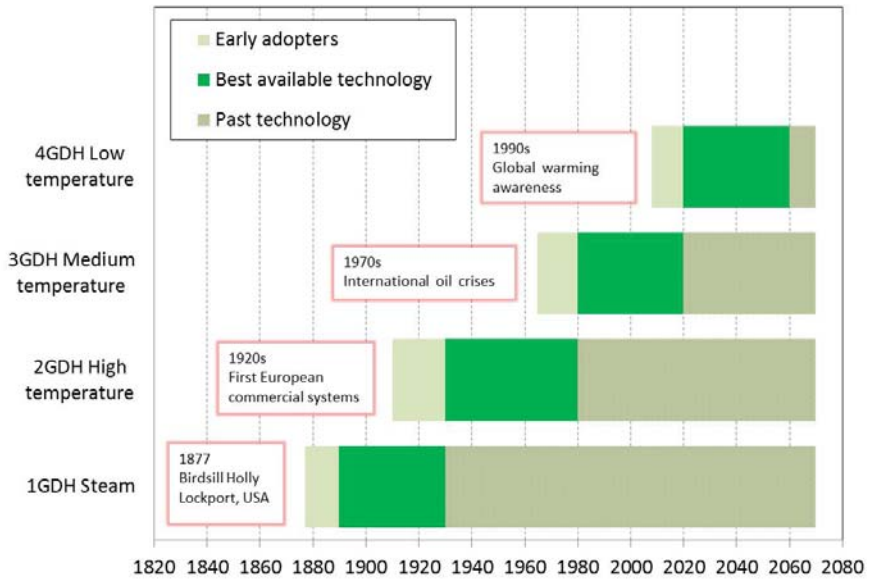
The current high distribution temperatures in district heating networks are major barriers for introducing renewables, heat recycling, and large heat storages

Challenge 4

ENHANCED DISTRICT HEATING TECHNOLOGY

4. Enhanced technology

The four generations of district heating technologies



4. Enhanced technology

4GDH, definition paper

Energy 68 (2014) 1–11

Contents lists available at ScienceDirect

Energy

journal homepage: www.elsevier.com/locate/energy

Review

4th Generation District Heating (4GDH) Integrating smart thermal grids into future sustainable energy systems

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4. Enhanced technology

The five abilities of 4GDH

1. Ability to supply low-temperature district heating for space heating and hot water
2. Ability to distribute heat in networks with low grid losses
3. Ability to utilise renewable heat and recycled heat from low temperature sources
4. Ability to be an integrated part of smart energy systems
5. Ability to ensure suitable planning, cost and motivation structures

Conclusions

The global DHC community must:

1. Communicate the DHC benefits to all global policymakers
2. Use new heat sources
3. Harmonize the district heating technology for lower heat demands
4. Develop the fourth generation of district heating technology

One fact and five dreams

Russian carbon dioxide emissions will be small!

Very welcome to my district heated house!

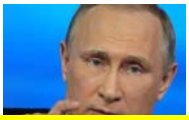
I prefer district heating pipes of this size!

USA will spend more money on DHC!

China and Russia agree that DHC is a sustainable solution!

Let us pray for DHC !

District heating dreams




These six world leaders live and work in buildings connected to district heating systems!


USA will spend more money on DHC!


China and Russia agree that DHC is a sustainable solution!


Let us pray for DHC !

The End

Thank you for your attention!

More info about Heat Roadmap Europe at:

http://heatroadmap.eu/

More info about the 4DH research centre:

http://www.4dh.dk/

The 4GDH definition paper by Henrik Lund et al:

http://www.sciencedirect.com/science/article/pii/S0360544214002369