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4DH Research in a European Context

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Background

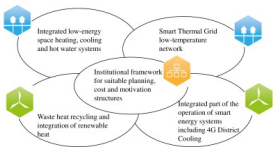
District heating is essential to achieve a fossil free society in 2050 in Denmark and the EU, but the technology has to be developed into a new generation to meet the challenges of the future. 4DH is an international research centre which develops 4th Generation District Heating Technologies and Systems. Main features:

- There are 31 project partners from Denmark and other countries, including 21 commercial organisations and 10 universities.
- The total project budget is about €8.5 million
- Approximately 30% of the total budget is co-financed by industrial and commercial partners.
- The centre is financed from 2012 to 2017 by Innovation Fund Denmark.

The 4DH research centre is the largest academic district heating project in Europe.

Research in 4DH

4th generation district heating (4GDH) provides lower and more flexible distribution temperatures, enabling the utilization of renewable energy sources such as geothermal and solar while meeting the requirements of low-energy buildings and energy conservation measures in the existing building stock.



Synergies between technologies and low-temperature district heating sources are not easily exploited. Research in 4DH is conducted in 3 work packages with 12 PhDs and in spin-off national and international research projects developed in 4DH and co-financed by 4DH.

Work package 1, District Heating Grids and Components: Development and evaluation of low-temperature district heating systems based on renewable energy. The research provides new knowledge of the hardware and software technologies of the new generation of district heating for existing energy renovated buildings and new low-energy buildings.

- Heating of existing buildings by low-temperature district heating
- Supply of domestic hot water at comfortable temperatures without Legionella
- Conversion of existing district heating grids to low-temperature operation and extension to new areas of buildings
- Minimising losses in the district heating grid

Work package 2, District Heating Production and System Integration: The hypothesis here is that 4GDH has an important role to play in efficient future energy systems. Energy systems analysis tools, methodologies and theories for the study and scenario-building of future sustainable energy systems are developed with the aim to identify the role of district heating systems and technologies in various countries. Project focuses include:

- Energy Scenarios for Denmark with 4DH
- Thermal storage in district heating systems
- Distributed CHP plants optimized across more electricity markets
- Low-temperature energy sources for district heating
- The role of district heating in the Chinese energy system

Work package 3, District Heating Planning and Implementation: Further development of planning and management systems based on spatial analysis and geographical information systems (GIS) as a tool for planners and decision makers. Project focuses include:

- Strategic energy planning in a municipal and legal perspective
- Price regulation, tariff models and ownership as elements of strategic energy planning
- Geographical representations of heat demand, efficiency and supply
- Geographical representations of renewable energy systems.

Acknowledgement

This poster was created in 4DH in October 2014 for Innovation Fund Denmark's Conference: ENERGY AND ENVIRONMENT FOR THE FUTURE, Sustainable energy for a fossil free society and environmentally friendly technologies - A conference presenting state of the art research. 4DH is financed by Innovation Fund Denmark.

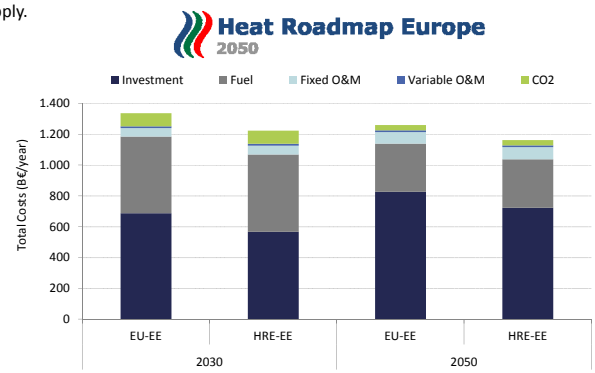
4DH – Key research results

Research results already after two years of work include:

1. A clear concise definition of 4th Generation District Heating as integrated smart thermal grids in future sustainable energy systems
2. The role of district heating and district cooling in the current system, in future energy systems and in the balance between energy savings and supply systems.
3. Denmark is at the forefront of the development of district heating. The centre provides methods and tools to quantify the role of district heating.
4. 4DH has established district heating as an important research field by:
   - Publishing a series of peer-reviewed papers in internationally recognized journals
   - Conducting large international and Danish conferences and seminars
   - Conducting PhD seminars and courses open to other PhD fellows and industry
   - By training 12 PhDs to become researchers focused on district heating
   - By hosting PhDs and scholars from other Universities at the Centre
5. Establishment of a large number of spin-off Danish and European research and demonstration projects
6. Technology transfer from the Danish context to the European and Chinese contexts by providing the first thermal heat atlas for Europe and the first quantification of the role of district heating in Europe and in China.
7. District heating education: Academic books and papers used in teaching and Master students in university education programmes making dedicated student projects within district heating.
8. Re-engineering district heating to low-temperature district heating by showing concrete cases and concepts
9. Quantifying how district heating fits into current and future scenarios for Denmark, Europe and China, i.e., how low-temperature district heating, renewable energy and energy savings can make more efficient solutions than the alternatives
10. Showing how concrete economic structures can facilitate smart energy systems and low-temperature DH

Heat Roadmap Europe - Summary

In Heat Roadmap Europe (HRE), the principals developed under the 4DH project have been applied at an EU level to demonstrate how district heating can reduce the cost of a low-carbon EU energy system by €100 billion per year (EU-EU vs. HRE-EE below). HRE is the first study on the EU27 scale which combines geographical mapping of energy demand and supply in unprecedented detail with detailed energy system modelling of the European heat supply.



Heat Roadmap Europe – Key Results

- **Energy Efficiency:** heat savings are a key component in the decarbonisation of the EU energy system. The total heat demand in Europe should be reduced by 30-50%.
- **District Heating:** currently more heat is being wasted in Europe than the amount required to heat all of the buildings. District heating can capture this surplus heat and provide approximately 50% of the total heat demand in buildings in Europe.
- **Individual Heat Pumps:** in rural areas, individual heat pumps should replace existing oil boilers. Heat pumps connect cheap renewable electricity production (such as wind and solar) with efficient renewable heat production (due to the COP of heat pumps).
- **Energy System:** heat savings, district heating, and individual heat pumps are key components in a future low-carbon EU energy system. They are fundamental to the technical and economic viability of the Smart Energy System.