Heat Roadmap Europe 2050

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Who Am I?

- From Ireland
- Background in Mechanical Engineering
- Now living in Copenhagen, Denmark
- Assistant Professor in Energy Planning at Aalborg University
What do we do…?

Sustainable Energy Planning:

- Energy System Analysis (incl. GIS)
- Feasibility Studies
- Public Regulation
Heat Roadmap Europe

Why do we need Heat Roadmap Europe?
The Context/Background
EU Energy is Changing

Specific Targets
- 80% less CO2 in 2050
- 2020 Targets:
  - 20% Renewables
  - 20% CO2 reduction
  - 20% Efficiency

But... 28 Member States
Existing Studies

- Energy Roadmap 2050 (EU Commission)
- Roadmap 2050 (European Climate Foundation)
- The energy report – 100% renewable energy by 2050 (WWF)
- Energy Technology Perspectives 2010 (IEA)
- World Energy Outlook (IEA)
- Deciding the Future: Energy Policy Scenarios to 2050 (WEC)
- Academic Journal Papers
Why Heat Roadmap Europe?

Existing scenario reports:
- Fail to provide proper analysis of heating and cooling
- Have a too low time and geographical resolution to model the realities of the energy market, especially DHC
- Acknowledge the importance of DHC until 2030/2050, but assume high shares of electric heating, low heat consumption, and low shares of DHC by 2050

General Consensus:
"Combined heat & power (CHP) and district heating (DH) are important"

... but fail to quantify to which extent these options can be used in the future energy system...

The European Commission in the Energy Roadmap 2050 communication:
"An analysis of more ambitious energy efficiency measures and cost-optimal policy is required. Energy efficiency has to follow its economic potential. This includes questions on to what extent urban and spatial planning can contribute to saving energy in the medium and long term; how to find the cost-optimal policy choice between insulating buildings to use less heating and cooling and systematically using the waste heat of electricity generation in combined heat and power plants."

Introducing Intermittent RE

Resources

Conversion

Relocation

Exchange and Storage

Demand

Wind etc. → Fluctuating Electricity

Power Plants

Power Exchange

Mobility

Electricity

Cooling

Heating

Fuels

Boilers
District Heating & Thermal

- Resources
- Conversion
- Relocation
- Exchange and Storage
- Demand

- Wind etc.
- Fluctuating Electricity
- CHP (or Quad)
- Boilers
- fuels

- Power Exchange
- Thermal Storage
- Mobility
- Electricity
- Cooling
- Heating
Heat Pumps & Thermal Storage

Resources → Conversion → Relocation → Exchange and Storage → Demand

- Wind etc.
- Fluctuating Electricity
- CHP (or Quad)
- Fluctuating Heat
- Solar etc.
- Fuels

Conversion:
- Heat Pump

Relocation:
- Power Exchange

Exchange and Storage:
- Thermal Storage

Demand:
- Mobility
- Electricity
- Cooling
- Heating
Thermal Storage

- 28,500 m\(^3\) tank
  - ~2 GWh
  - Assuming a height of 15 m
  - Area ~1900 m\(^2\)
  - Diameter ~50 m
  - Investment ~€3/kWh

- 75,000 m\(^3\) pit storage
  - ~5.25 GWh
  - Investment ~€0.5/kWh

- Requires a tank or pit of water
The EU is wasting energy (heat)...

Energy Balance for the EU27 in 2010 (EJ)

- Primary Energy Supply
- Final Consumption
- End Use

- Non-specified
- Non-energy use
- Transport
- Electricity
- Heat for Industry
- Heat for Buildings
Focus for Today

1. What is Heat Roadmap Europe (HRE)?
2. How did we complete HRE?
3. What are the key results from HRE?
4. What can the HRE study do?
5. What do we plan for the future?
1. What is HRE?

Two Reports:

- Pre-study 1 (2012): is DHC beneficial in a business-as-usual scenario
- Pre-study 2 (2013): is DHC beneficial in a low-heat demand scenario
  - This is also a complete heat strategy
2. How did we make HRE?

Methodology
Heat Roadmap Europe
2050

STUDY FOR THE EU27

by

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for

Ecoheat & Power
Methodology

GIS Mapping

- District Heating Demands
- District Heating Resources

Energy System Modelling

- BAU (References)
- District Heating Alternatives
- Results (PES, CO2, Costs)
Urban areas (Heating Demands)
- Power and Heat Generation
- Waste Management
- Industrial waste heat potential
- Geothermal heat
- Solar Thermal

The study indicates that the market shares for district heating for buildings can be increased to 30% in 2030 and 50% in 2050.
Energy Systems Analyses Model

- Hourly model of the energy system
- Quantifies the impact of different alternatives

www.EnergyPLAN.eu
Combining the Mapping & Modelling
Pre-Study 1 (2012)

Is DHC beneficial for the EU energy system in a business-as-usual scenario?
What is a Business-as-Usual Scenario?

Energy Roadmap 2050
- Completed for the European Commission in 2011, by the National Technical University in Athens

Presents 6 energy scenarios for the EU27:
- Reference: Business-as-usual
- CPI: Updated business-as-usual
- EE: Energy Efficiency
- CCS: Carbon Capture and Storage
- Nuclear
- High Renewable Energy
Designing the DHC Alternatives

EU CPI
PRIMES Data
2030 & 2050 Model

District Heating Alternatives

2010 = 12% DH
2030 = 30% DH
2050 = 50% DH

Results
(PES, CO2, Costs)
3. What are the key results?
Pre-Study 1 (2012)

Is DHC beneficial for the EU energy system in a business-as-usual scenario?
Year 2030 & 2050: Total Energy Demand

EU27 Primary Energy Supply & CO2 from 2010 to 2050
EP CPI vs HRE RE

HRE 2050 compared to EU CPI 2050:

- 5% reduction in Primary Energy Supply
- 10% reduction in fossil fuels
- 13% reduction in CO2-emissions

Other Renewables
Biomass
Natural gas
Oil
Coal
Nuclear
CO2 Emissions
- Saved fuel costs of annual approx. 30 Billion EUR in 2050
- In total cost are reduced by 14 Billion EUR in 2050
- Additional investments of a total of 500 billion EUR
- Additional jobs from to 2013 to 2050: 8-9 million man-year in total
  Approx. 220,000 jobs.

Annual EU27 Costs for Heating Buildings from 2010 to 2050

- Fuel
- Fixed operation costs
- Annual investment costs

<table>
<thead>
<tr>
<th>Year</th>
<th>IEA 2010</th>
<th>EP CPI 2030</th>
<th>HRE RE 2050</th>
<th>EP CPI 2050</th>
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HRE1 Conclusion: 50% DH in 2050

- Decrease primary energy supply and especially fossil fuels and CO2 emissions
- Decrease annual costs of energy in Europe by approximately €14 Billion in 2050
- Create additional 220,000 jobs over the period 2013-2050
- Further integration of RES
Pre-Study 2 (2013)

Is DHC beneficial for the EU energy system in a low-heat demand scenario?
EU-EE vs. HRE-EE: Total Energy Demand & CO2
EU-EE vs. HRE-EE: Heat & Cooling Costs -15%

Total Costs for Heating and Cooling in the Residential and Services Sectors (€/year)

- End-Use Energy Efficiency Investments
- Heating System Investments
- Cooling System Investments
- Centralised Electricity & Heat Plants
- Fuel
- CO2

Year: 2030
- EU-EE (13% DH)
- HRE-EE (30% DH)

Year: 2050
- EU-EE (13% DH)
- HRE-EE (50% DH)
If we implement a lot of energy efficiency measures, then district heating will:

- Meet the same goals:
  - Utilise the same amount of fossil fuels
  - Enable the same CO2 emission reductions

BUT, Cost approximately 10% less

Therefore, in both scenarios (business-as-usual and a high energy efficiency scenario) district heating can reduce the costs of energy in the EU, while also utilising more renewable energy.

BUT, Cost approximately 10% less
HRE Quantified the Key Benefits of District Heating

- Improves the efficiency of the system (CHP, O&M, etc.)
- Creates short-term and long-term flexibility
- Enables more renewable energy resources and surplus heat to be utilised
- Reduces the thermal capacity necessary
- Increases the comfort-levels for the end-user
1. What is Heat Roadmap Europe (HRE)?
   - 2 Studies: DH in business-as-usual & DH in efficiency

2. How did we complete HRE?
   - Combination of mapping and modelling

3. What are the key results from HRE?
   - DH (in combination with other technologies) can reduce the cost of energy in the EU27, while also increasing the use of renewable energy

4. What can the HRE study do?

5. What do we plan for the future?
4. What can HRE do?

Inform Policymakers
Give Industry a Target
Inform Policymakers

Existing Studies

Heat Roadmap Europe

2050

Heat Roadmap Europe

EUROHEAT & POWER

AALBORG UNIVERSITY

DENMARK

PlanEnergi
Who are these Policymakers?

**Policymakers:**
- Politicians
- Public Servants
- City/Municipality Councils
- NGOs

**Can be informed by:**
- Authors
- Industry
- Lobby Organisations
  - Such as Euorheat & Power
What has HRE given Policymakers?

Mapping:
- Potential for district heating and cooling in the EU
- Potential for heat recycling in the EU
- Estimate the renewable heat resource in the EU

Modelling:
- Hourly energy system modelling of electricity, heat, and gas
- Capture the benefits of district heating
- Enhance the Energy Roadmap scenarios
Give Industry a Target

District Heating in Denmark:
- 50% of the heat demand in buildings
- 60% of houses connected
- Enough?

Heat Plan Denmark
- Should expand DH to 63-70% of the heat demand
- Add buildings in neighbouring areas to DH (63%)
- Add buildings within a distance of up to 1 km (70%)
5. What do we plan for the future?

Europe:
- Develop national plans that connect the local (mapping) and EU (modelling) results.
- Create an electric heating scenario for the EU27

Policy:
- Encourage EU policymakers to include district heating and cooling in their new scenarios

Technology:
- 4th Generation District Heating: [http://www.4dh.dk/](http://www.4dh.dk/)
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4. What can the HRE study do?
   - Provide policymakers with knowledge and evidence
   - Change perceptions and mind-sets

5. What do we plan for the future?
   - Develop more EU plans and district heating technology
Thank you

Need a copy of the report?

www.heatroadmap.eu

www.4dh.dk/hre