Heat Roadmap Europe
2050

Heat Roadmap Europe 2050

Mapping and modelling

Professor Henrik Lund, Aalborg University

IEA CHP/DHC Working Group Joint Strategic Workshop

27-28 May 2014

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Heat Roadmap Europe 2050

STUDY FOR THE EU27

by

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Why this study?

- The **heating and cooling sector has largely been overlooked** in all scenarios exploring the energy future towards 2050.

- This study focuses on the future European heat and cooling market and its importance in terms of cost-savings, job creation, investments, and **a smarter energy system**

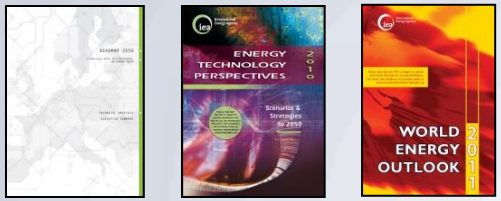
Existing Studies

- Exis
  - R heating and cooling
  - Have a too ical resolution to model the realitie ly DHC
  - Acknowled 2030/2050, but
  - Assume high shares of electric heating, low heat y 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."



What is this Study?

- 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

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What is this Study?

HRE1

2010

- 12% DH - Today
- 30% DH
- 50% DH

HRE1

2030

- BAU
- 30% DH

2050

- BAU
- 50% DH

HRE2

2030

- EE
- 30%

2050

- EE
- 50% DH

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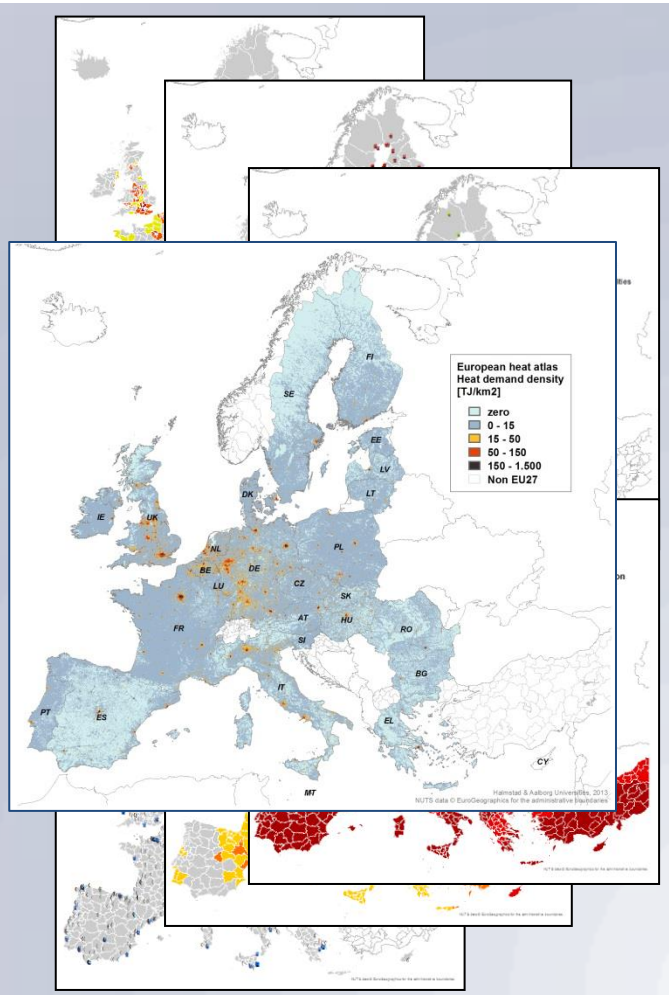
GIS Mapping: Many Heat Sources

- 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.**



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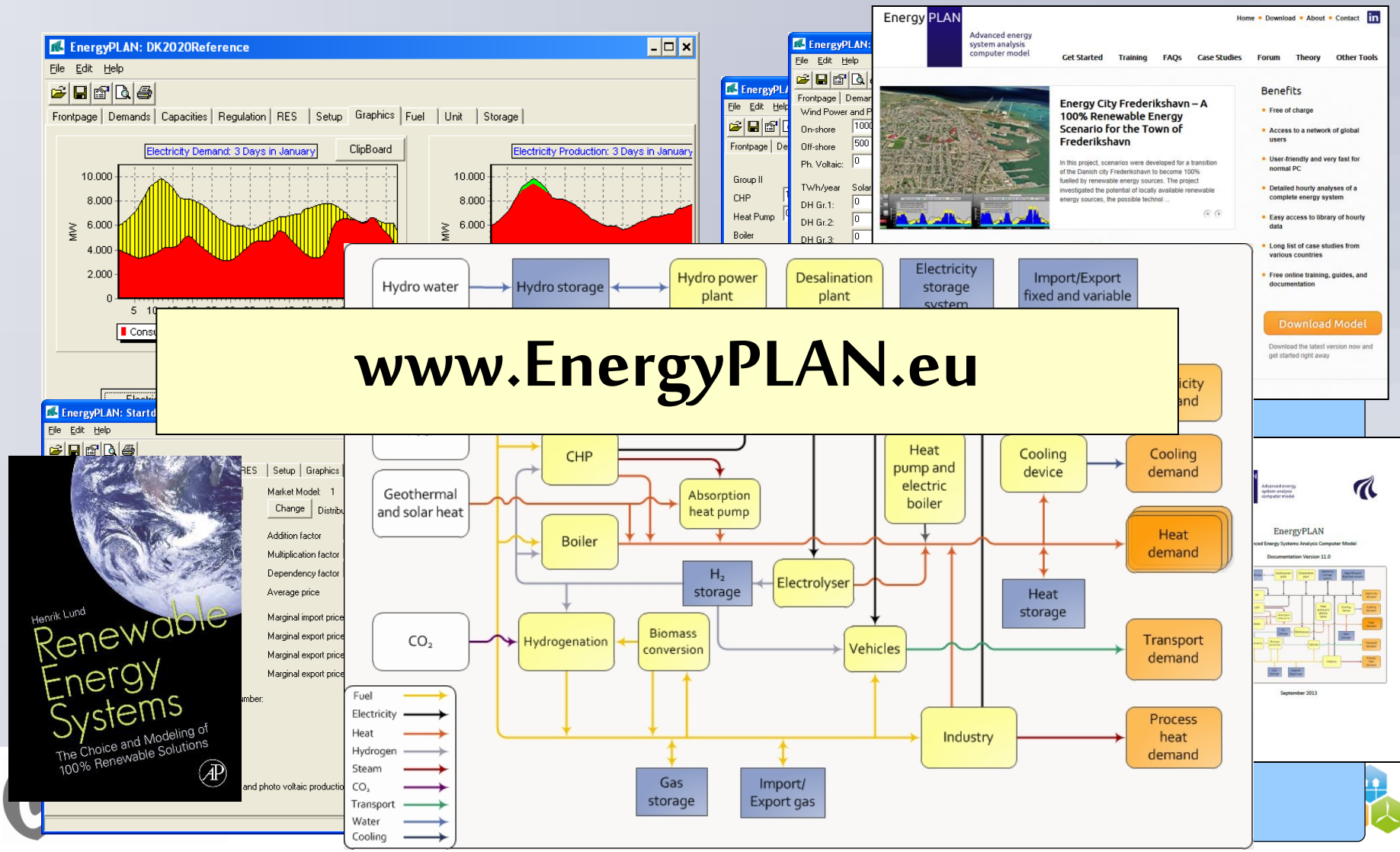
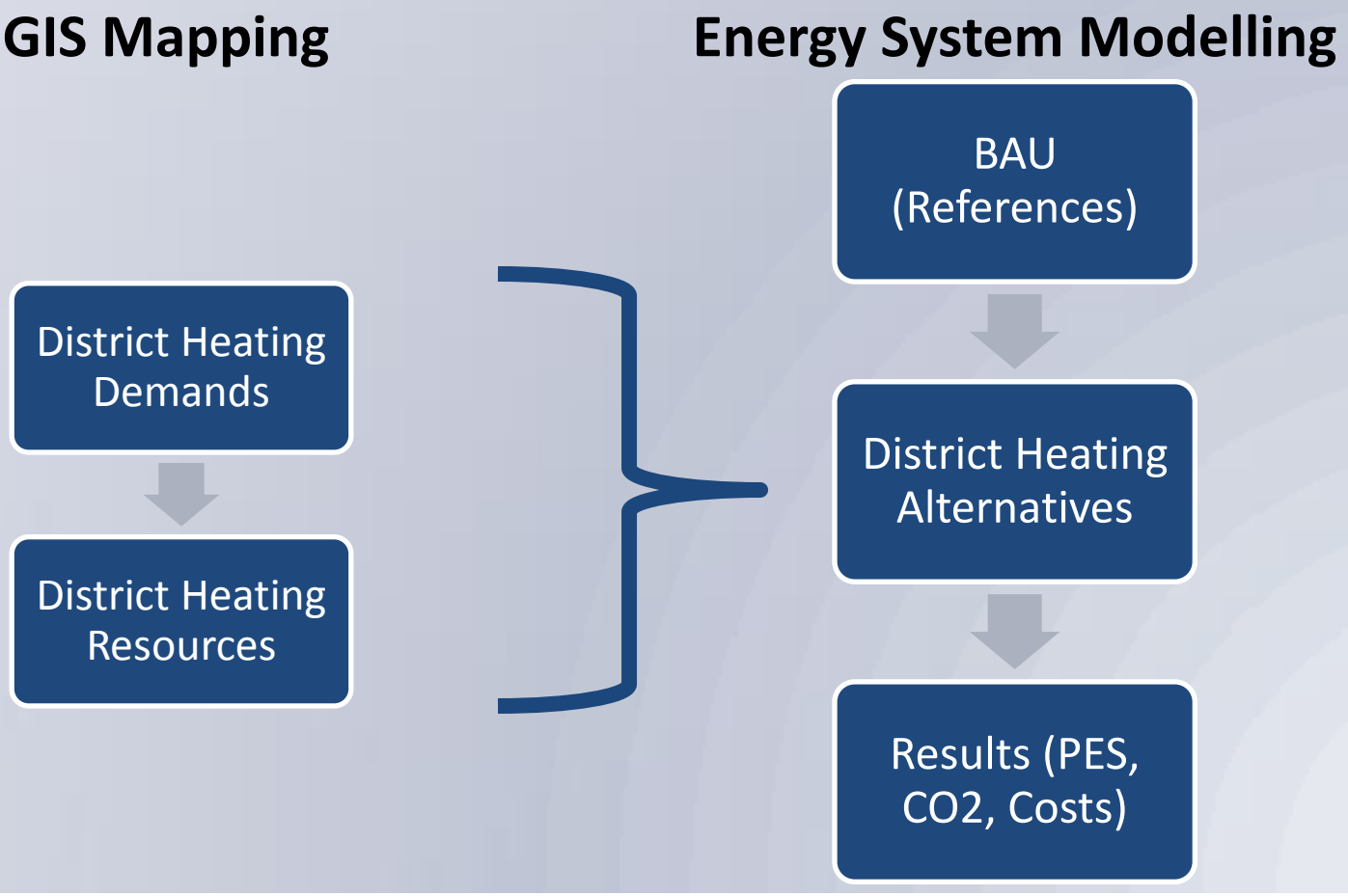
Energi System Analyse Model



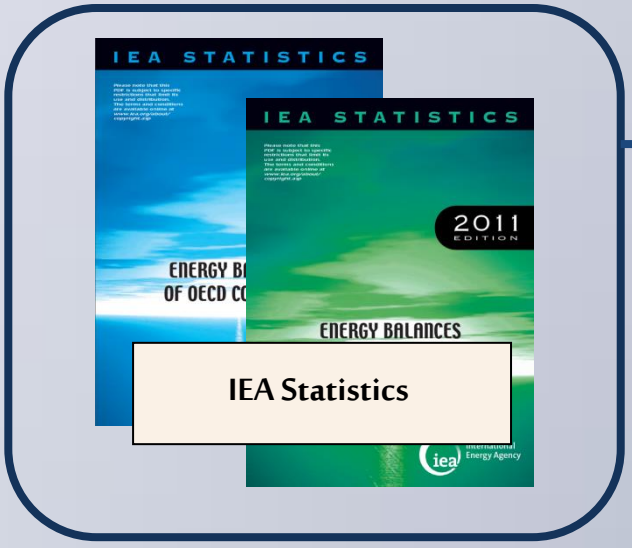
Methodology

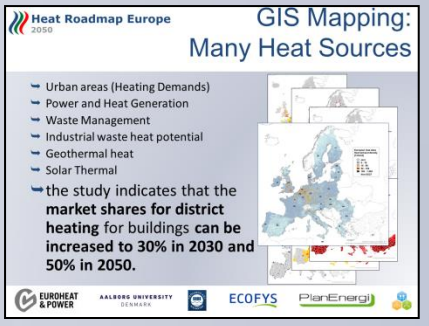


Pre-Study 1 (2012)

Is DHC beneficial for the EU energy system in a business-as-usual scenario?

2010 Modelling





IEA Data
2010 Model

District Heating Alternatives

Ref = 12% DH
2010 = 30% DH
2010= 50% DH

Results
(PES, CO2, Costs)

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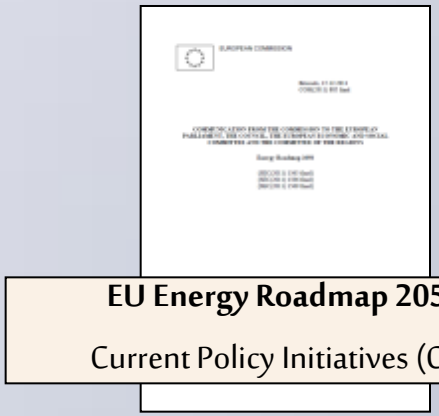
Designing the DHC Alternatives



EU Energy Roadmap 2050

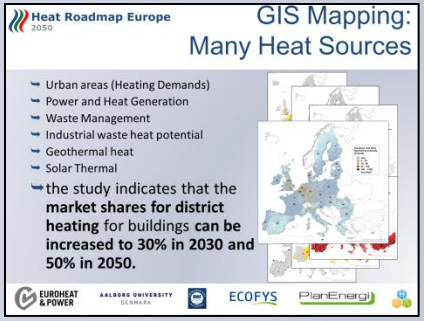
Current Policy Initiatives (CPI)

EU CPI

PRIMES Data

2030 & 2050 Model

District Heating Alternatives



2010 = 12% DH

2030 = 30% DH

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Results

(PES, CO2, Costs)

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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

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District Heating Benefits in 2 steps

Step 1: (Energy Efficiency)

- Increasing DH to 30% then 50%
- Increasing CHP
- Using Oil/Natural gas in CC-CHP

Step 2: (Utilise waste and RE sources)

- Industrial waste heat
- Waste incineration
- Geothermal heat
- Large-scale Solar Thermal







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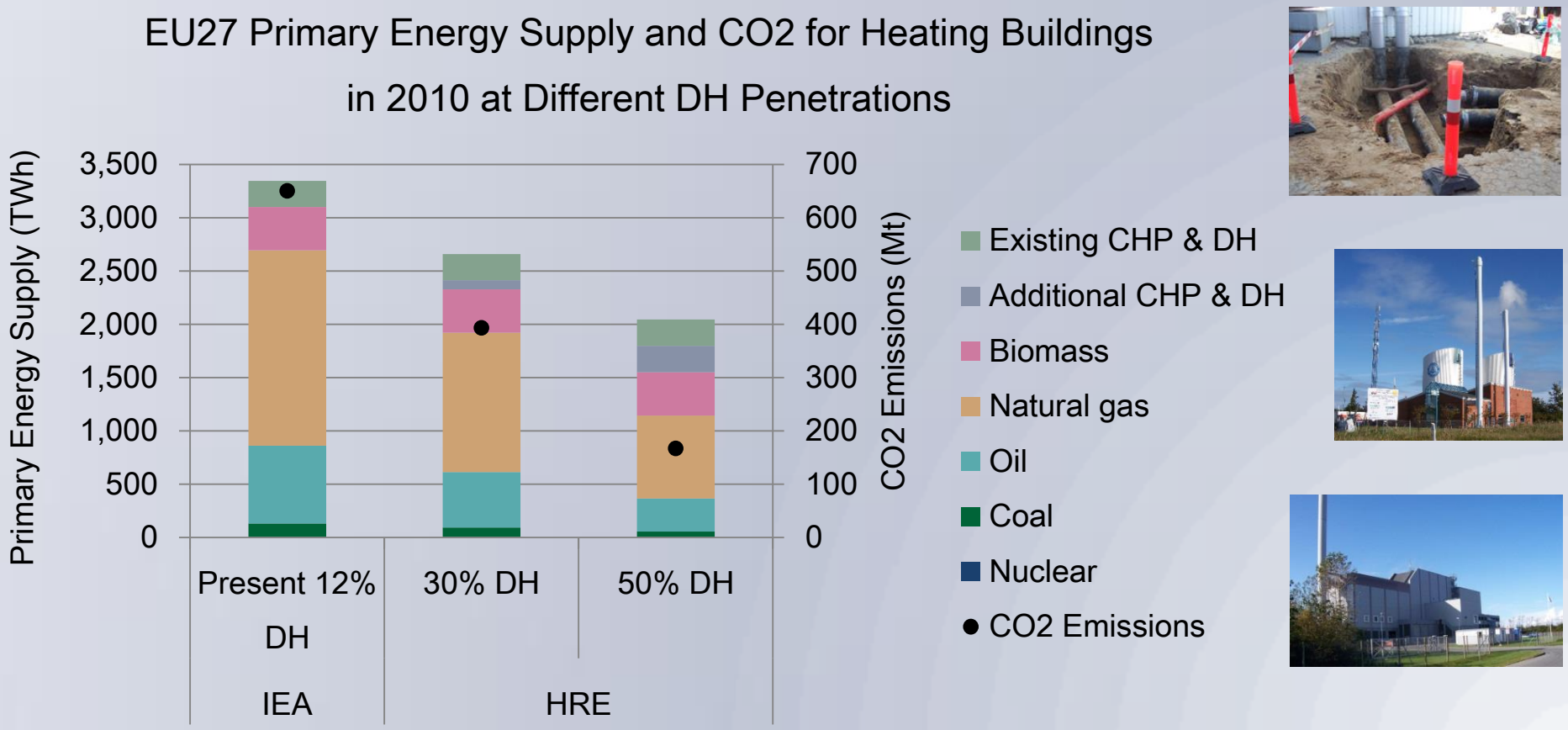
Year 2010
Step 1: Energy Efficiency



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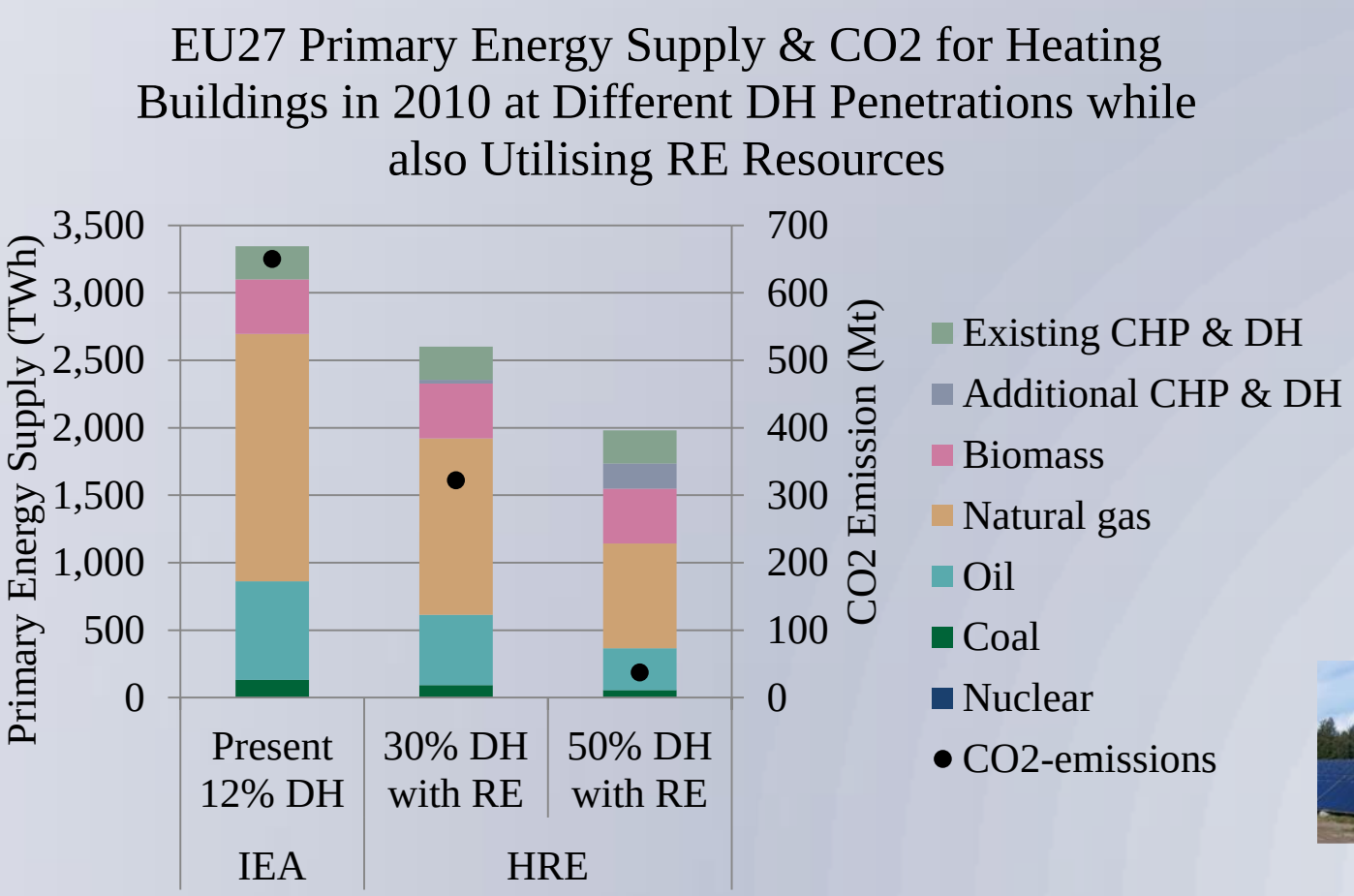
Year 2010
Step 2: Utilise Resources



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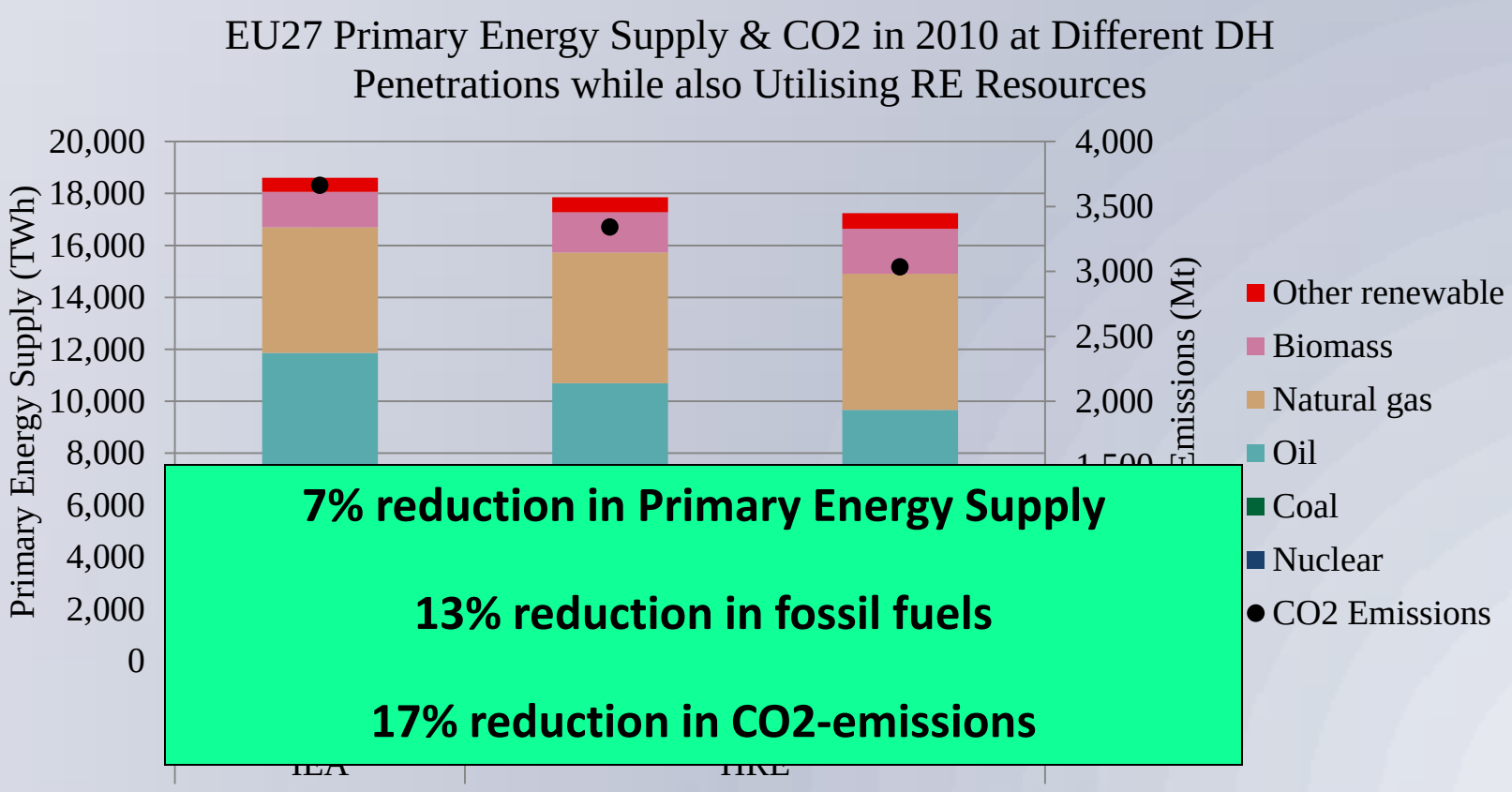
Year 2010 Total Energy Supply



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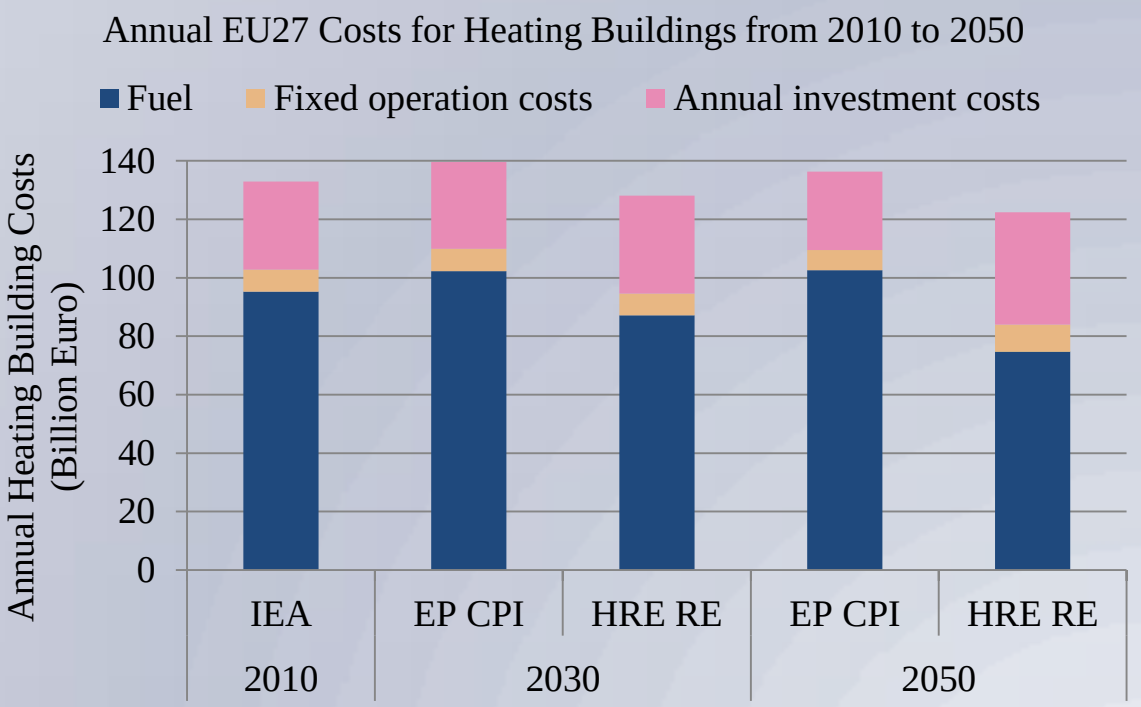
Cost and Jobs

- 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.



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Heat Roadmap Europe 2050

HRE1 Conclusion: 50% DH and CHP

- Decrease primary energy supply and especi… CO2 emissions — **LESS FUEL**
- Decrease annual costs of energy in Europe … 14 Billion in 2050 — **LESS MONEY**
- Create … obs over the period 2013-2050 — **MORE EU JOBS**
- Furthe… — **MORE RE**

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Pre-Study 2 (2013)

Is DHC beneficial for the EU energy system in a low-heat demand scenario?

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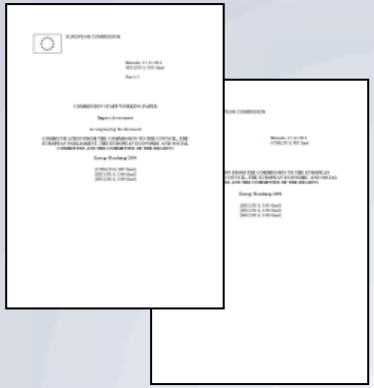
Future: EU Energy Roadmap 2050

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

HRE2: Is district heating a good idea if we implement a lot of energy efficiency in the buildings?

- Pr
  - Reference: Business-as-usual
  - CPI: Updated business-as-usual
  - Energy Efficiency (EU-EE)
  - Carbon Capture & Storage
  - Nuclear
  - High Renewable Energy



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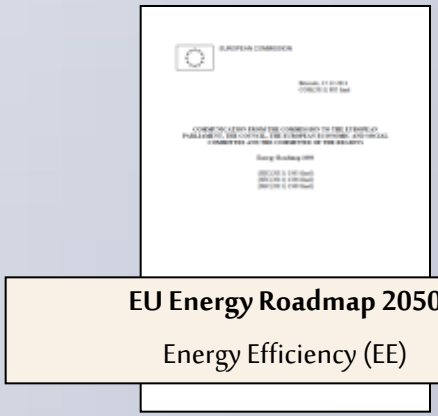
Energy Modelling

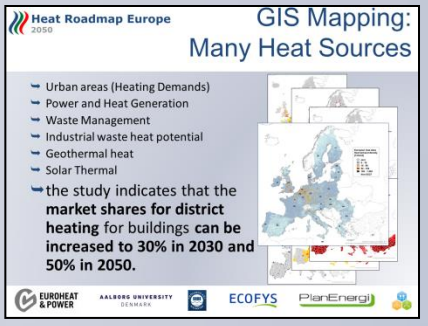


EU Energy Roadmap 2050

Energy Efficiency (EE)

EU-EE
PRIMES Data
2030 & 2050 Model

District Heating
Alternatives



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

Results
(PES, CO2, Costs)

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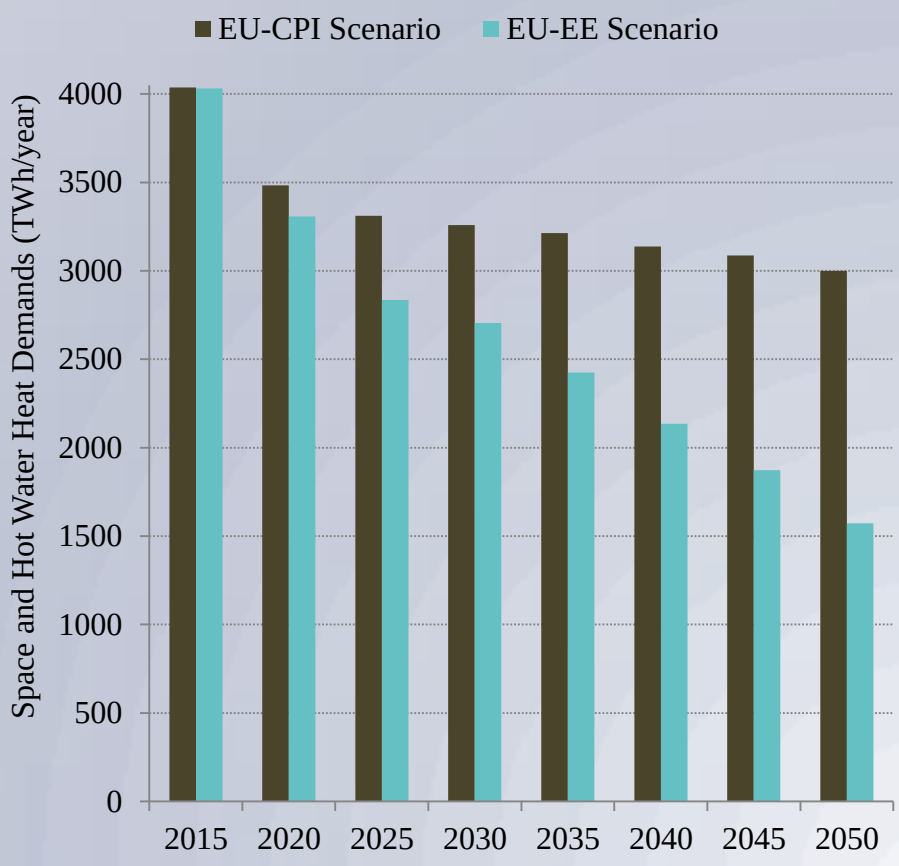
EU-EE Scenario Heat Demand Concerns

- Hot water demand decreases by 50% between 2010 and 2050
- Specific Heat Demands reduce by 70% between 2010 and 2050



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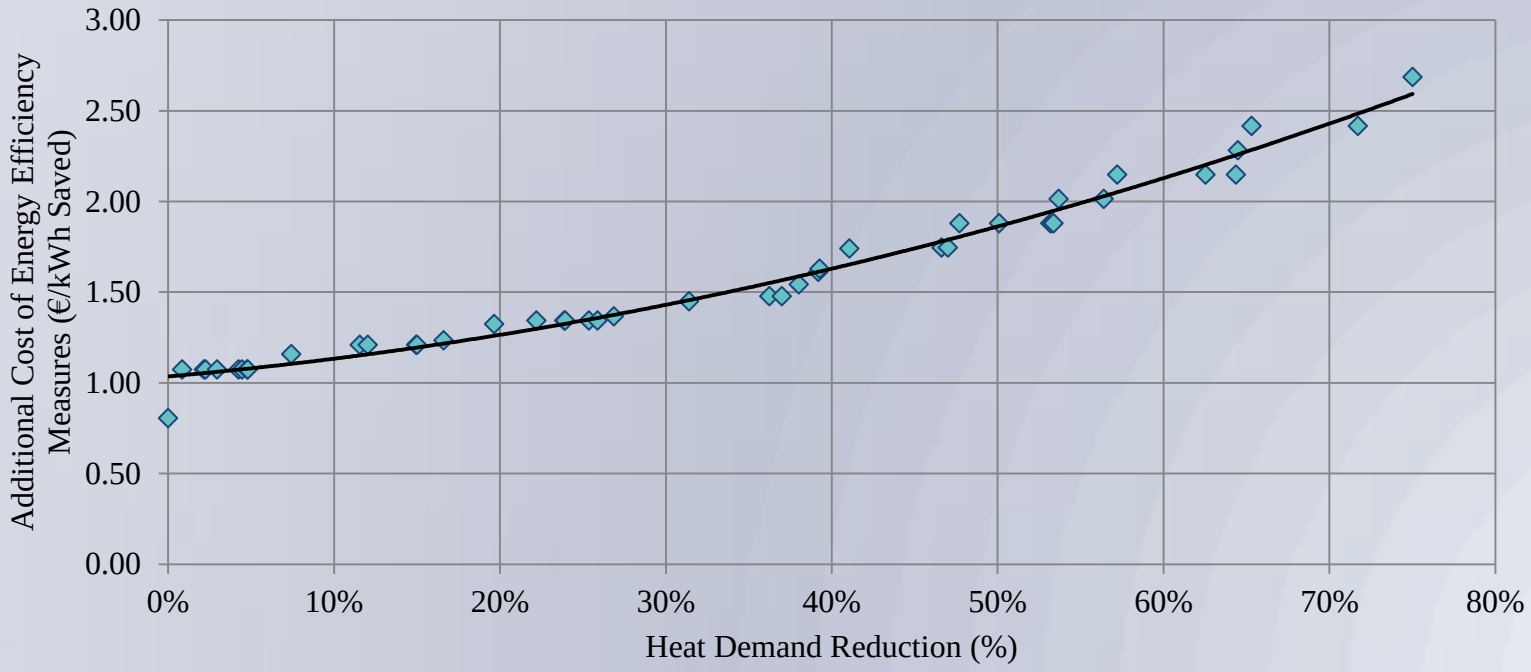
Energy Efficiency Costs

- EU-EE Scenario 63% Drop in Heat Demands Cost B€300/year 2010-2050



HRE-EE Hot Water Growth = +16%

- Residential and non-residential buildings is expected to grow by 32% and 42% respectively between 2015 and 2050
- Population will grow by 3.2% between 2010 and 2050.
- Individuals are likely to take more showers and baths in the future than they do today.
- People are not expected to live with one another as much in the future.
- At present, there are regions in Europe where the use of hot water is limited due to technical and financial limitations.

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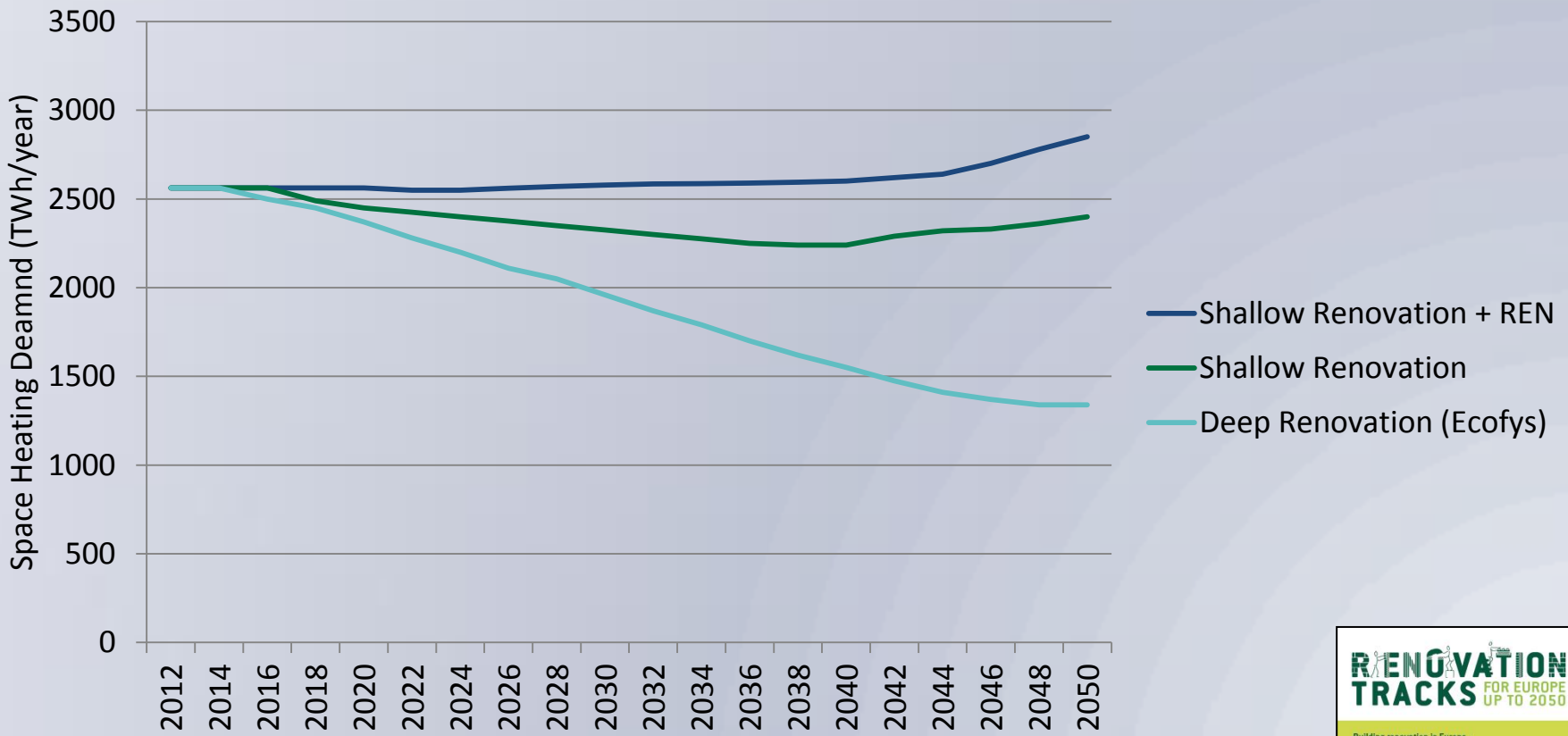
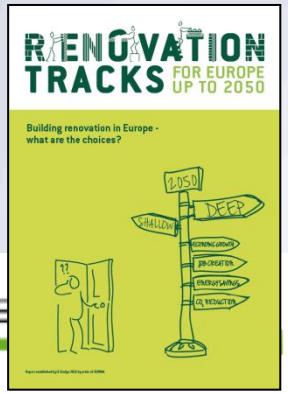
HRE-EE Space Heating = -47%





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Implementing District Heating

1. Individual boilers are replaced by district heating:
   - ➥30% in 2030 and 50% in 2050
   - ➥Individual heat pumps are not replaced

2. Individual cooling units are replaced with district cooling.
   - ➥10% in 2030 and 20% in 2050
   - ➥Natural cooling and absorption heat pumps are both used.

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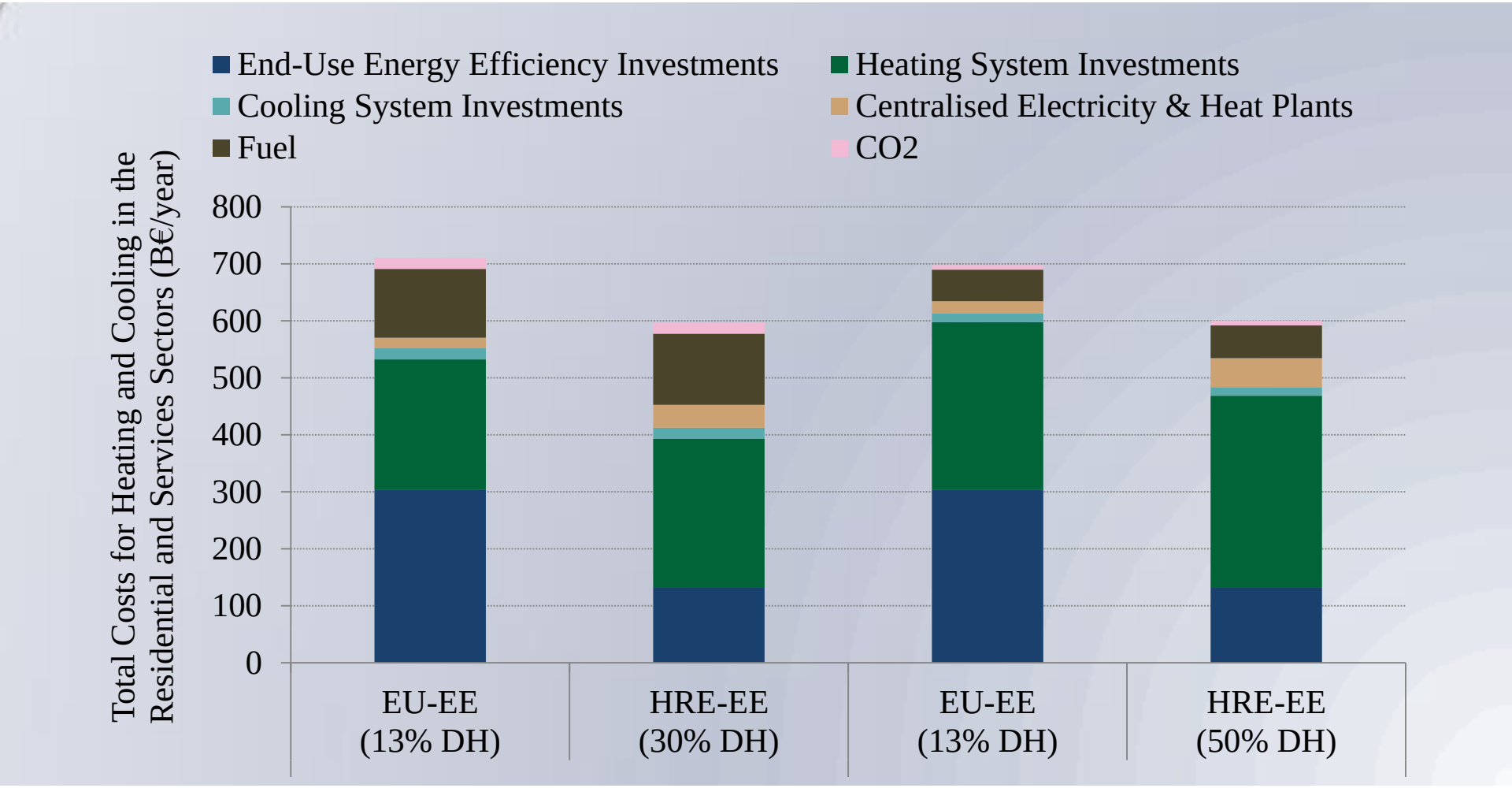
EU-EE vs. HRE-EE: Heat & Cooling Costs -15%



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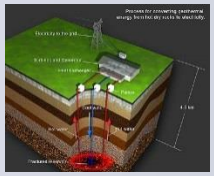
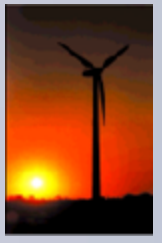
Renewables and Energy Efficiency

Additional Renewables

- 100 TWh Geothermal
- 100 TWh large-scale solar
- 65 TWh wind (due to a smarter energy system)

Context: 2050 total heat is 2600 TWh





Energy Efficiency

- Demand side is extremely important, but eventually it will become expensive

- Supply side also has many options:
  - PP converted to CHP
  - 100 TWh surplus industrial heat
  - 200 TWh heat from waste incineration

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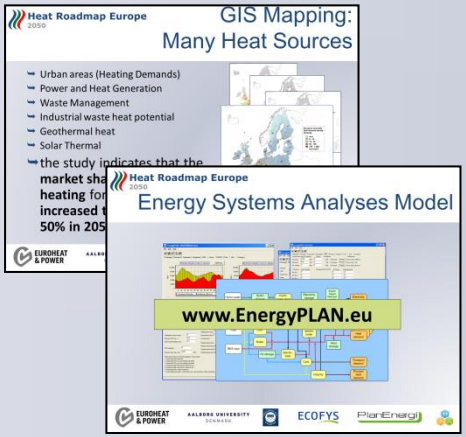
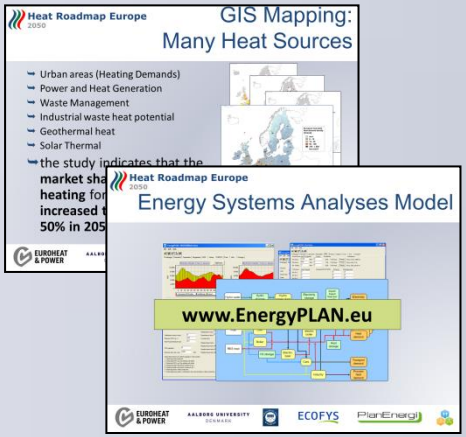
HRE1 Conclusions



- If we continue under a business-as-usual scenario, then district heating can:
  - Reduce the PES
  - Reduce the CO2 emissions
  - Reduce the costs of the energy system
  - Use more renewable energy

HRE2 Conclusions



- 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

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

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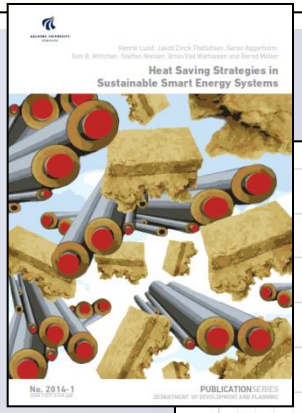
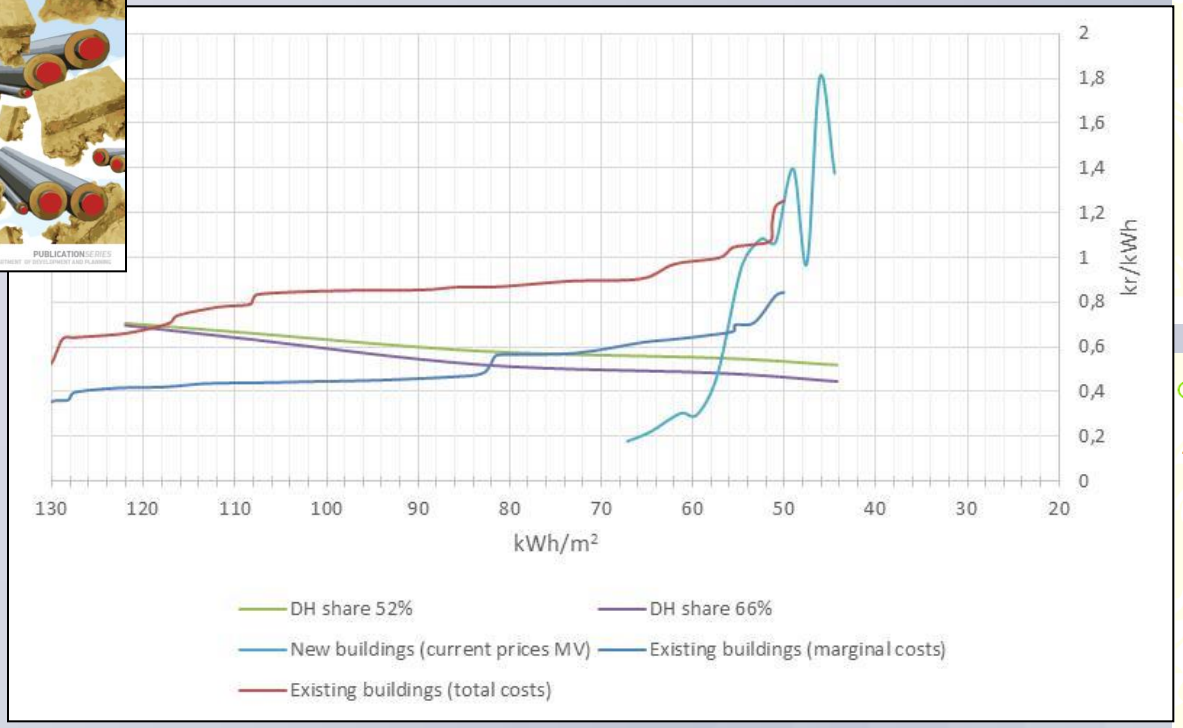
strategic research centre for
ZERO ENERGY BUILDINGS





Industry

- Danfoss A/S
- Saint Gobain Isover A/S
- VKR Holding A/S
- AffaldVarme Århus
- Velux A/S
- Alufacadesektionen, Dansk Byggeri

Research

Aalborg University
- Department of Architecture and Design
- Department of Civil Engineering
- Department of Energy
- Department of Electronic Systems
- Department of Planning and Development
- Danish Building Research Institute, Department of Energy and Environment

Technical University of Denmark
- Department of Civil Engineering

Danish Technological Institute
- Department of Energy Efficiency and Ventilation
- Department of Cooling and Heat Pump Technology
- Department of Renewable Energy

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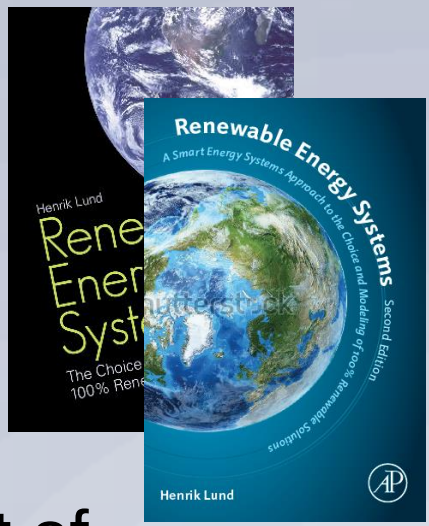
Smart Energy Systems

- A sole focus on renewable **electricity** production leads to electricity storage and flexible demand solutions!



- Looking at renewable electricity as a part of the **energy systems** including heating, industry, gas and transportation opens for cheaper and better solutions…

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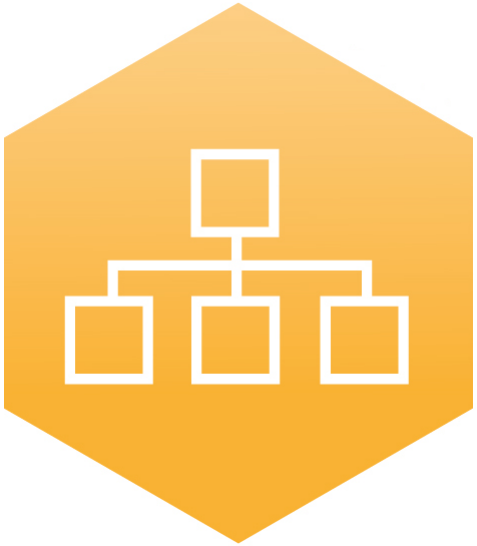
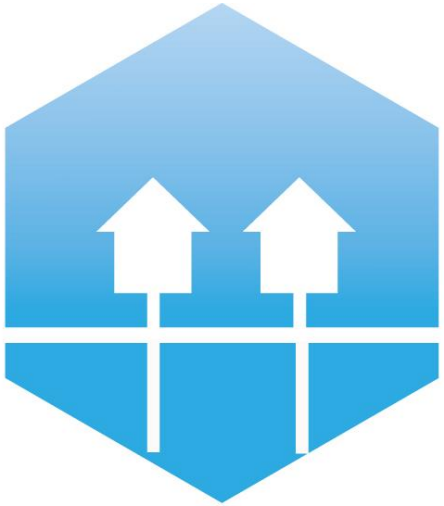
4th Generation District Heating





4DH

4th Generation District Heating Technologies and Systems

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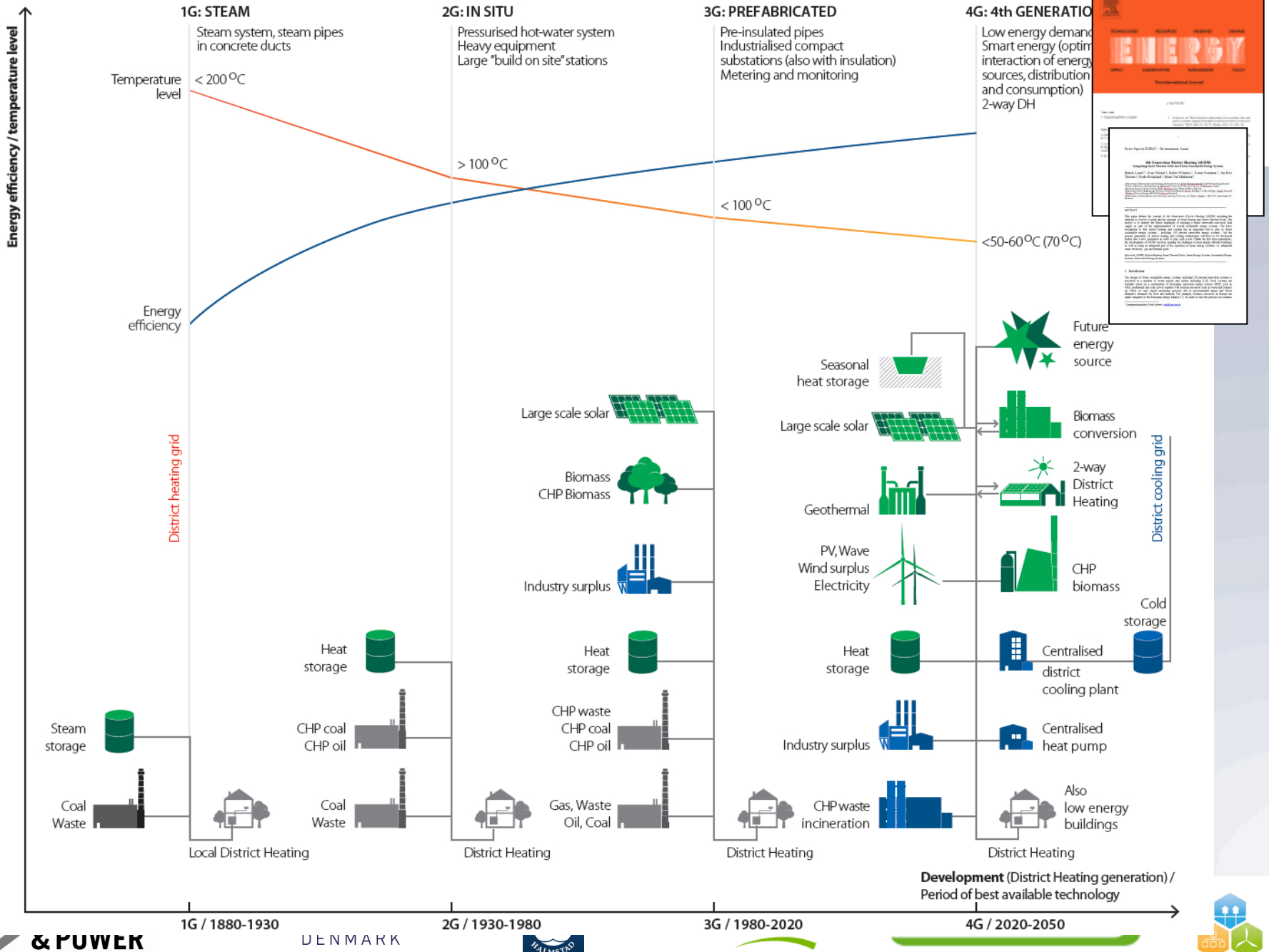

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4th Generation District Heating

4th Generation District Heating technological Systems are defined as a coherent technological and institutional system, which by use of *district heating smart grids* helps a suitable implementation of renewable energy systems by providing for heat supply of low-energy-buildings with low grid losses in a way in which the use of low-temperature heat sources are integrated with the operation of electricity and gas smart grids. The concept involves the development of an institutional and organisational framework to facilitate suitable cost and motivation structures.

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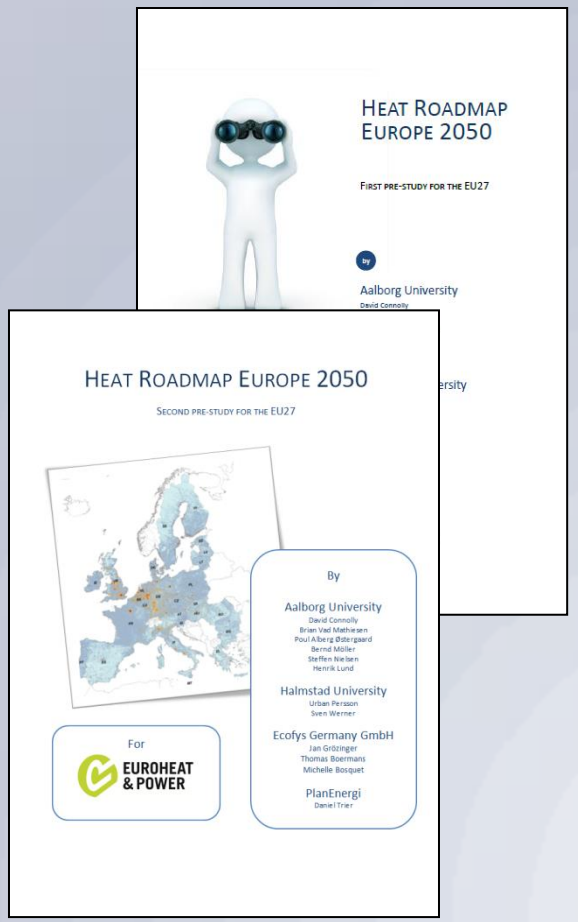
Thank you

- Need a copy of the report?
- www.heatroadmap.eu
- www.4dh.dk/hre



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