Heat Roadmap Europe
2050

Heat Roadmap Europe 2050

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Seoul, South Korea, 3 July 2013

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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

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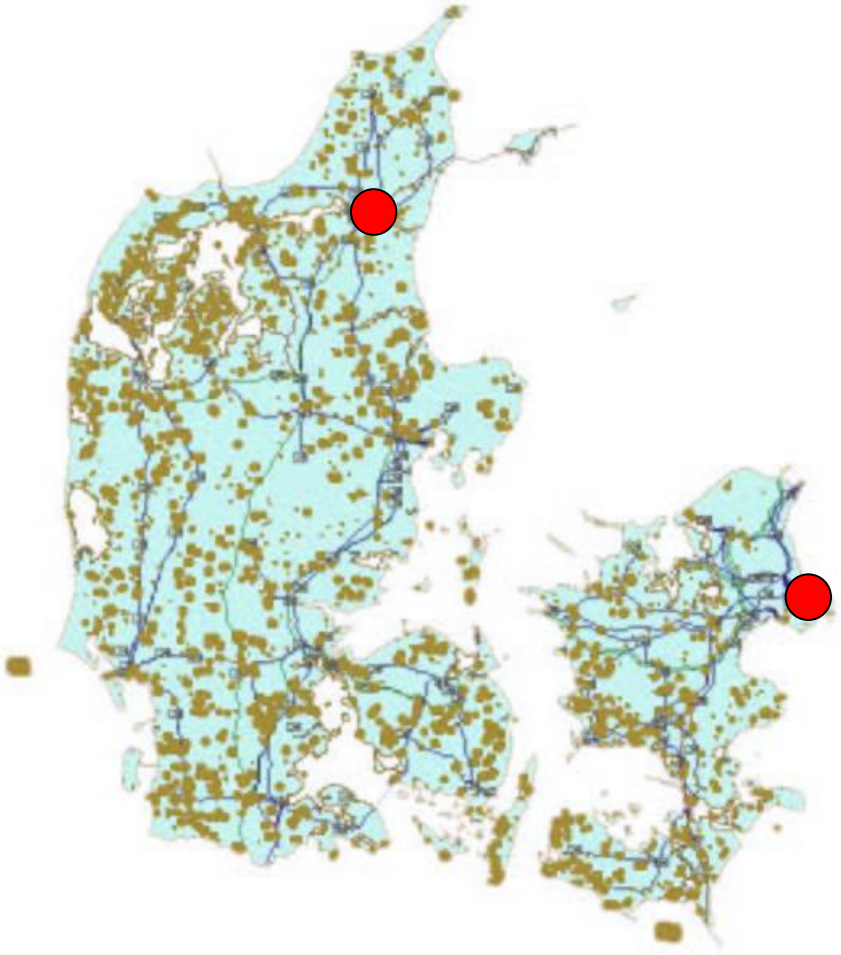
Aalborg University, Denmark



Key Energy Facts from Denmark:

- 25% wind power (120,000 owners)
- High share of the world's offshore power
- 30% Distributed Generation
- 50% of electricity supplied by CHP
- 60% of houses connected to DH

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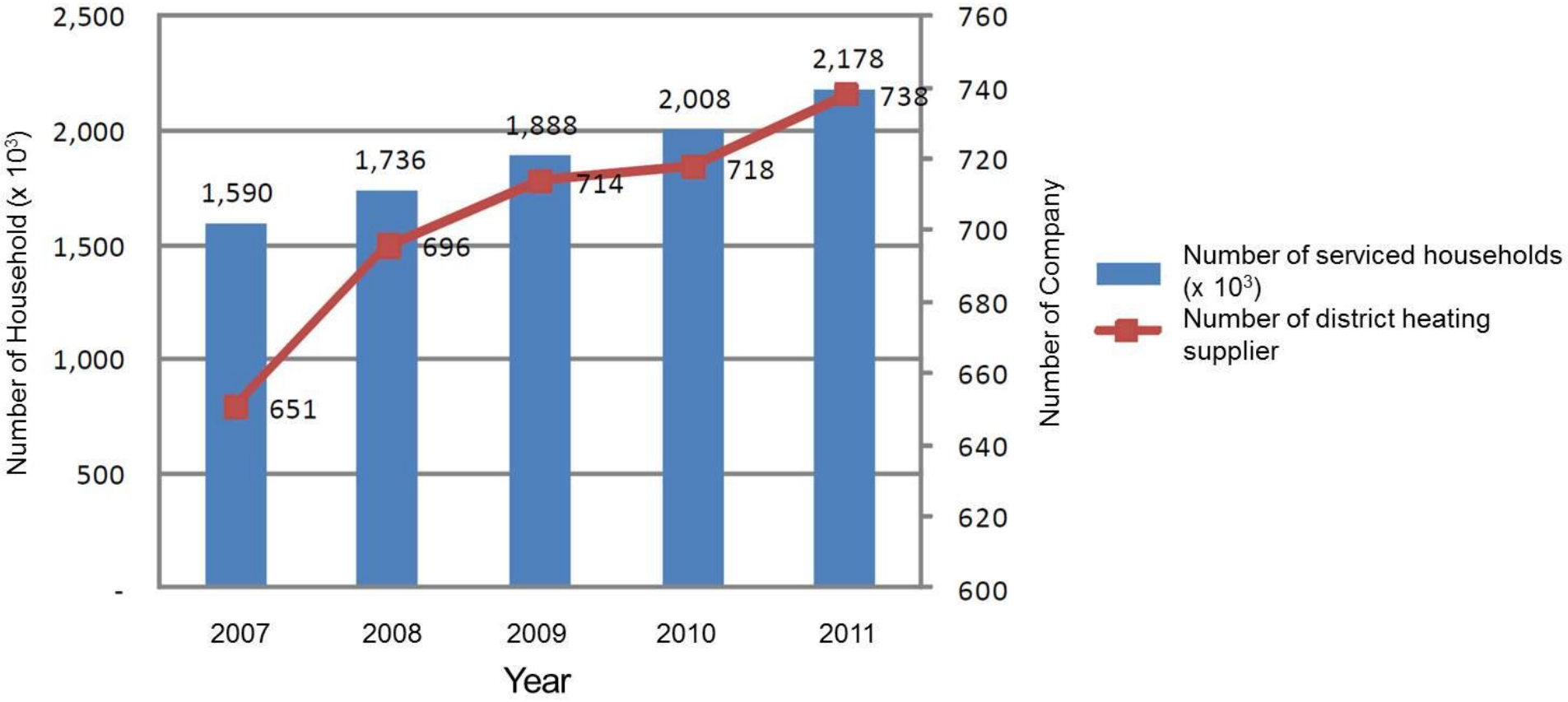
DH in South Korea ~14% of Houses



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Sustainable Energy Planning Research Group

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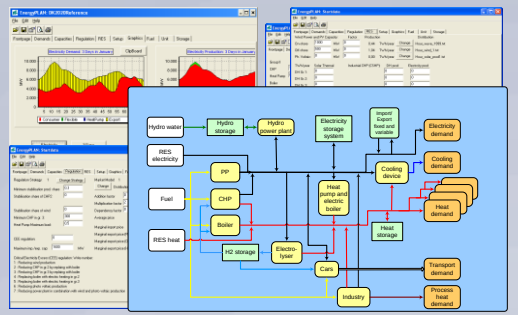
What do we do…?

- Sustainable Energy Planning:
  - Energy System Analysis (incl. GIS)
  - Feasibility Studies
  - Public Regulation



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Heat Roadmap Europe

Why do we need Heat Roadmap Europe?

The Context/Background

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EU Energy is Changing

Specific Targets

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

But… 28 Member States

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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

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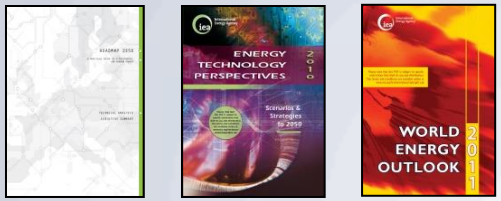
Why Heat Roadmap Europe?

- Exis
  - R heating and cooling
  - Have a too lly 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."



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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

Aalborg University

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Brian Vad Mathiesen
Poul Alberg Østergaard
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Steffen Nielsen
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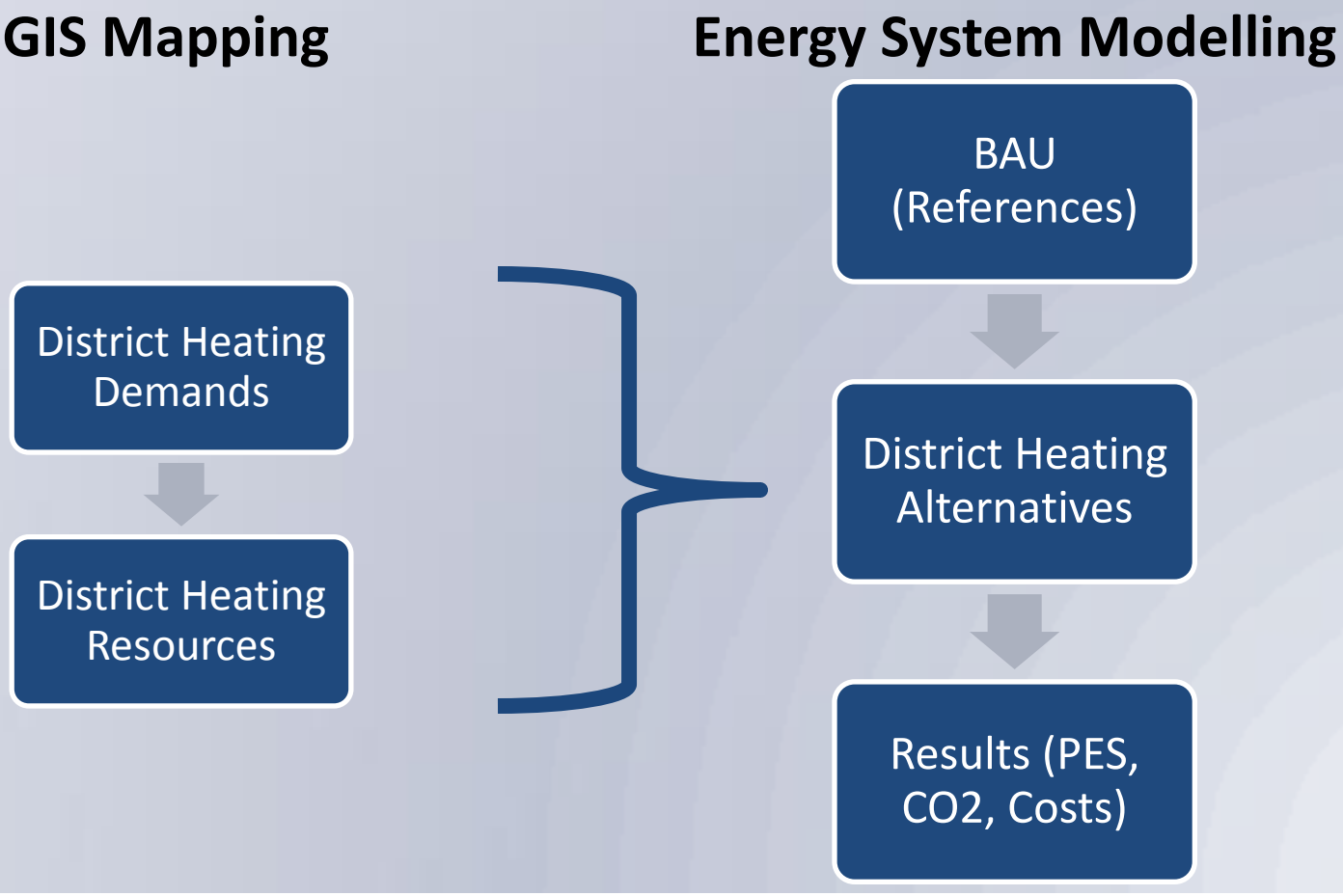
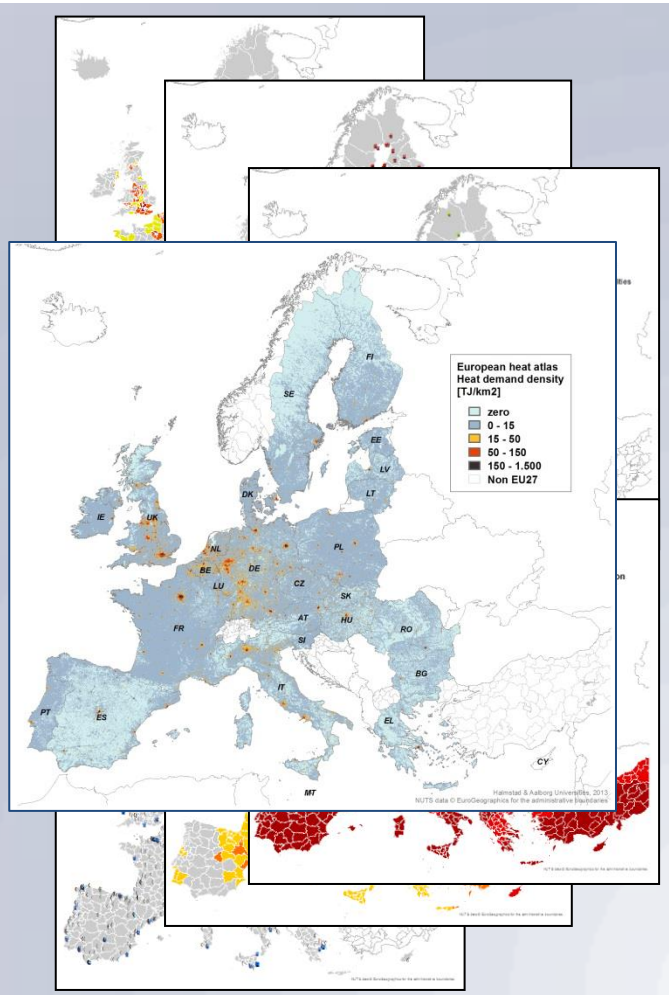
Methodology



Heat Roadmap Europe 2050

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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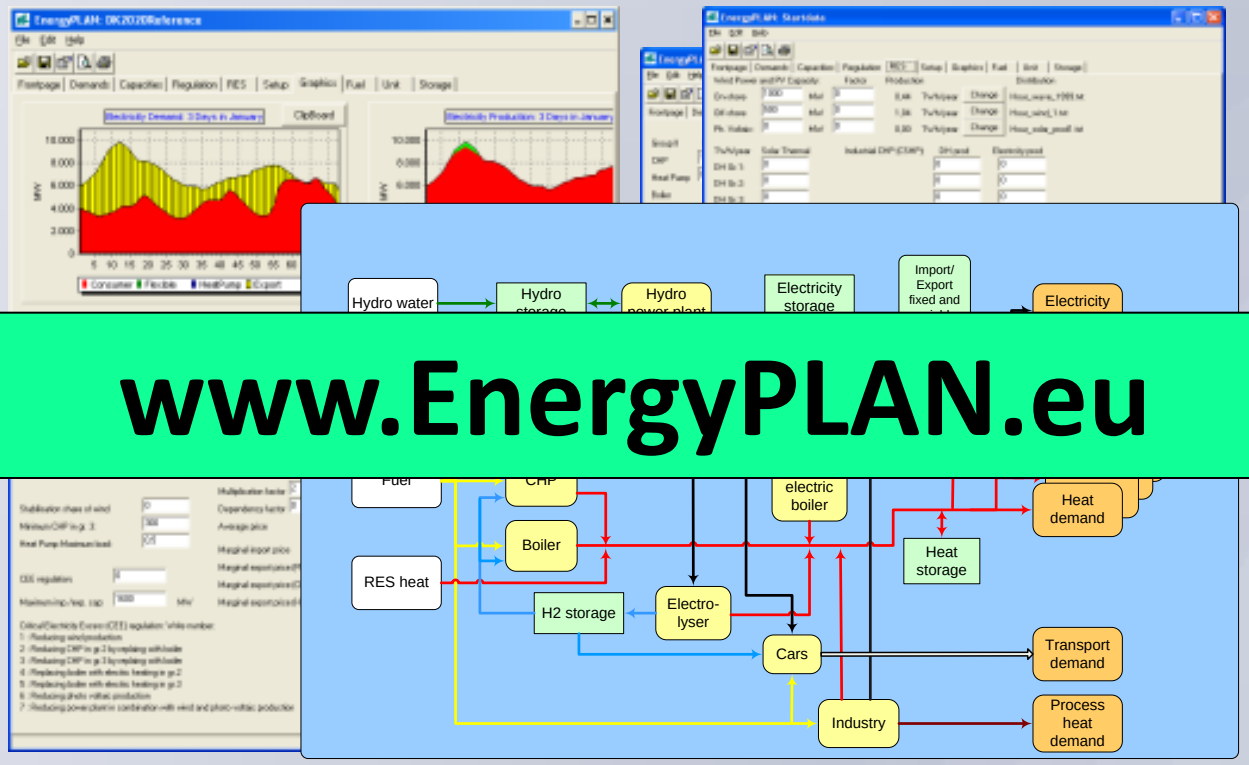
Heat Roadmap Europe 2050

Energy Systems Analyses Model



www.EnergyPLAN.eu

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

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Combining the Mapping & Modelling Pre-Study 1 (2012)

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

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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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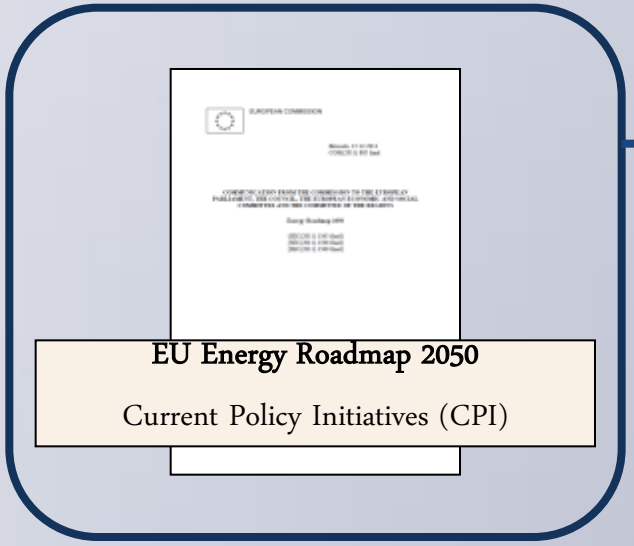
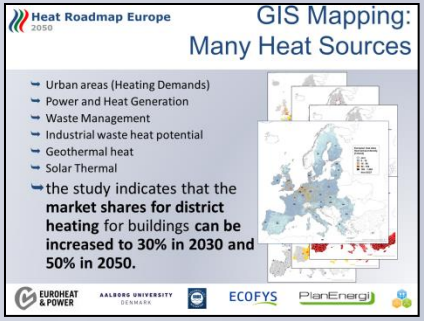
Designing the DHC Alternatives



EU Energy Roadmap 2050

Current Policy Initiatives (CPI)



EU CPI
PRIMES Data
2030 & 2050 Model

District Heating Alternatives

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

Results
(PES, CO2, Costs)

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3. What are the key results?

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Pre-Study 1
(2012)

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

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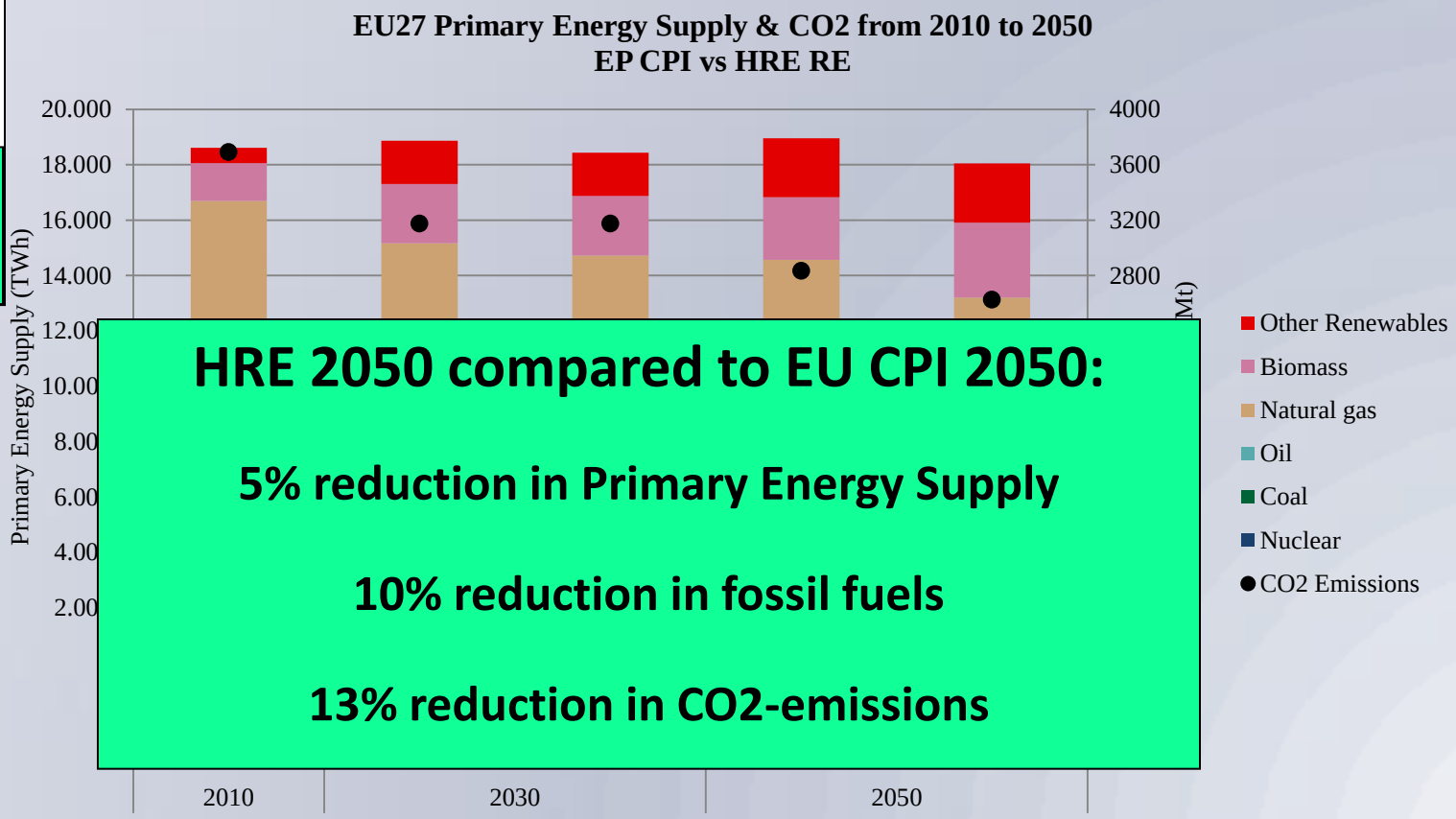
Year 2030 & 2050: Total Energy Demand

EU Energy Roadmap 2050



HRE 2050 compared to EU CPI 2050:

5% reduction in Primary Energy Supply

10% reduction in fossil fuels

13% reduction in CO2-emissions

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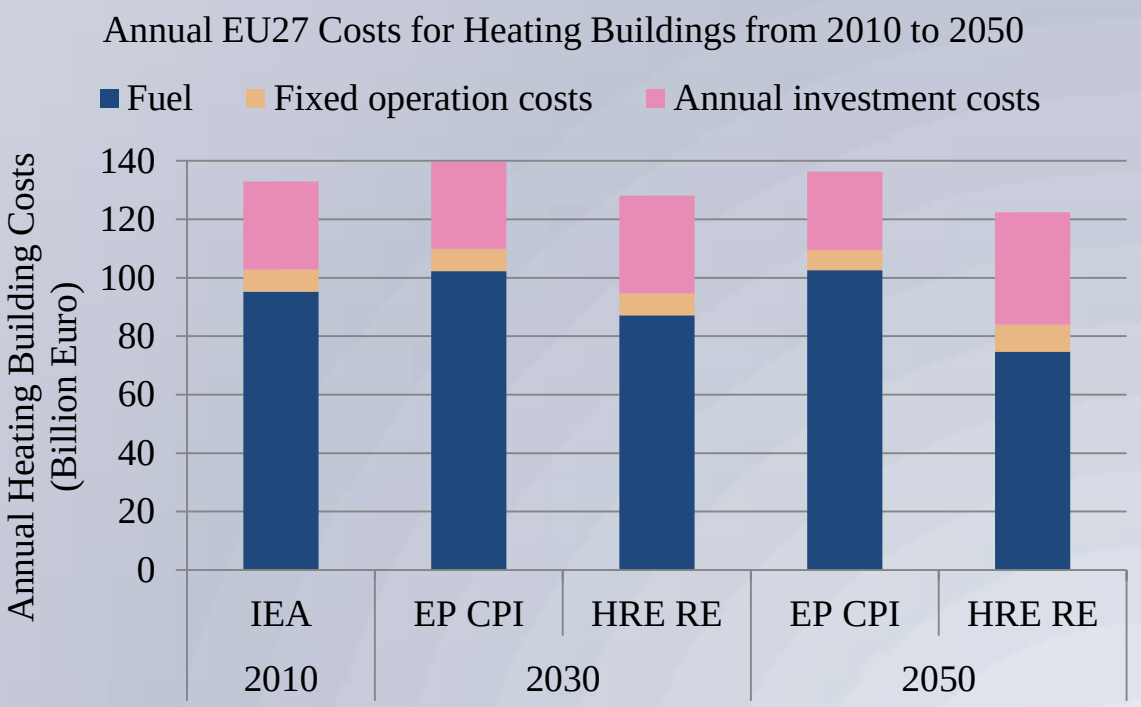
Cost and Jobs

- 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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HRE1 Conclusion: 50% DH in 2050

- Decrease primary energy supply and especi… CO2 emissions

LESS FUEL

- Decrease annual costs of energy in Europe… 14 Billion in 2050

LESS MONEY

- Create… jobs 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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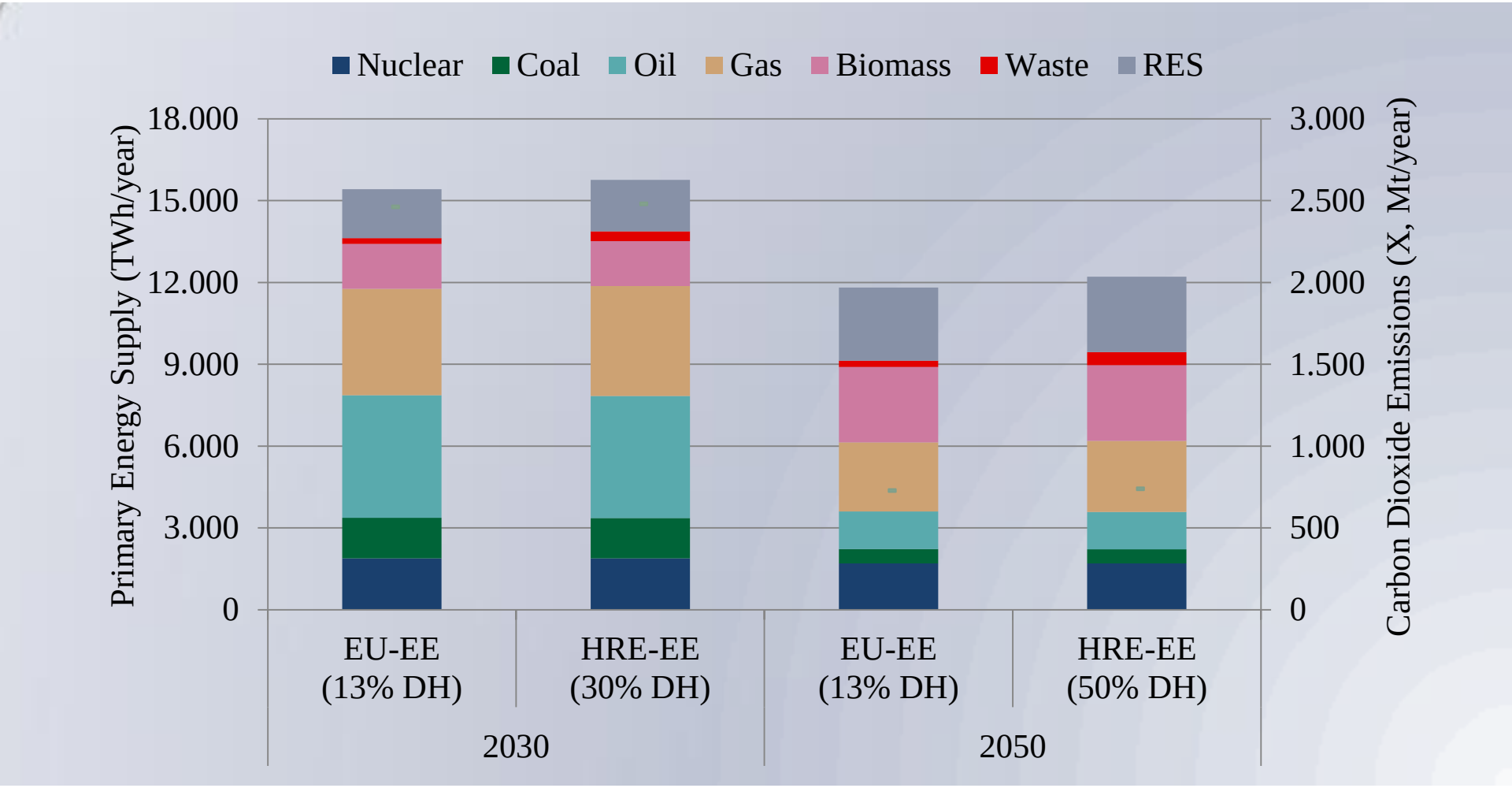
EU-EE vs. HRE-EE: Total Energy Demand & CO2



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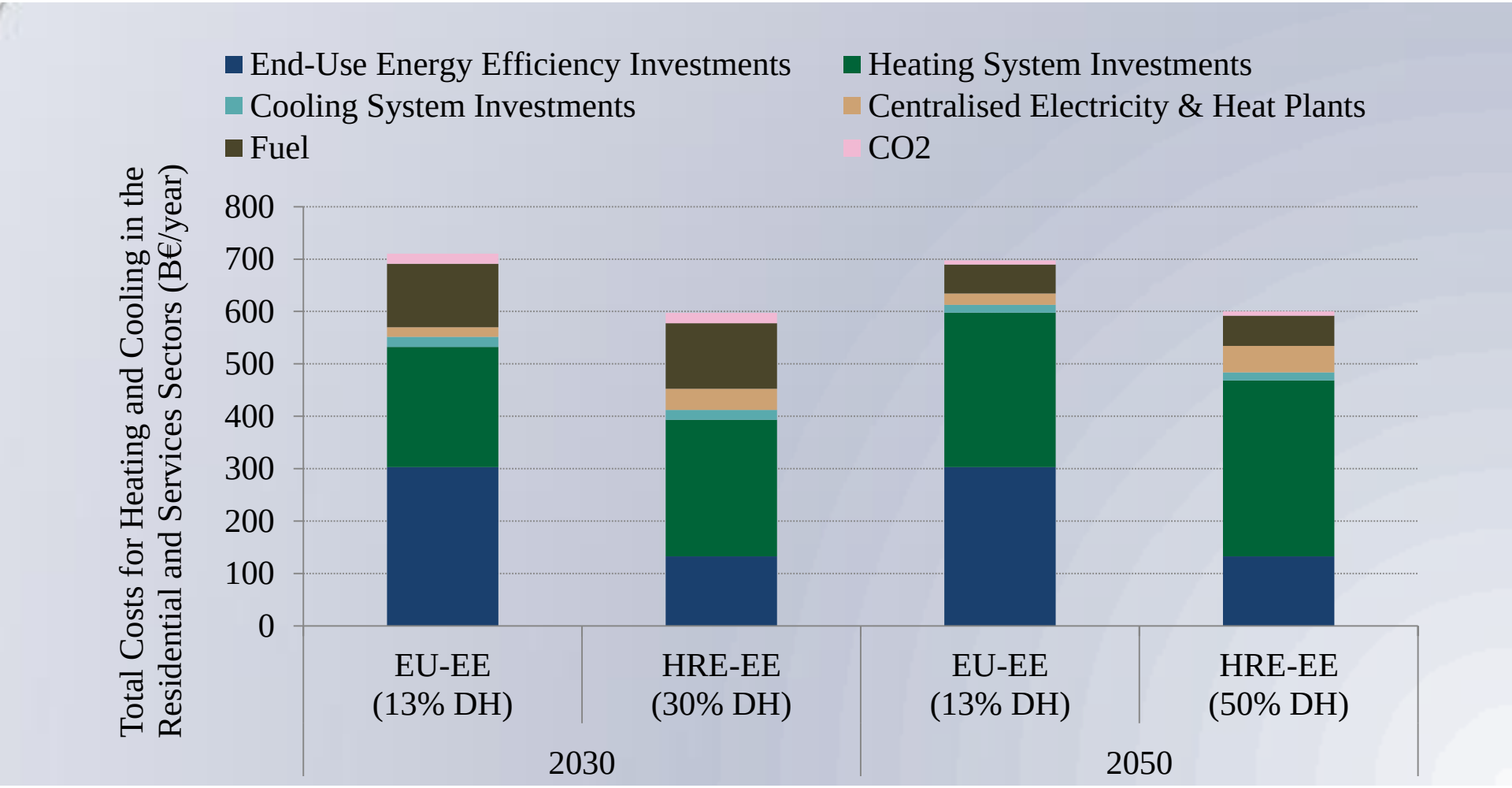
EU-EE vs. HRE-EE: Heat & Cooling Costs -15%



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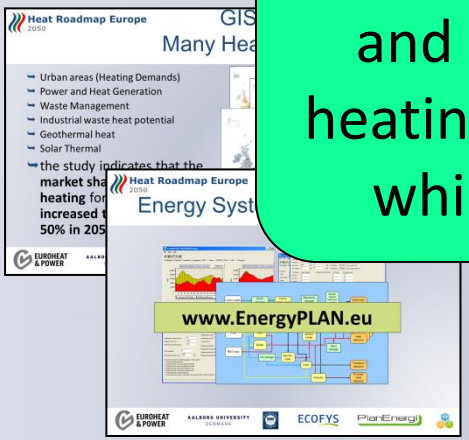
HRE2 Conclusions



- If we implement a lot of energy efficiency measures, then district heating will:

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**.

fuels

- BUT, Cost approximately 10% less

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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

Summary so far…

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

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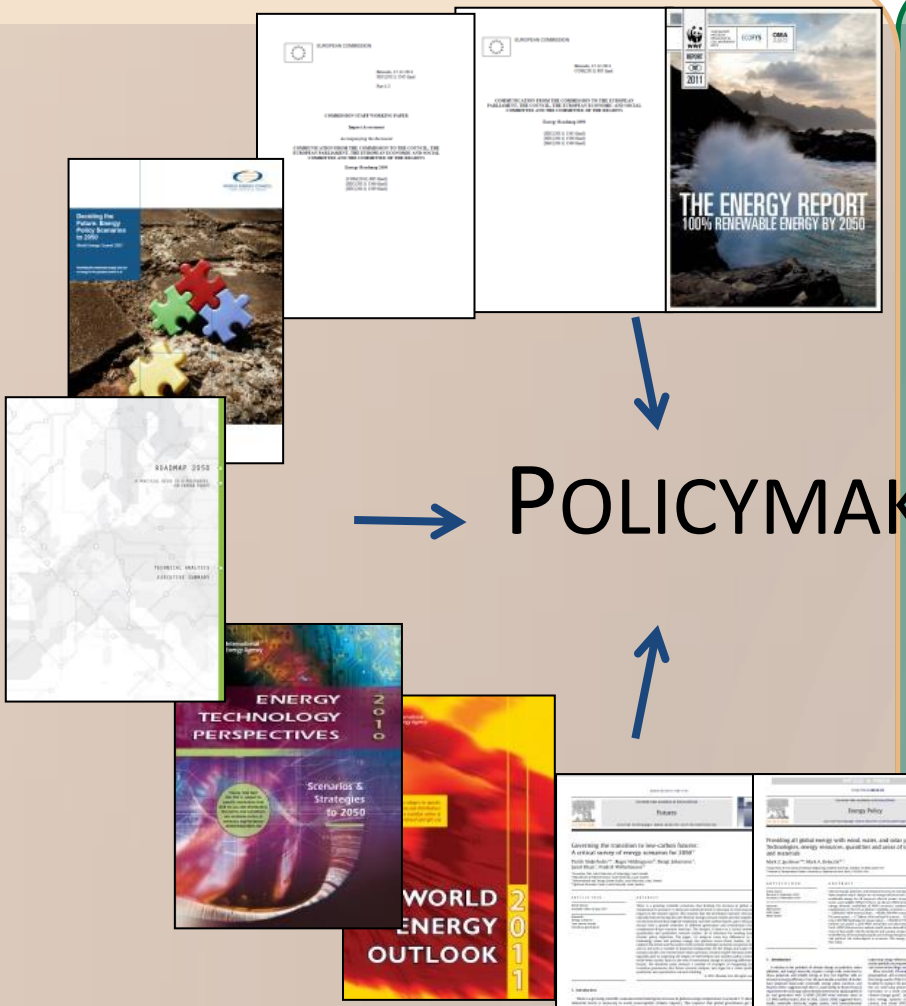
Inform Polcymakers

Existing Studies



POLICYMAKERS

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Who are these Policymakers?

Policymakers:

- Politicians
- Public Servants
- City/Municipality Councils
- NGOs

Can be informed by:

- Authors
- Industry
- Lobby Organisations
  - Such as Euorheat & Power

COMMISSION EUROPÉENNE
Direction générale de l'énergie

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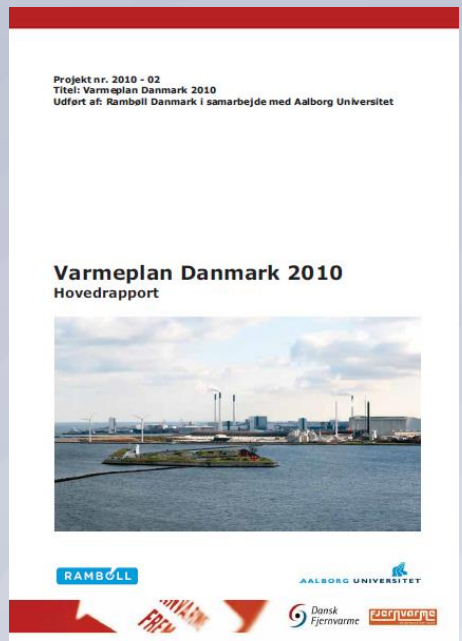
What has HRE given Policymakers?

- 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

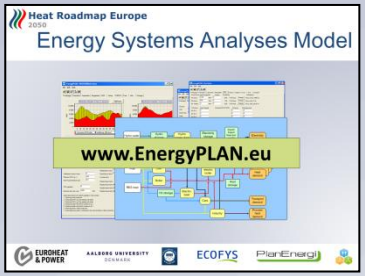
- District Heating in Denmark:
  - 50% of the heat demand in buildings
  - 60% of houses connected
  - Enough?

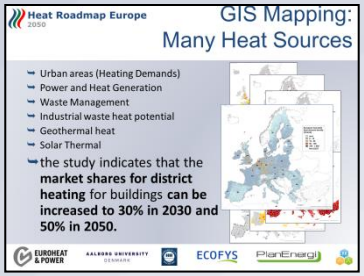


- Heat Plan Denmark
  - Should expand DH to 63-70% of the heat demand
  - Add buildings in neighbouring areas to DH (63%)
  - Add buildings within a distance of up to 1 km (70%)

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/



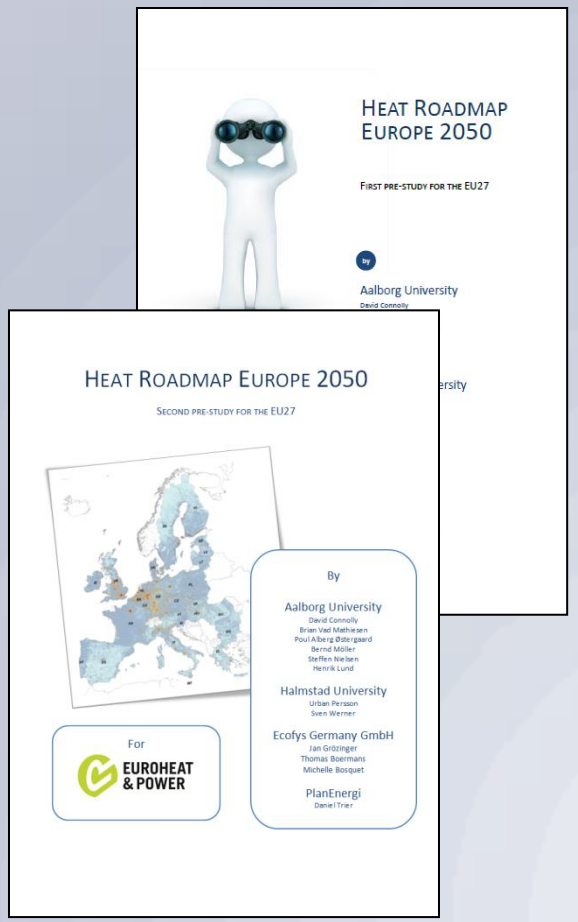


To Conclude

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?
   - ➥ 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



Extra Slides

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District Heating and Smart Energy Systems

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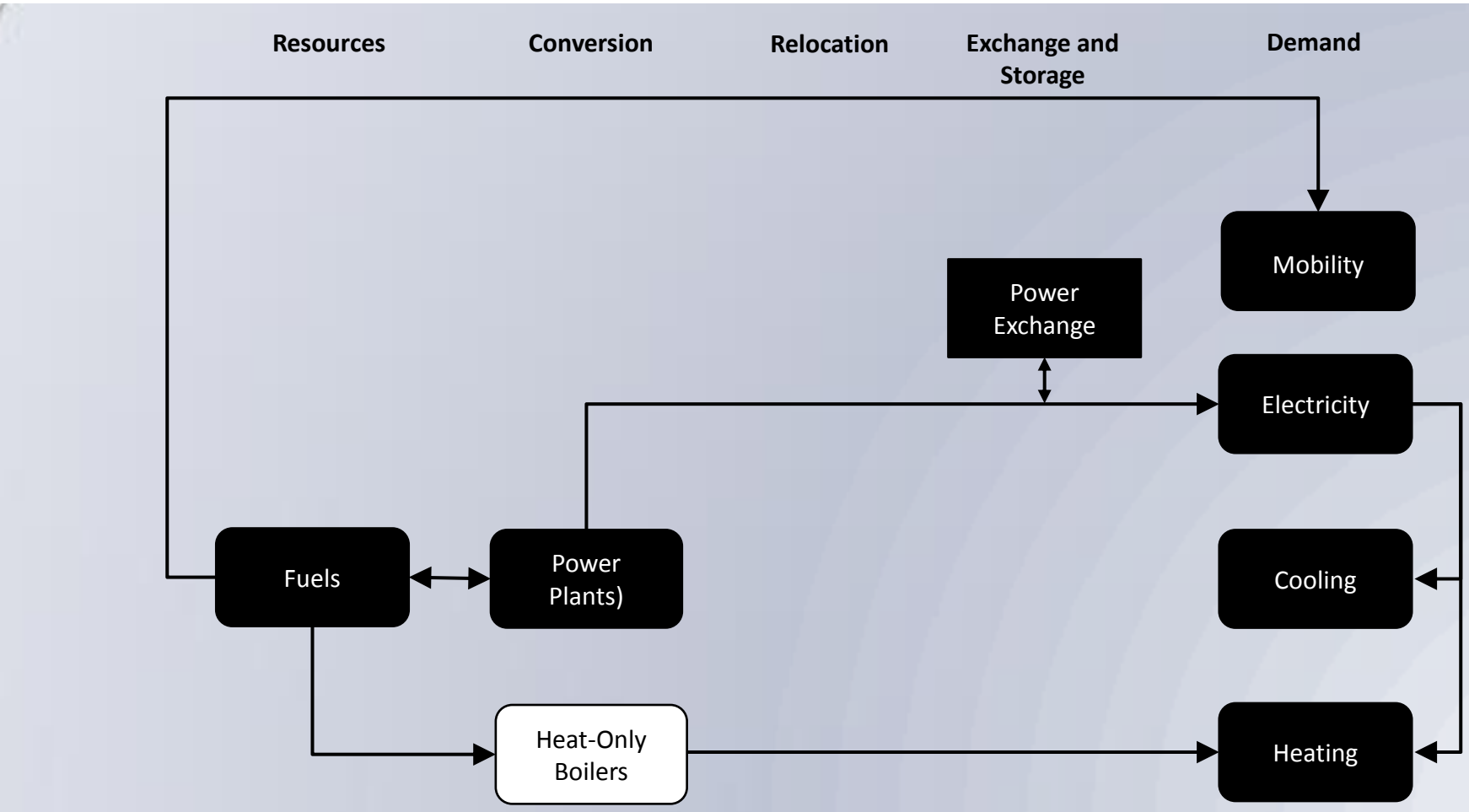
Energy System 0.0



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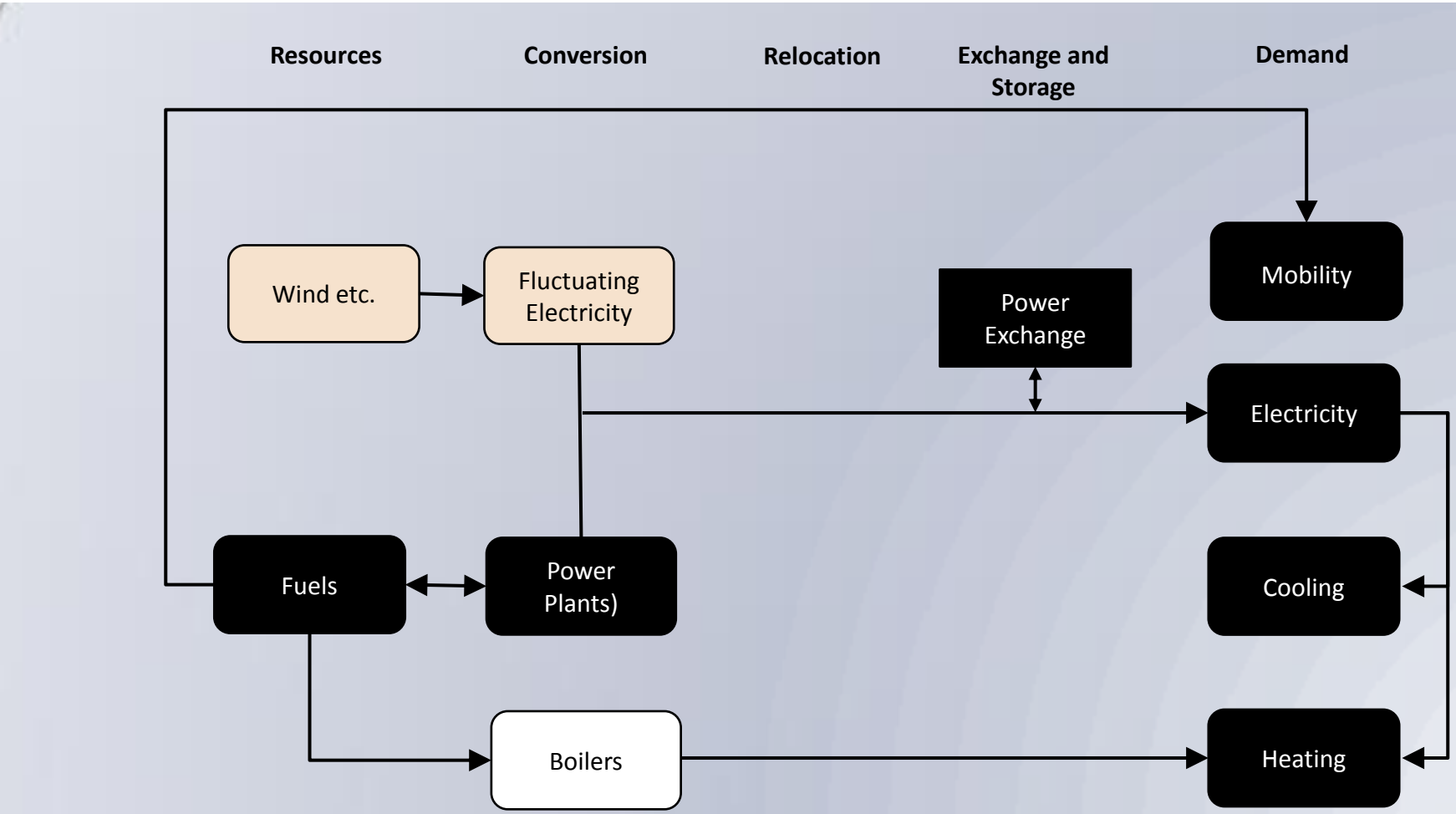
Introducing Intermittent RE



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Electricity Storage

- Turlough Hill, Ireland
- Pumped Hydro Facility

- 2,300,000 m^3 of water
- Storage Capacity of 1.8 GWh
- Site area:
  - ~1.5 km x 750 m
  - 1,125,000 m^2

- Restricted to specific sites
- Investment ~170 €/kWh

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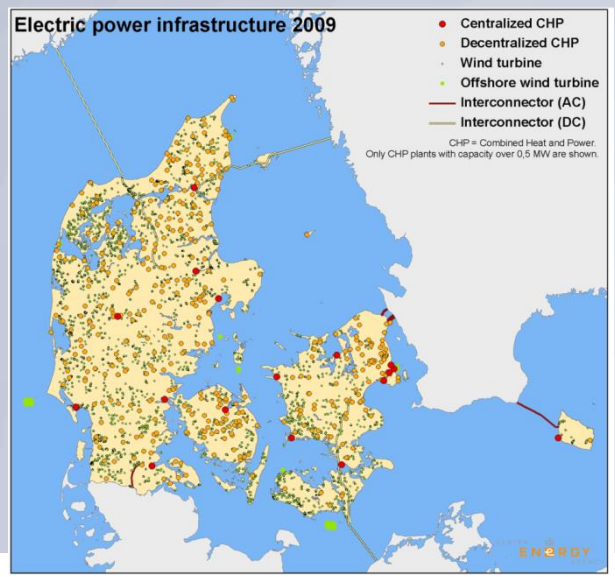
Thermal Storage

- 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



Flexibility using Electricity or Heat?

Electricity (2 GWh)

- Requires 1,125,000 m^2
- Restricted to specific sites
- Investment ~170 €/kWh

Thermal (2 GWh)

- Requires 2000 m^2
- Requires a tank or pit of water
- Investment ~3 €/kWh

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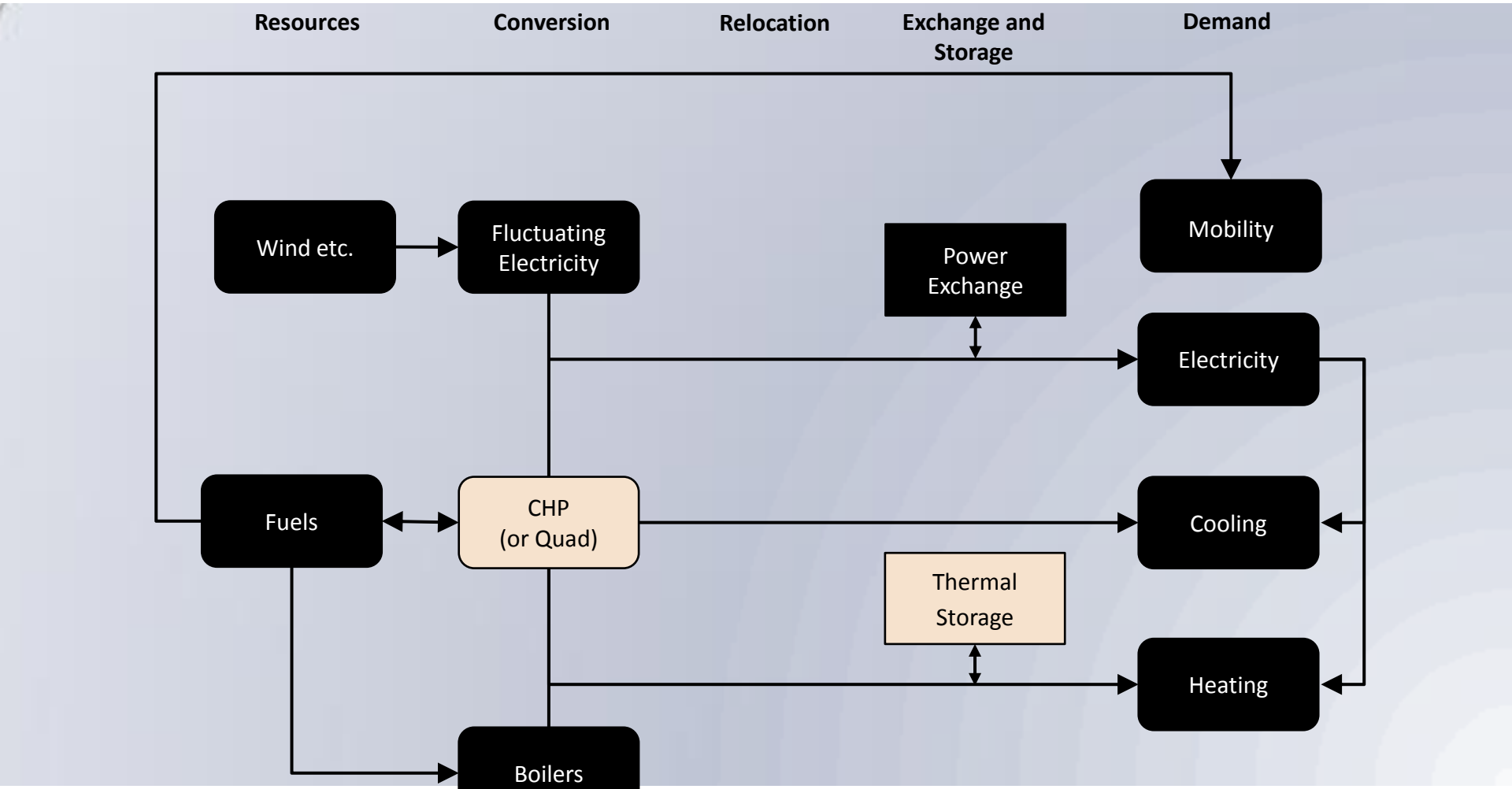
District Heating & Thermal



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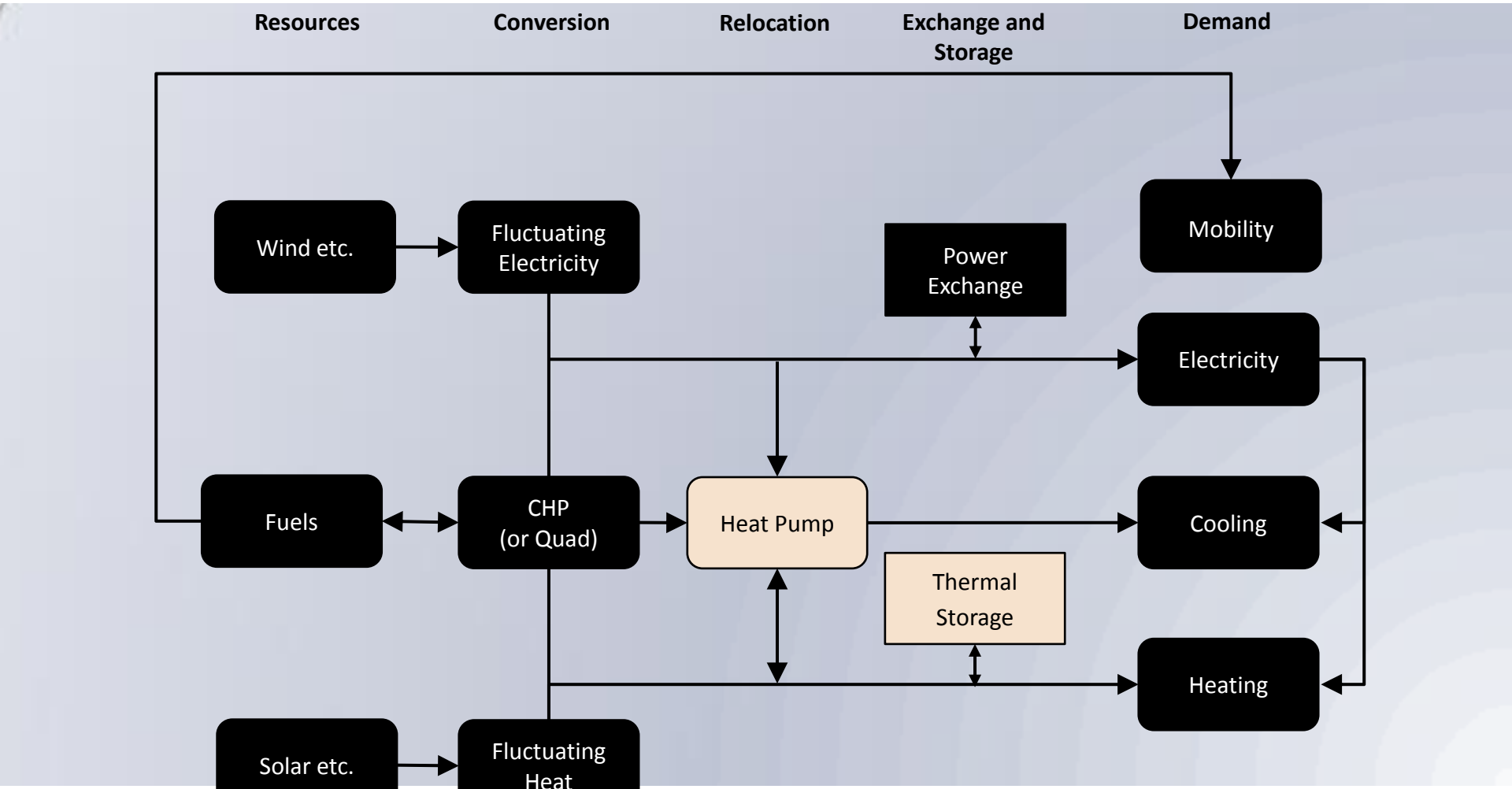
Heat Pumps & Thermal Storage



Other DH Benefits

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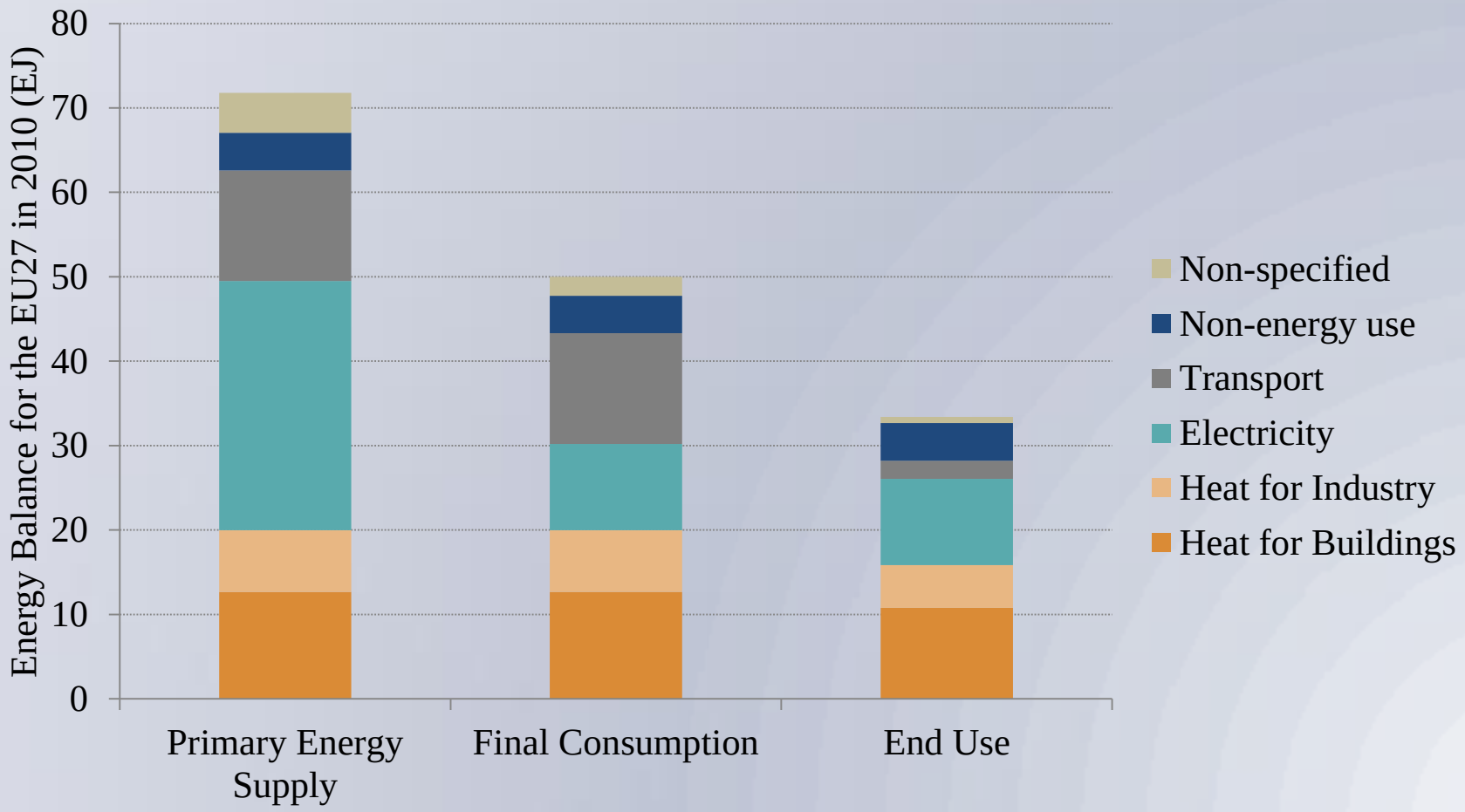
The EU is wasting energy (heat)...



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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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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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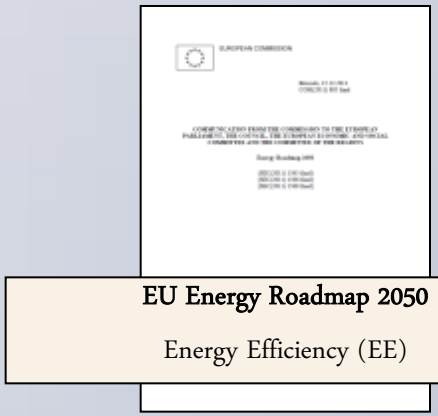
Energy Modelling



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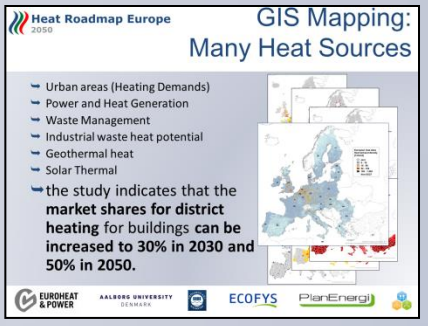
Energy Efficiency (EE)

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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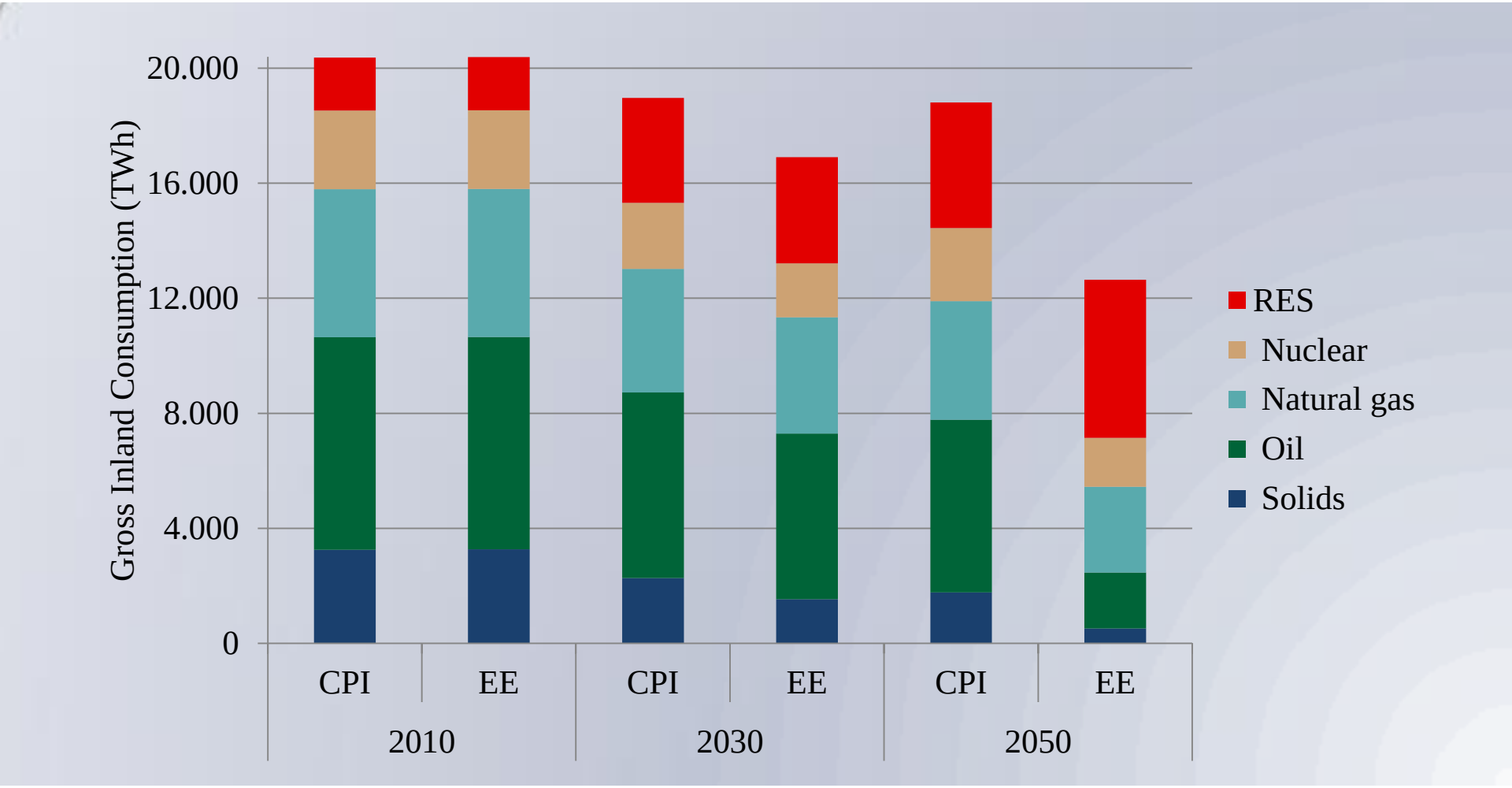
Heat Roadmap Europe 2050

Key Measures in the EU-EE Scenario

- High renovation rates for existing buildings due to better/more financing and planned obligations for public buildings (more than 2% refurbishment per year)
- Passive houses standards after 2020
- Obligation of utilities to achieve energy savings in their customers' energy use over 1.5% per year (up to 2020)
- Strong minimum requirements for energy generation, transmission and distribution including obligation that existing energy generation installations are upgraded to the

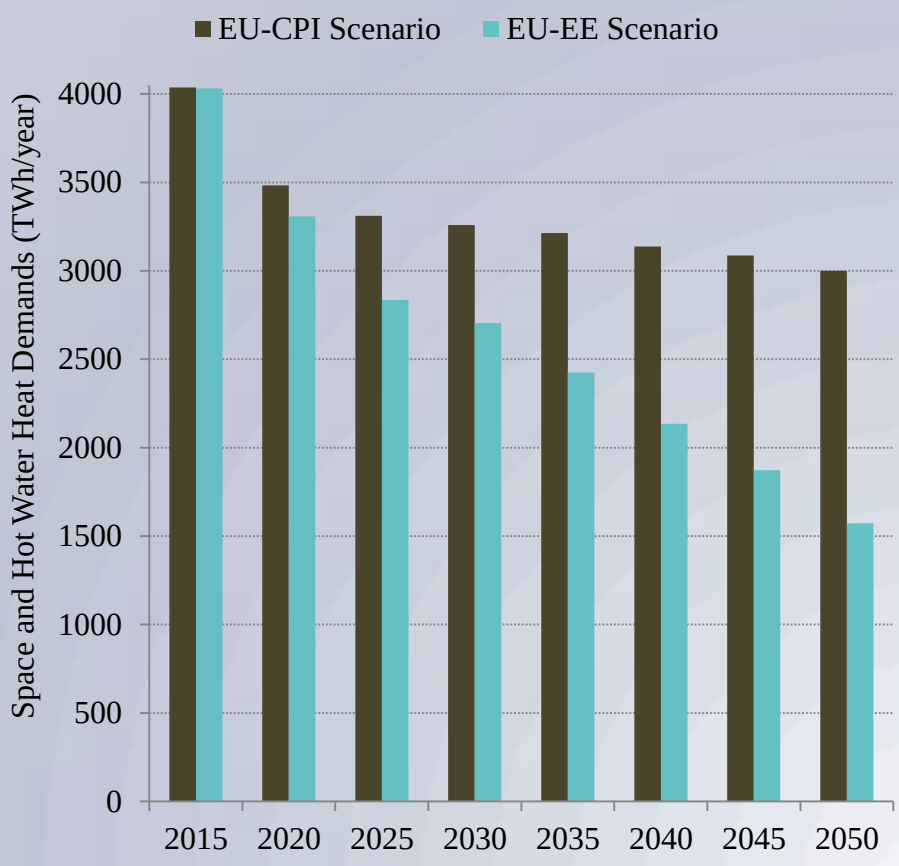
CPI vs. EE


Gross Inland Consumption (TWh)
20.000
16.000
12.000
8.000
4.000
0
CPI
EE
CPI
EE
CPI
EE
2010
2030
2050
RES
Nuclear
Natural gas
Oil
Solids

Heat Roadmap Europe 2050

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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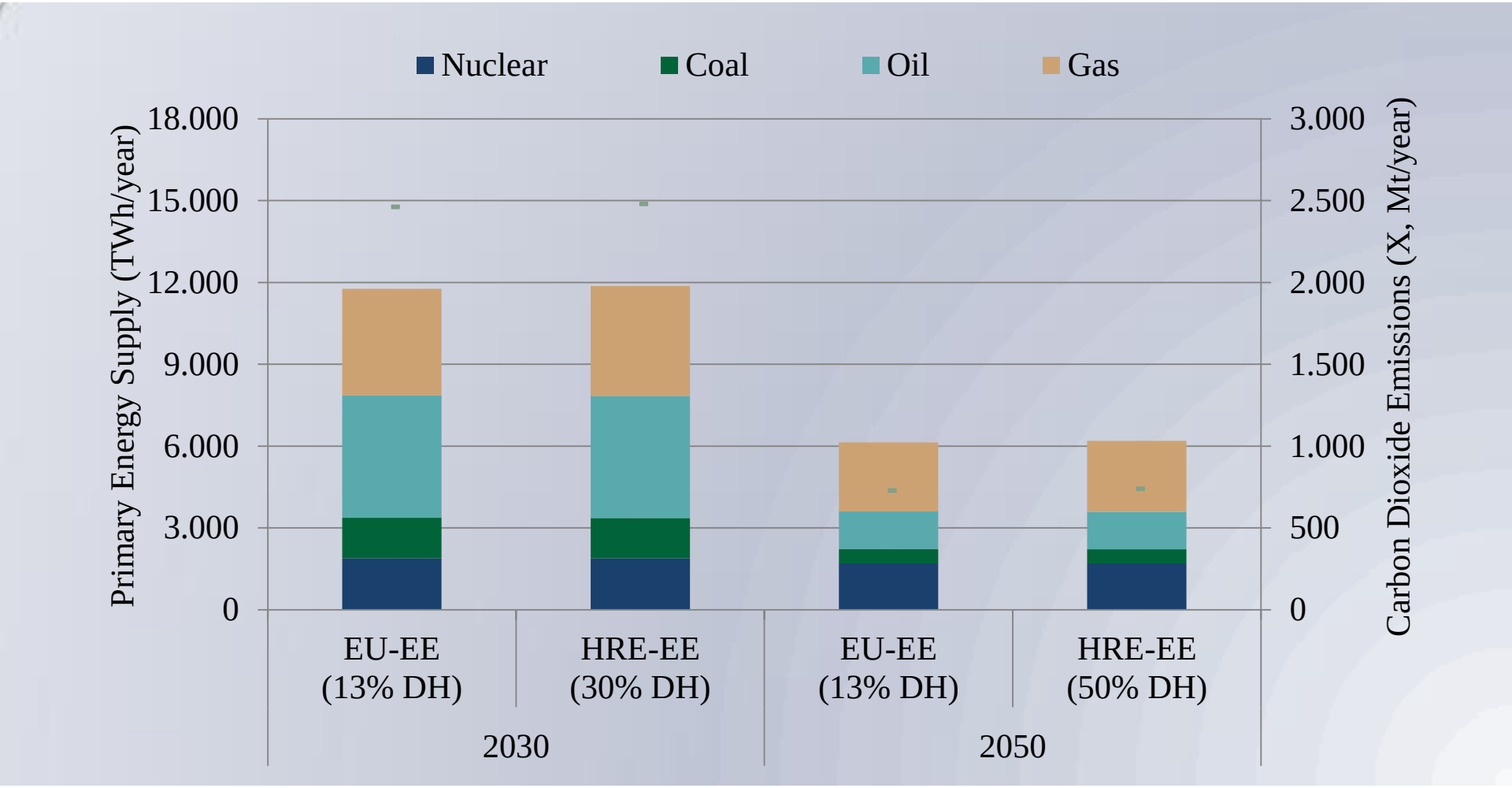
EU-EE vs. HRE-EE: Total Energy Demand & CO2



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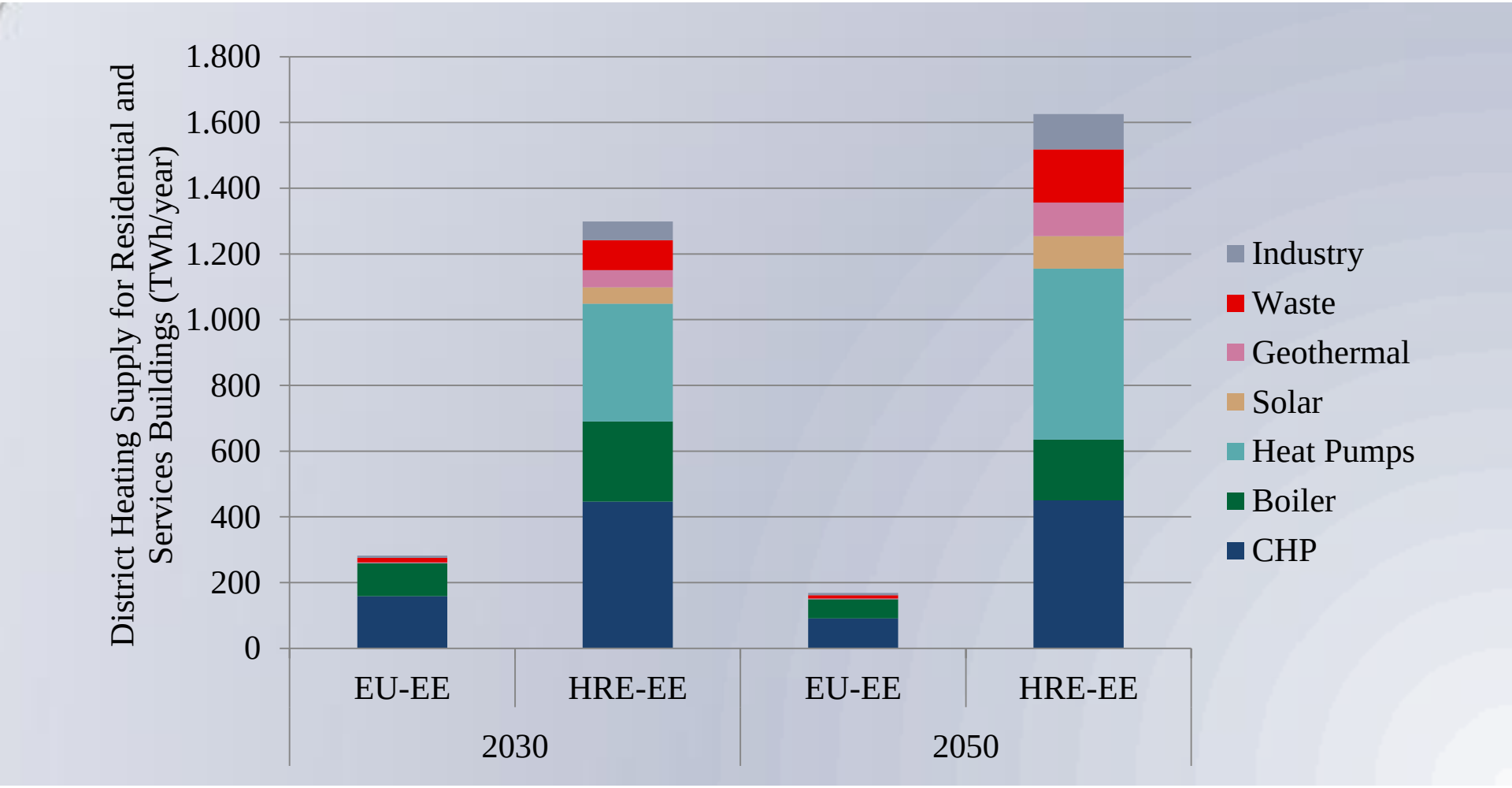
2050

EU-EE vs. HRE-EE DH Supply



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