Electricity and Heat
The Rival Brothers?

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REDEVELOP
RECREATE
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2nd International Research Conference
5-6 November 2013 - Brussels
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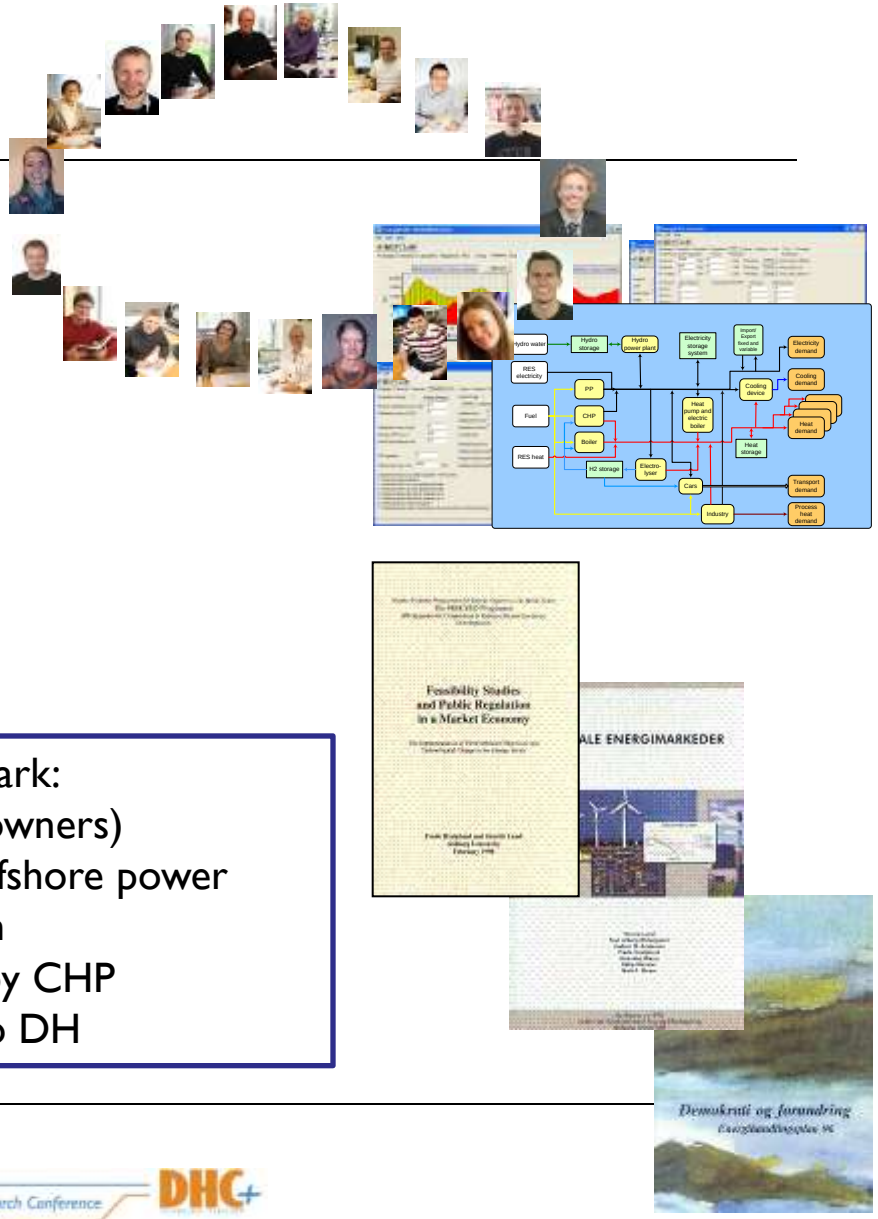
What do we do…?



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

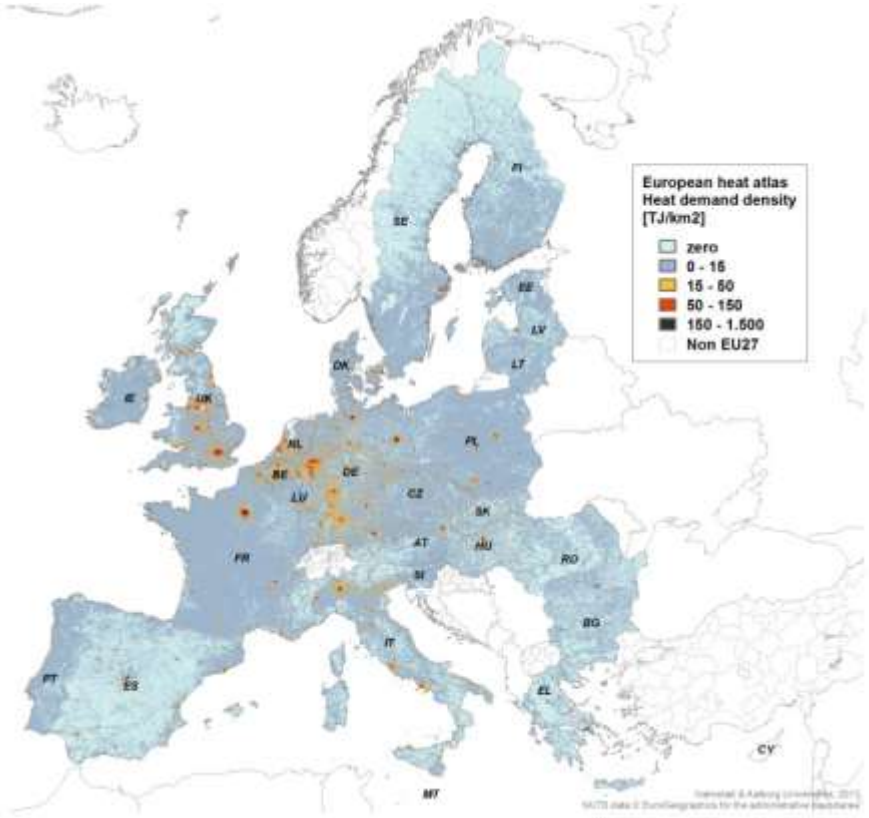
Key Energy Facts from Denmark:
- 30% wind power (120,000 owners)
- High share of the world's offshore power
- 30% Distributed Generation
- 50% of electricity supplied by CHP
- 60% of houses connected to DH

My Proposition

Electricity and Heat
They are Brothers, but not Rivals

We all know the game, but do we know our position?

Everyone Loves Heat!



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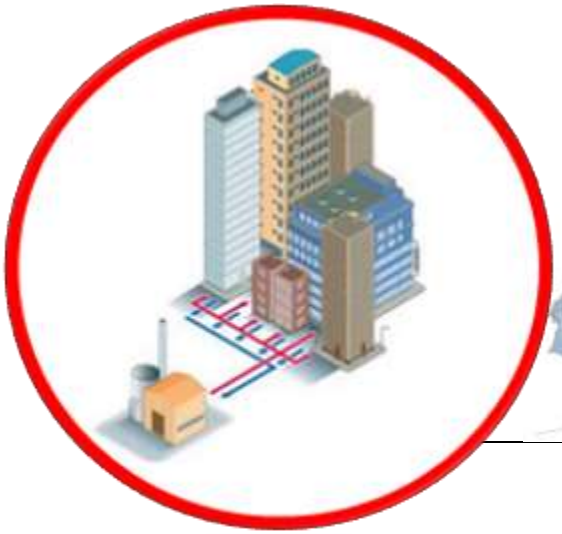
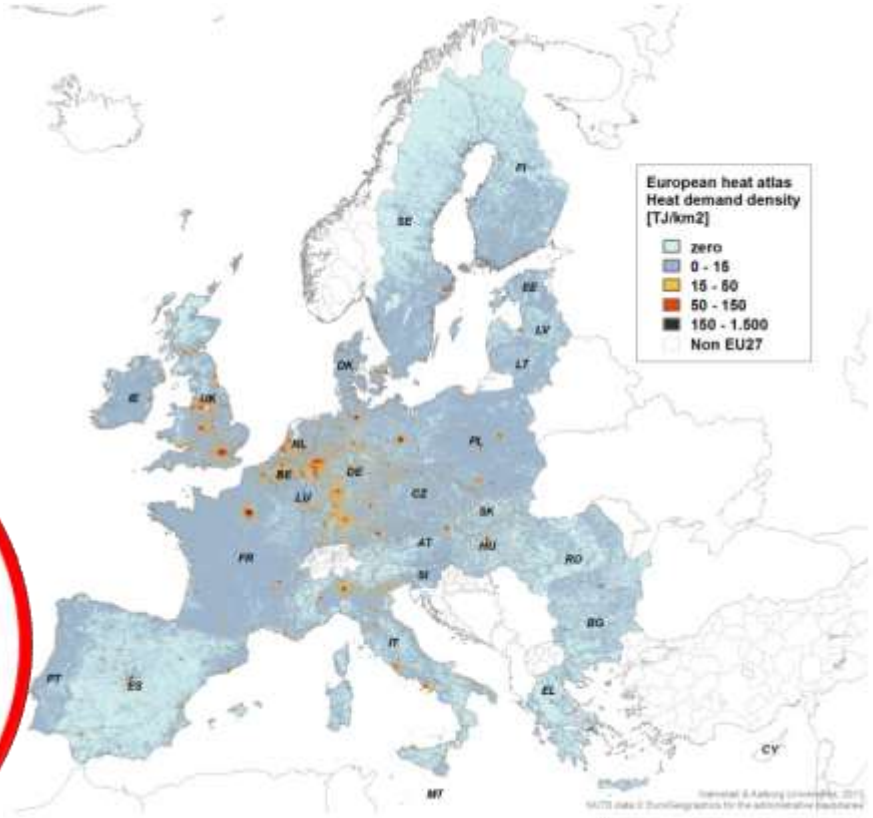
We Have Heat…

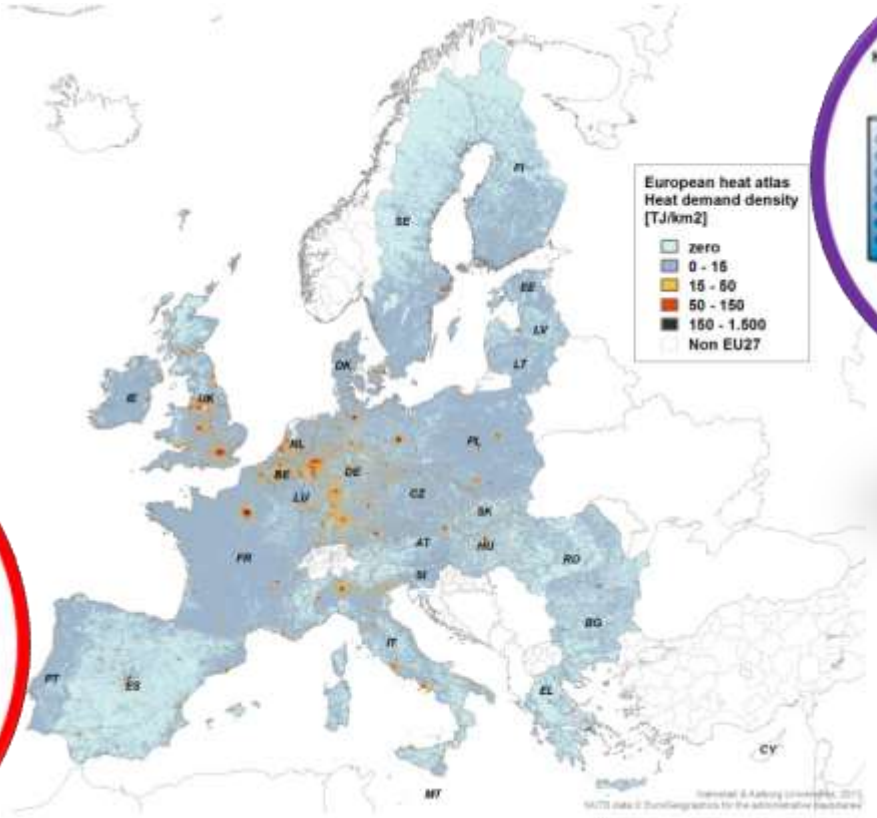


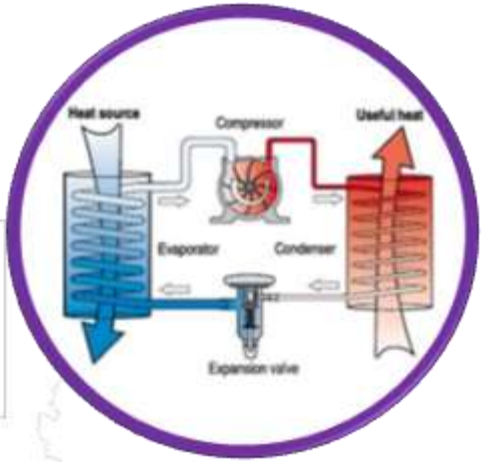


We all know the game, but do we know our position?

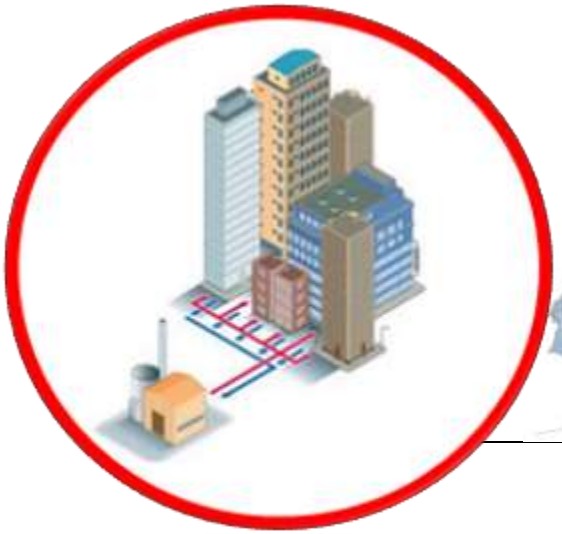
…& We Have Electricity

Everyone Loves Heat!





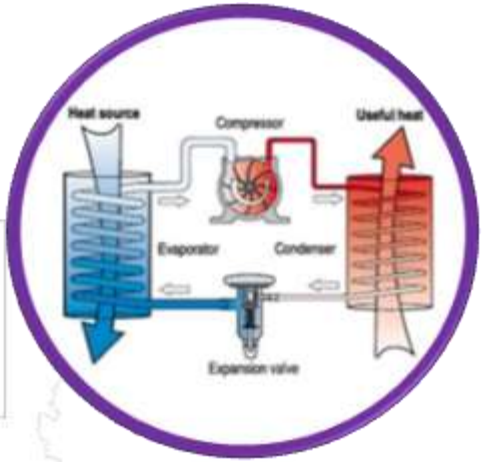
We Have Heat…



Heat and Electricity are in Different Positions

Heat and Electricity are Brothers, but not Rivals…
Heat is a player for the urban areas &
Electricity is a player for the rural areas.
…Both benefit from energy savings….

…& We Have Electricity



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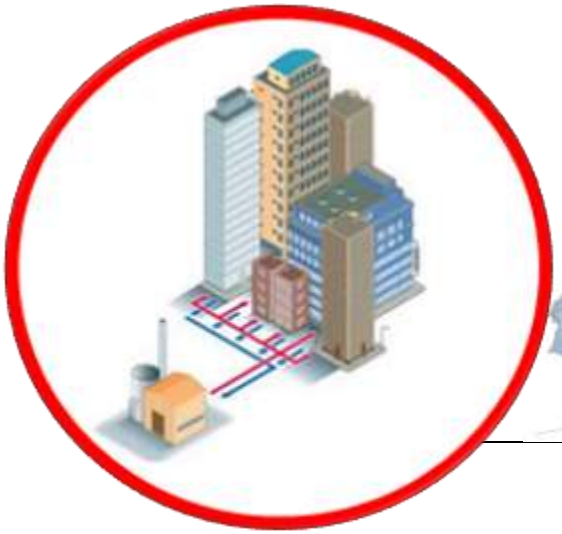
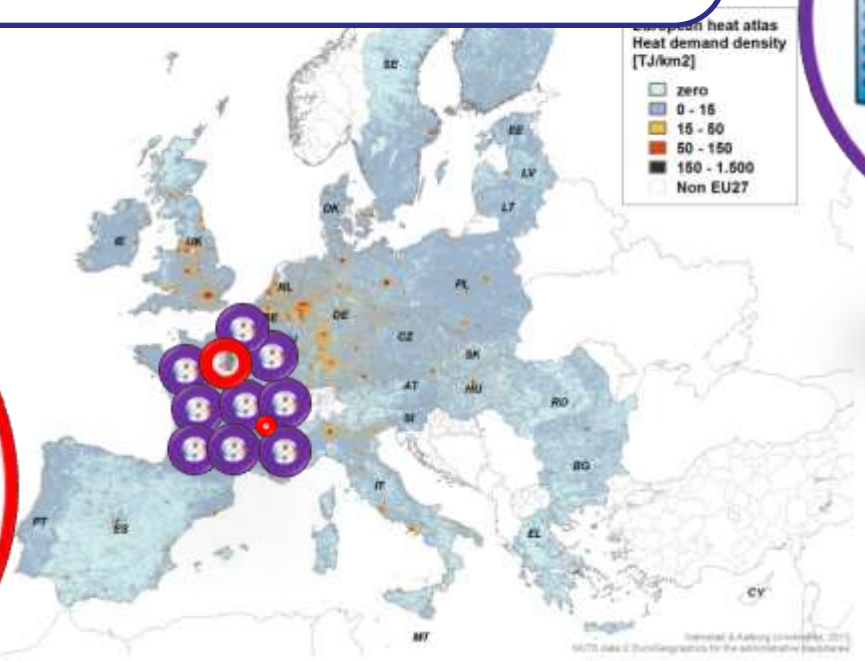


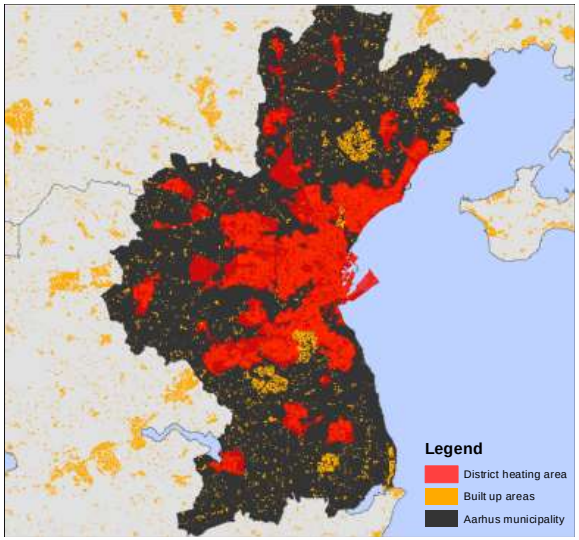


Where is the Evidence?

Case Studies

Local

- The city of Århus



National

- Heat Roadmap Europe

Århus, Denmark

Comparison between district heating and heat pumps for an urban area with significant heat savings

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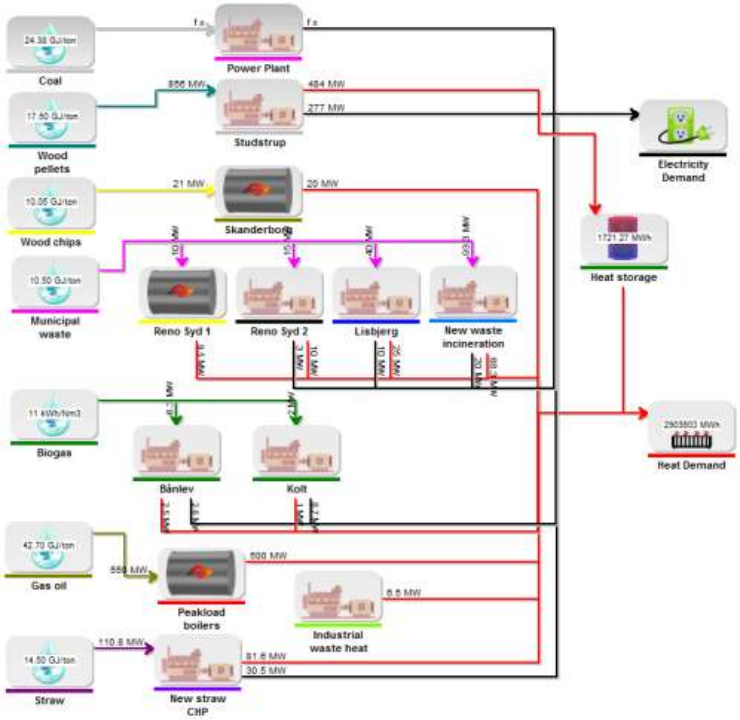
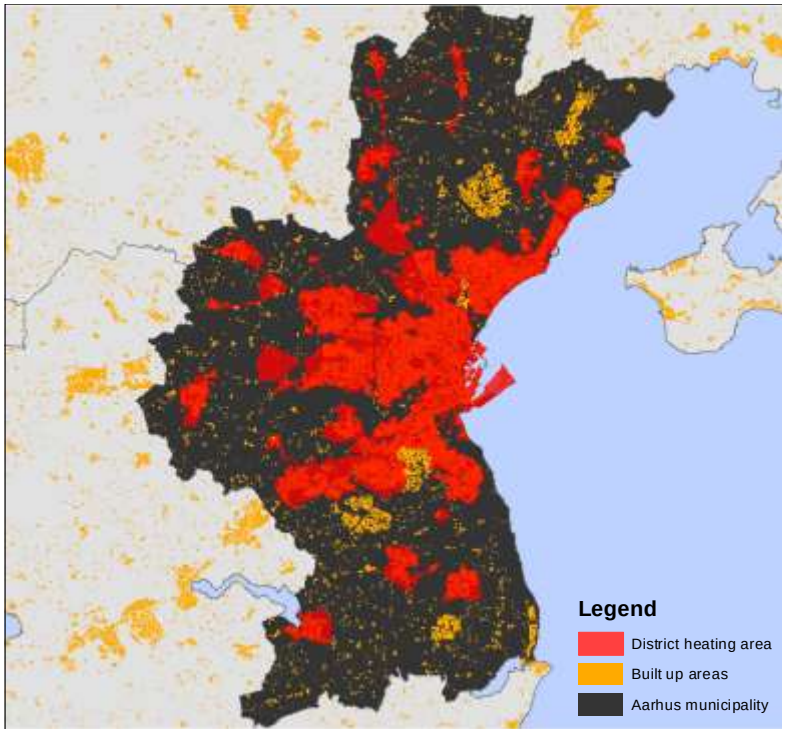
Methodology

Modelled Centralised Supply

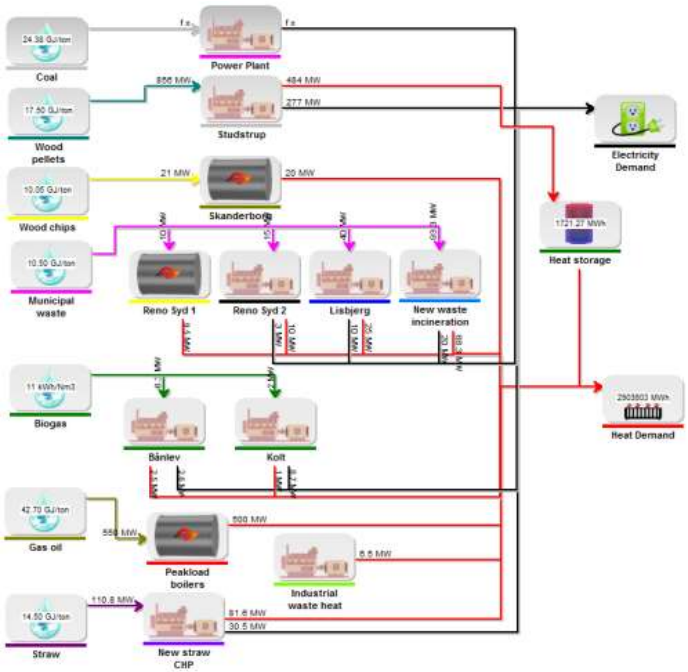


& Heat Demands by Building

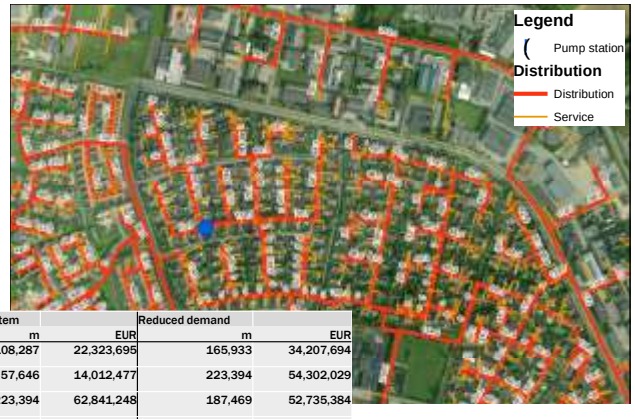


Calculating the Costs of the Århus DH System

Based on the Existing Supply



Detailed Costs of the Network

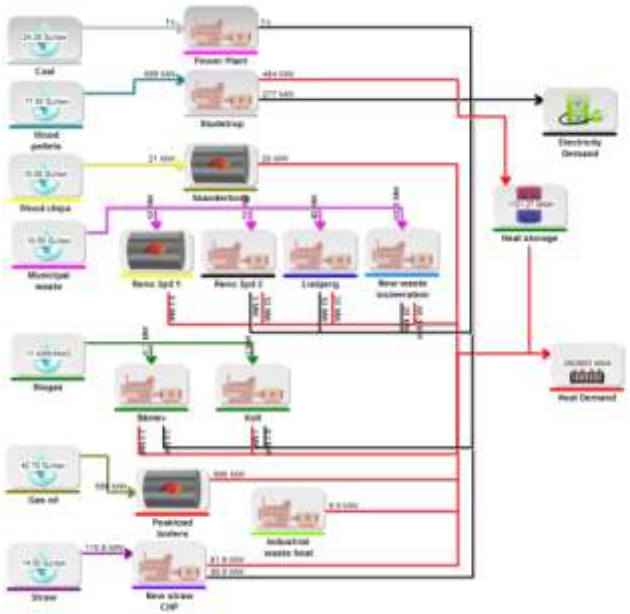


Size	Cost		Existing system		Reduced demand	
mm	DN	EUR/m	m	EUR	m	EUR
34	25	206	108,287	22,323,695	165,933	34,207,694
42	32	243	57,646	14,012,477	223,394	54,302,029
48	40	281	223,394	62,841,248	187,469	52,735,384
60	50	334	187,469	62,563,644	130,331	43,494,982
76	65	376	130,331	48,985,838	77,613	29,171,478
89	80	422	77,613	32,762,803	115,652	48,820,227
114	100	508	115,652	58,756,724	68,458	34,779,903
140	125	600	68,458	41,066,697	84,169	50,491,422
168	150	718	84,169	60,392,482	102,233	73,353,744
219	200	848	102,233	86,734,784	37,706	31,989,895
273	250	907	37,706	34,212,097	48,718	44,203,810
324	300	1,011	48,718	49,271,653	8,769	8,868,812
406	400	1,145	8,769	10,042,533	2,112	2,418,600
508	500	1,317	2,112	2,780,752	1,015	1,336,238
610	600	1,522	1,015	1,544,372	-	-

Map & Cost for Each Pipe

Århus Individual Heat Pumps

A New Supply



& Some New Heat Pumps

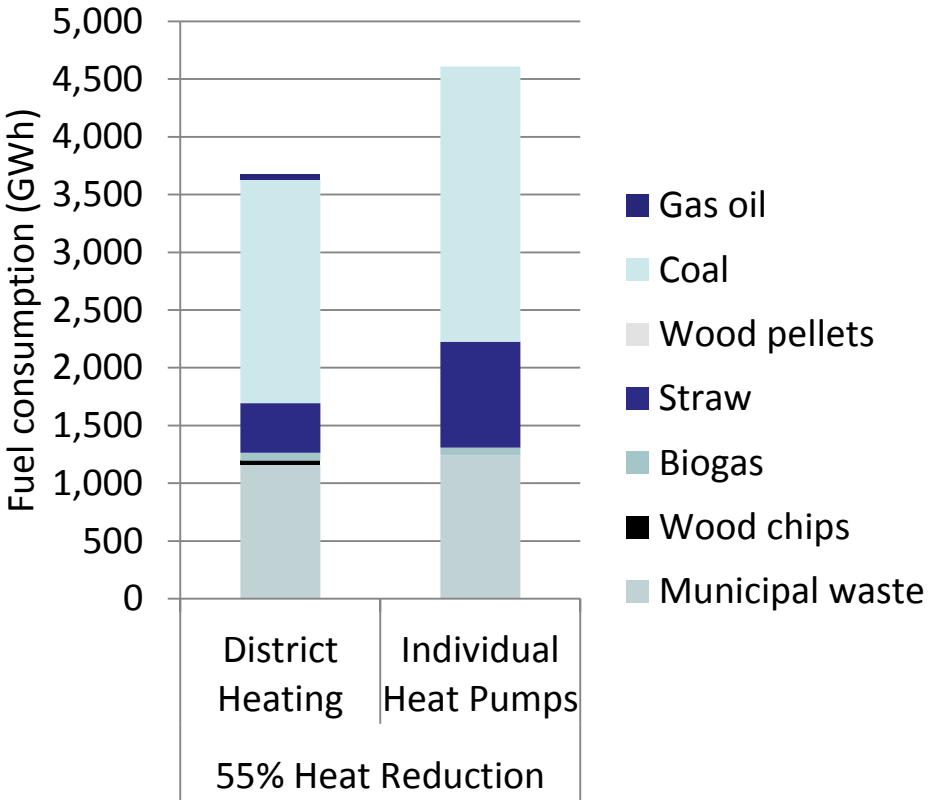
Specific Heat Pump **Size** and **Cost** for Each **Building Type**

Ground source heat pumps			
Capacity	0-5 kW	5-10 kW	Above 10 kW
Investment (EUR)	20,000	23,000	1,770
O&M (EUR/year)	135	135	400
Air to water			
Capacity	0-5 kW	5-10 kW	Above 10 kW
Investment (EUR)	10,500	13,000	1,000
O&M (EUR/year)	133	135	400

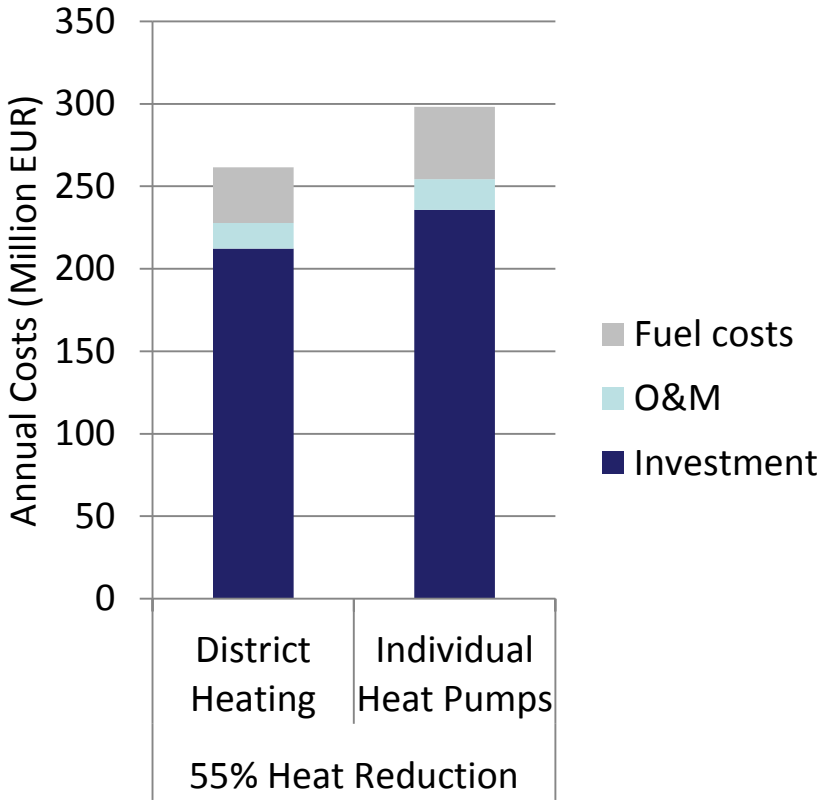
Building type	Investment ground source (EUR)	Investment air-to-water (EUR)
110	750,710	422,531
120	515,358,129	284,309,228
130	6,622,648	3,728,019
140	303,967,140	171,648,107
150	4,936,236	2,788,834
160	6,044,427	3,414,131
190	465,816	253,580
210	16,751,827	9,464,309
220	16,818,455	9,483,565
230	1,840,955	1,037,689
290	11,795	6,664
310	1,040,982	587,326
320	109,555,070	61,845,955
330	3,603,918	2,034,513
390	730,527	412,727
410	11,391,629	6,434,350
420	42,591,986	24,062,470
430	20,840,494	11,774,290
440	12,513,170	7,066,390
490	2,644,343	1,493,979
510	100,000	52,500
520	118,821	67,131
530	7,657,500	4,323,073
590	911,158	508,383
930	32,486	18,354

Århus Results

DH is More Efficiency



DH is Cheaper



Heat Roadmap Europe

Do these results apply to the rest of Europe?

Heat Roadmap Europe 2050

STUDY FOR THE EU27

by

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Daniel Trier

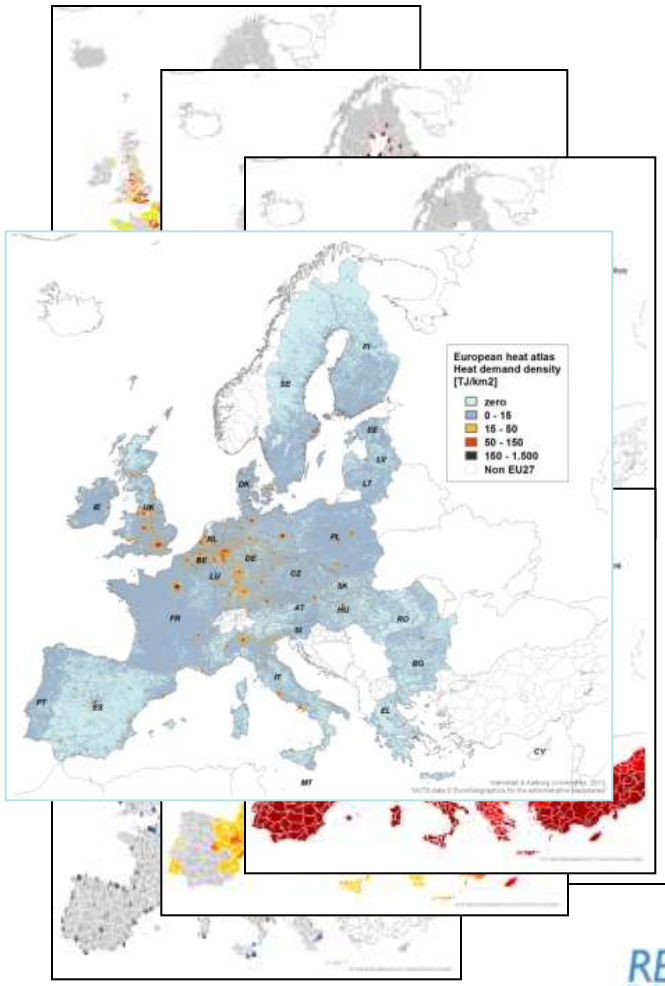
for

EUROHEAT & POWER

Heat Roadmap Europe Reports

- 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

Methodology



GIS Mapping

District Heating Demands

District Heating Resources

Energy System Modelling (www.EnergyPLAN.eu)

BAU (References)

District Heating Alternatives

Results (PES, CO2, Costs)

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 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)

HRE1 Conclusions

- Decrease primary energy supply and especi… O2 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

Pre-Study 2 (2013)

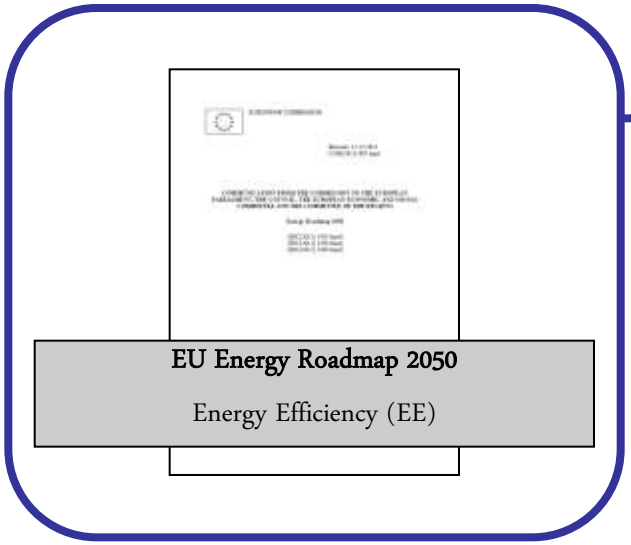
Is DHC beneficial for the EU energy system in a low-heat demand scenario?

Future: EU 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
  - Energy Efficiency (EU-EE)
  - Carbon Capture & Storage
  - Nuclear
  - High Renewable Energy

Same methodology as HRE1



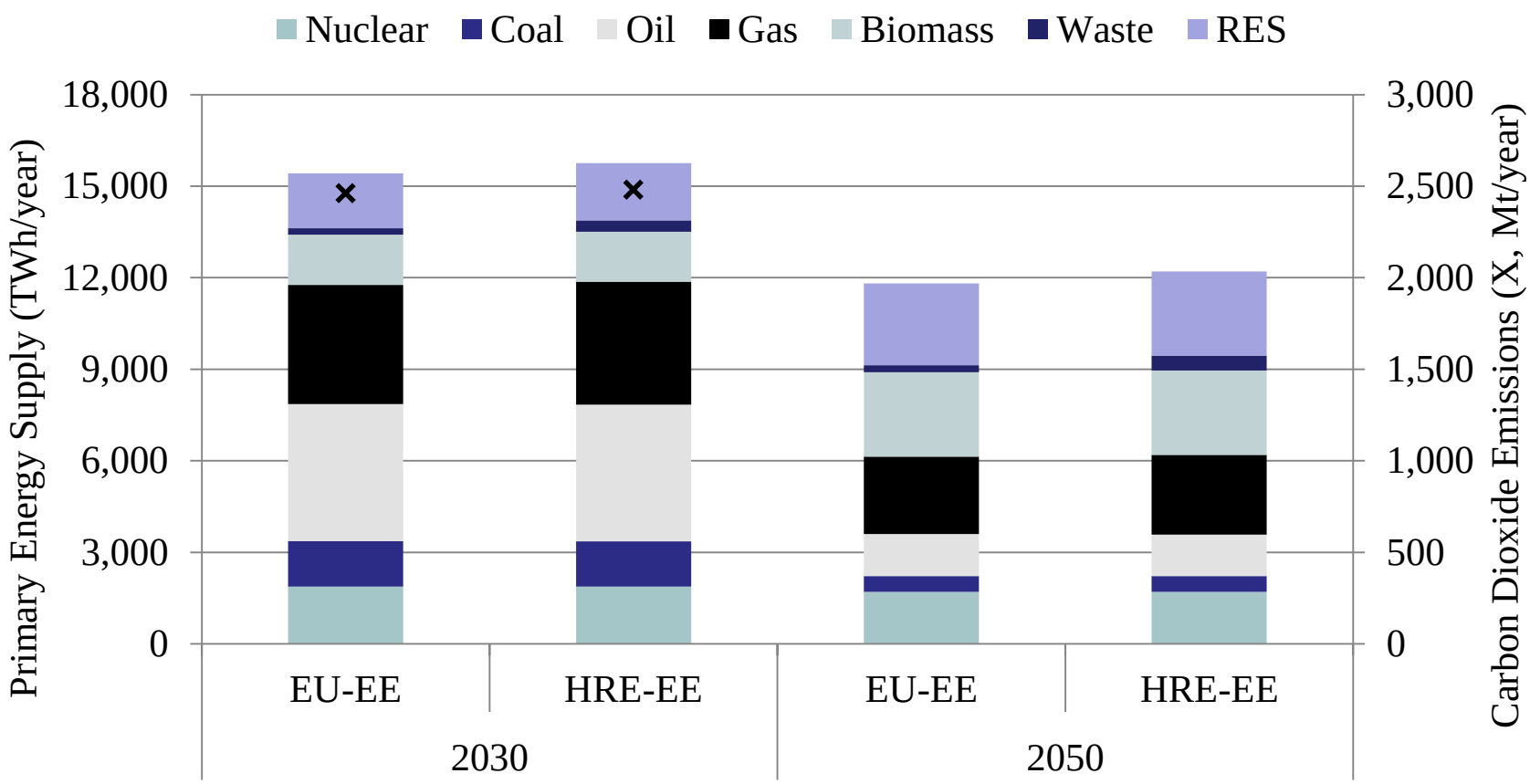
EU-EE
PRIMES Data
2030 & 2050 Model

District Heating
and Heat Pumps

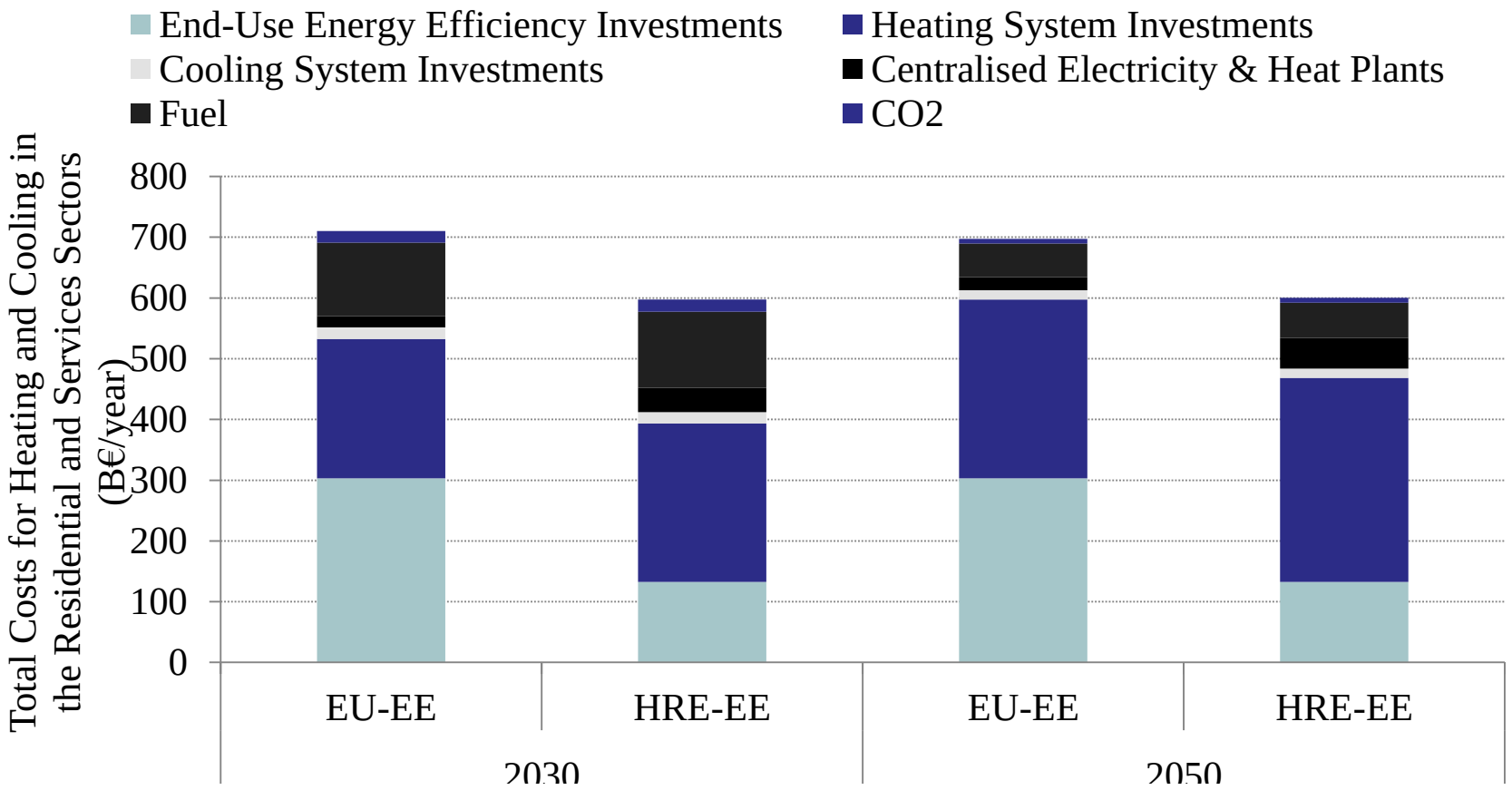
2010 = 12% DH
2030 = 30% DH
2050= 50% DH

Results
(PES, CO2, Costs)

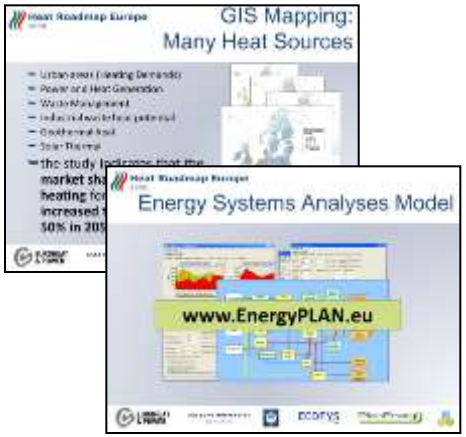
EU-EE vs. HRE-EE: Primary Energy Supply & CO2



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



HRE2 Conclusions



- If we implement a lot of energy efficiency measures, then district heating will:
  - Meet the same goals:
    - Utilise the s
    - Enable the same CO2 emission reductions
  - BUT, cost appr

SAME TARGETS

LESS MONEY

Conclusions

- Electricity and Heat are part of the same game, but they are playing in different positions:
  - District heating is for the urban areas
  - Electricity is for the rural areas
- District heating is a cheaper and more efficient alternative for high heat density areas, such as cities.
- Heat pumps are an excellent solution in the lower heat density areas.
- There are sufficiently high heat densities in the EU to expand district heating
- Large-scale heat pumps will be important on district heating networks

HRE-2 - based on known technologies but new configurations….

- Heat savings equal to the most ambitious deep renovation space-heating scenario in the Eurima3 study from 2012. The total heat demand in buildings is reduced by 34% between 2010 and 2050.
- Expansion of district heating from the present level of 12% to 50% in 2050.
- Combined Heat and Power: increase from 41 GWe in 2010 to 205 GWe in 2050
- Large-Scale Heat Pumps: 0 GWe in 2010 to 40 GWe in 2050
- Thermal Storage: 160 GWh in 2010 and 750 GWh in 2050
- Centralised Boilers: 132 GWth to 532 GWth in 2050 (mostly on Biomass)
- Heat from Waste Incineration: 50 TWh in 2010 and 200 TWh in 2050
- Large-Scale Solar Thermal: 0 TWh in 2010 and 100 TWh in 2050
- Individual Solar Thermal: 22.5 TWh in 2010 and 130 TWh in 2050
- Industrial Excess Heat: 7 TWh in 2010 and 105 TWh in 2050
- Geothermal Heat: 2 TWh in 2010 and 100 TWh in 2050
- Individual Heat Pumps: 40 GWe in 2010 and 175 GWe in 2050
- Wind Power: 150 TWh in 2010 and 1490 TWh in 2050 (this includes the 65 TWh
- of additional wind Power in the HRE-EE scenario in 2050)

Smart energy systems are crucial in 100% renewable energy systems

- **Smart Electricity Grids** to connect flexible electricity demands such as heat pumps and electric vehicles to the intermittent renewable resources such as wind and solar power.

- **Smart Thermal Grids** (District Heating and Cooling) to connect the electricity and heating sectors. This enables thermal storage to be utilised for creating additional flexibility and heat losses in the energy system to be recycled.

- **Smart Gas Grids** to connect the electricity, heating, and transport sectors. This enables gas storage to be utilised for creating additional flexibility. If the gas is refined to a liquid fuel, then liquid fuel storages can also be utilised.

Thank you

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