Heat Roadmap Europe 2050
A low-carbon heating and cooling strategy

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Heat Roadmap Europe: Democratizising knowledge bottom-up and top-down

Varmepumpefabrikantforeningen, Varmepumpedagen 2018
Eigtveds Pakhus København, 20 Sept. 2018

www.heatroadmap.eu / www.4dh.eu / www.reinvestproject.eu
@HeatRoadmapEU / @4DHresearch / @REInvestEU

4DH
4th Generation District Heating Technologies and Systems

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 695989.

reINVEST
Innovation Fund Denmark

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What does the future bring for you?

- More or less district heating?
- Net zero emission buildings?
- Passive houses?
- Gas-electricity hybrid heat pumps?
- What types of district heating are fit for the future?
- Should district heating decrease or increase?
- Who should own and profit from district heating system?

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Who are we?
– Sustainable Energy Planning Research Group

- Smart Energy Systems and energy system modelling
- International GIS mapping
- Local/National/EU/international focus
- Strategic energy planning local implementation,
- EnergyPLAN tool development
- Transport and renewable fuels
- Public regulation,
- Ownership and market design

www.energyplan.eu
www.smartenergysystems.eu

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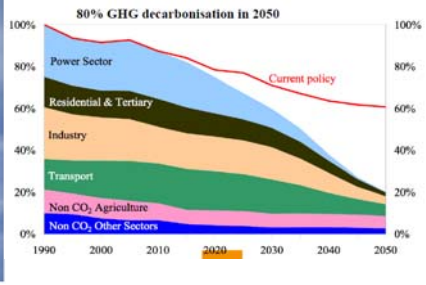
Targets and challenges in Europe

Long-term target (2011)
- 80-95% reduction of CO emissions in th energy sector

Short term in the energy union (2015)
- Security of supply (electricity and gas)
- An integrated marked
- Energy efficiency
- Lower CO2 emissions
- Research and innovation
- New directives (RED, EPBD, ED etc.)



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Examples of infrastructures promoted

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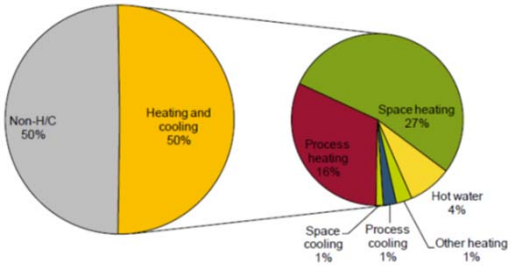
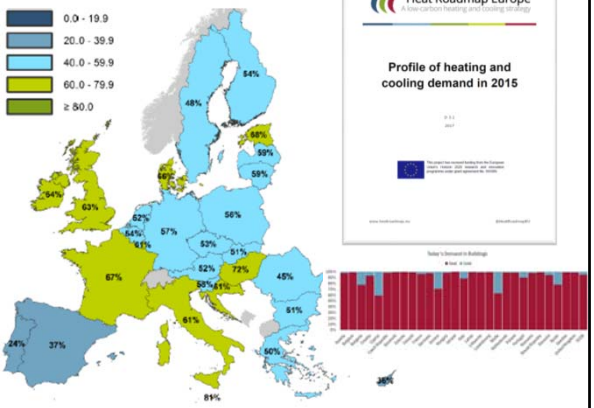
Heating vs. other sectors



Heating and cooling demand in 2015 in the EU28 by end-use compared to total final energy demand
- Large share for All Member States (not just the 'cold' North)
- Overall cooling share in general is 10-15%



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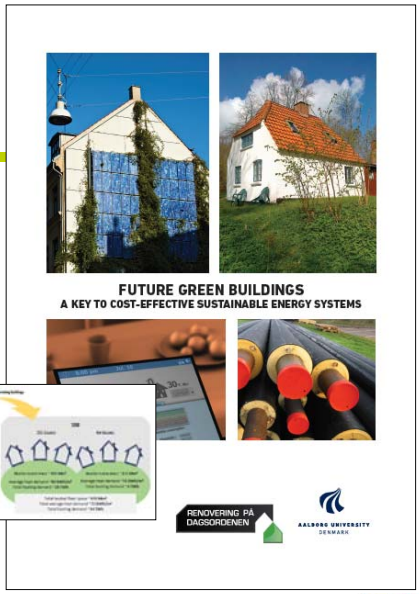
Three focus areas for buildings



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Making an Impact at Member State Level

90% of EU heat demand

Technical Outputs

- Profiling (incl. industry and cooling)
- Maps
- Models
- Technology Data
- Low-Carbon Heating & Cooling Strategies

Communication

- Website, Videos
- Newsletters,Twitter
- Workshops
- Reports and Scientific Papers

HEAT ROADMAP EUROPE 4
WEBINARS

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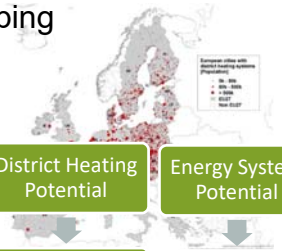
HRE Methodology

Data and mapping



Building Demand Savings Potential

District Heating Potential

Energy System Potential

Costs of Making Savings

District Heating Resources

Energy System Resources

Energy System analyses

BAU (References)

Heat Roadmap Europe Alternatives

Results (PES, CO2, Costs)

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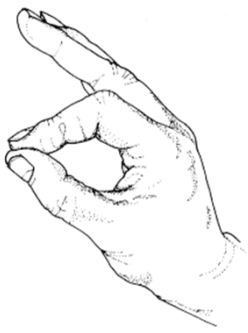
Target audience to democratize decisions

- Pinch-grip the problem!
- Aim to bring knowledge from the
  - ***top level and from***
  - ***bottom level stakeholders!***



Target groups	Implementation
Local and regional authorities	- Local political and technical decision-makers responsible for implementing national energy strategies and legislation
General public	- With specific interest in energy management and sustainable development
Targeted media	- With specific interest in energy management and sustainable development
Industry/Bank/Experts	- City utilities, energy agencies, consultancies, heating and cooling manufacturers, energy companies, financial sector
Policy-makers	- EU level: EU Parliamentarians on the Industry, Research and Energy Committees and European Commission employees from DG Energy, DG Research, DG Regio, others - National level: energy authorities, national energy ministries, national parliamentarians, energy utilities, energy companies
Associations	- Local networks, EU and national sectorial and technologic networks
NGOs	- E.g. Friends of the Earth, WWF, European Climate Foundation
Academia	- Researchers involved with energy planning or heating and cooling research

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Heat Roadmap Europe 1, 2, 3, and 4

- Study 1 (2012): will district heating play a role in the decarbonisation of the European energy system?
- Study 2 (2013): what is the balance between heat savings and heat supply at an EU level?
- Study 3 (2015, STRATEGO WP2): low-carbon heating and cooling strategies for 5 member states
- Study 4 (2016-2019): low-carbon heating and cooling strategies for 14 member states

4. 2016-2019

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From Research to Implementation in 4DH and Heat Roadmap Europe, Impact at EU Level

(EC: European Commission)

Research: Internal & External to EC	Short-Term EC Communication	Long-Term EC Strategy
>5 journal articles published with over 100 citations in other peer-reviewed scientific articles since their release in 2014	*Paul Hodson, who is head of the Energy Efficiency Unit in DG Energy, referred to HRE/STRATEGO as "the most advanced on the EU's heating and cooling sector as a whole"*	*Referenced >20 times in the EU's first ever Heating and Cooling Strategy, which was launched in 2016*

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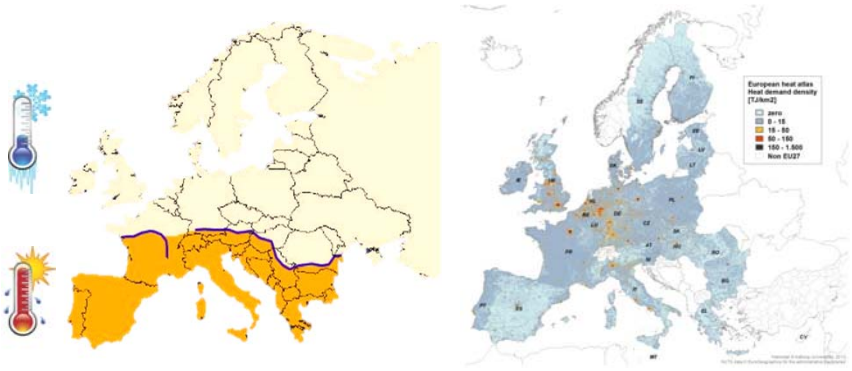
50% of the heat demand in Europe can be supplied with district heating



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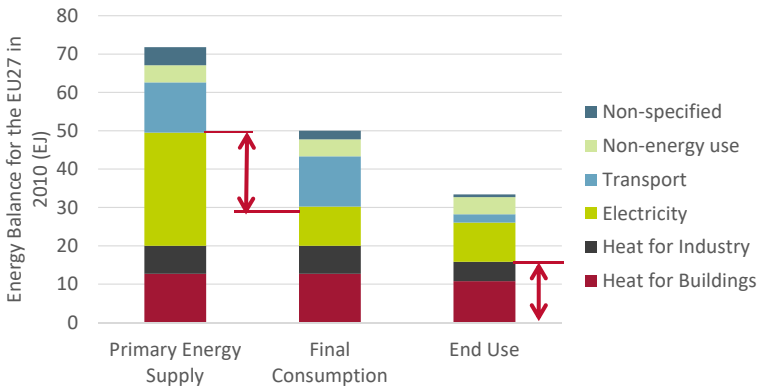
There is more excess heat in Europe than all of the heat demand in buildings



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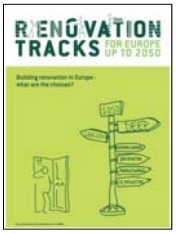
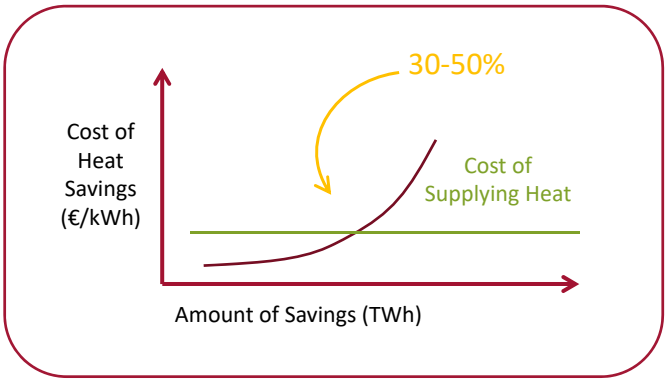
Energy efficiency is required on both the demand and supply side of the heat sector





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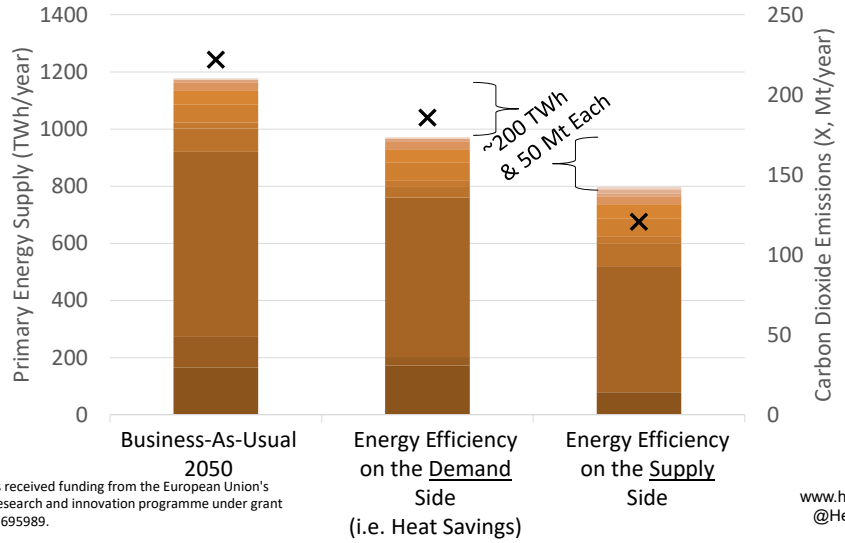
Energy Efficiency on Both Sides Can Save Similar Levels of Energy & CO2



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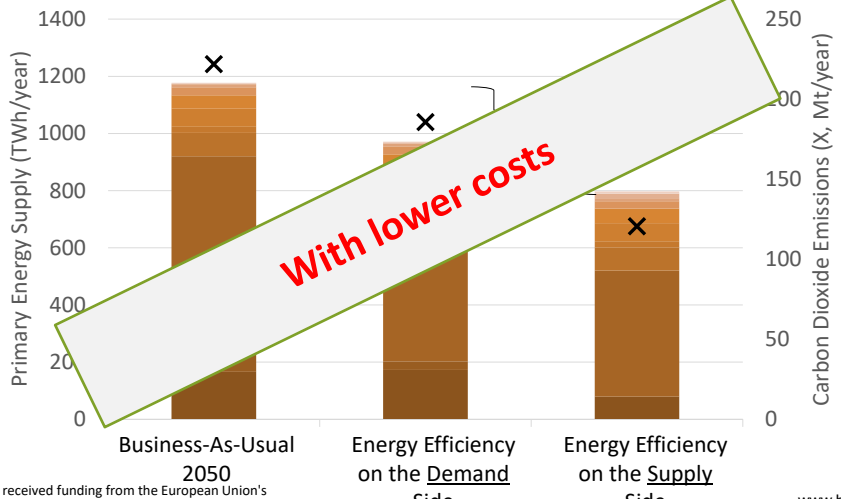

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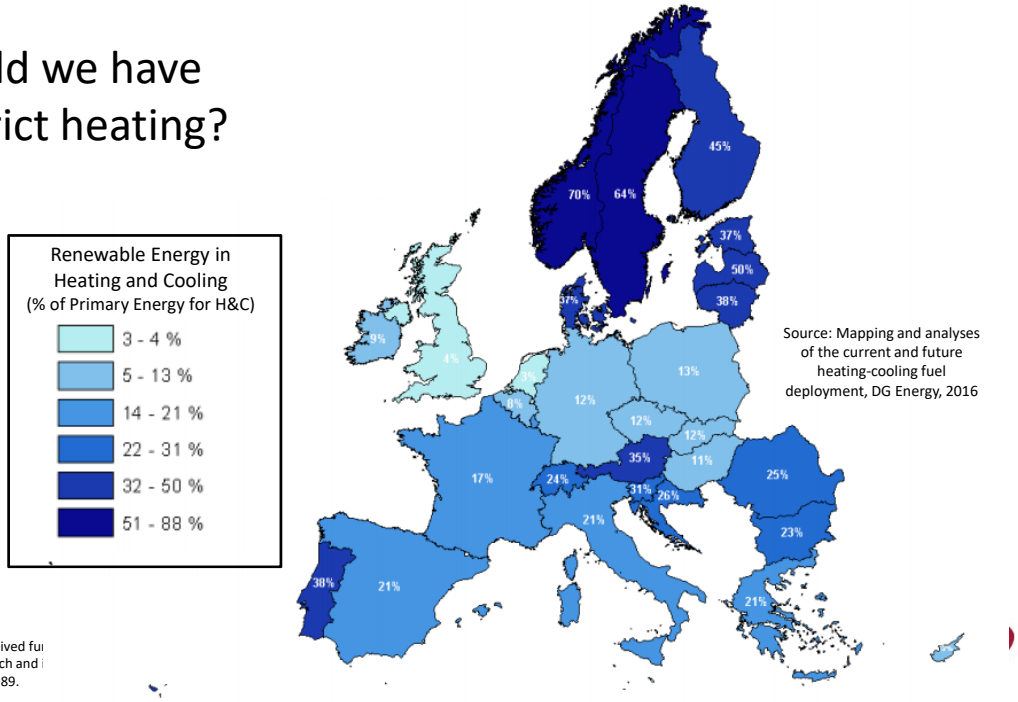
Why should we have more district heating?



Source: Mapping and analyses of the current and future heating-cooling fuel deployment, DG Energy, 2016

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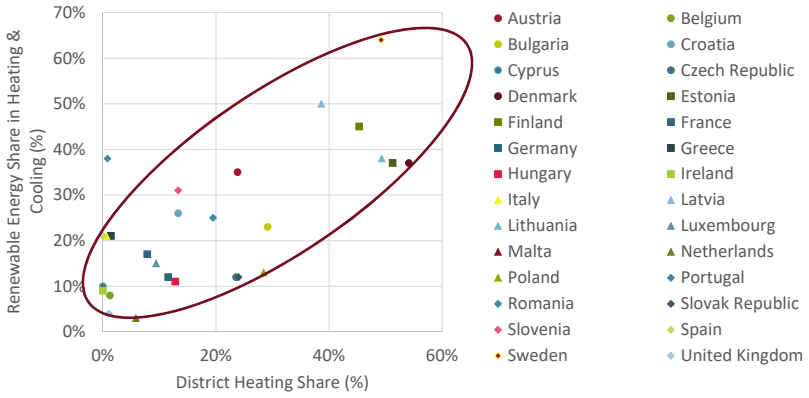
agreement No. 695989.

Proven Technology!
Renewable Energy vs. District Heating



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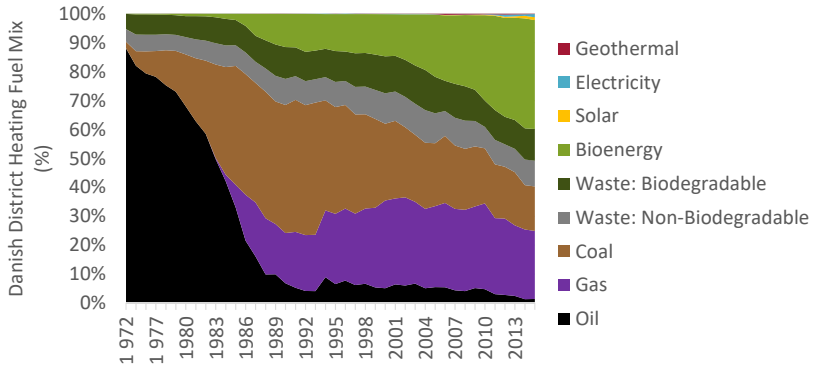
Resources for Danish District Heating1972-2015



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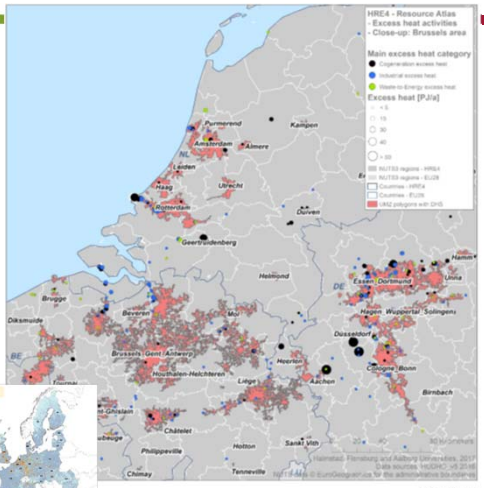
Energy Mapping

- Demand atlases of heating and cooling demands
  - Interactive web map application Peta4.2
- Mapping the renewable heat resources
  - Large scale solar thermal, geothermal, residual biomass



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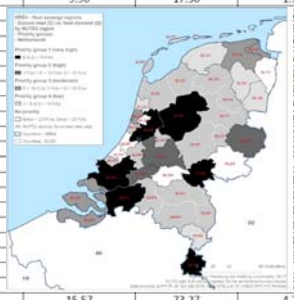
Heat synergies map in PETA4 example: Netherlands

- Heat demands: 296 PJ/y
- Excess heat: 560 PJ/y
- District heating share: 6%
- Renewable energy in heating: 3%
- - Not a Technical barrier to improve energy efficiency

NUTS3 Regions	Heat demand [PJ/a]	Excess heat [PJ/a]	Excess heat ratio [-]
NL111	3.83	0.20	0.05
NL112	1.22	11.32	9.28
NL113	9.90	17.30	1.75
NL121			25
NL131			92
NL132			55
NL213			48
NL224			08
NL225			09
NL226			40
NL230			99
NL310			12
NL322			16
NL323			27
NL325			05
NL326			05
NL332			05
NL337			09
NL339			06
NL33A			39
NL341			41
NL342			78
NL411	15.57	73.27	4.71
NL422	5.96	8.10	1.36
NL423	15.28	39.67	2.60
Grand Total	**295.84**	**559.23**	**1.89**



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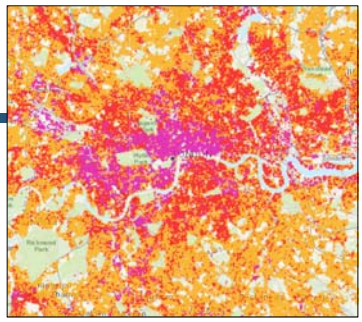
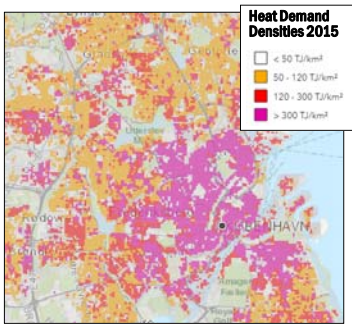
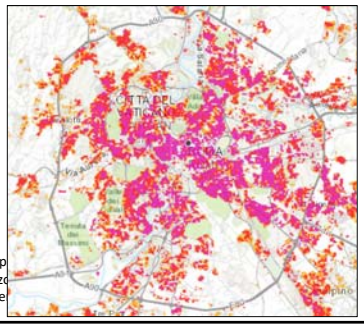
Today's Heat Demand from Peta 4.2 (www.heatroadmap.eu)



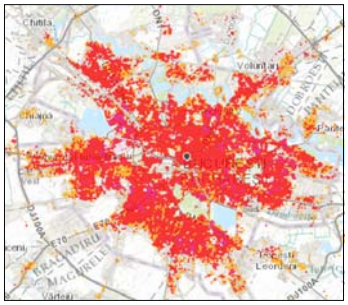
London
←<5% DH



Copenhagen
>90% DH →



Roma
←<5% DH



Bucharest
~75% DH →

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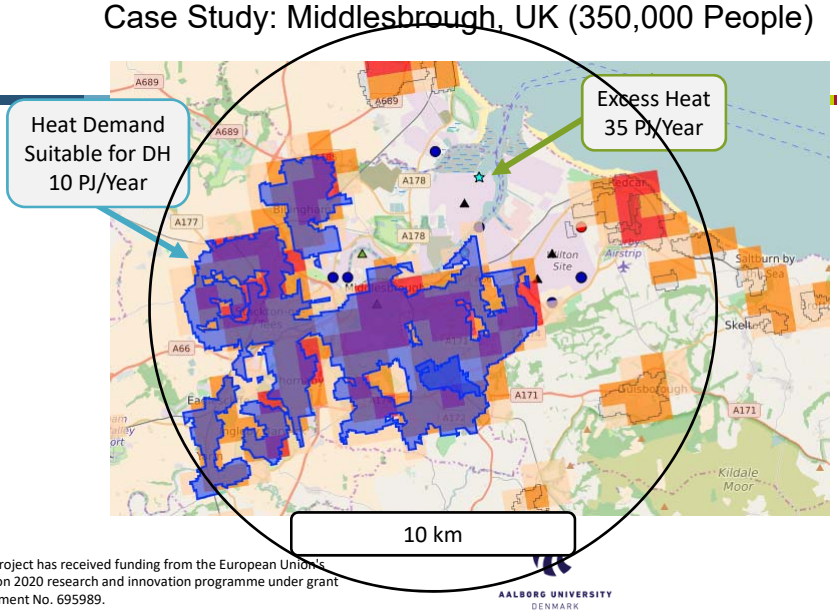
WP2: Pan-European Thermal Atlas: www.heatroadmap.eu

Case Study: Middlesbrough, UK (350,000 People)



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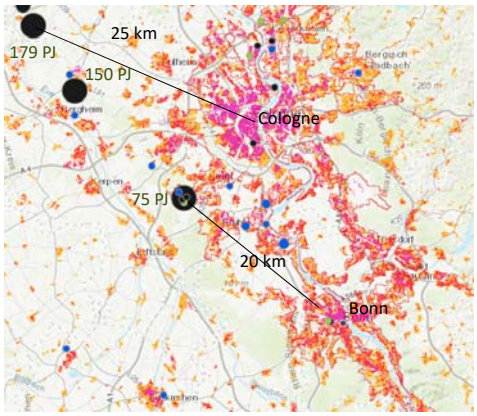
AALBORG UNIVERSITY DENMARK

Bonn-Cologne

- **Population**: 1.76 million
- **Area**: 511 km^2
- **Total Heat Demand (HD)**: 64 PJ
  - HD in density > 300 TJ/km^2: 26 PJ
  - HD in density 120-300 TJ/km^2: 24 PJ
- **Biomass resourses in the region:**
  - Forest residues: 1 PJ
  - Biowaste: 3 PJ
  - Straw: 2 PJ
- **Estimated excess heat**: > 450 PJ



Heat Demand Densities 2015 [PETA 4.2]

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Key Recommendations for the Heat Sector

Everywhere

- Heat Savings
- Balance Savings vs. Supply
- 30-50% Total Reduction

Urban Areas

- District Heating Networks
- High Heat Density Areas
- Supply ~50% of the Heat Demand

Rural Areas

- Primarily Electric Heat Pumps
- Smaller Shares of Solar Thermal & Biomass Boilers
- Remaining ~50% of the Heat Demand

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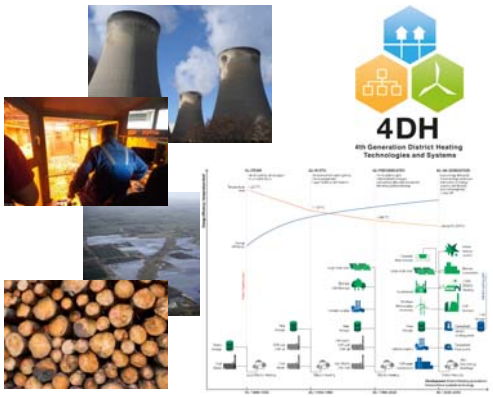
Access to More Sustainable Resources: These Can Only Be Used with District Heating

- Excess heat from Power Plants
- Industrial Excess Heat
- Waste Incineration
- Bio-refinary Excess Heat
- Synthetic fuel Excess Heat (electrofuels)
- Large-Scale Solar Thermal
- Geothermal
- Large-Scale Heat Pumps (new study out)
- Large-Scale Electric Boilers



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Today's Energy System

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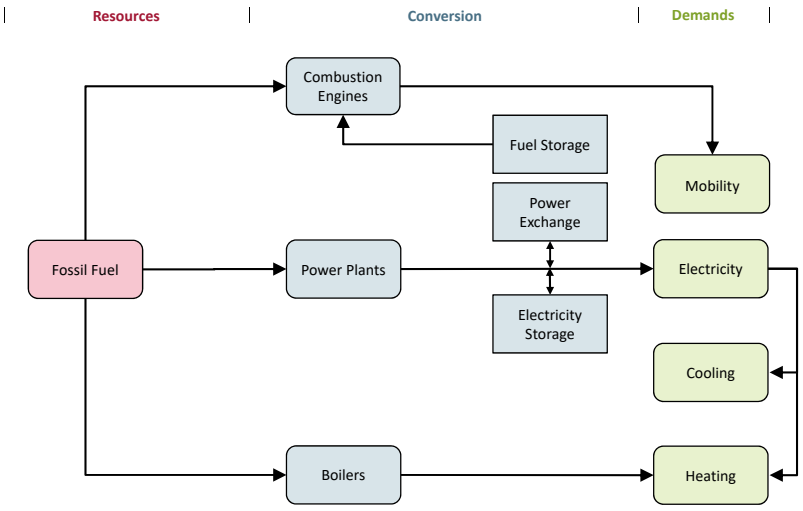
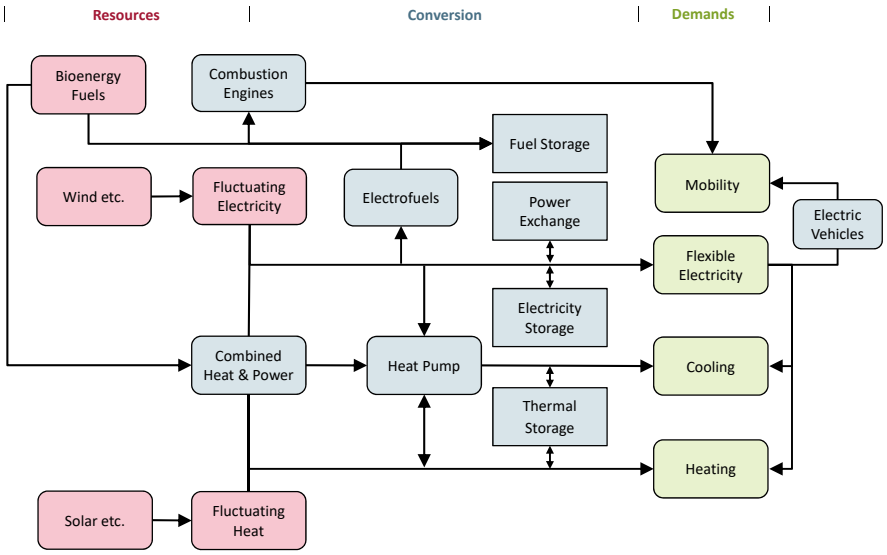
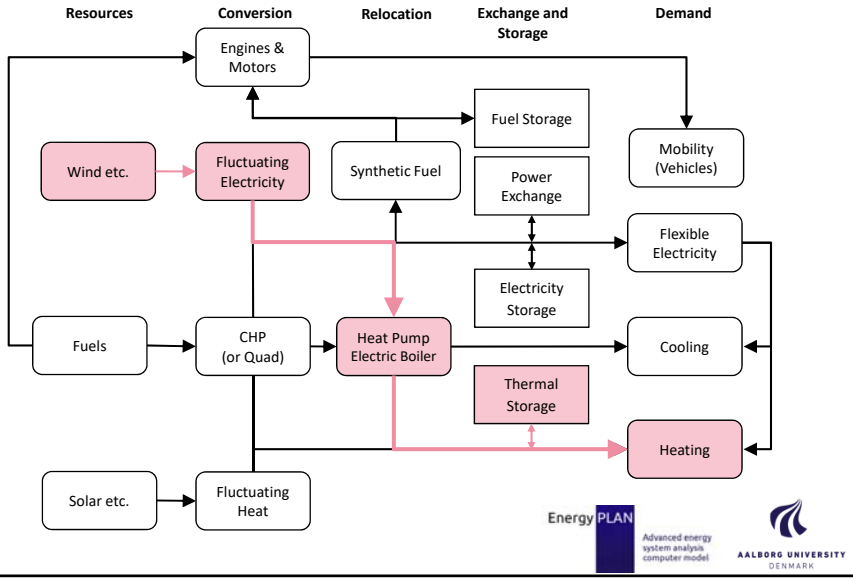


Smart Energy System

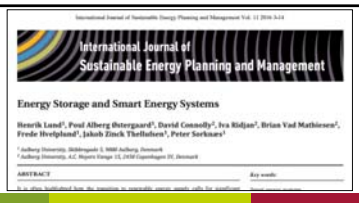
(www.SmartEnergySystem.eu)



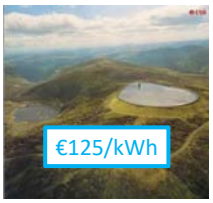
Integrating Wind Power with Thermal Storage (~€1-3/kWh) is much cheaper than Electricity Storage (~€125/kWh)



Unit Investment Costs for Energy Storage



Electricity



Thermal

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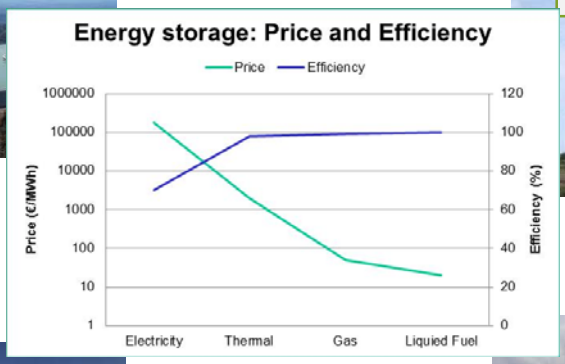
Energy Storage

reINVEST
Innovation Fund Denmark

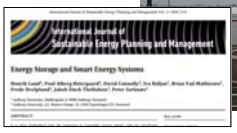
Pump Hydro Storage
175 €/kWh
(Source: Electricity Energy Storage Technology Options: A White Paper Primer on Applications, Costs, and Benefits. Electric Power Research Institute, 2010)



Thermal Storage
1-4 €/kWh
(Source: Danish Technology Catalogue, 2012)

Oil Tank
0.02 €/kWh
(Source: Dahl KH, Oil tanking Copenhagen A/S, 2013: Oil Storage Tank. 2013)

Natural Gas Underground Storage
0.05 €/kWh
(Source: Current State Of and Issues Concerning Underground Natural Gas Storage. Federal Energy Regulatory Commission, 2004)



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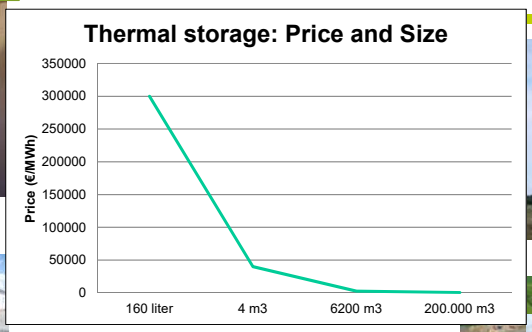
agreement No. 695989.

Thermal Storage

0.16 m3 Thermal Storage
300.000 €/MWh
(Private house: 160 liter
for 15000 DKK)

4 m3 Thermal Storage
40,000 €/MWh
(Private outdoor: 4000 m3
for 50,000 DKK)



6200 m3 Thermal Storage
2500 €/MWh
(Skagen: 6200 m3
for 5.4 mio. DKK)

200,000 m3 Thermal Storage
500 €/MWh
(Vojens: 200,000 m3
for 30 mio. DKK)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 695989.

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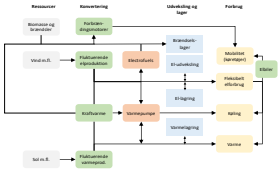
How should storage be used in the long term?

- Three crucial grids in Smart Energy Systems,
  - Smart electricity grids, Smart thermal grids, Smart gas grids
- High capacity electrolyses (Power-to-gas)
- More district heating and district cooling
- Large and small-scale heat pumps (Power-to-heat)
- CHP, solar thermal, etc.
- Electricity storage in transport (batteries and electrofuels)
- Production of green gasses and synthetic fuels



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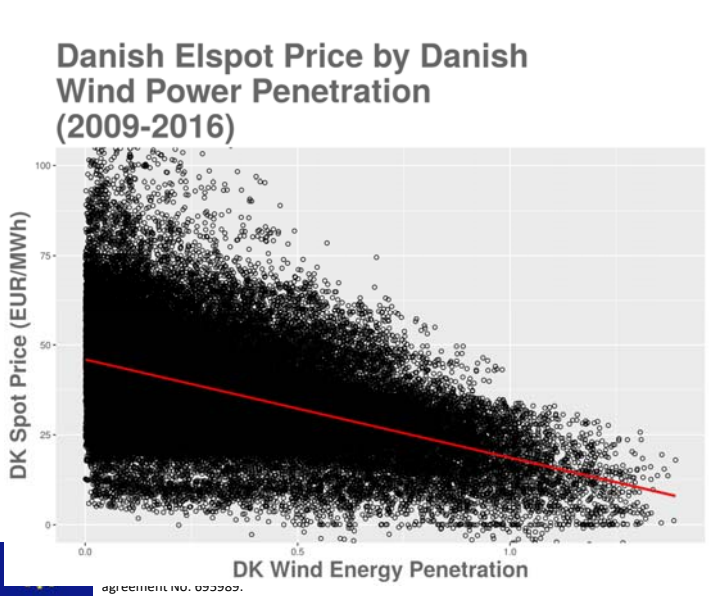
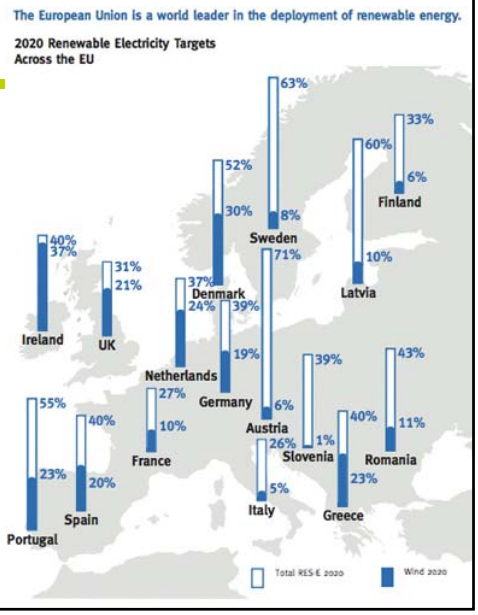
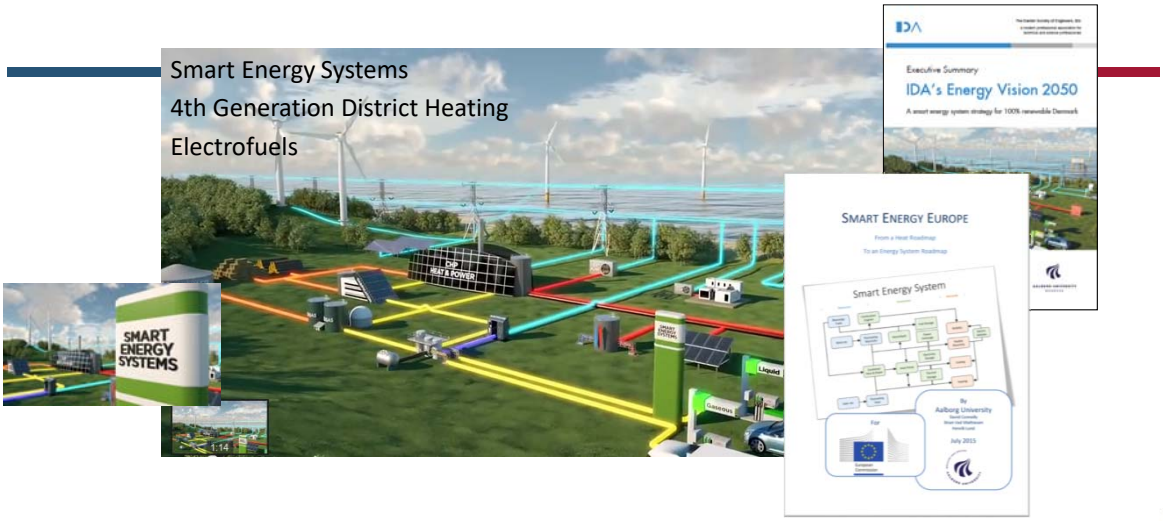




agreement No. 695989.

NEW CONCEPTS (AND VIDEOS)

Smart Energy Systems
4th Generation District Heating
Electrofuels



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