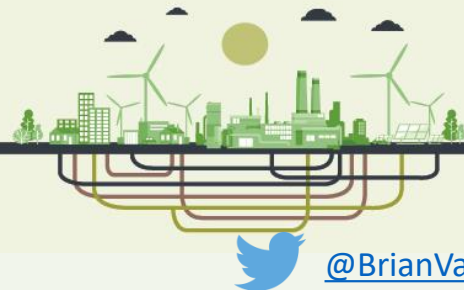




## KEYNOTE: ROADMAP FOR NET ZERO EMISSIONS WITH KNOWN TECHNOLOGIES

**Keeping our cities sustainably warm** - Inspiring the Efficient Renewal of District Heating for the Just Transition

*Brian Vad Mathiesen, Aalborg University  
November 12 2020, Brussels - Online*





# New scenarios: Target of net zero emissions in Europe?

IN-DEPTH ANALYSIS IN SUPPORT OF THE COMMISSION  
COMMUNICATION COM(2018) 773

A Clean Planet for all  
A European long-term strategic vision for a prosperous, modern, competitive and  
climate neutral economy



## Positives

- A large variety of scenarios
- Two net zero emission scenario
- More details within buildings and industry

## Scenario problems

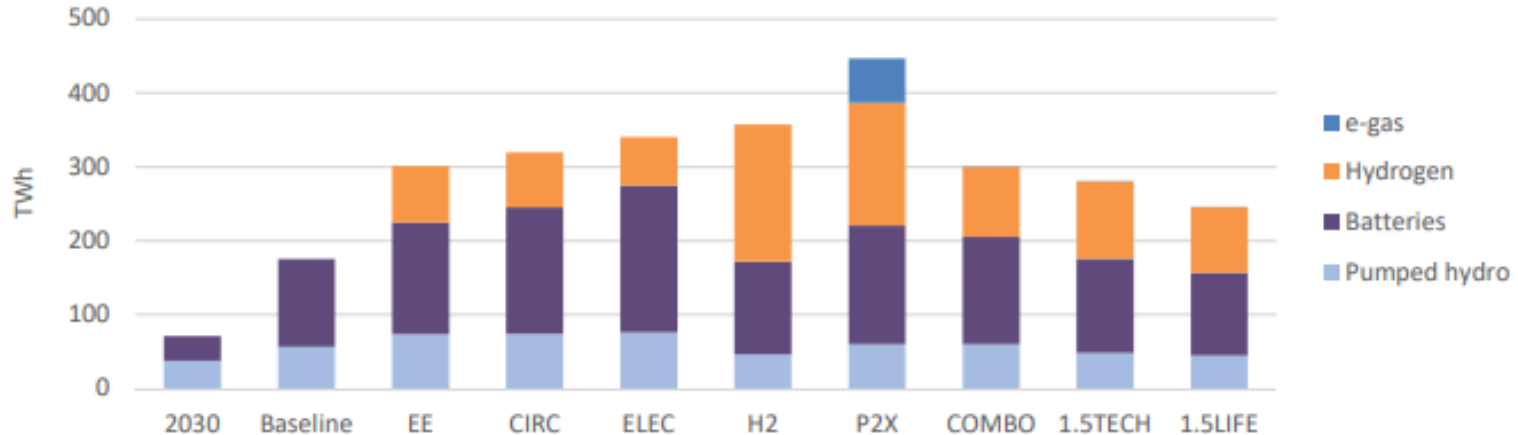
- Very high ambition in all scenarios with regards to energy efficiency in buildings
- No district heating implemented
- Politically driven scenarios for gas
- Claim to make "optimal systems"

## Tool problems

- 5 year time steps (until 2070 – focus on 2050)
- partial equilibrium modelling system that simulates an energy market
- Investment optimisation (with limits e.g. wind and nuclear)
- No clear distinction between private/business economy and socio-economy.



# Energy Storages



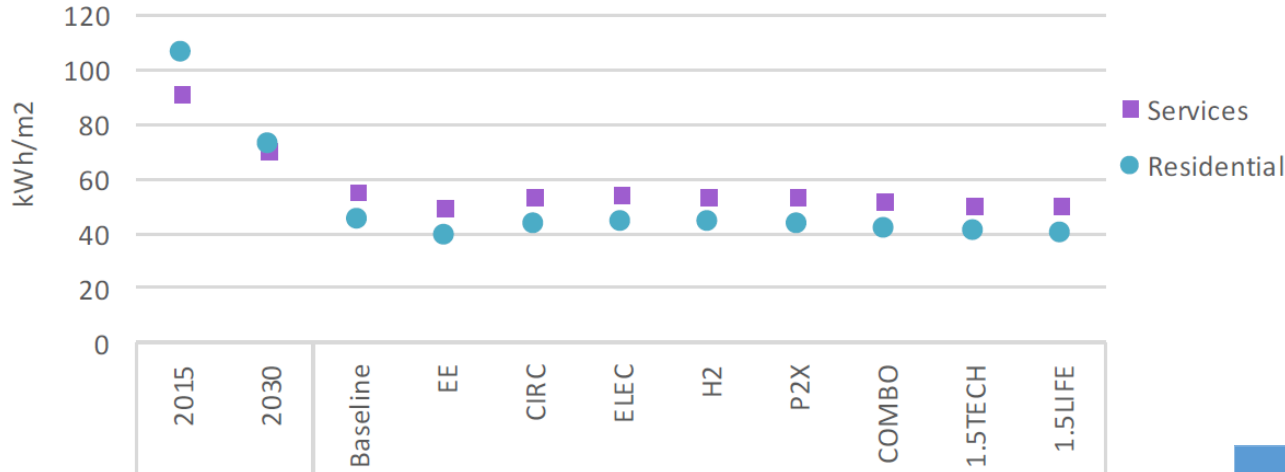
About 100 TWh batteries in all scenarios  
- annual costs ~ 900 billion EURO



Figure 44: Non-electricity fuel consumption in buildings.



Figure 40: Useful energy consumption for space heating in buildings



### Highlights

- Gas for heating dominates
- Stagnating district heating
- High ambition on EE in buildings due to tool)
- Higher costs than today

Source: PR

TWh	Total heat demand	Heat demand heat pumps	Total electricity demand
Baseline	2207,1	863,1	1537,3
COMBO	1789,1	883,7	1271,4
1,5 TECH	1620,7	806,2	1127,7
1,5 LIFE	1488,2	712,3	1101,7



# Total system costs

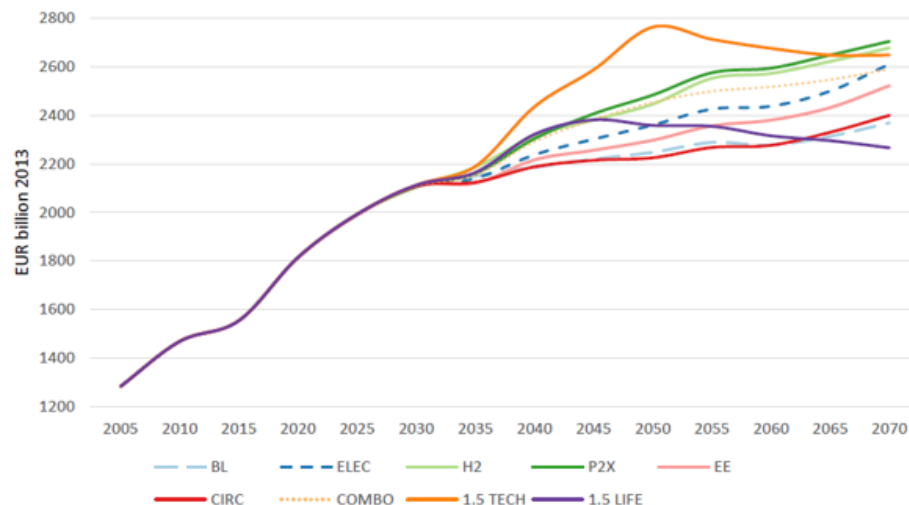


Table 10: Average annual investment by scenario (billion EUR 2013 over the 2031-2050 period; baseline for 2021-2030 is also shown).

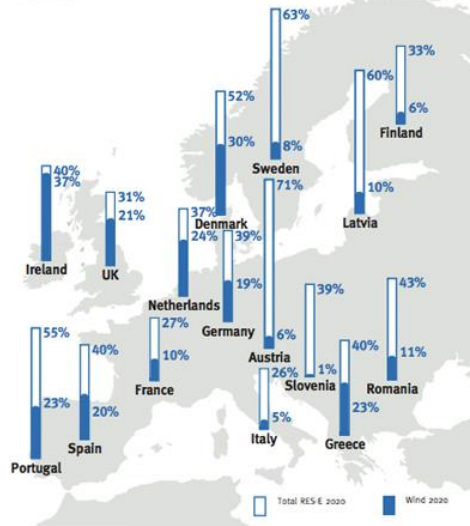
	Baseline 2021-2030	Baseline	EE	CIRC	ELEC	H2	P2X	COMBO	1.5 TECH	1.5 LIFE
<b>Supply</b>	<b>115</b>	<b>113</b>	<b>133</b>	<b>154</b>	<b>190</b>	<b>184</b>	<b>233</b>	<b>210</b>	<b>246</b>	<b>201</b>
Power grid	59.2	71.3	80.7	91.0	110.3	91.1	95.3	99.4	102.8	90.3
Power plants	53.9	40.2	50.5	60.3	76.8	86.6	107.9	93.6	120.3	93.9
Boilers	1.7	1.3	1.1	1.8	1.9	1.0	0.6	0.7	0.8	0.6
New carriers	0.1	0.3	0.9	0.9	1.0	5.5	28.9	16.2	21.9	16.5
<b>Demand exc. trans.</b>	<b>281</b>	<b>264</b>	<b>335</b>	<b>285</b>	<b>285</b>	<b>270</b>	<b>271</b>	<b>312</b>	<b>330</b>	<b>318</b>
Industry	18.1	11.1	35.6	13.2	13.6	13.2	13.8	26.3	28.1	22.3
Residential	198.9	199.4	235.1	211.6	214.4	198.9	198.1	218.3	225.9	227.7
Tertiary	64.3	53.7	63.8	60.3	57.0	58.0	59.5	67.1	76.0	67.8
<b>Transport</b>	<b>685</b>	<b>813</b>	<b>857</b>	<b>837</b>	<b>881</b>	<b>907</b>	<b>843</b>	<b>881</b>	<b>904</b>	<b>847</b>
<b>TOTAL</b>	<b>1081</b>	<b>1190</b>	<b>1325</b>	<b>1276</b>	<b>1356</b>	<b>1361</b>	<b>1347</b>	<b>1402</b>	<b>1480</b>	<b>1366</b>
(TOTAL exc. trans.)	(396)	(377)	(468)	(439)	(475)	(454)	(504)	(522)	(576)	(519)

Source: PRIMES.



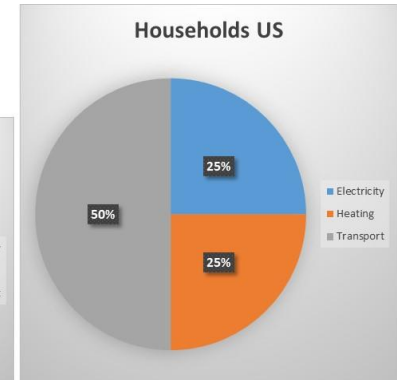
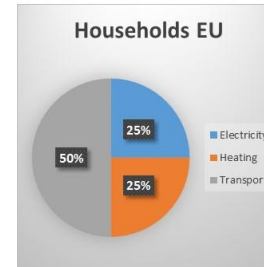
The European Union is a world leader in the deployment of renewable energy.

2020 Renewable Electricity Targets  
Across the EU



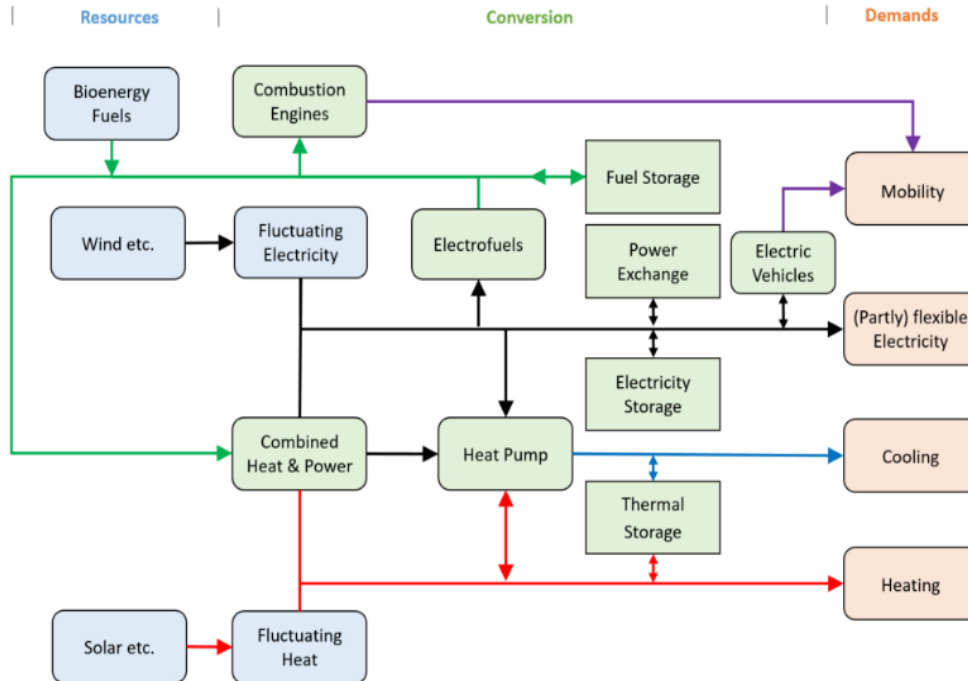
# Solutions on the table

1. Interconnectors and trading (infrastructure investments)
2. Flexible electricity demands and smart grids (batteries and single string supply)
3. Integrated efficient Smart





# A new path based on the baseline scenario



Other technology pathways using Smart Energy Systems

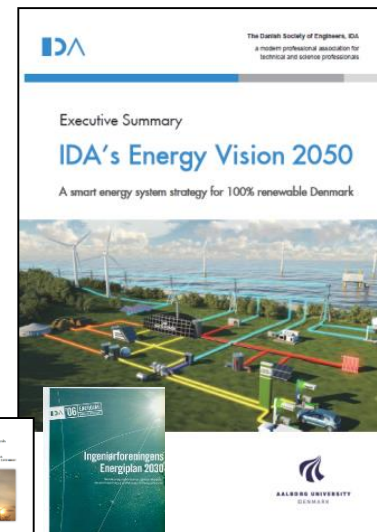
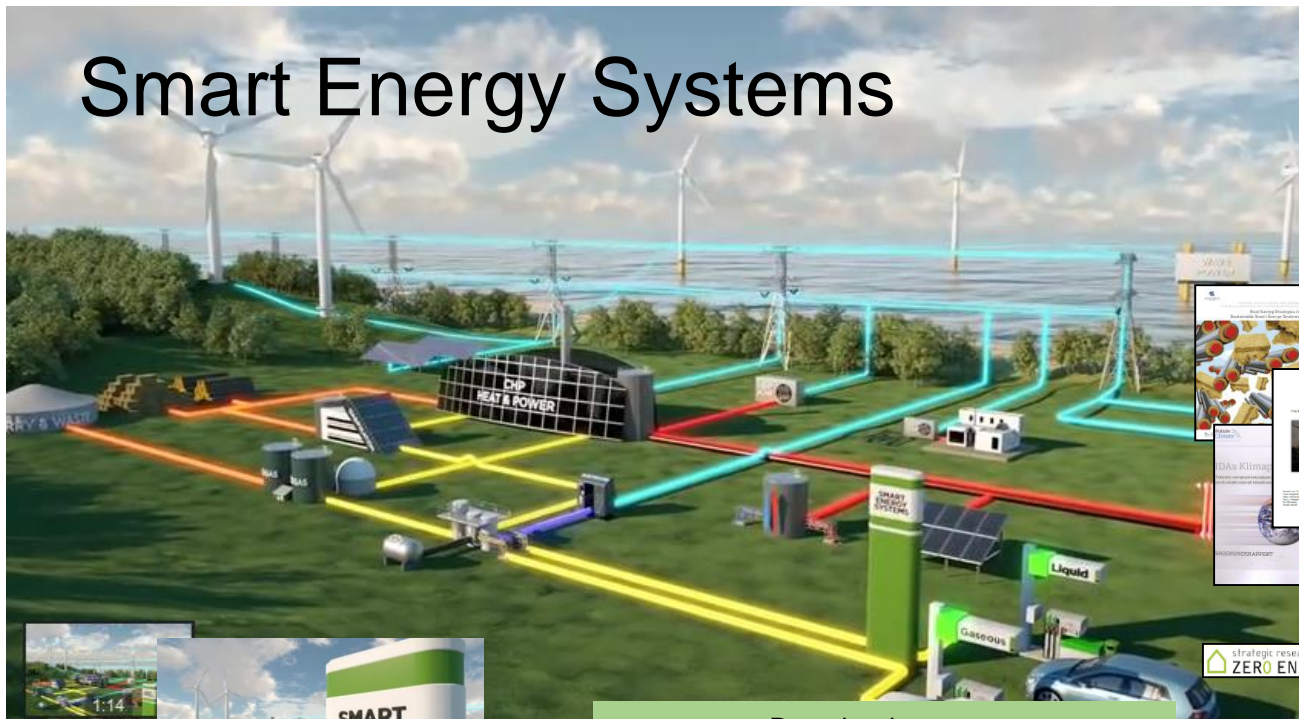
- Balance of energy savings and energy supply
- Use of electrofuels
- End use of gas
- Types of storages
- Can we manage without nuclear?

Scenario research targets and goals:

- Create more net zero emission scenarios with lower cost and a sustainable bioenergy use
- Create negative carbon and carbon free options



# Smart Energy Systems



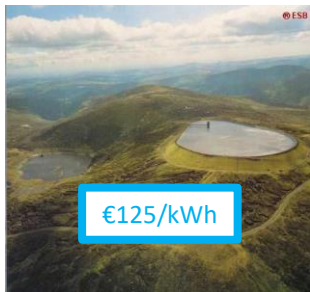
Download rapport:  
[www.EnergyPLAN.eu/IDA](http://www.EnergyPLAN.eu/IDA)



# Unit Investment Costs for Energy Storage

## 1. Thermal Cheaper at All Scales

Electricity



Thermal





# Unit Investment Costs for Energy Storage

## 1. Thermal Cheaper at All Scales

Electricity



Thermal



2. Bigger is Better i.e. Cheaper



### 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)

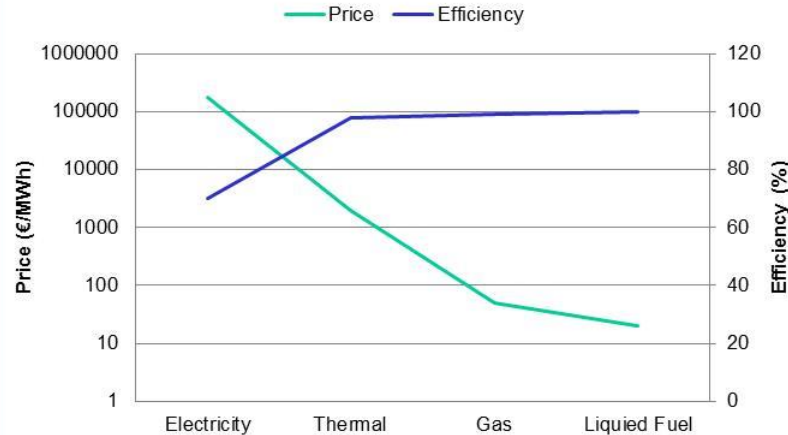


### Thermal Storage 1-4 €/kWh

(Source: Danish Technology Catalogue, 2012)



## Energy storage: Price and Efficiency



### Oil Tank 0.02 €/kWh

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



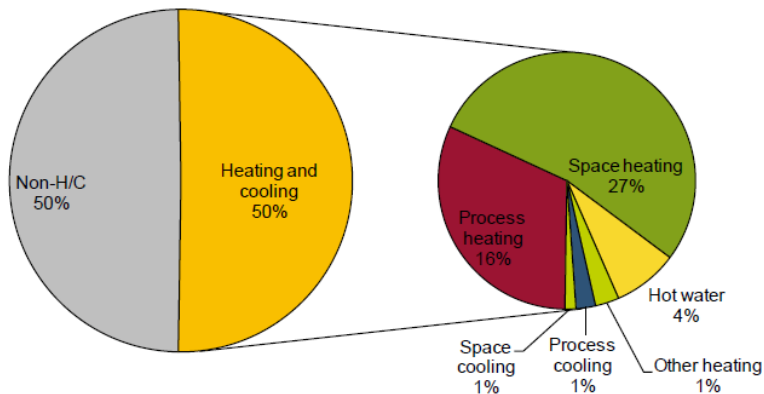
### Natural Gas Underground Storage 0.05 €/kWh

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



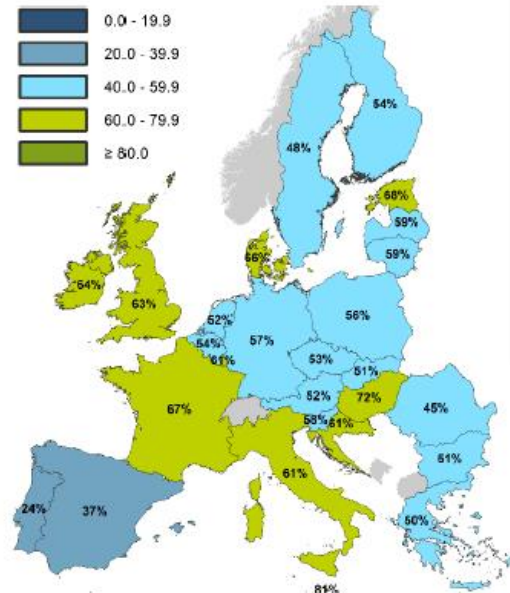


# Heating vs. other sectors

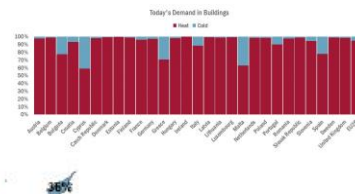
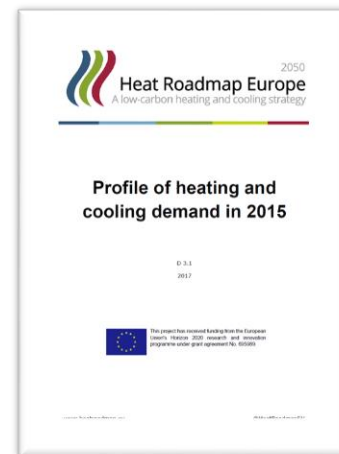


Heating and cooling demand in 2015 in the EU28 by end-use compared to total final energy demand

- Large share for All Member States (not just the 'cold' North)
- Overall cooling share in general is 10-15%



Heating and cooling demand in 2015 in the EU28 by end-use compared to total final energy demand



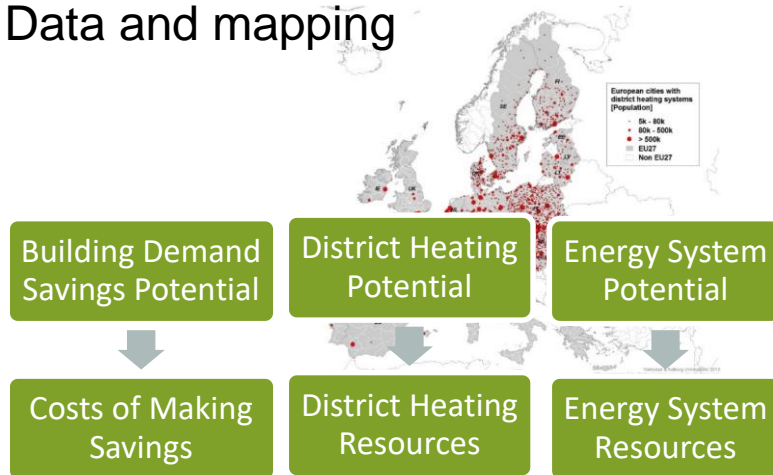


AALBORG UNIVERSITY  
DENMARK

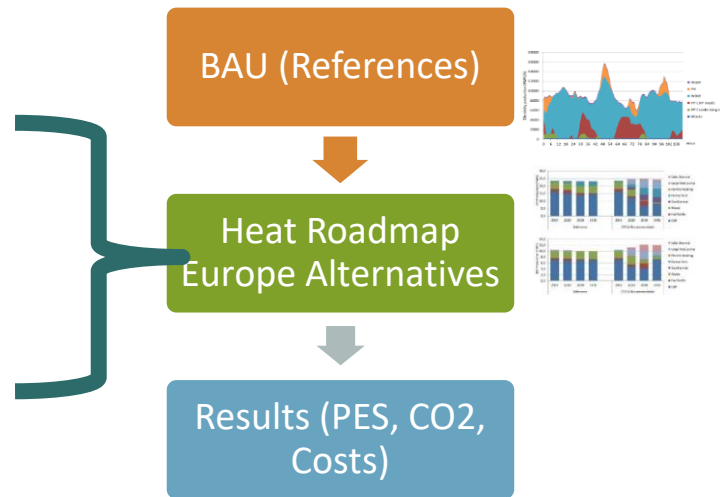


# HRE Methodology

## Data and mapping



## Energy System analyses





# Heat Roadmaps for transitions

- Decarbonise in line with Paris Agreement
- Technically possible, socio-economically feasible
- Consider local nature of heating and cooling
- Consider the wider energy system
- Heating is the largest end-use demand
- District heating increases energy efficiency and access to supply sources
- Smart energy systems and sector coupling

## Everywhere

Deep energy savings

Combine savings and supply

~30-50% demand reduction

## Urban areas

District energy networks

High demand density areas

Supply ~half of energy demand

## Rural areas

Mainly heat pumps

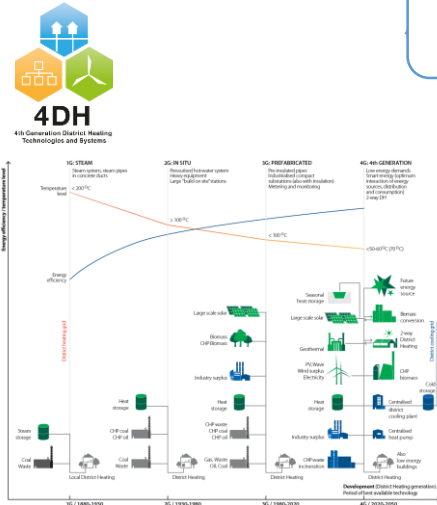
Low demand density areas

Remaining ~half of the energy demand



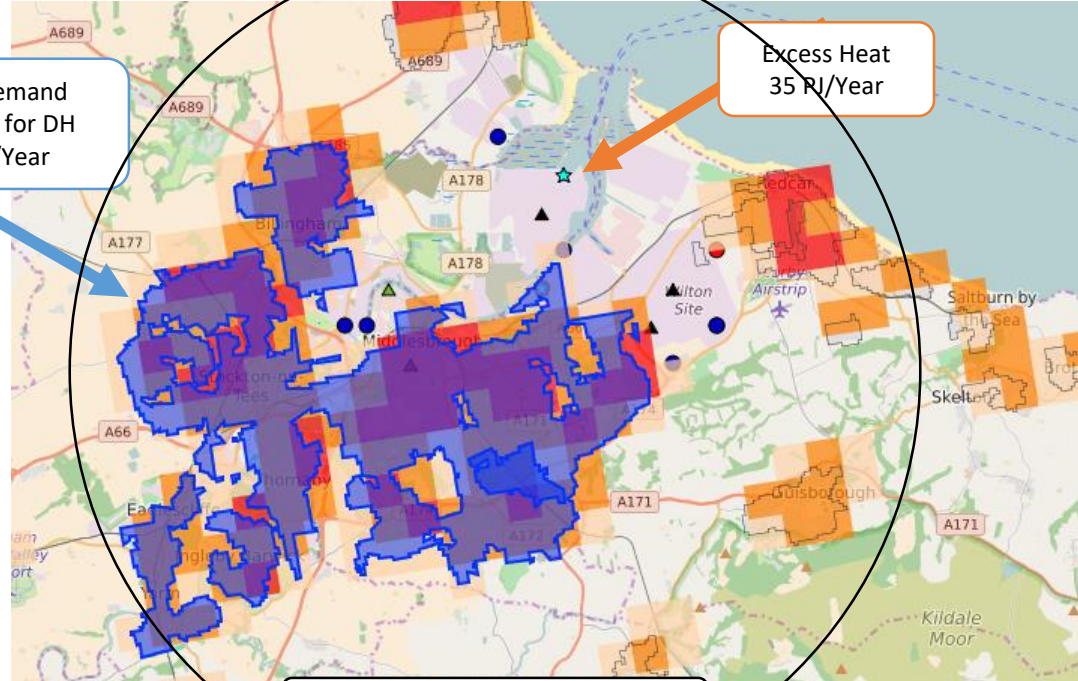
## WP2: Pan-European Thermal Atlas: [www.heatroadmap.eu](http://www.heatroadmap.eu)

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



Heat Demand  
Suitable for DH  
10 PJ/Year

Excess Heat  
35 PJ/Year



10 km

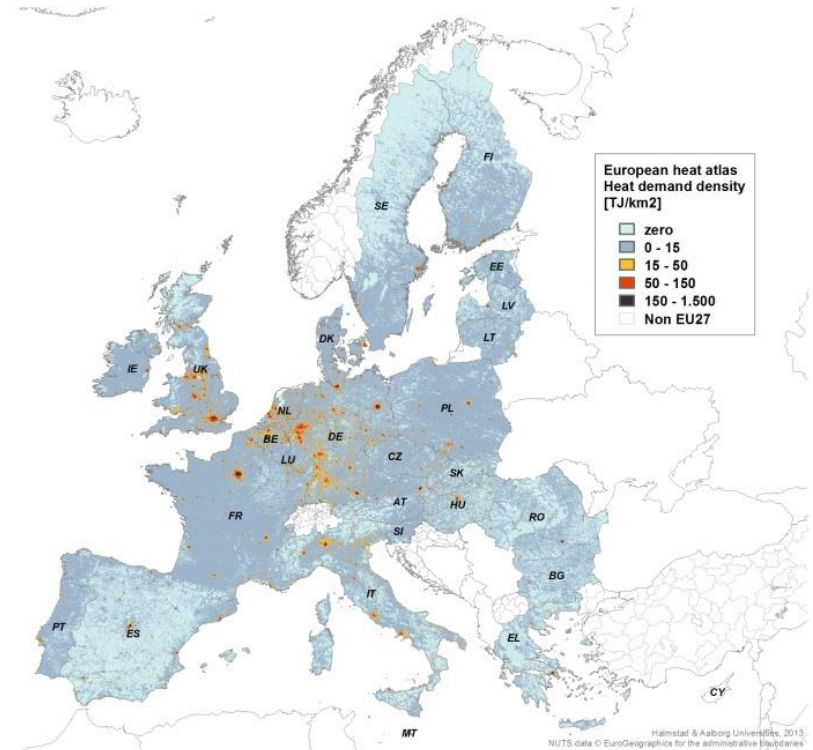
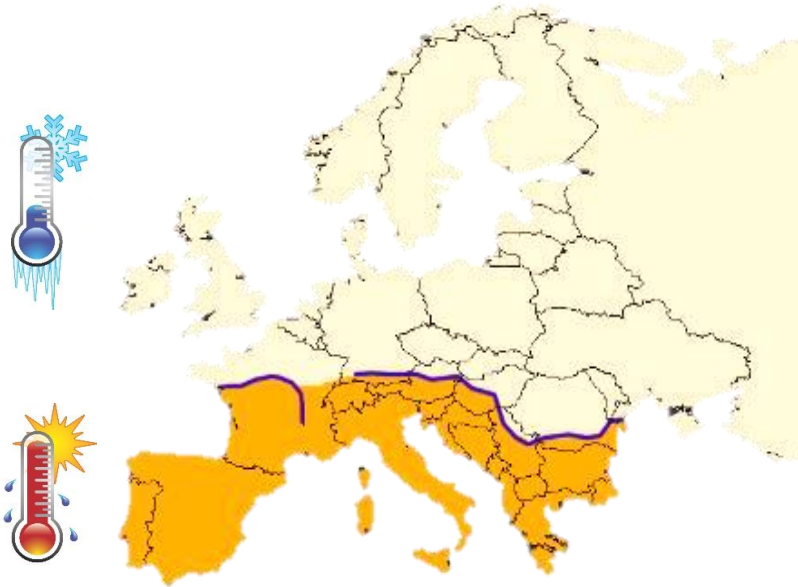


This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 695989.



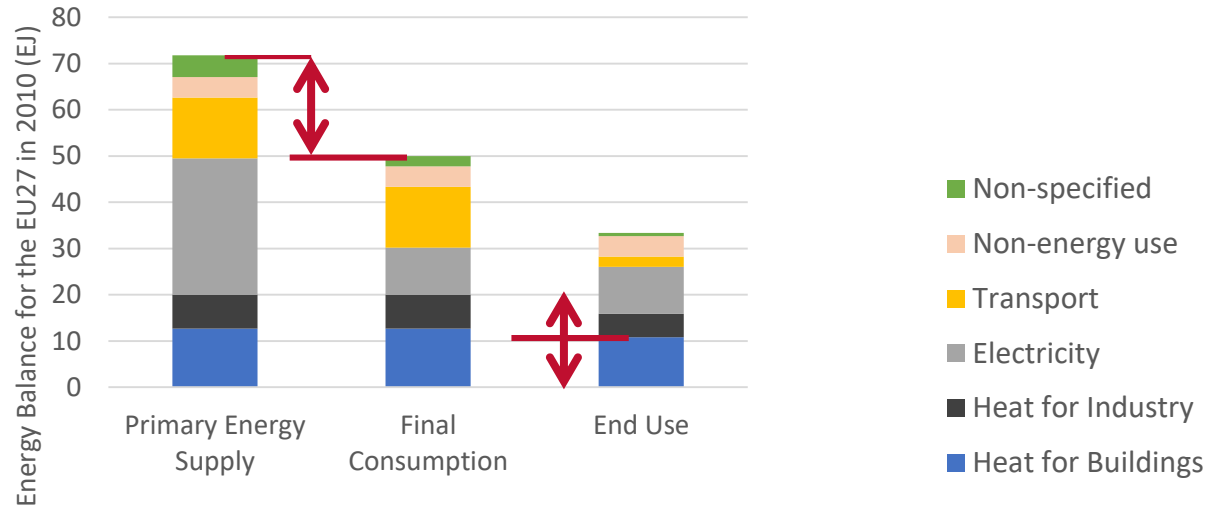


50% of the heat demand in Europe can be supplied with district heating



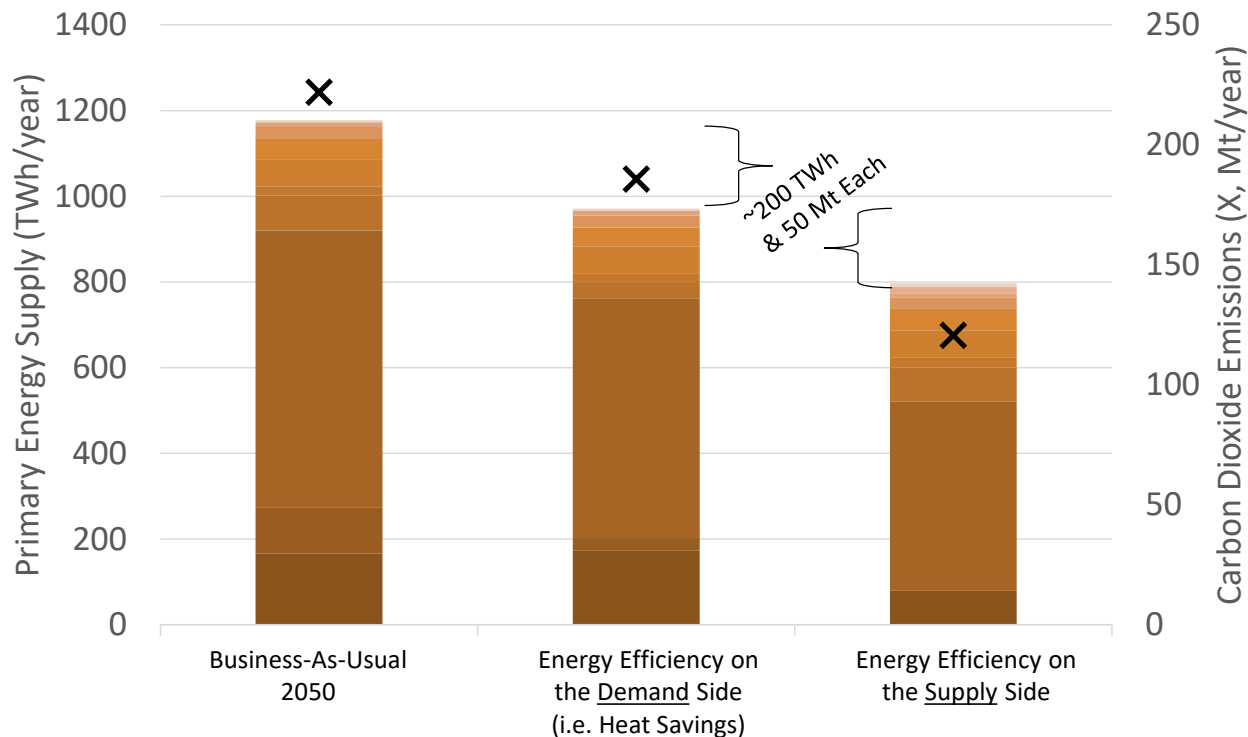


There is more excess heat in Europe than all of the heat demand in buildings



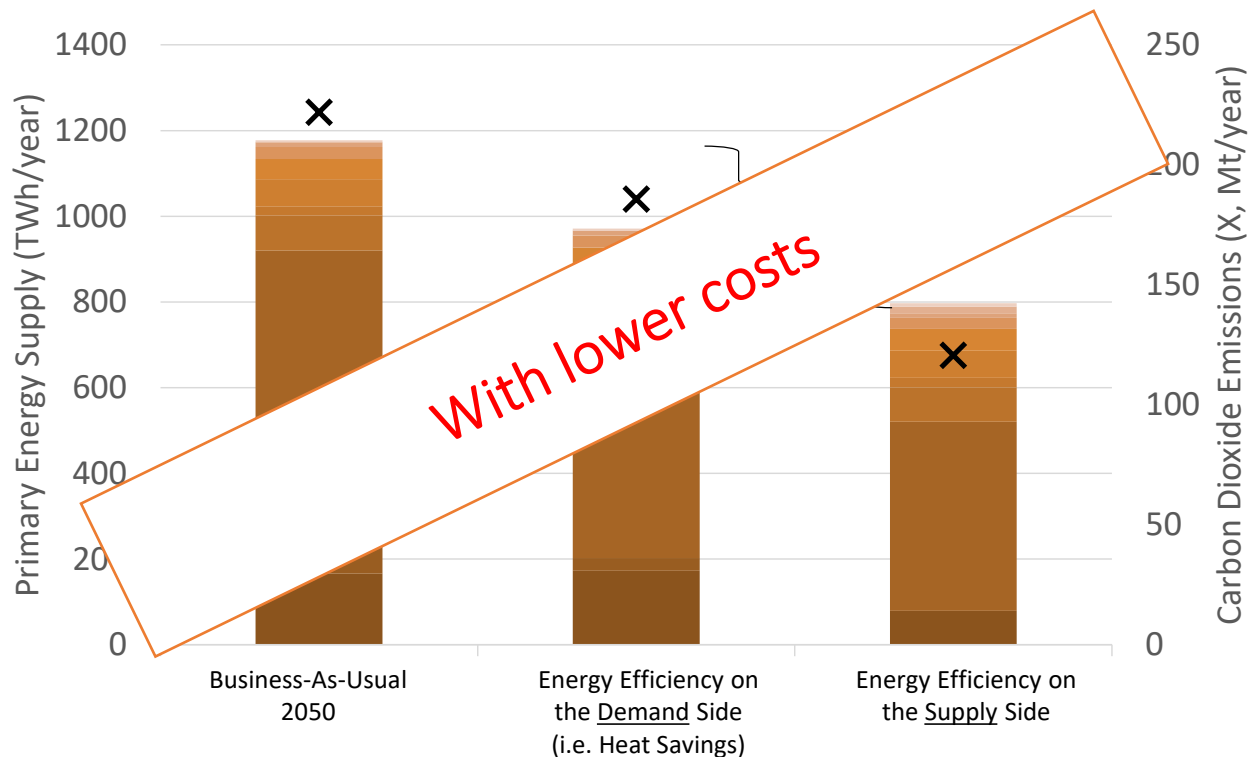


## Energy Efficiency on Both Sides Can Save Similar Levels of Energy & CO2



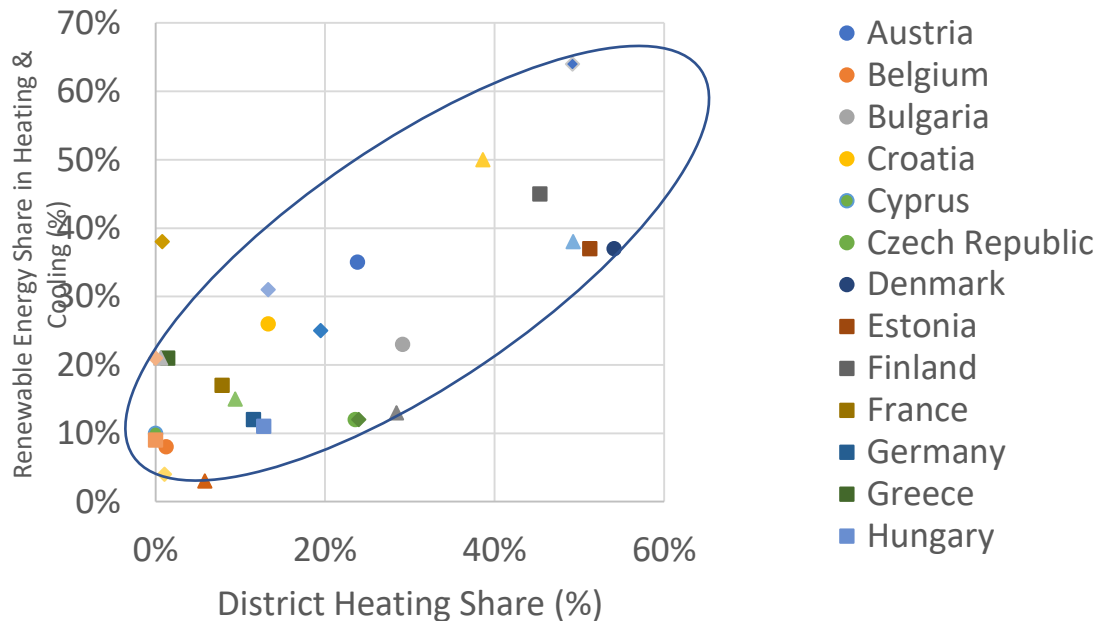


## Energy Efficiency on Both Sides Can Save Similar Levels of Energy & CO2



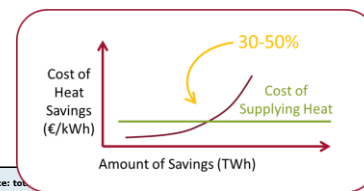
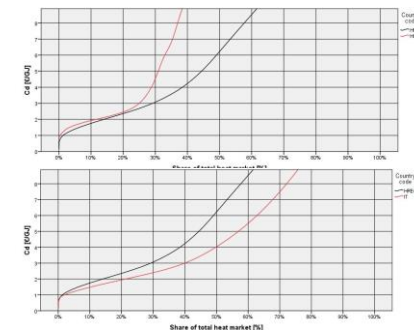
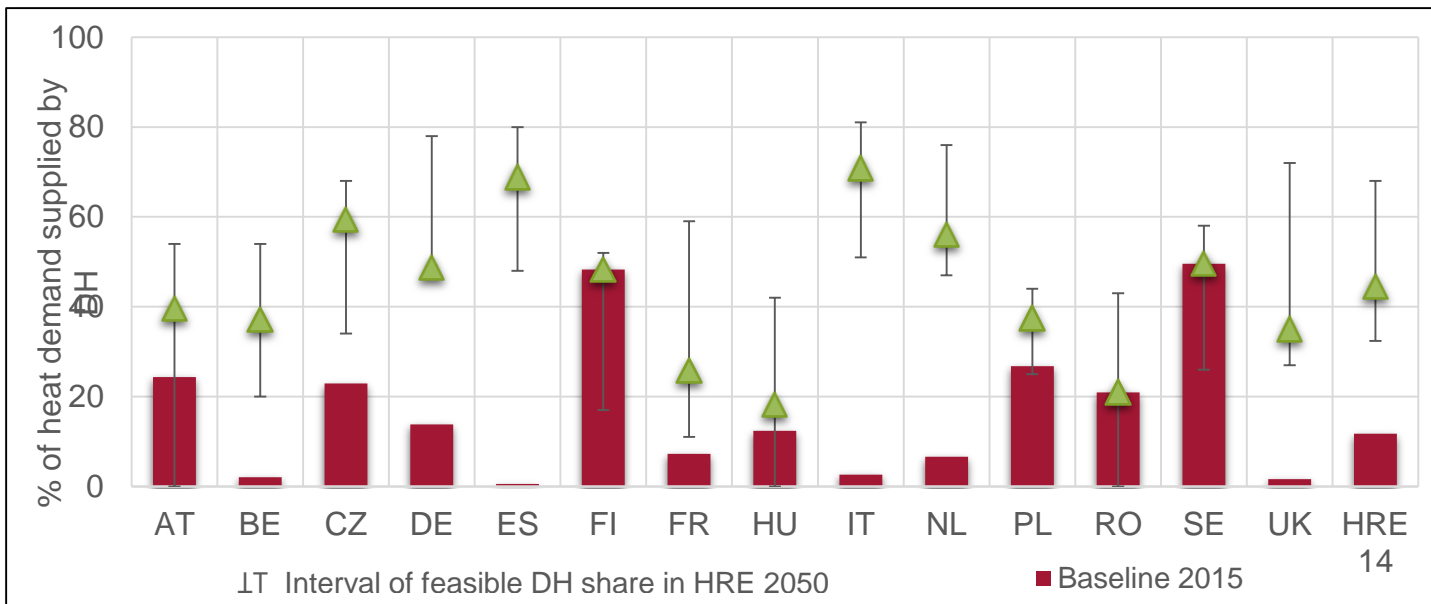


## Proven Technology! Renewable Energy vs. District Heating





## Recommended district heating levels in Europe



Amount of Savings (TWh)							
France: to energy system costs (M€/year)		a 30% reduction already in the Baseline)					
Percentage of market share covered by DH	0%	0	5%	10%	15%	20%	
	0%	175532	175582	175266	175452	175883	175978
	5%	175219	175263	174932	175104	175529	175608
	11%	174875	174898	174548	174699	175099	175162
	18%	174566	174570	174197	174329	174706	174752
	26%	174327	174317	173922	174037	174394	174418
	34%	174197	174168	173752	173852	174191	174200
	42%	174190	174142	173709	173789	174107	174101
	51%	174400	174334	173878	173940	174240	174216
	59%	175121	175038	174562	174604	174885	174844
68%	176559	176454	175961	175986	176246	176185	
	79%	185811	185799	185725	185781	185824	185841



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

www.heatroadmap.eu  
@HeatRoadmapEU



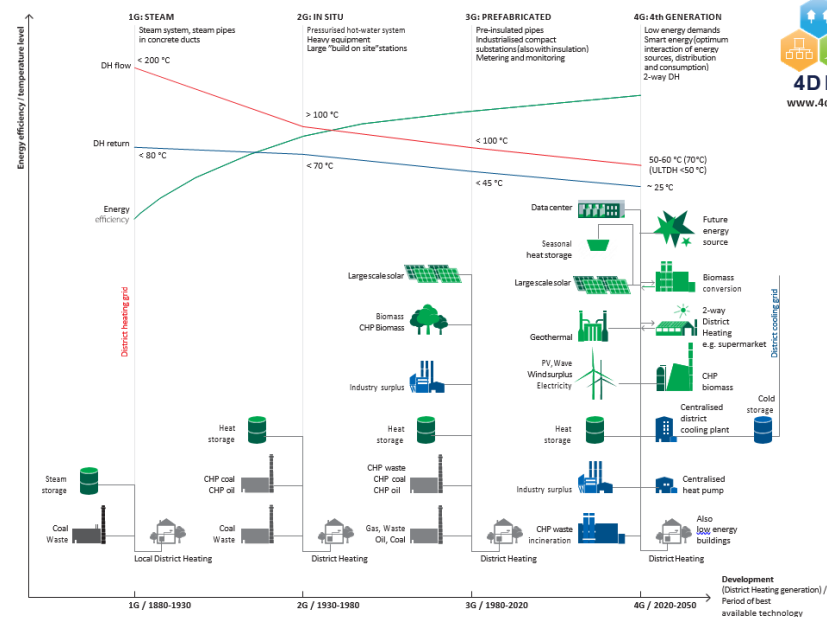
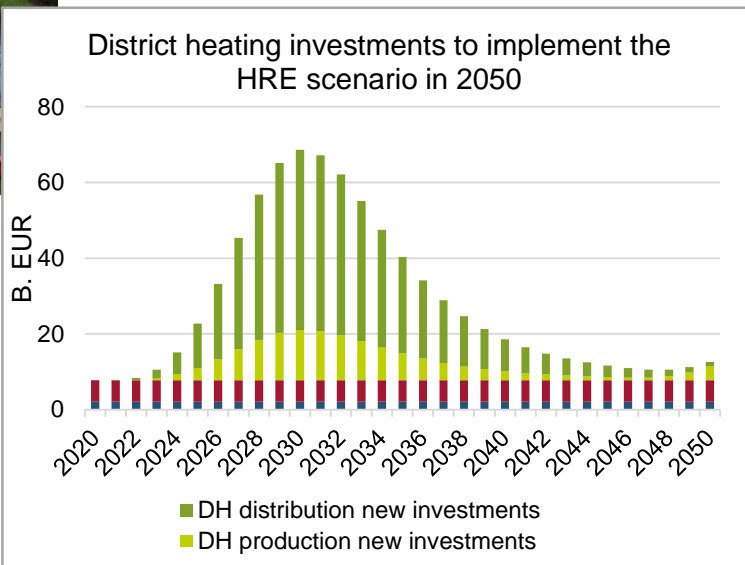


# Roadmap: heat sector investments towards 2050



Towards a decarbonised heating and cooling sector in Europe

Unlocking the potential of energy efficiency and district energy





# What is the challenge?

- According to the European Climate Foundation the Energy Union EEFP can be explained as:
  - *Efficiency First is the fundamental principle around which EU's Energy System should be designed. It means considering the potential value of investing in efficiency (including energy savings and demand response) in all decisions about energy system development - be that in homes, offices, industry or mobility. Where efficiency improvements are shown to be most cost-effective or valuable, taking full account of their co-benefits, they should be prioritized over any investment in new power generation, grids or pipelines, and fuel supplies. In practice, Efficiency First means giving EE a fair chance in the models and impact assessments that policy-makers use to make decisions, strengthening those laws that already target efficiency, and integrating it into all other Energy Union policies. That includes funding decisions and infrastructure planning. Applying this principle will help to correct the persistent bias towards increasing supply over managing demand, a bias towards increasing supply over managing demand, a bias which has impeded Europe's ability to create a least-cost, jobs-rich, low-carbon energy system.*
- Key questions:
  - How do we prioritise energy efficiency measures today that also have an effect in the future?
  - What are the supply chain effects of energy savings in future energy systems?
  - What does the future look like?

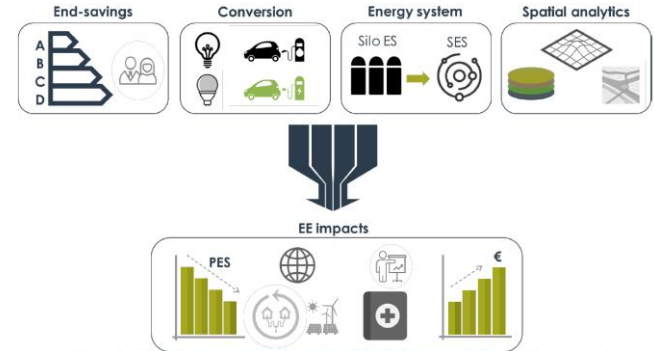


Figure 2. Make EE more operational by using sEnergies' improved EE-modelling approach

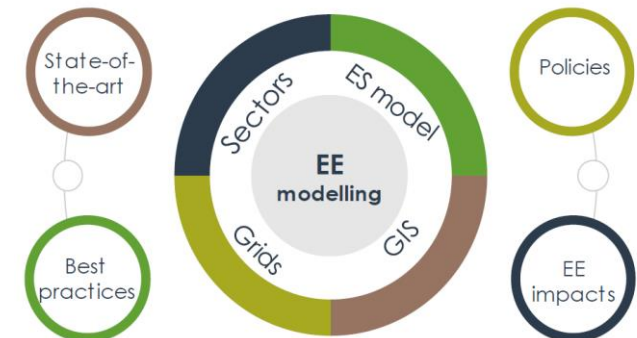


Figure 3. Overall concept of sEnergies' novel EE modelling approach



# Thank you for your attention – Questions?

<a href="http://www.brianvad.eu">www.brianvad.eu</a>	<a href="http://www.energyplan.eu/building">www.energyplan.eu/building</a>	<a href="https://ida.dk/om-ida/temaer/klimasvar">https://ida.dk/om-ida/temaer/klimasvar</a>
<a href="http://www.EnergyPLAN.eu">www.EnergyPLAN.eu</a>	<a href="http://www.energyplan.eu/smartenergysystems/">www.energyplan.eu/smartenergysystems/</a>	<a href="http://www.heatroadmap.eu">www.heatroadmap.eu</a>
<a href="http://www.energyplan.eu/SmartEnergyEurope">www.energyplan.eu/SmartEnergyEurope</a>	<a href="http://www.4DH.eu">www.4DH.eu</a>	<a href="http://www.energyplan.eu/solar">www.energyplan.eu/solar</a>

## Roadmap for achieving the 70% 2030 greenhouse gas emission reduction target in Denmark

- Keynote, INTERNATIONAL CONFERENCE ON GREEN DIGITALIZATION

**Brian Vad Mathiesen, Aalborg University**

*Kolding/Online, November 11th 2020*



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