2050 Heat Roadmap Europe

A low-carbon heating and cooling strategy

From HRE results to governance requirements

realizing innovative district approaches & recommendations for Germany

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Energy context of Germany

Energy demand

- **Total final energy demand (FED)** *[1]*:

  2 467 TWh (**19,6% of EU28**)

  - ***Highest*** *among all EU countries*

- **FED from renewables** *[2]* :

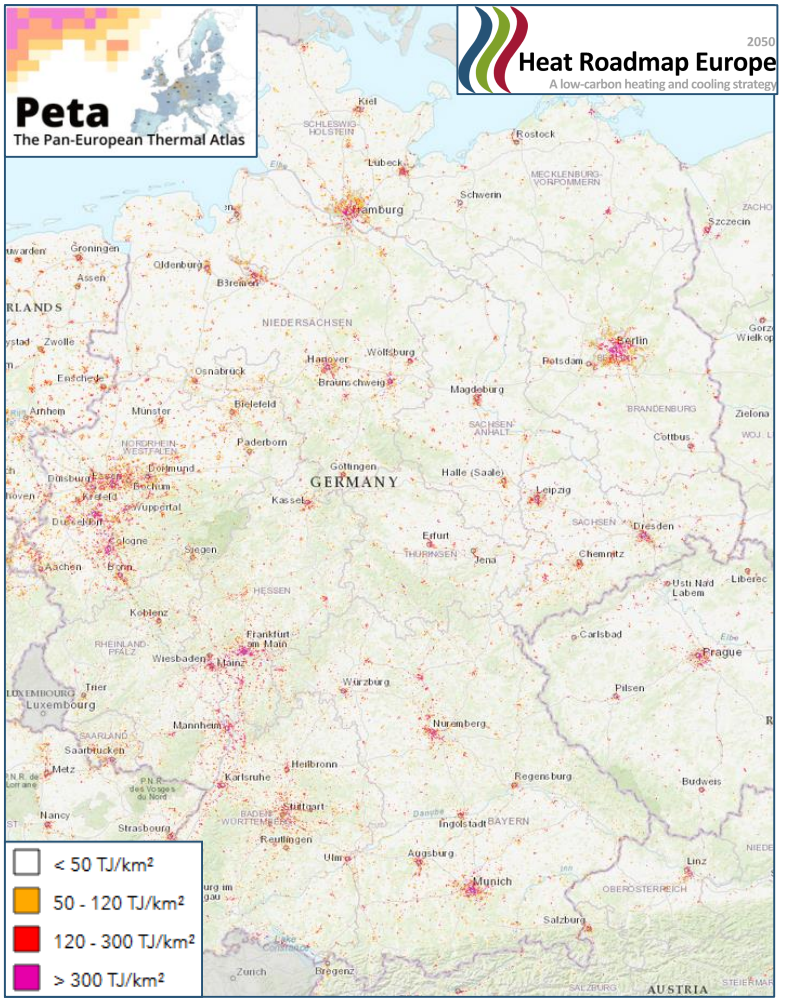
  360 TWh (14,6% of total FED)

  - *9th highest of 14HRE (**18th** of EU28)*

- **FED-H&C from renewables** *[2]*:

  177,9 TWh (12,9% of total H&C)

  - *11th highest of 14HRE (**22nd** of EU28)*



***Heat Demand Density**, only for residential and service sectors, from Peta4 showing major population centres [HRE4, 2018]*

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1. Eurostat's 2015 data on annual energy quantities in Germany
2. Eurostat's RES Shares 2015 results

Climate and emissions

- Germany has committed to reduce GHG emissions by 40%[1] by 2020, compared to 1990

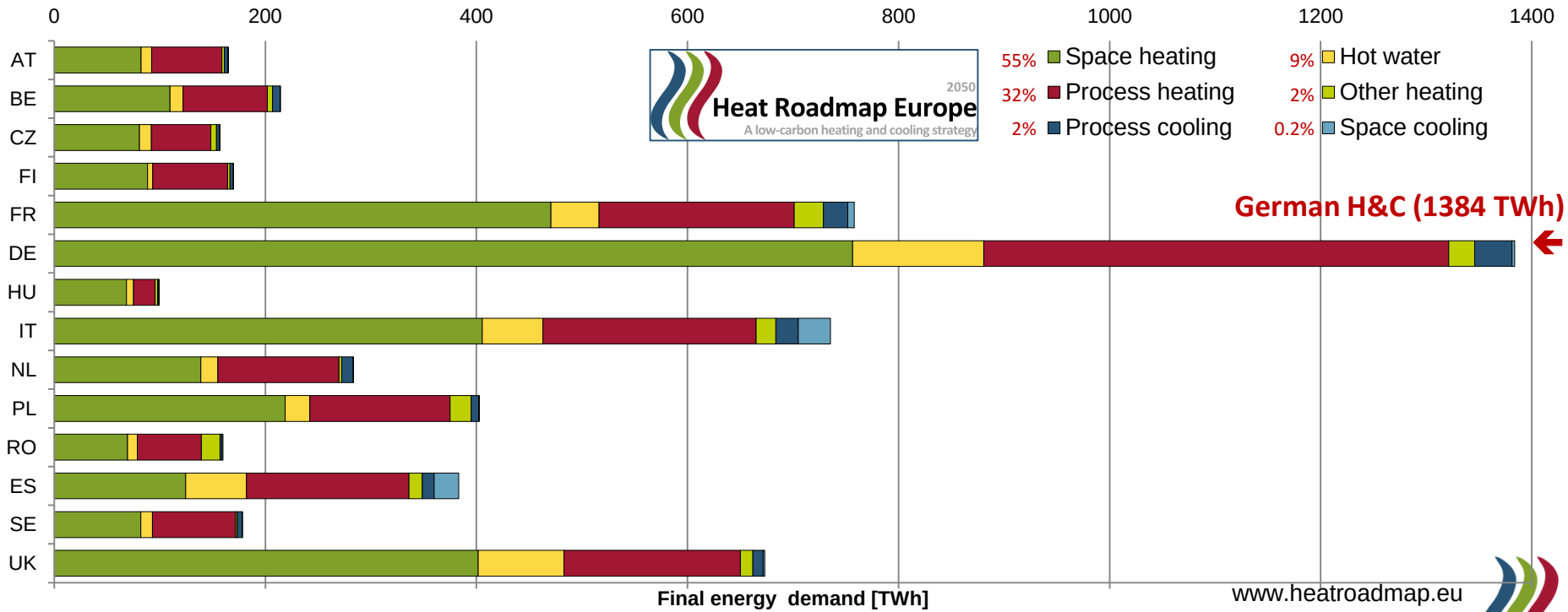
Carbon per capita [kg CO_2/person]	**Carbon per GDP** [ton CO_2/billion EUR]	**Carbon Emission per tonne of energy carrier (carbon intensity)** [kg CO_2/toe]
10 117	299	2 611
The highest among the 14 HRE	*5th highest among the 14 HRE*	*2nd highest among the 14 HRE*
data [2]		

1 German Federal Ministry for the Environmental, Nature Conservation, Building and Nuclear Safety (BMUB)
2. DG Energy's 2014 data from the German datasheet (2016)

Current national H&C situation

H&C in Germany and 14 HRE countries

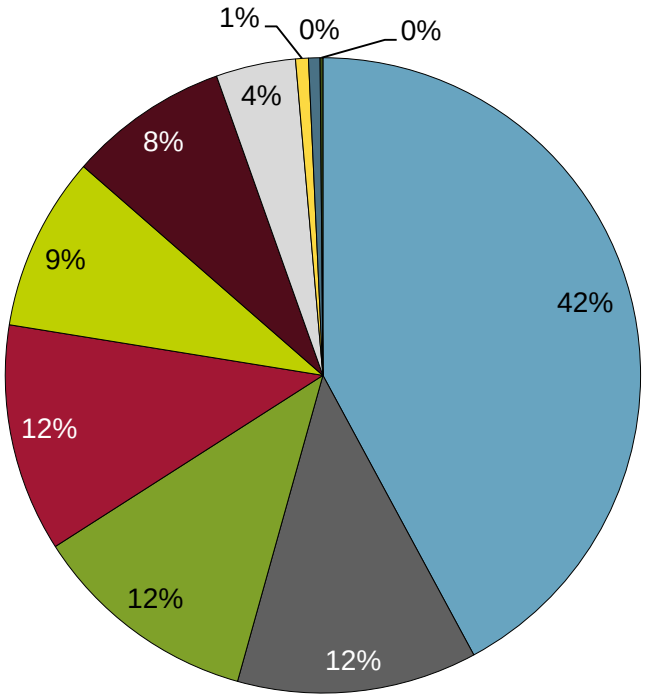
- Among EU countries, Germany has the **highest** FED-H&C
  - H&C is **56%** of Germany's total FED (1,38 PWh)
- As with most countries, German H&C is dominated by **space and process heating**, and **little cooling demand** at the moment (mainly process cooling), but this is rising all across the EU



* All the graphs in this section come from HRE's H&C baseline profiles (based on 2015 data)

German H&C energy carriers

- Germany accounts for **22%** of the EU28's total delivered H&C demand.
- Compared to the EU28, it uses **more oil**, **less biomass** and **less electricity** for H&C.



EU28 H&C (6352 TWh)

Gas
Oil
Biomass
Electricity
District heating
Coal
Others (fossil)
Solar thermal
Heat pumps
Others (RES)

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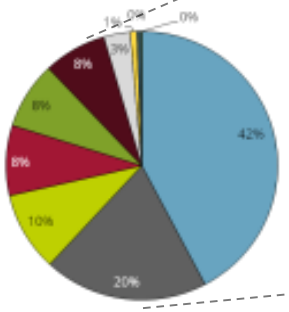
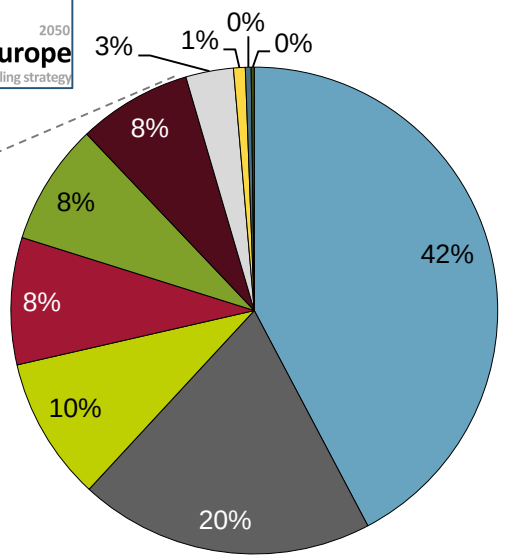
A low-carbon heating and cooling strategy



Germany H&C (1,384 TWh)



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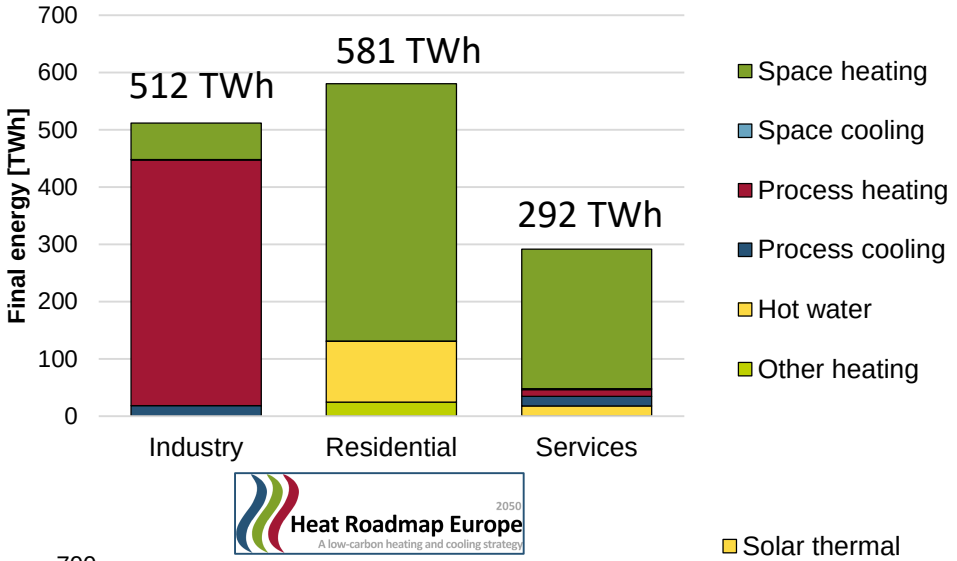
H&C breakdown among sectors



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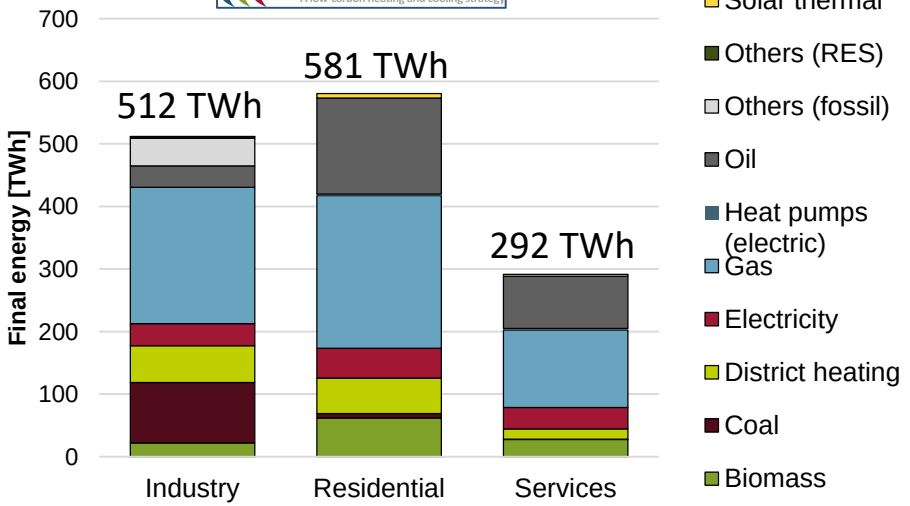

- German industries are overwhelmingly dominated by **process heating** (72%), the built environment by **space heating** (81%).
- All sectors rely (too) much on fossil fuels, especially **gas**, while industry also relies on **coal** (19%) and the other sectors on **oil** (27%).
- **District heating** plays a minor role so far (8%), mainly in households

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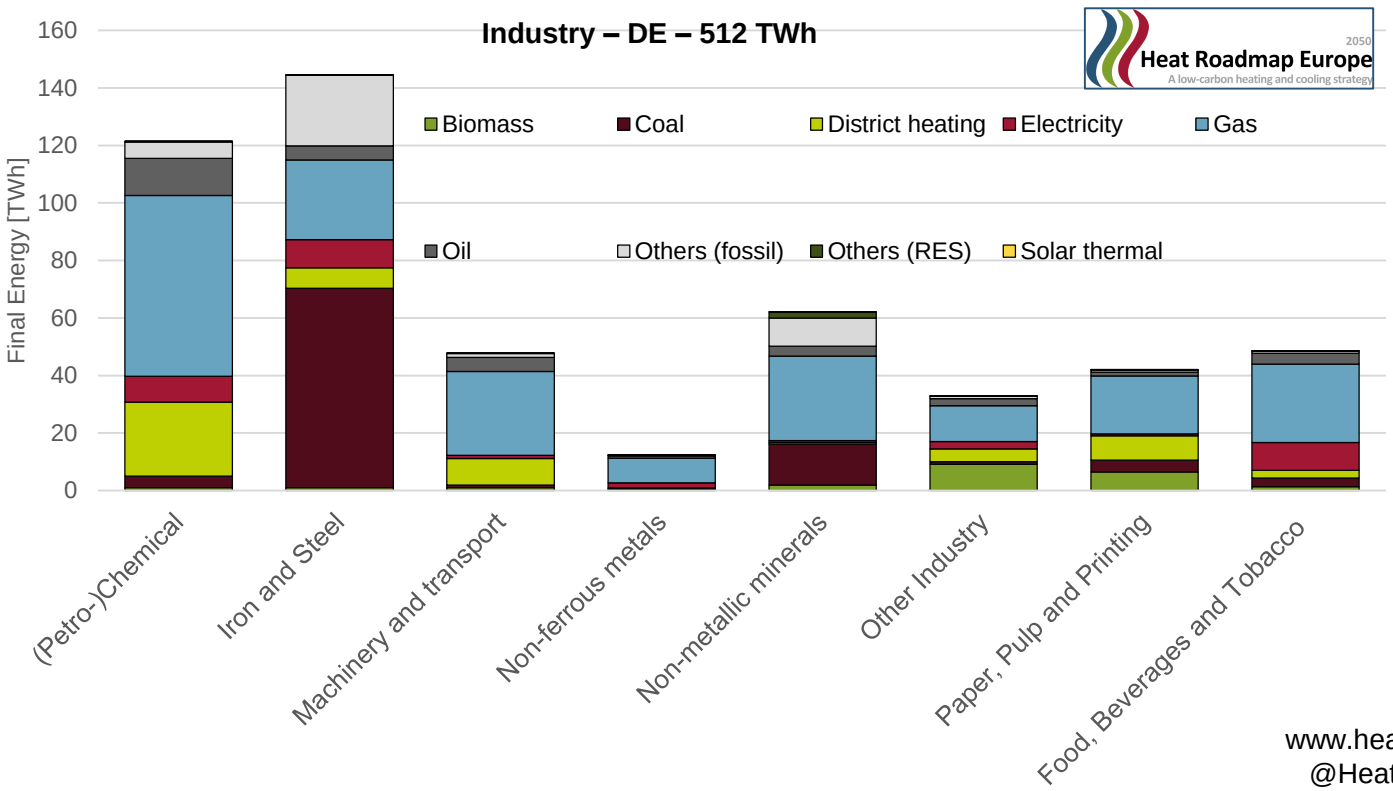
H&C breakdown among industries

- **Fossil fuel** dependence for high temperature processes.
- Paper and “other” are industrial leaders in using **biomass** (22%)
- (Petro-)Chemical uses more **DH** (18%) than other industries
- *Are there some industries which could use alternatives?*



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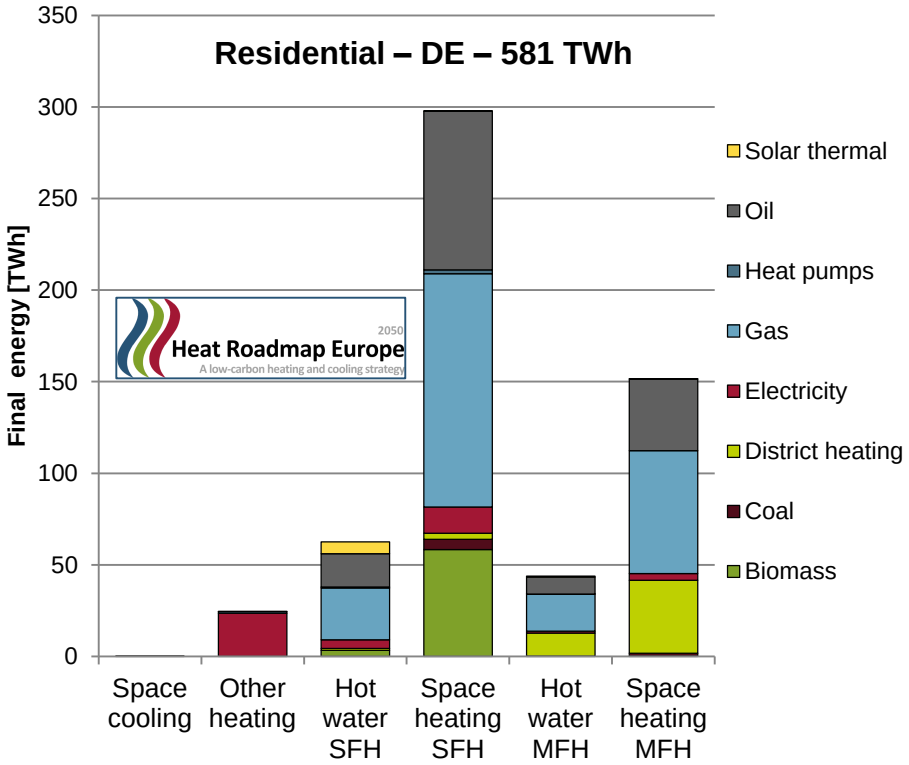
H&C breakdown in the built environment

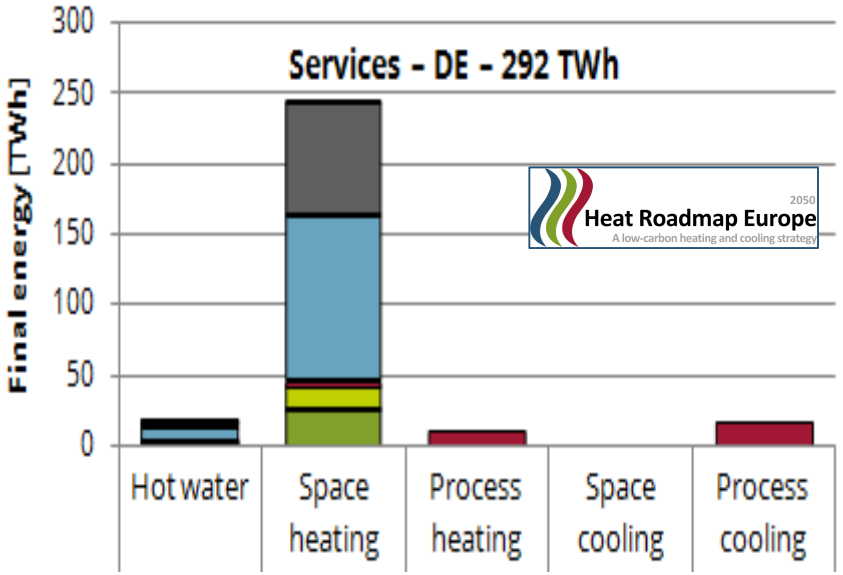
Residential:

- **SFHs** have the most demand
- But **DH** (11%) mostly just for some MFHs



Services:

- **DH** (9%) mostly for space heating
- All H&C **processes** covered by electricity only



Besides reducing demand, how to supply better H&C?

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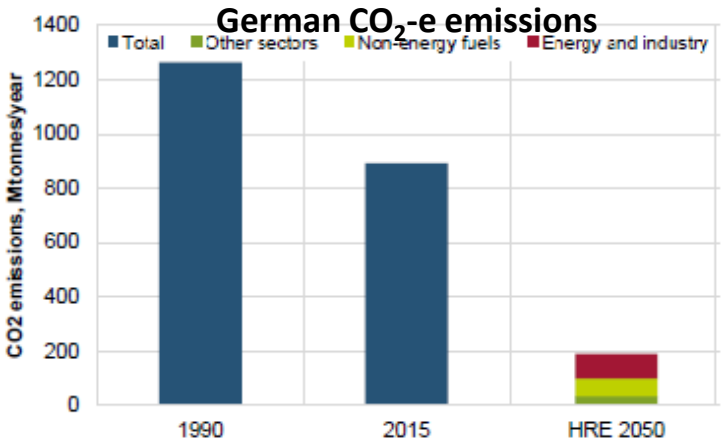
HRE pathway forward for Germany

Heat Roadmap Germany

- HRE4 suggests a **deep decarbonisation** pathway for the German energy system by 2050 which is **technically feasible** and **economically viable**
- *How deep?*
  - **85% CO_2-e reductions** (compared to 1990)
  - In line with Germany's 2050 ambitions
- *How cheap?*
  - Net annual savings of **€18 billion**
- *How now?*
  - Possible using **proven technologies already deployed** in Germany and Europe
  - Needing **no new nuclear or coal** power plants, and **without CCS** at all



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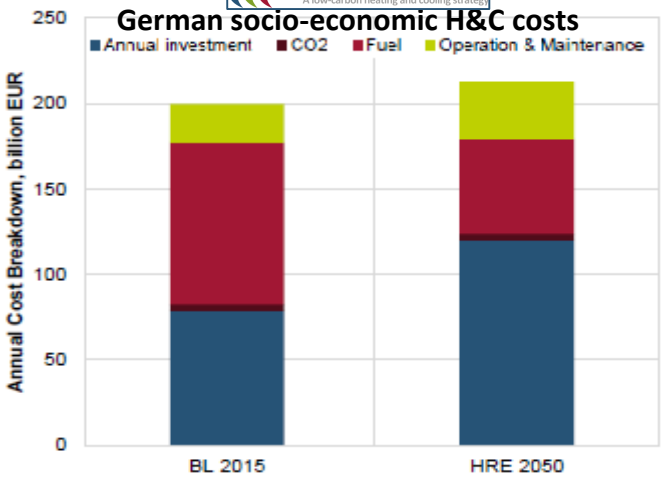

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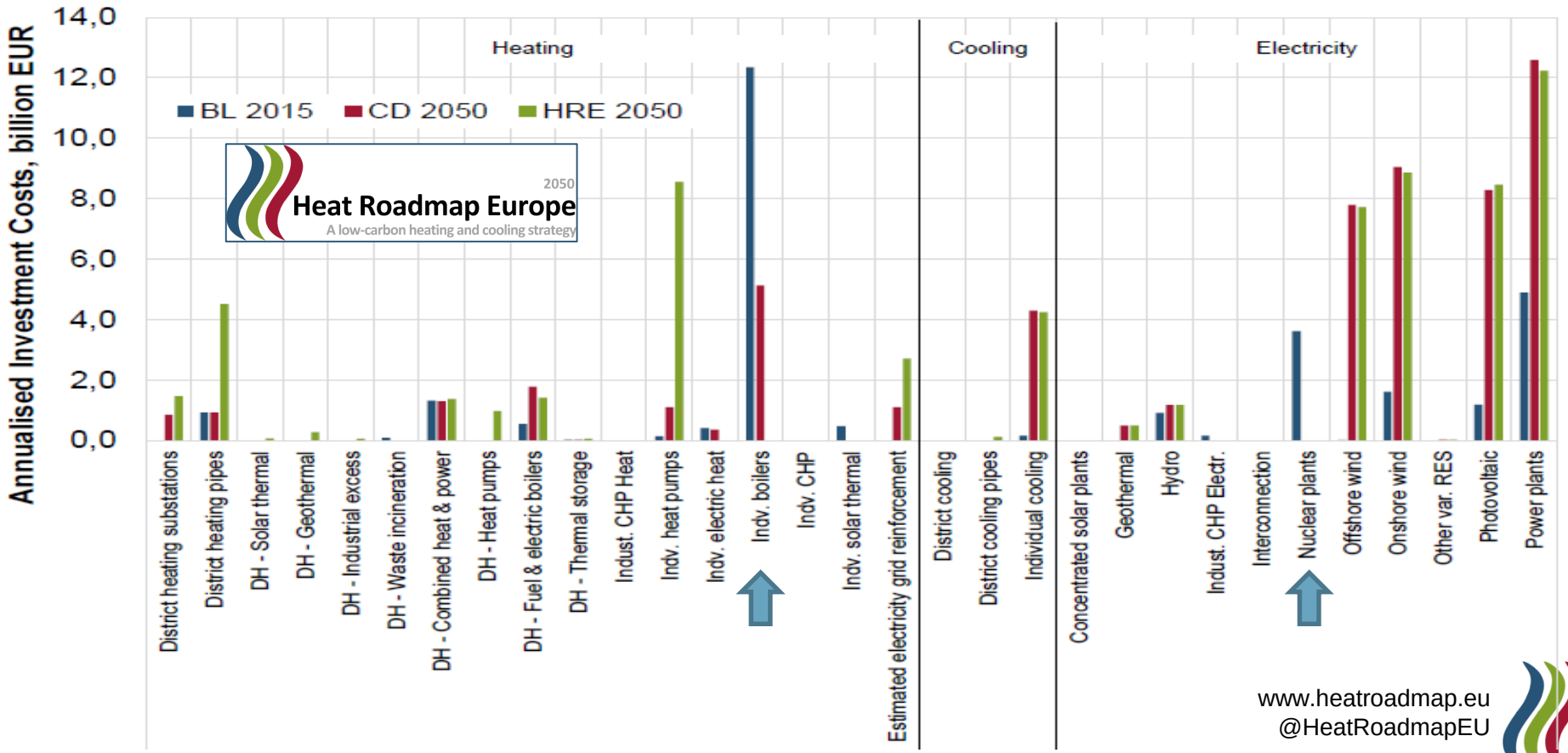
* All the graphs in this section come from HRE's Heat Roadmap Germany (2018)

3 “easy” steps to decarbonise!

1. Save energy (*~2/3 of costs*)
2. Low-carbon energy
3. (De)Centralised systems



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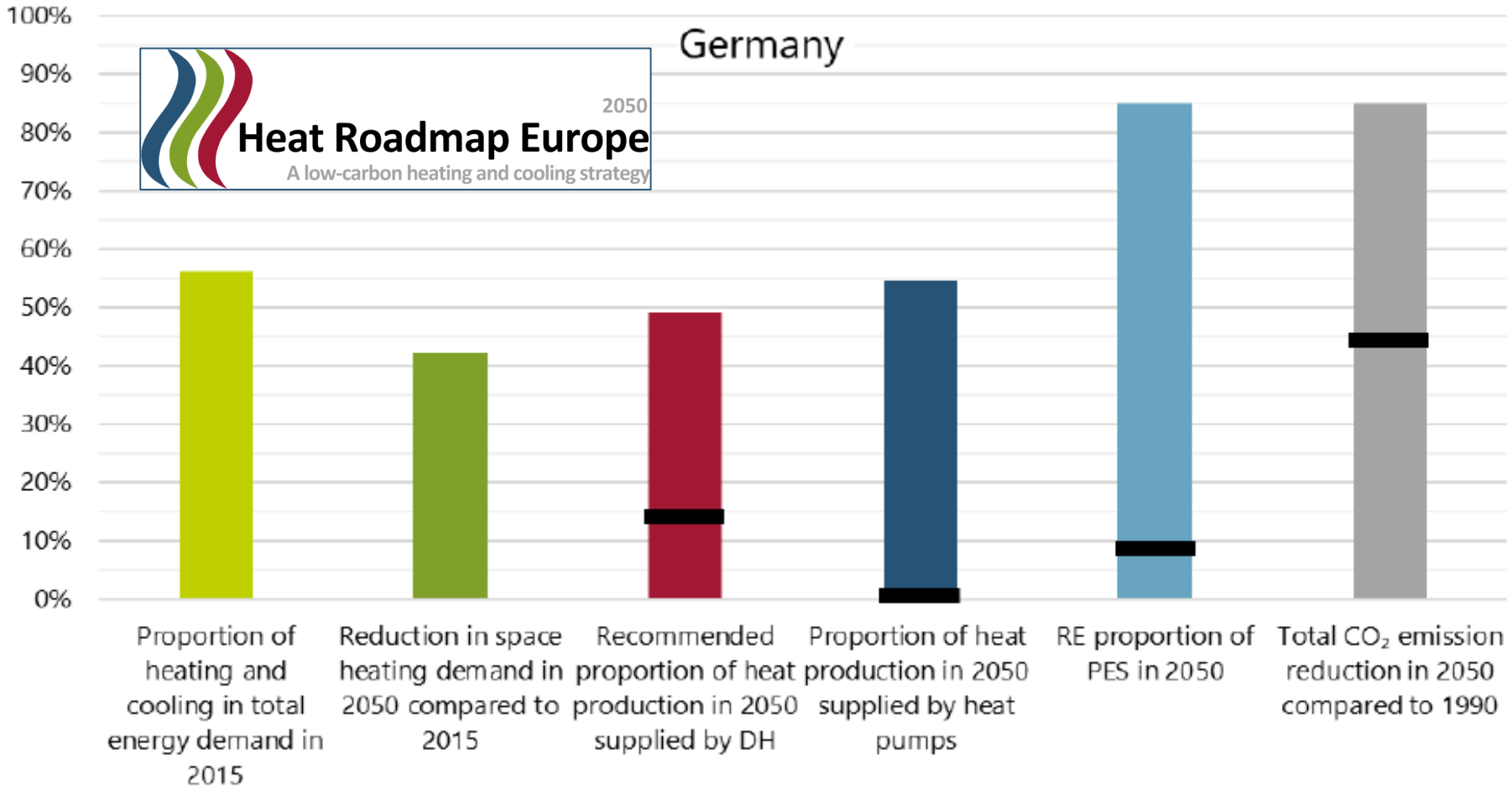
Heat Roadmap Germany - scenario



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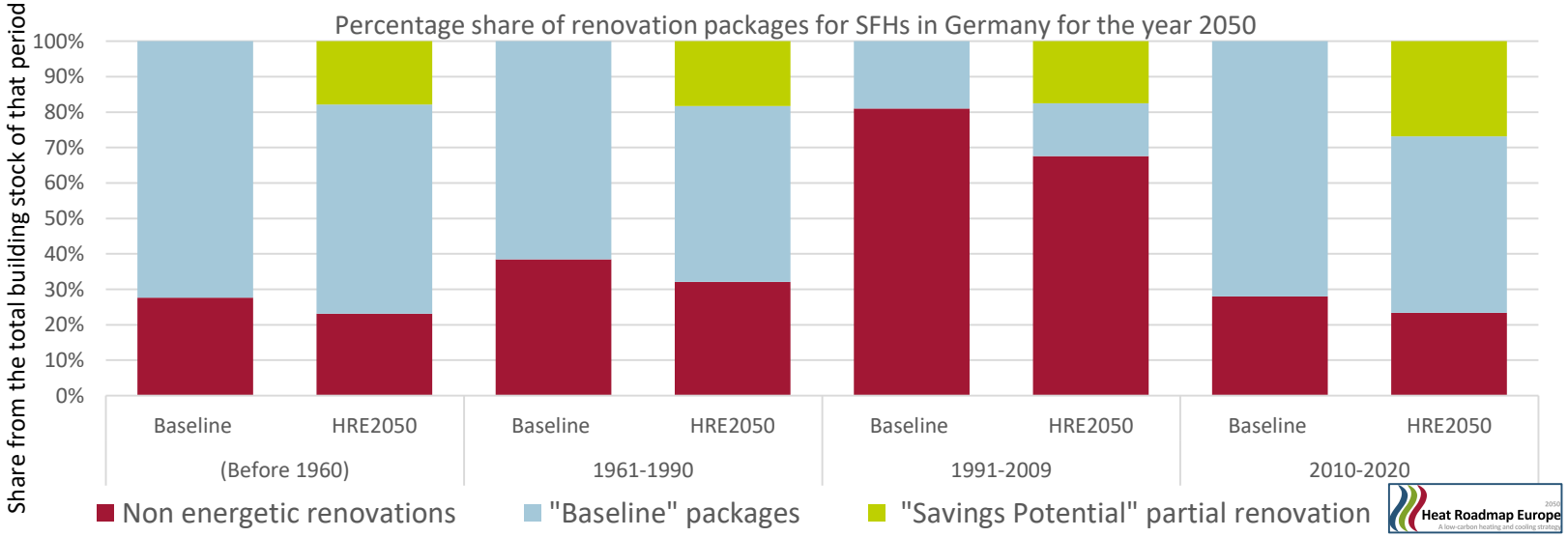
* All the graphs in this section come from HRE's National-level Guidelines for the Energy System Transition (2018)

Pillar 1: Energy efficiency savings

- End-use savings on **space heating** (especially in the built environment), should aim for ~**40%**
  - **Doubled rates** of refurbishment (1,5-2%)
  - **Deeper renovations** than now planned
  - More efficient **demands** ⇨ more efficient **supplies** possible



- Need to ensure ambitions with **follow-through** on the ground, in particular **industrial** – to widen focus traditionally mainly oriented towards savings in (residential) space heating

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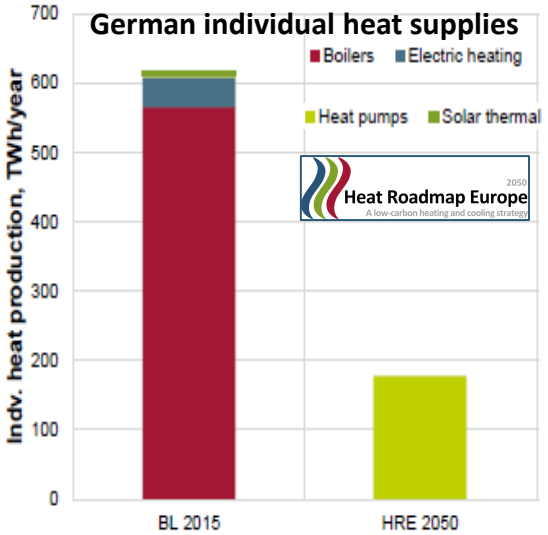
* All the graphs in this section come from HRE's Cost curves for Germany (2018)

Pillar 2: Low-carbon H&C supplies

Heat pumps

- HPs are ideal, decentralised solutions for **less-urbanised** areas
- Also **large heat pumps** very beneficial for DH
- From Germany's current negligible levels ⇨ **40-50%** coverage of demand (especially in rural and disperse suburbs)



- Proliferation of heat pumps will necessitate some increases in the levels of **electrification** planned for Germany
  - effectively supports the **integration of fluctuating RES** into the electric grid, especially if combined with (thermal) storage options
- Strong need remove **financial/administrative barriers** to encourage a switch, especially for homes and businesses now using individual (fossil-fuel) boilers to **invest in heat pumps**

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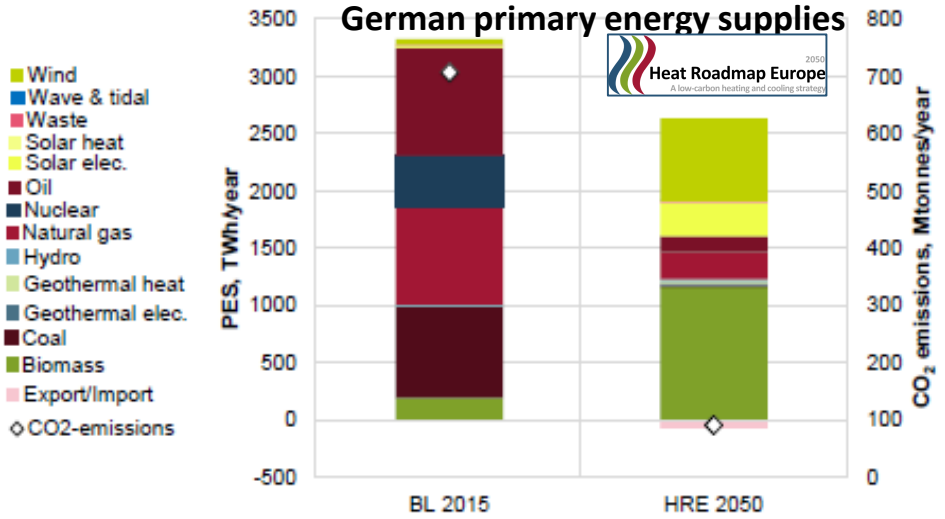
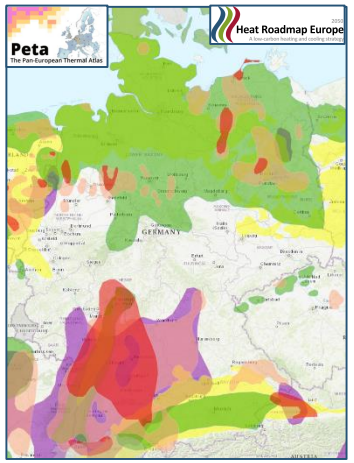
* All the graphs in this section come from HRE's Heat Roadmap Germany (2018)

Renewable energy sources



- **85%** of primary energy in Germany could be from RES, as compared to ~9%
- In terms of **DH**, RES inputs mainly biomass for CHP, geothermal and solar thermal

- RES also foreseen to greatly increase its share in **power** production (e.g. ~33% from power plants as largest consumers of biomass, 44% from wind and 18% from PV), supported by **synergies with the H&C** sector:
  - **Fluctuating RES** electricity (e.g. solar and wind) can be better integrated via **heat pumps** and (thermal) **storage**, as well as e-vehicles and e-fuels



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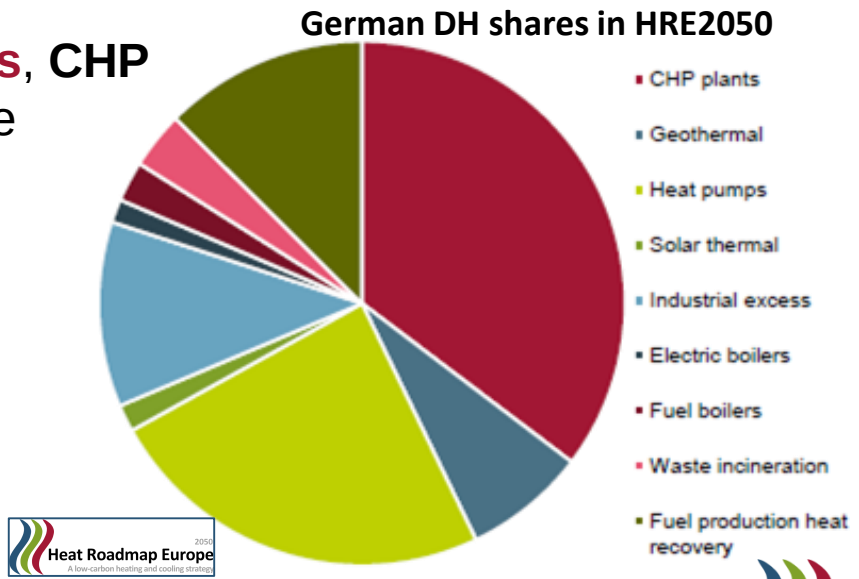
* The above graph comes from HRE's Heat Roadmap Germany (2018), and the geothermal map from its *Peta4*

Pillar 3: Thermal grid expansions

- Significantly **increase DH** levels 14% ⇨ **48-79%** of demand
- Focus on implementing/financing DH:
  - switching from **gas** networks and individual **boilers** – no direct burning of fossil fuels at all
  - using DH for **low-temperature processes** (industrial and commercial)
  - 25-35% each of large **heat pumps**, **CHP** and **excess heat**, as well as some **geothermal**, **solar thermal**, etc.
- Switch to **district cooling** solutions, especially for the built environment, to match this as the fastest-growing demand (~3x)
- **Thermal storage** (seasonal and short-term) important for optimising grids



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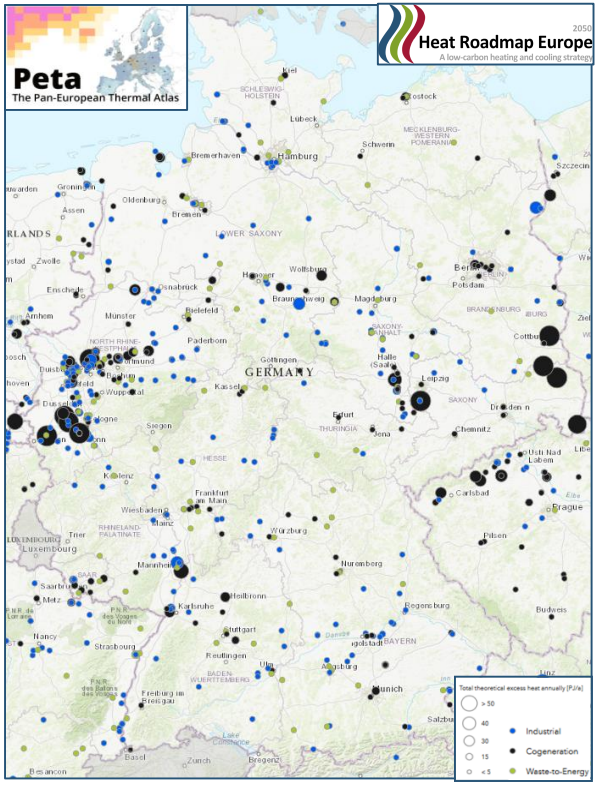
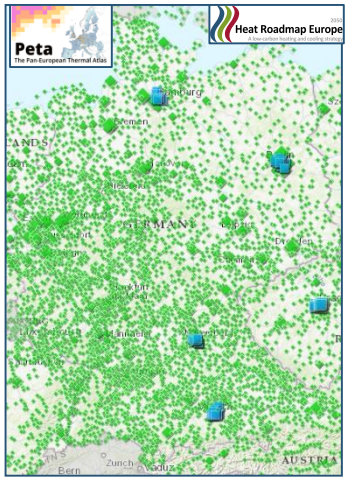
Integration of excess heat

- Identify **suitable excess heat** options from industrial and commercial sectors
  - factories, refineries, power plants, waste incineration…
  - wastewater treatment , underground metro stations , data centres…
- Excess heat fed into grids to cover ~**27% of DH needs**
- There remains a need to still **reduce financial / administrative** barriers in order to integrate excess heat into DH
- Strong potential for **Heat Synergy Regions** to develop to synergise demand with resources
  - Case in point: **Essen**





*Conventional **excess heat** sources (left), and low-temperature excess heat sources (below), from Peta4 showing major facilities [HRE4, 2018]*

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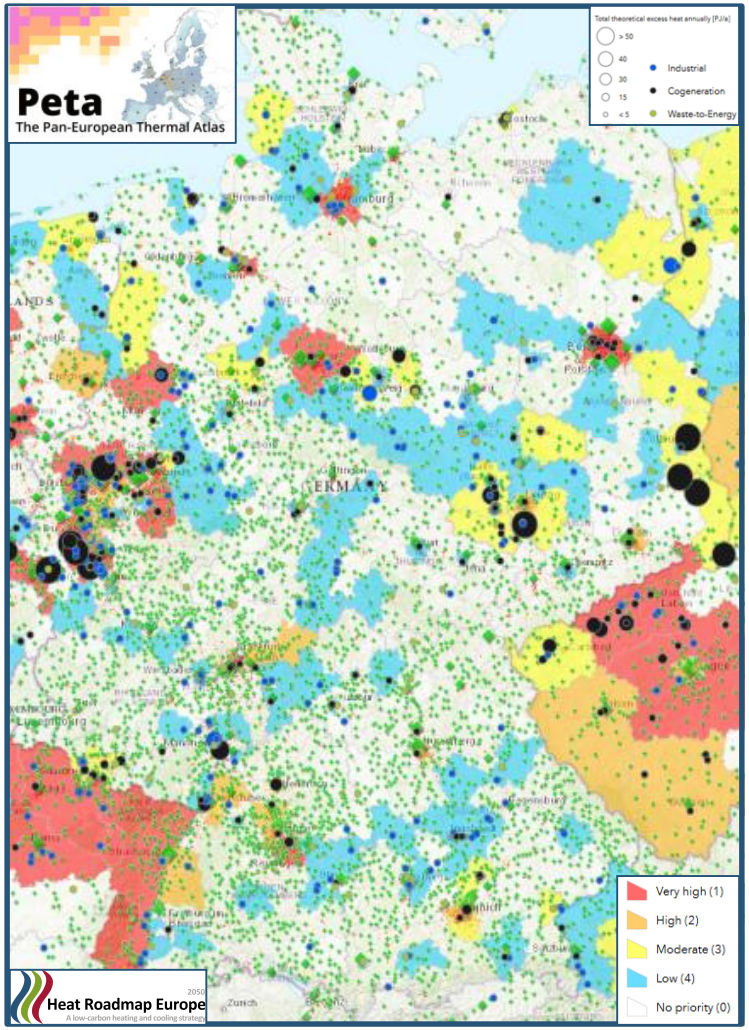
* All maps in this section come from HRE's *Peta4 (Pan-European Thermal Atlas) [HRE4, 2018]*

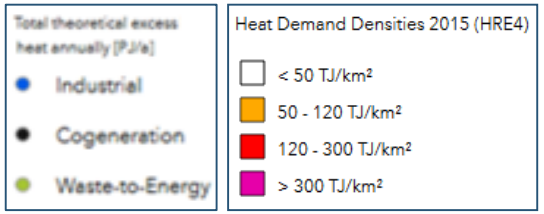
Heat Synergy Regions

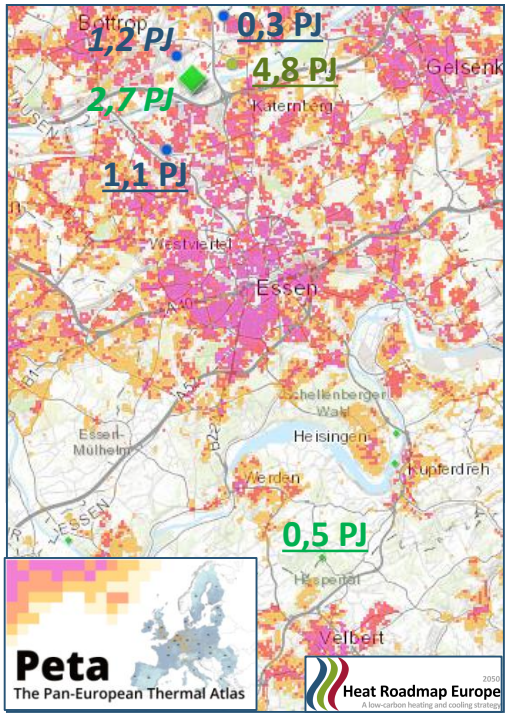


- HSRs: bringing energy from a wider region to the demand centres where it can be used
  - Though energy demands and supplies are each (relatively) discrete, energy flows do not need to be.
- *Why not look beyond current administrative borders for synergies?*
  - **Balance** supply and demand
  - Increase energy system **flexibility**
  - Create new economic **opportunities**
- There is a need for administrative / political **frameworks** to support multi-jurisdictional cooperations and management

***Heat Synergy Regions**, conventional **excess heat** sources (left), and low-temperature excess heat sources (below), from Peta4 showing major facilities [HRE4, 2018]*

Essen





Essen:

- Active member of HRE's **Cities and Regions Interest Group**
- **Green Capital** of Europe
- **half million** residents
- context of **Ruhrgebiet**, ~5 mill.
- **0,8 PJ** of biowastes

Essen's total **heat demand** (HD): **16,5 PJ**

- HD < 20 TJ/km²: 0,17 PJ
- HD 20-50 TJ/km²: 0,25 PJ
- HD 50-120 TJ/km²: 2,7 PJ
- **HD 120-300 TJ/km²: 6,1 PJ (37%)**
- **HD > 300 TJ/km²: 7,3 PJ (44%)**

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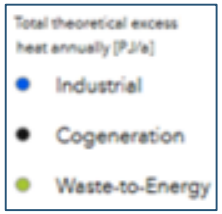

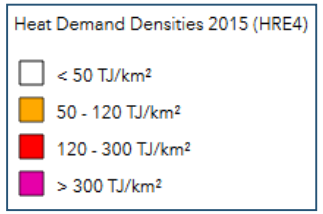

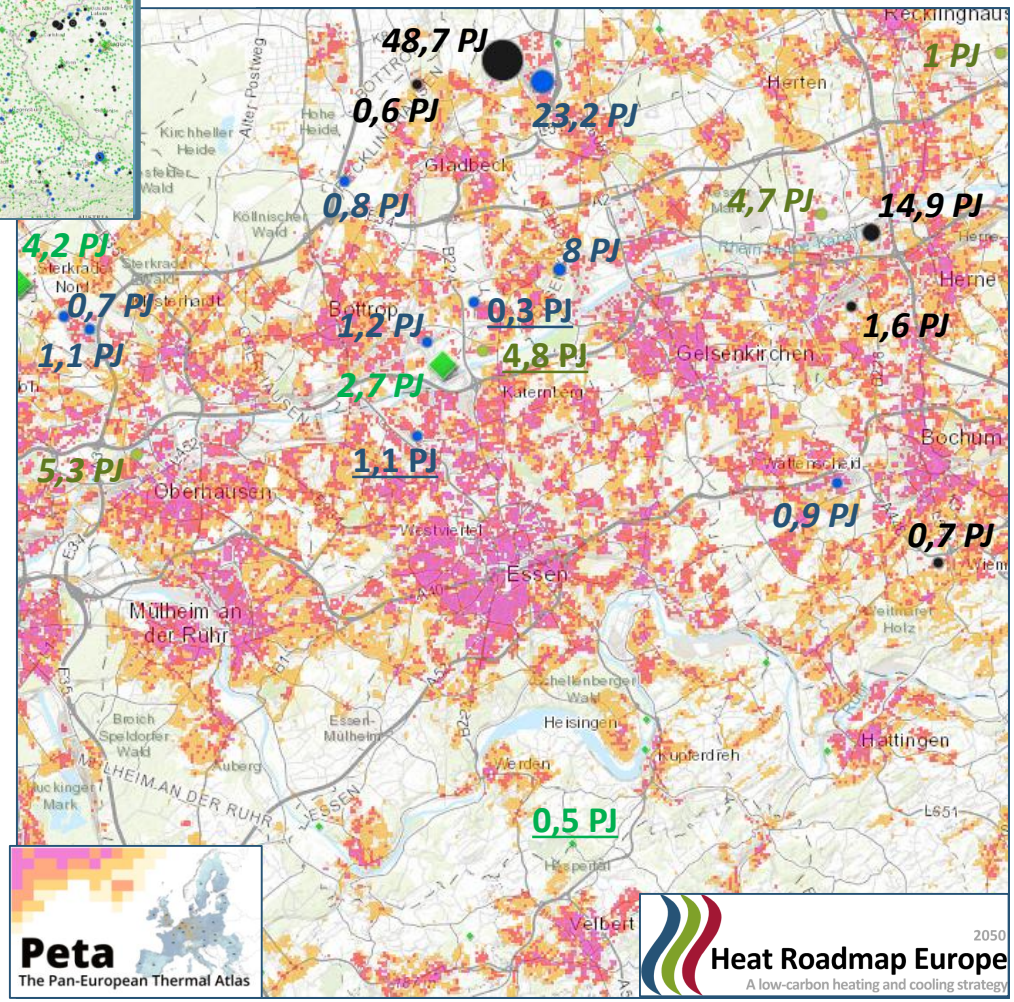

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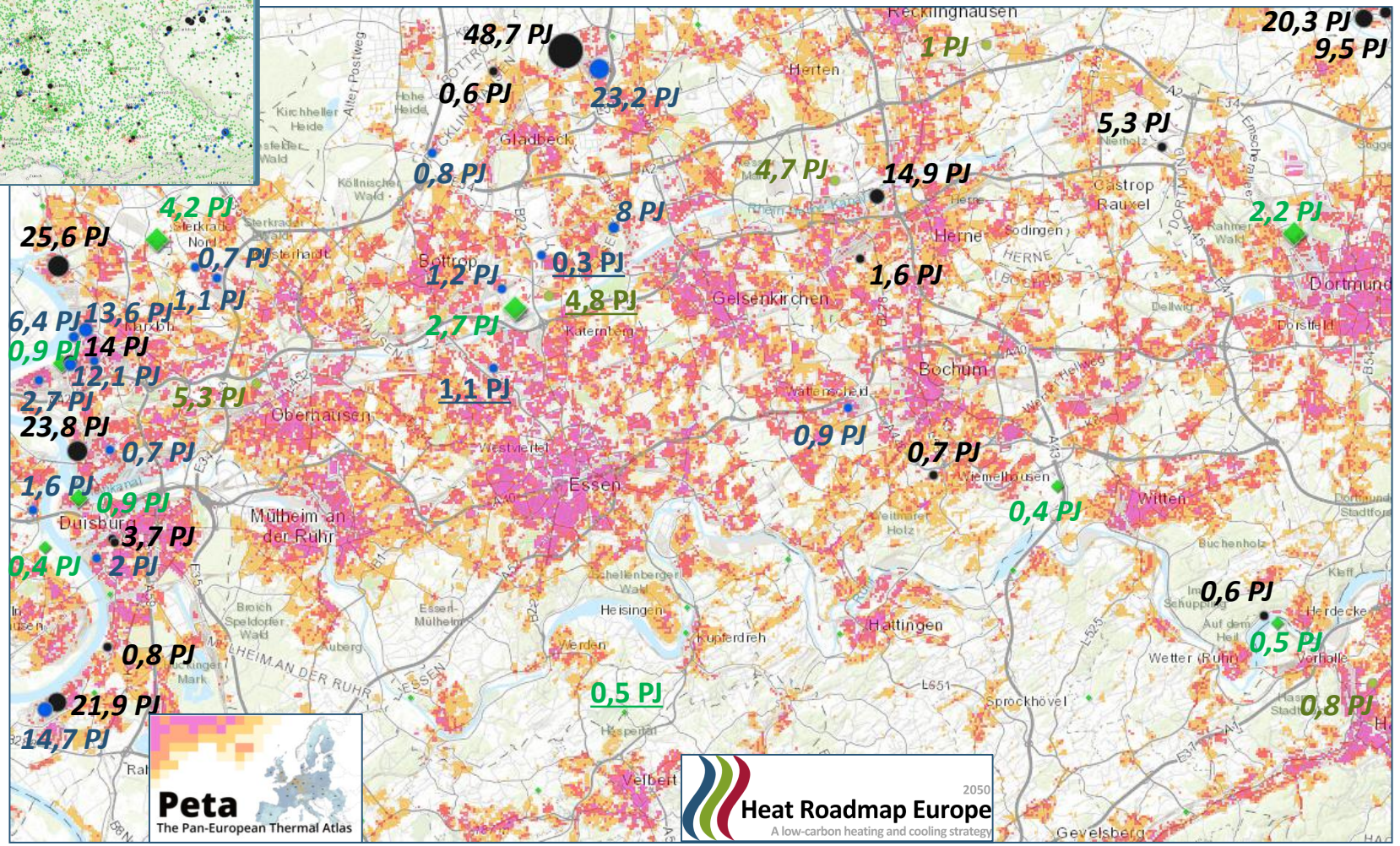
Essen



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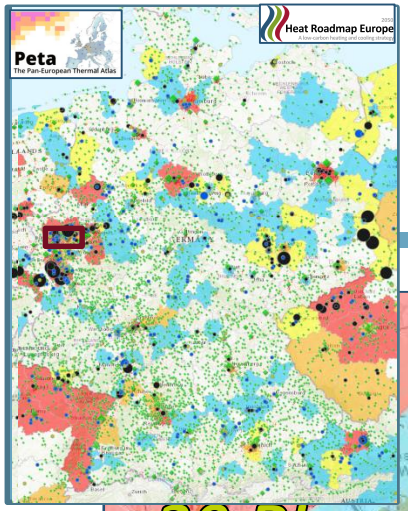
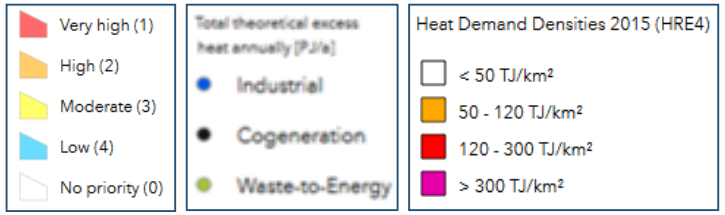
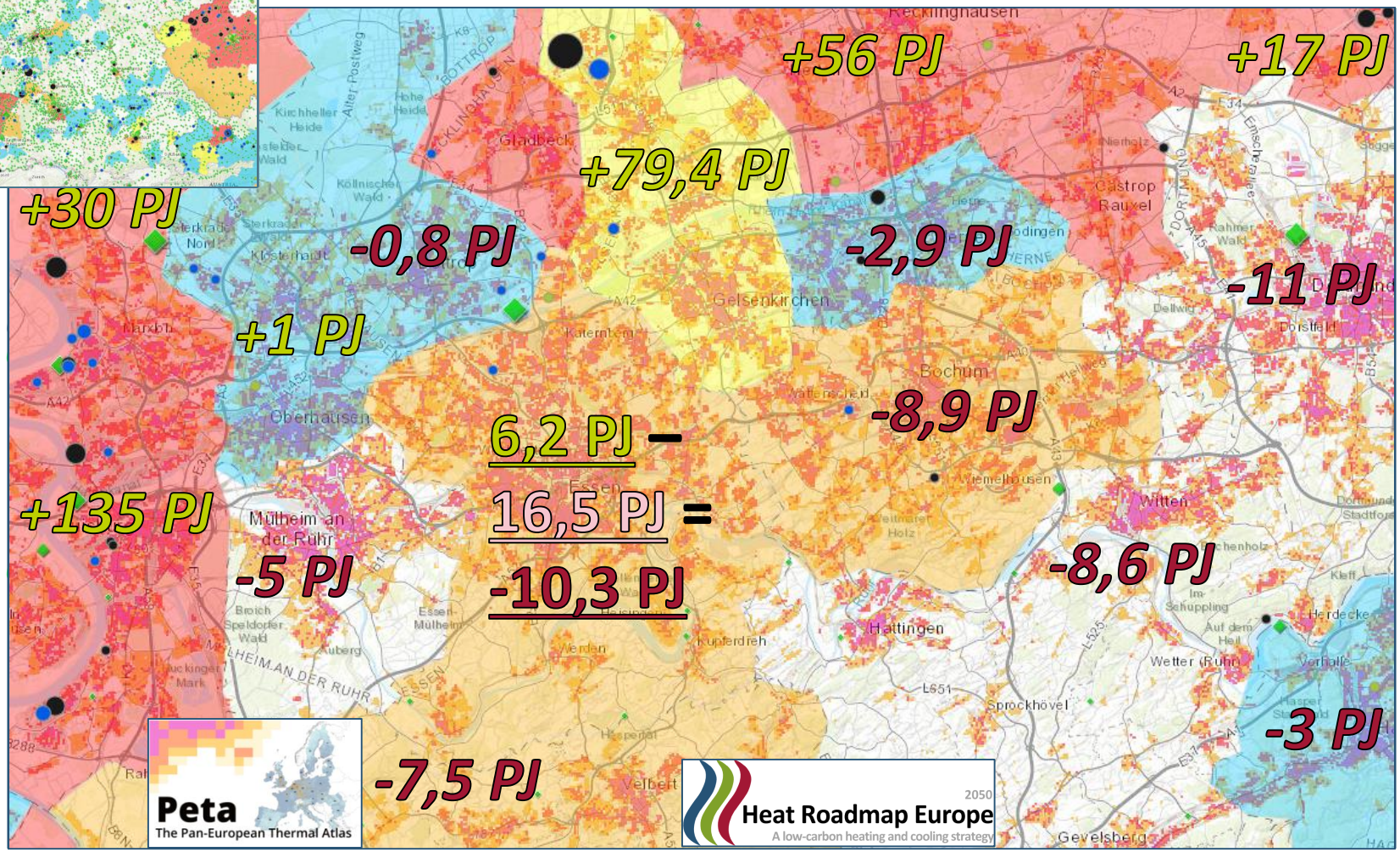


Essynergy?





318,4 PJ - 58 PJ = 260,4 PJ !?!?

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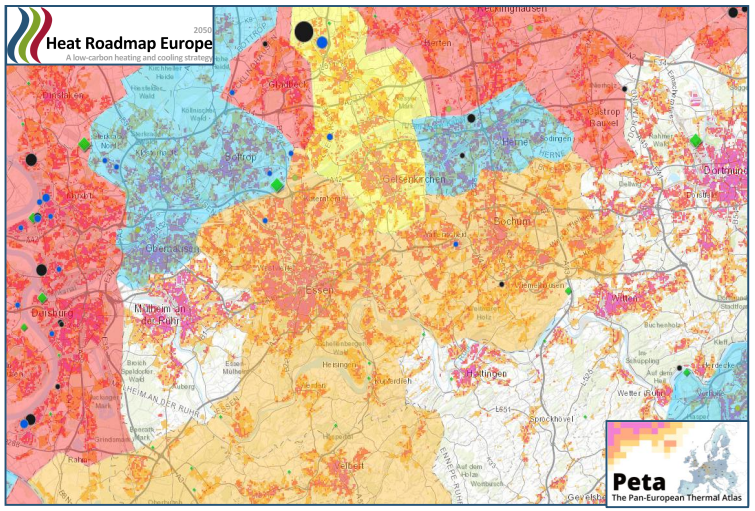
Ruhrgebiet Heat Synergy?

- *Is the 260,4 PJ net total extra excess heat in the Ruhr region **realistic?***
  - Peta‘s excess heat values are **theoretical** maxima
  - Most from **questionably-sustainable** sources (power plants, refineries, incinerators...)
  - Power plants likely **closing by 2050**
- **HSRs driving regional strategies**:
  - **Replace far plants** with decentralised systems (e.g. **heat pumps**)
  - **Convert “urban”** plants (to RES)
  - **Smart specialisation** of regions (e.g. “**export**” excess or demand)
  - Energy-oriented **spatial planning** (e.g. energy density or new industries)
- **Cooperation** across multiple administrations
  - ***Political will** between city/regional levels?*
  - **Frameworks** needed to govern financing, administration, infrastructure, sustainability...



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Thank you! Questions?

Dankeschön! Fragen?

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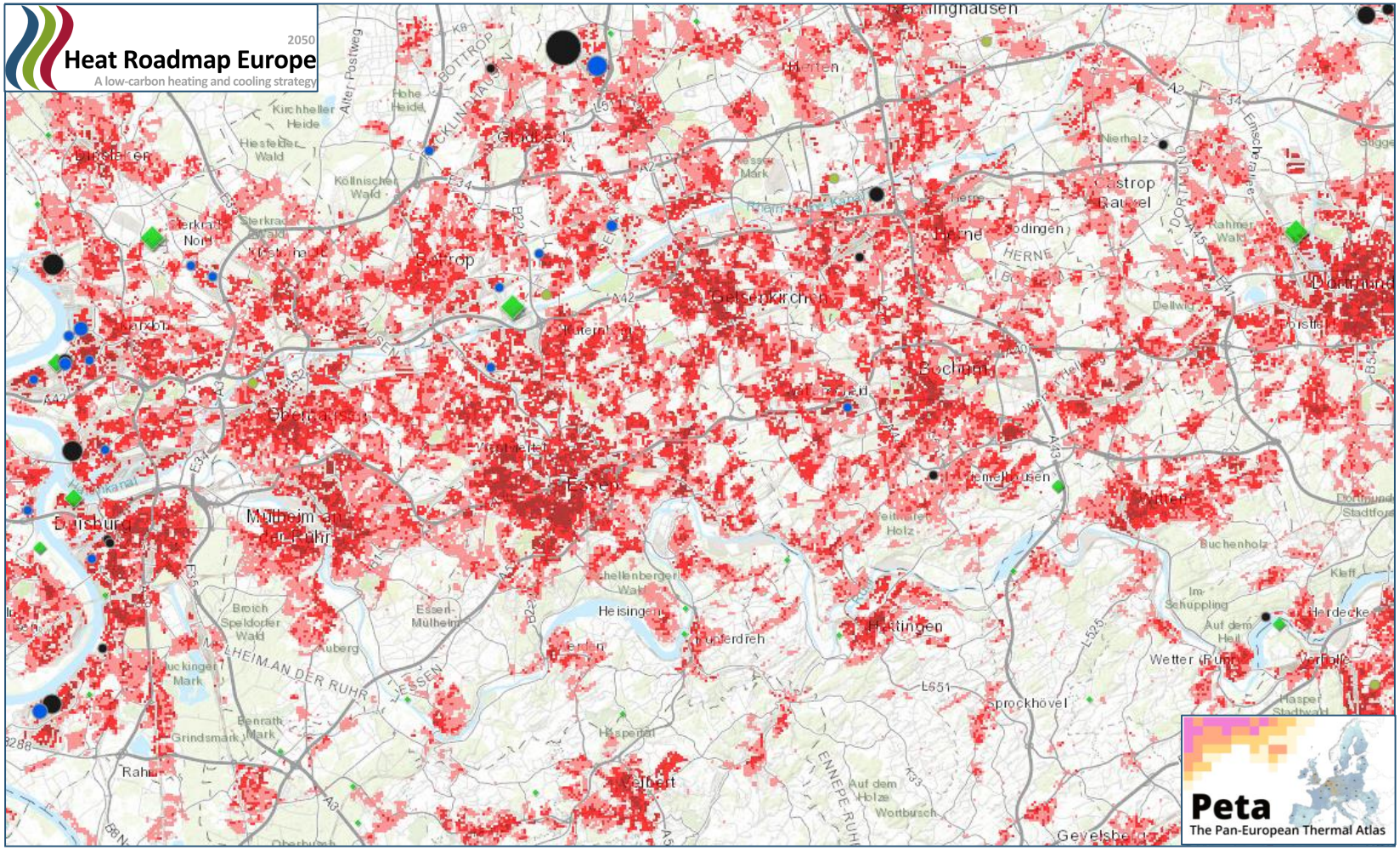
Essen and Ruhrgebiet – DH costs



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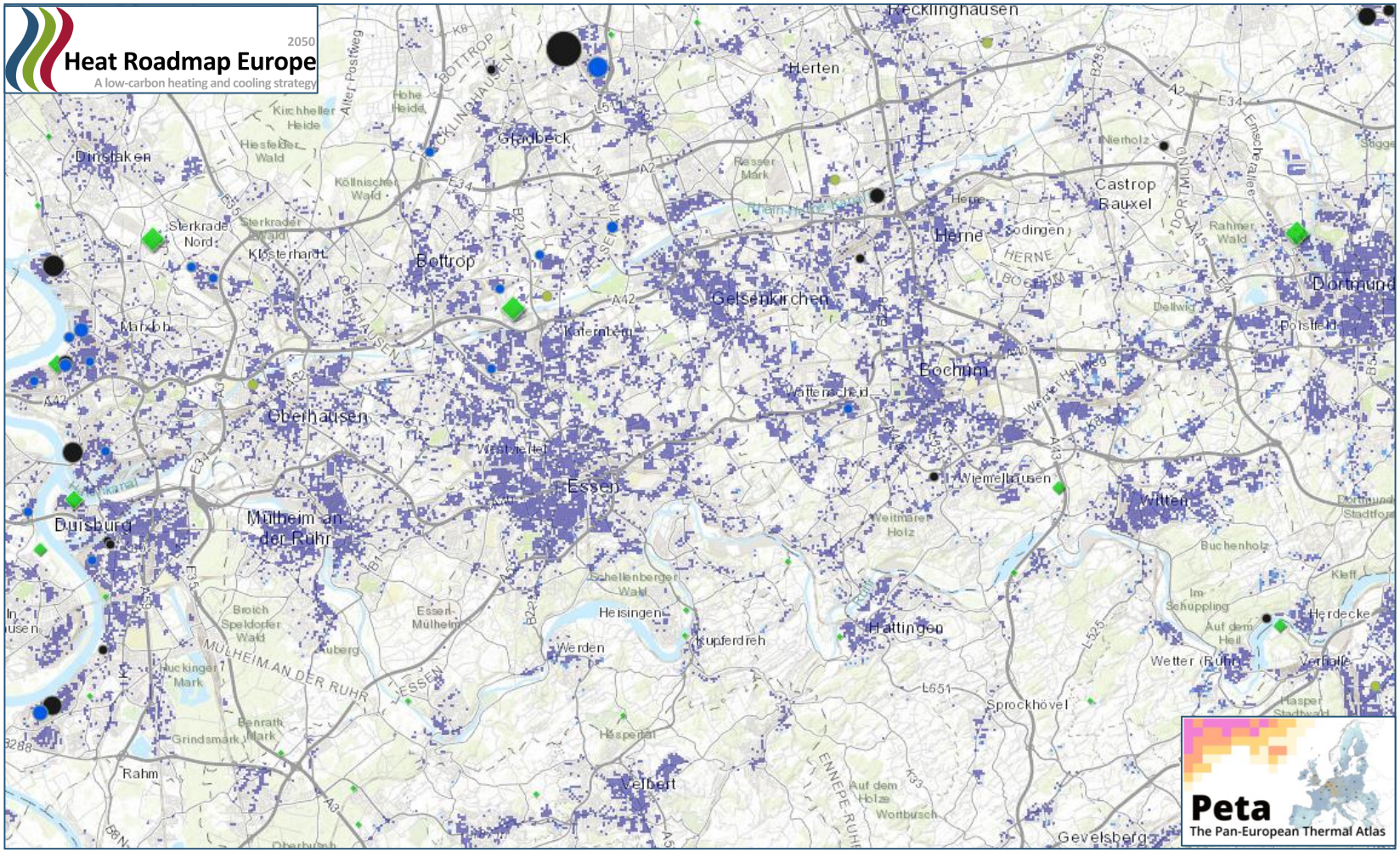
Essen and Ruhrgebiet – cooling demand



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