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Institute of
Energy Systems, Energy Efficiency
and Energy Economics

Transformation of district heating supply towards climate neutrality in Germany

Results of the project „Dashboard for the transition of the heating sector – system analysis and visualisation of regional impacts “

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Agenda

- Motivation and project overview
- Modelling of the transition of the building sector
- Scenario framework
- Regionalisation
- Conclusion

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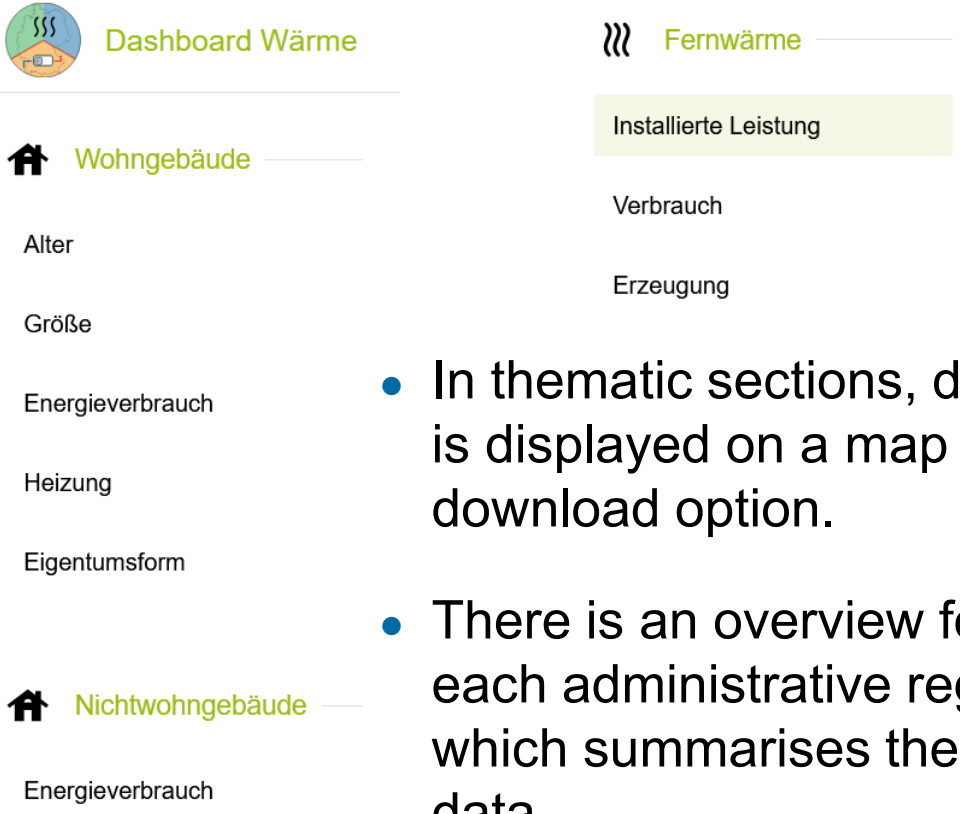
Motivation and project overview

- Development of an interactive web platform that visualises the impacts for the transition of the heating sector towards climate neutrality.
- Analysis and processing of spatially resolved data relevant to the heat transition.
- The data is made available to the public as open data via the use of the Open Energy Platform.
- A quantitative and model-based spatially resolved analysis of the development of the heating sector in Germany.



- In thematic sections, data is displayed on a map with download option.
- There is an overview for each administrative region, which summarises the data.

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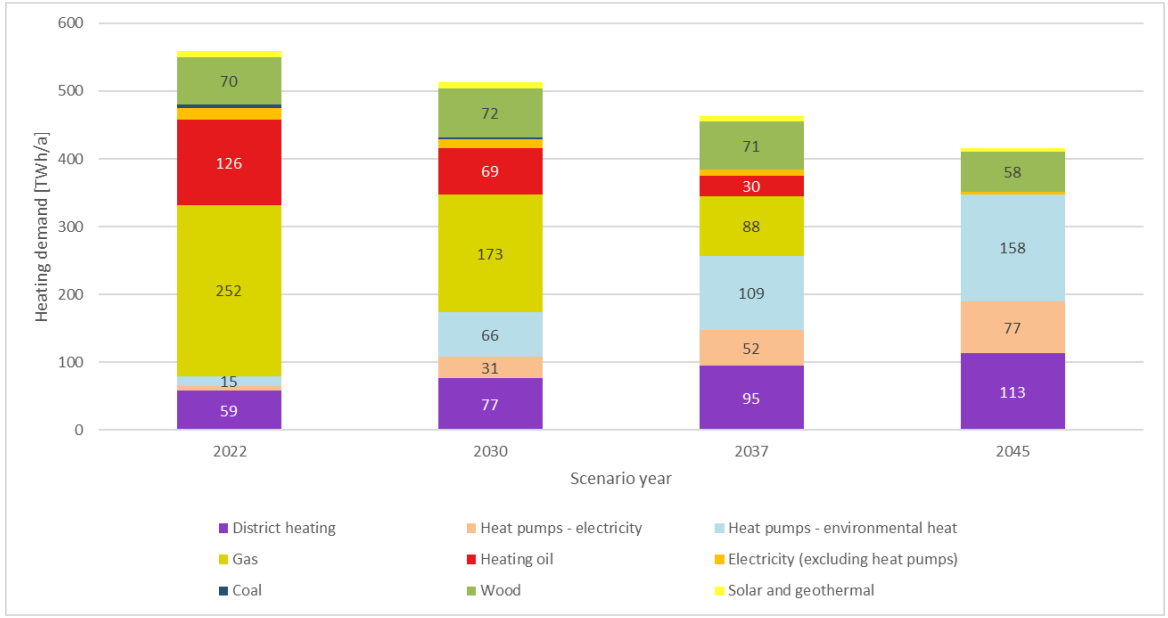
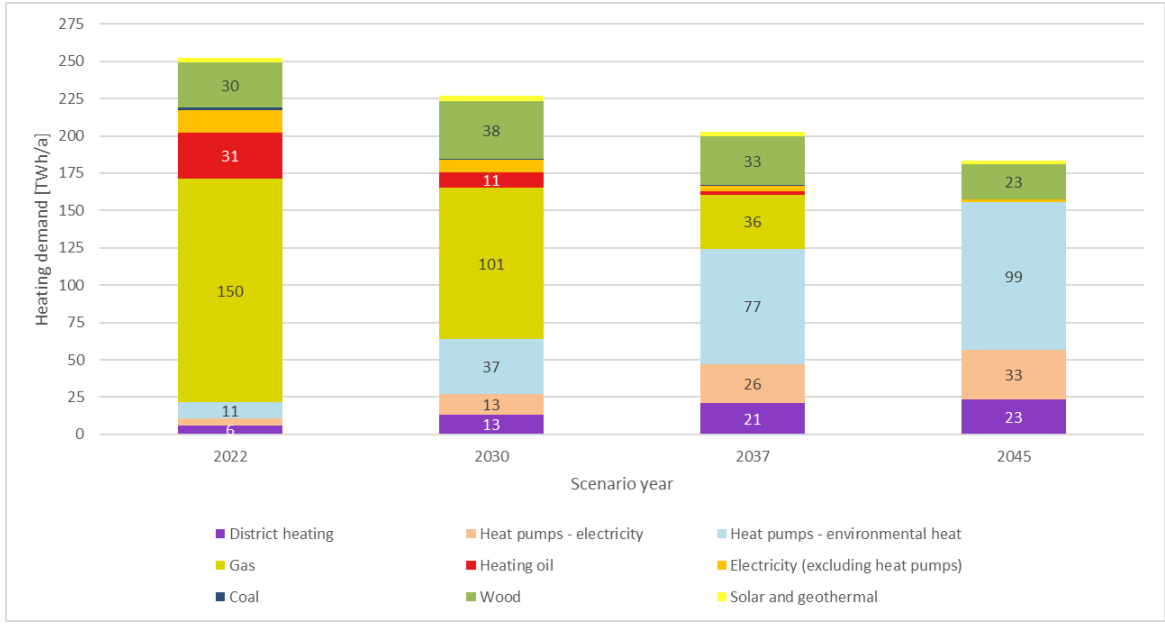
Modelling of the transition of the building sector

- Stock-exchange approach on annual basis (model Building Star)
- Investment decisions lead to energetic retrofits and changes in heating systems

Energy carrier specific heat demand of residential buildings



Energy carrier specific heat demand of non-residential buildings



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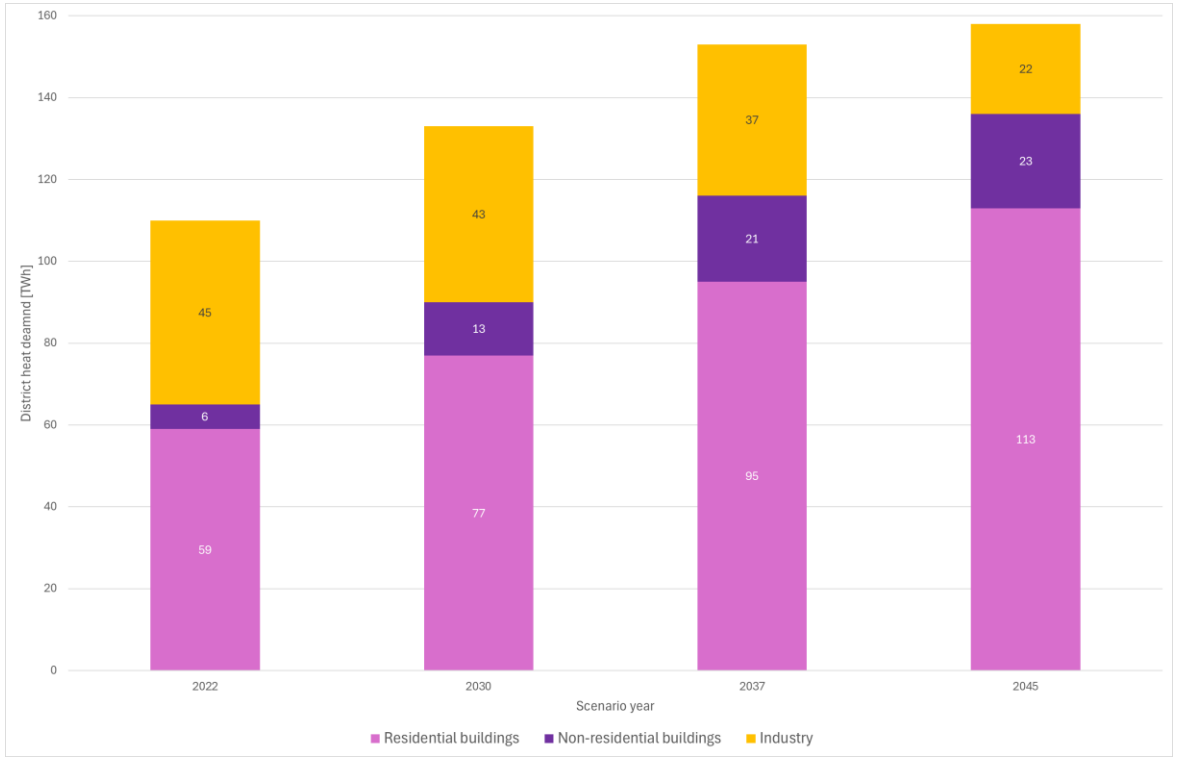
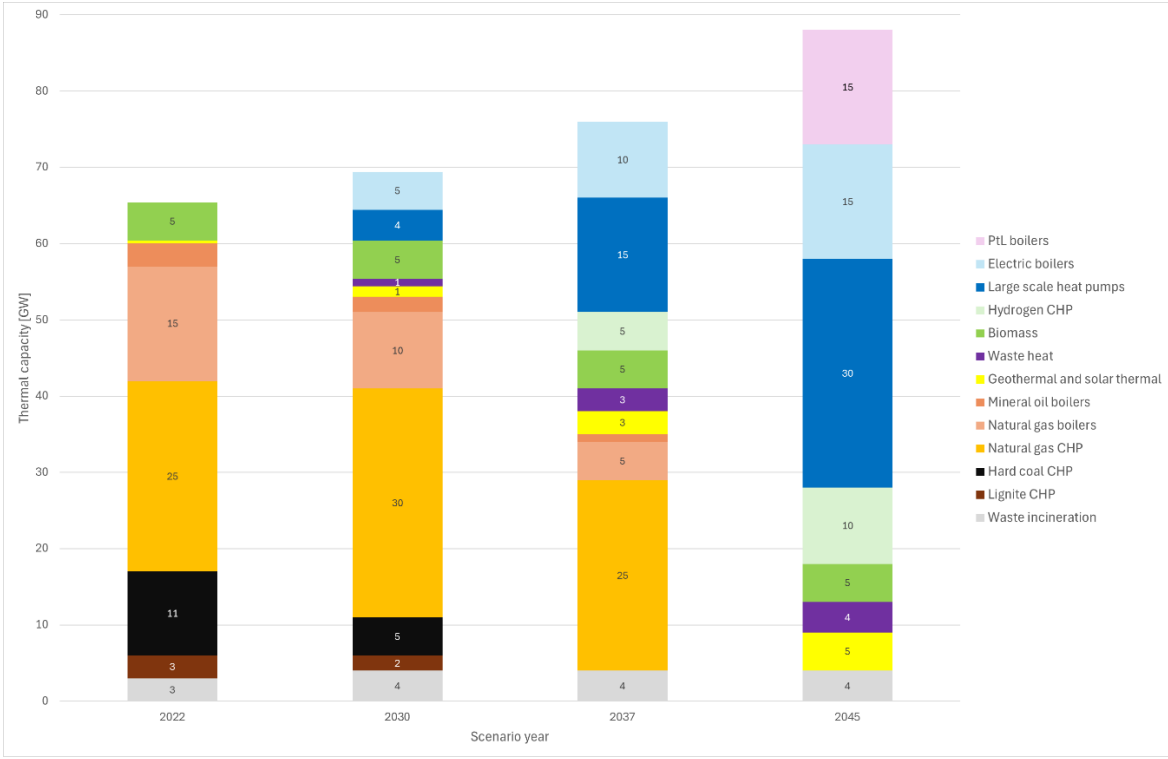
Scenario framework

- District heat



- District heat generation



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Methodology for regionalisation of district heat demand

- Buildings
  - Starting point 2022: census data for residential buildings and mix of distribution keys for non-residential buildings
  - Target year 2045: GIS analysis based on data from sEEnergies Open Data and other sources with proportion of district heating in the heating demand of buildings per district as interim result
  - Python script that allows national modelling results to be spatially differentiated based on starting point and target year
- Industry
  - Paper industry and basic chemicals: distribution according to the production capacity at each plant site
  - Food and tobacco industry, rubber and plastics manufacturing, and vehicle and machine construction: spatial distribution is derived from the waste heat platform
  - Other industrial sectors: distribution according to the number of employees

Results of regionalisation of district heat demand for target year 2045

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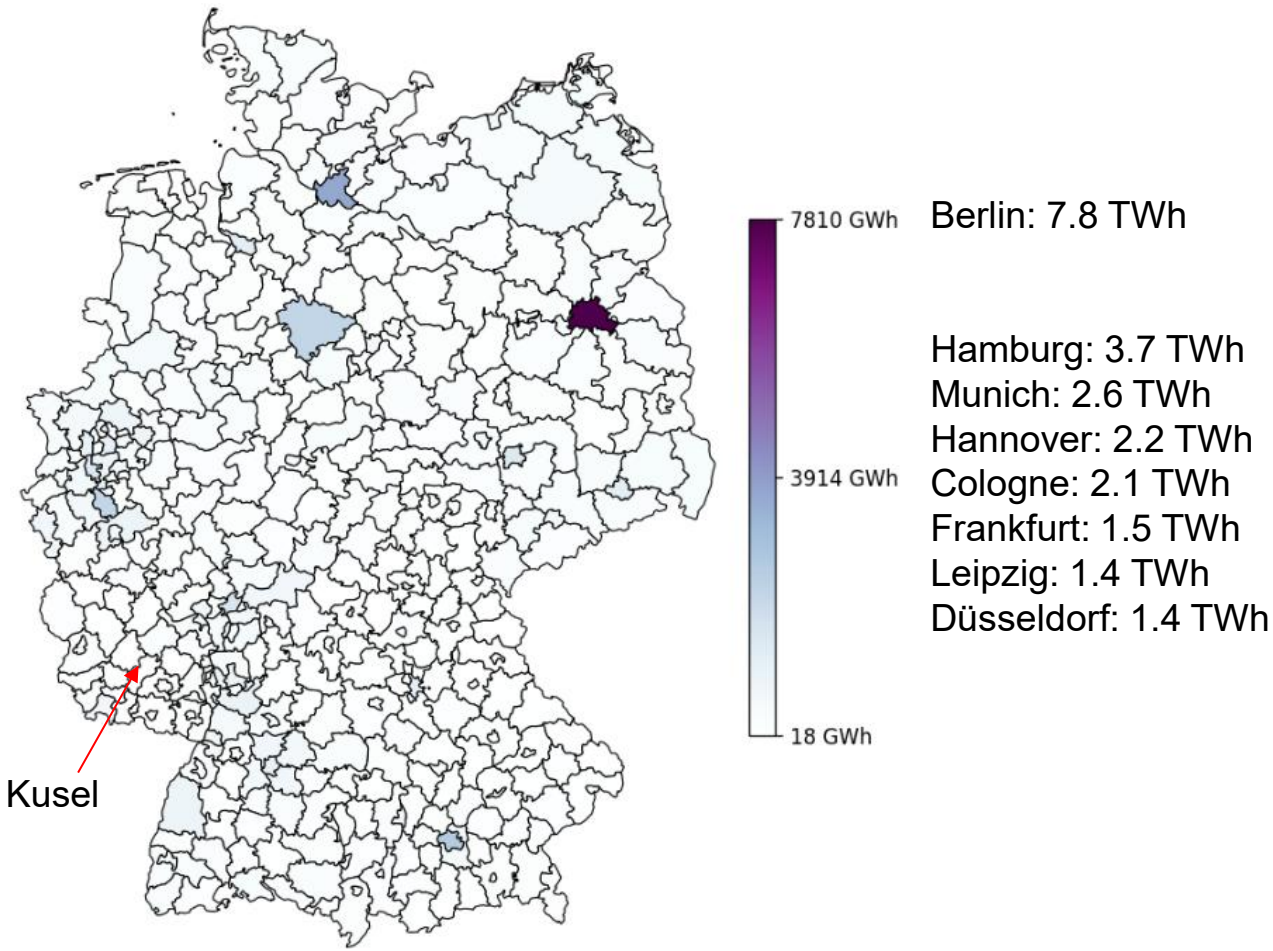
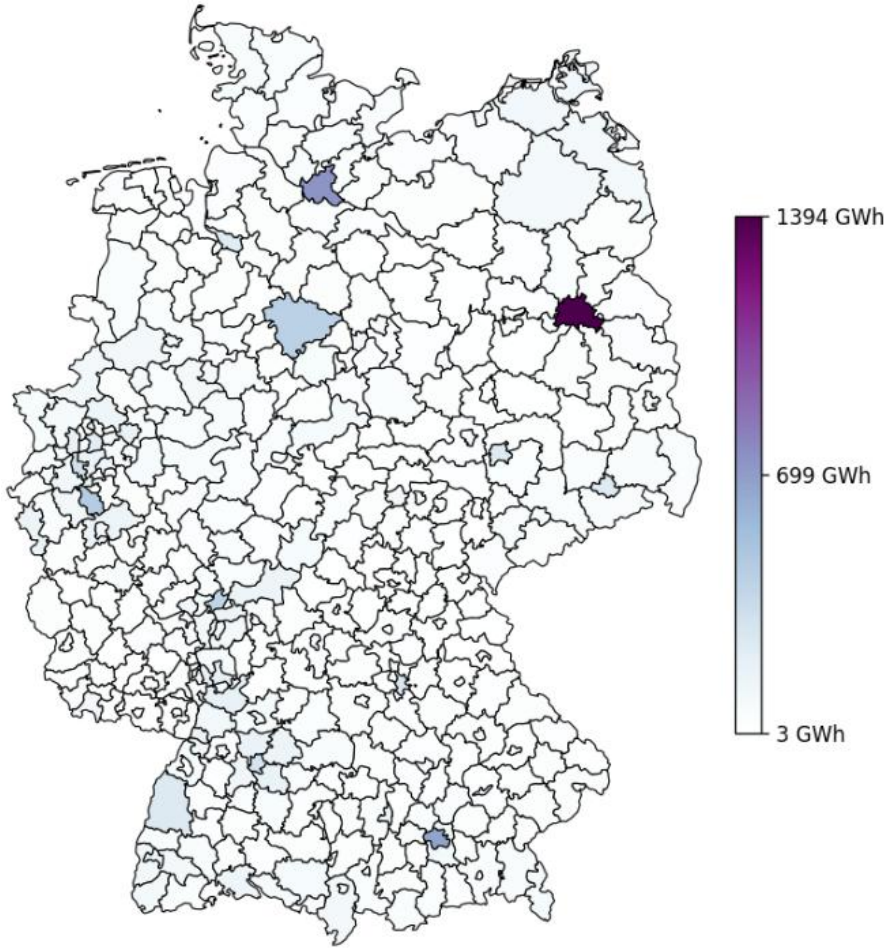


Berlin: 7.8 TWh

Hamburg: 3.7 TWh
Munich: 2.6 TWh
Hannover: 2.2 TWh
Cologne: 2.1 TWh
Frankfurt: 1.5 TWh
Leipzig: 1.4 TWh
Düsseldorf: 1.4 TWh



Modelled district heat demand per district in the scenario year 2045 for residential buildings (left) and non-residential buildings (right)

Results of regionalisation of district heat demand for target year 2045

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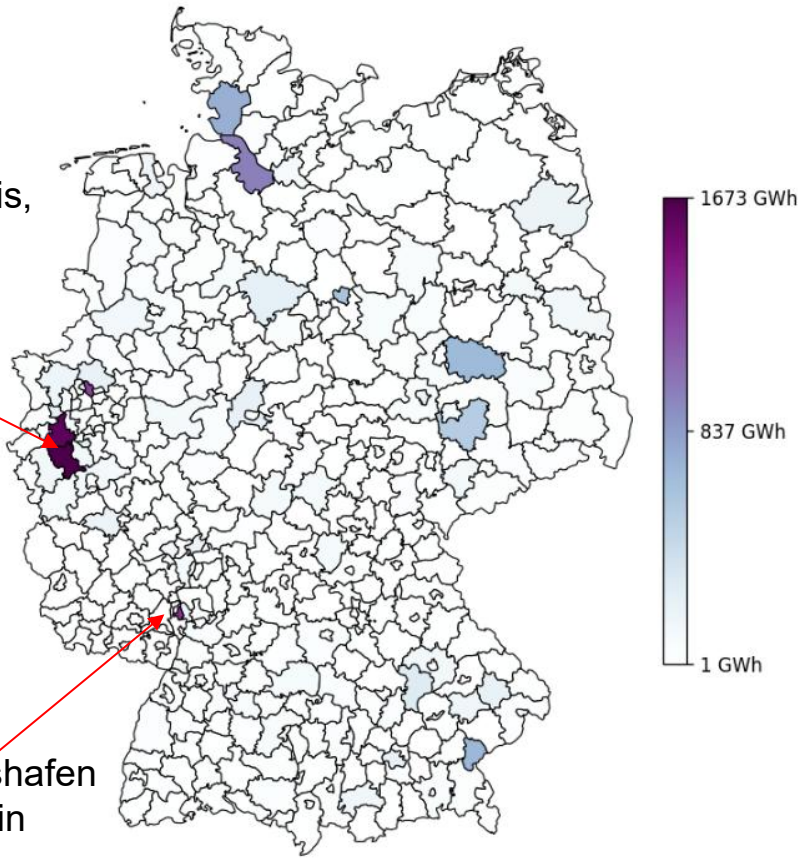
Rhein-Erft-Kreis, Rhein-Kreis Neuss

Ludwigshafen am Rhein

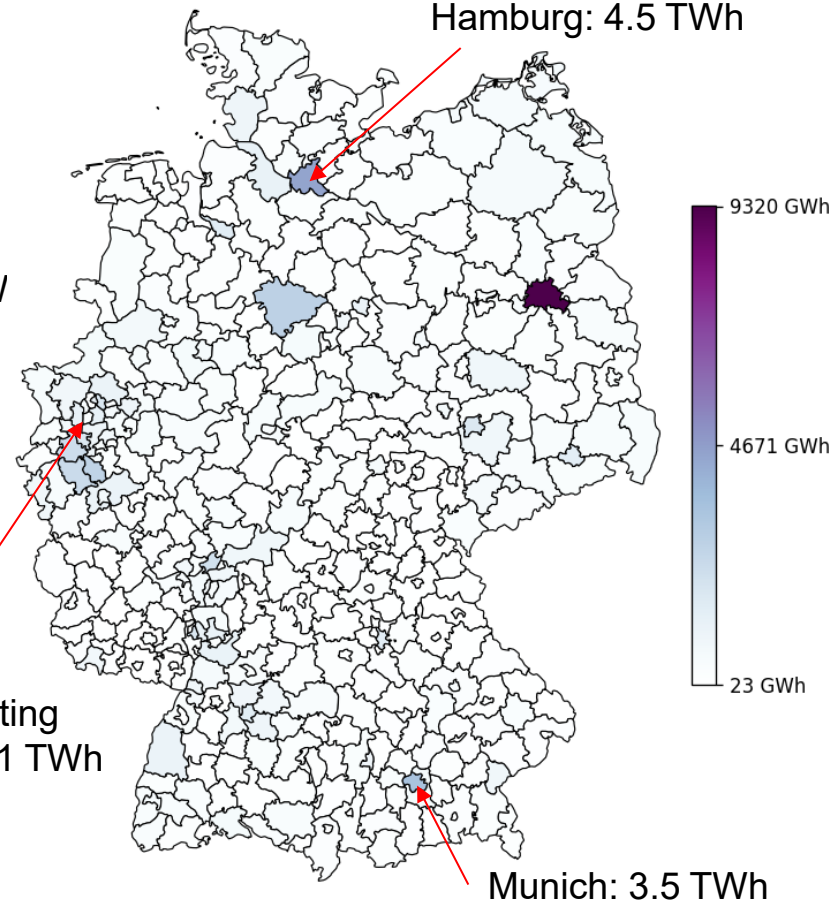


Rhein-Erft-Kreis: 1.7 TWh
Rhein-Kreis Neuss: 1.6 TWh
Ludwigshafen am Rhein: 1.3 TW
Gelsenkirchen: 1.3 TWh
Stade: 1.0 TWh
Dithmarschen: 0.7 TWh
Altötting: 0.7 TWh
Wittenberg: 0.7 TWh
Wolfsburg: 0.6 TWh
Leipzig: 0.5 TWh

Hamburg: 4.5 TWh

Rhine-Ruhr District Heating Network: 6.1 TWh

Munich: 3.5 TWh



Modelled district heat demand per district in the scenario year 2045 in industry (left) and in total (right)

Methodology for regionalisation of district heat generation

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- Technologies with a regional focus / potential (category 1)
  - Waste-to-energy plants, unavoidable waste heat, geothermal energy, large-scale heat pumps at sewage treatment plants or on surface water bodies
  - Existing and planned new combined heat and power stations
- Technologies with a “free choice” of location (category 2)
  - Heating plants powered by electricity, wood or oil
- Step 1: Gradual allocation from Category 1 technologies
  - Until the required district heating output is achieved
  - Taking inter-district heating networks into account (e.g. Rhine-Ruhr, Stuttgart-Esslingen, Mannheim-Heidelberg, Mainz-Wiesbaden)
- Step 2: Allocation for Category 2 technologies to fill the remaining generation gap

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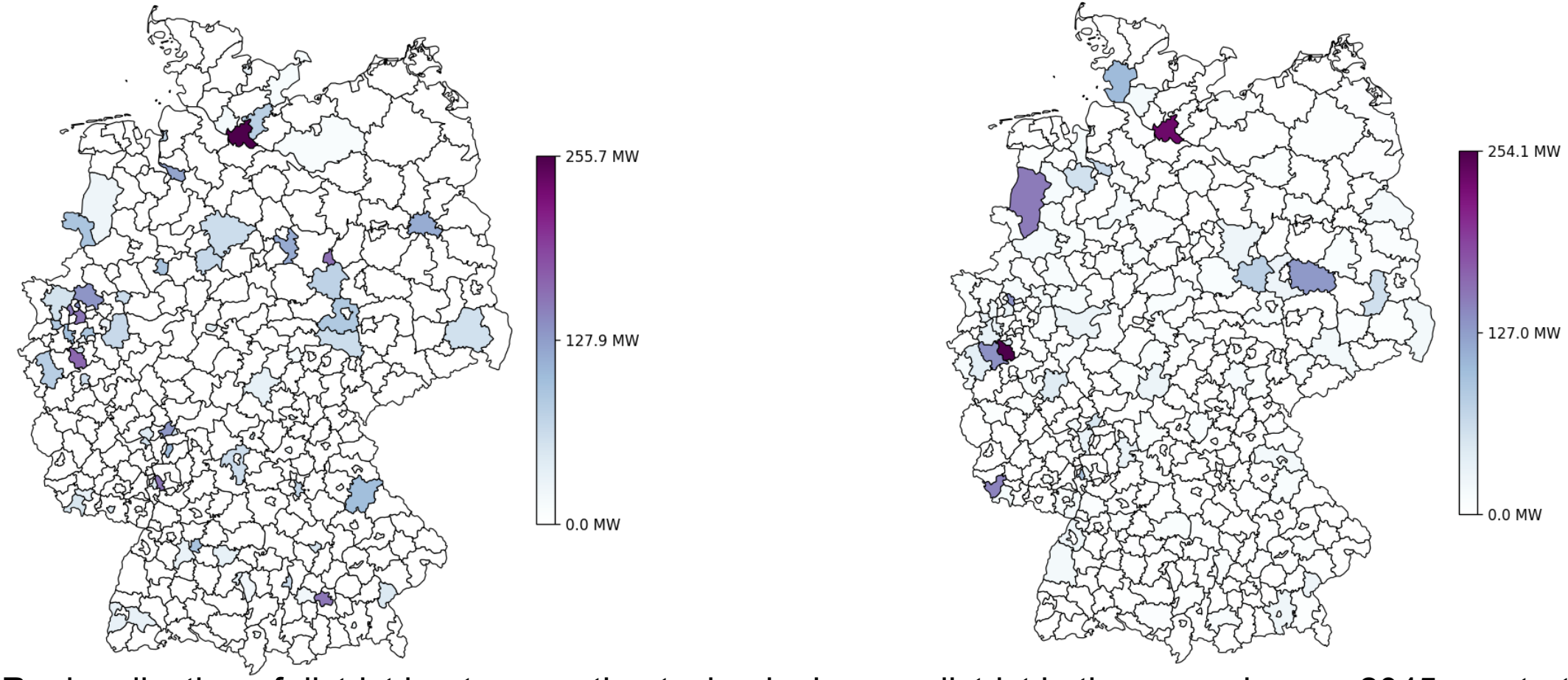
Results of regionalisation of district heat generation



Regionalisation of district heat generation technologies per district in the scenario year 2045: waste-to-energy plants (left) and unavoidable waste heat (right)

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Conclusion

- Transforming district heating networks towards climate neutrality requires a substantial shift in the heat supply mix.
- In the future, electric heat generators, renewable heat sources and unavoidable waste heat will need to cover the growing demand for district heating.
- The spatial distribution of district heating demand in buildings is primarily focused on urban districts and metropolitan regions. District heating is becoming the dominant heating technology in buildings there.
- While demand for district heating in buildings will roughly double between 2022 and 2045, it will halve in industry.
- As a result, the spatial distribution of district heating demand in Germany is shifting to large cities and metropolitan regions. These regions then face a particular challenge in meeting district heating demand with renewable energies and unavoidable waste heat.

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Next steps and funding

- Next steps
  - Completion of the regionalisation of district heat generation technologies.
  - Comparison of the findings with the transformation plans of major district heating networks.
  - Dispatch optimisation of electricity and district heating generation. This analysis will be carried out using the Öko-Institut's electricity market model PowerFlex.
  - The dashboard is scheduled to be published at the end of the project in autumn 2026.

- Funding: This work was carried out as part of the project "Dashboard heat transition - system analysis and visualization of regional effects" (2023 – 2026), which is funded by the Federal Ministry for Economic Affairs and Energy based on a resolution of the German Bundestag.

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Thank you for your attention!

Do you have any questions?

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