# Programme

## Day 1 | 26th October | Policies & Targets

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|---|---|---|
| 10:30-11:00 | **Welcome & Opening Address** | with Jeroen Schuppers (DG Research & Innovation), Andreas Zucker (DG ENER), Stéphanie Bouckaert (International Energy Agency) & Anthony Patt (ETH Zurich, SENTINEL Project Coordinator) |
| 11:00-13:00 | **Plenary Panel I: Policies and Targets** | *Insights and strategies to meet our short- and medium-term targets*<br>**Panel Chair(s):** Anthony Patt (ETH Zurich) & Stefan Pfenninger (TU Delft)<br>**Presentations:**<br>· Latest insights on why energy modelling is necessary in the context of EU climate neutral targets & how energy models are used in policy making (Diana Ürge-Vorsatz, Central European University, IPCC)<br>· The modelling of Strategies for a fully decarbonized society (Henrik Lund, Aalborg University)<br>· Achieving the EU 2030 targets - what level of carbon prices and enabling policies are needed? (Robert Pietzcker, Potsdam Institute for Climate<br>· Impact Research)<br>· Towards a net-zero emissions world: the Global Energy & Climate Outlook 2021 (Rafael Garaffa, JRC Seville) |
| 13:00-14:00 | *Lunch Break* | |
| 14:00-15:30 | **Parallel Session 1: Reaching our Targets** | *Making Europe fit for 55*<br>**Session Chair(s):** Johannes Emmerling (European Institute on Economics and the Environment)<br>**Presentations:**<br>· Preparing for "Green Growth": Incorporating investment-led growth effects into climate-economy-energy models (J. Christopher Proctor, University of Technology of Compiègne)<br>· Sufficiency policies: a systematic review (Benjamin Best, Wuppertal Institute for Climate, Environment and Energy)<br>· Economic, social and environmental implications of revising minimum energy tax rates in the EU (Toon Vandyck, JRC Seville)<br>· Alternative roads to achieve mid-century CO2 net neutrality in Europe (Renato Rodrigues, Potsdam Institute for Climate Impact Research)<br>· EU carbon neutrality by 2050: What will be the impact of a revised RED II with a higher binding renewable energy target for the EU for the coming decades? (Gunhild Allard Reigstad, SINTEF Energy Research) |
| | **Parallel Session 2: Making energy models more relevant for policy-making** | *An increasing number of energy models is becoming more and more intertwined with the policymaking process: Models can help investigate policy options and ambitious target setting, but they can also be instrumentalised to justify already decided policies and targets. This session will take a deep dive to understand how and why models are used so differently and shed light on the factors that foster or hinder the use of energy models in policymaking processes.*<br>**Session Chair(s):** Andrzej Ceglarz (Renewables Grid Initiative), Diana Süsser (IASS) & Vassilis Stavrakas (TEESLab UPRC)<br>**Presentations:**<br>· Modelbased policymaking or policybased modelling? How energy models and energy policy interact (Diana Süsser (IASS) & Vassilis Stavrakas (TEESLab UPRC)<br>· Discussants: Andreas Zucker (DG ENER), Jörg Mühlenhoff (CAN Europe), Alessia De Vita (E3-Modelling) & & Olivier Lebois (ENTSO-E) |



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**Parallel Session 3:**
**Capacity Planning amid Uncertainty**

**Session Chair(s)**: Alban Kitous (DG CLIMA)

**Presentations:**

- Using DESSTINEE model for forecasting nationally granular energy demand and emission scenarios, compatible with newly announced EU and UK decarbonisation targets (Gabriel Oreggioni, Imperial College London)
- Understanding and taming climate risk for the energy transition: a century of European renewable variability (Jan Wohland, ETH Zurich)
- Discount and hurdle rates: the dark horses of capacity expansion planning (Smaranda Sgarciu, BTU Cottbus-Senftenberg)
- Strategic Development of the Pan-European Power Network Considering Long-Term Uncertainties (Stefan Borozan, Imperial College London)
- Sufficiency aspects in transport modelling (Johannes Thema, Wuppertal Institute for Climate, Environment and Energy)

**Parallel Session 4:**
**Improving Integration and Efficiency**

**Session Chair(s):** Zenaida Mourão (INEGI - Institute of Science and Innovation in Mechanical and Industrial Engineering)

**Presentations:**

- Disclosing the heat density of centralized heat networks in Austria 2050 under the 1.5°C climate target (Sebastian Zwickl-Bernhard, TU Wien)
- Converting PRIMES results into EnergyPLAN - towards modeling of a Smart Energy Europe (Jakob Zinck Thellufsen, Aalborg University)
- Apples with apples and pears with pears? Design of intercomparison experiments and database for different energy models in the SENTINEL project (Mark Roelfsema, Utrecht University, Copernicus Institute)
- Solar photovoltaics is ready to power a sustainable future (Marta Victoria, Aarhus University)
- Modeling the transition of the multimodal pan-European energy system including an integrated analysis of electricity and gas transport (Dieter Most, Siemens AG)

15:30-16:00 *Coffee Break*

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16:00-17:30 *Parallel Skills Workshops:*

**Skills Workshop 1:**
**Energy System Models: Basic principles and concepts**

This session is open to researchers, experts and students who have an interest in modelling energy systems and climate policies. In addition to learning how energy systems operate, participants will gain expertise in different ESMs used by decision makers, analysing the most important modelling paradigms, and identifying linkages between climate policy and energy system developments.
**Organized by** E3 Modelling and Renewables Grid Initiative

**Skills Workshop 2:**
**High resolution time series processing**

This session is designed for data scientists in the energy field. The objective is to present a methodology to assess high-resolution time series from smart meters. Participants will gain a general understanding of the basic steps to process big datasets and signify different behaviours of household electricity consumption.
**Organized by** University of Deusto and GoiEner

**Skills Workshop 3:**
**What Energy System Modellers should know about [open] data and software licences**

This session is accessible to anyone interested in the legal aspects of open and closed modelling, including datasets and licenses, and the potential benefits of open models for facilitating transparency, inclusion and collaboration. Finally, this session discusses public interest analysis to gain insights on open models for public policy development.
**Organized by** Robbie Morrison (open energy modeling community)

EMP-E 2021: Re-Energising Sustainable Transitions in Europe

Energy Modelling Platform for Europe

Energy System Modelling, Methods & Results to support the European Green Deal

26th to 28th October · online

# Disclosing the heat density of centralized heat networks under the 1.5°C climate target

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[2]International Institute for Applied Systems Analysis

**Parallel Session 4: Improving Integration and Efficiency (Day 1)**

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# Current state of the European heating sector

- The average share of renewables in the heating & cooling sector is only just above $20\%$ on average in all EU member states[1]
- In Austria it is $34\%$ - but fossil fuels continue to dominant the provision of heating and cooling services here as well
- $900{,}000$ dwellings are heated with natural gas and $500{,}000$ with oil (Austria 2020)
- Retrofitting of $50{,}000$ appliances per year, or more than $130$ per day since the viability of green gas is uncertain at the end-user device level
- Requires to a massive expansion of centralized heating (and cooling) networks to…
  - …ensure a highly efficient usage of renewable heat sources (e.g., biomass/waste, hydrogen)
  - …achieve significant retrofitting rates by high connection rates
  - …unburden the electricity sector (high electrification of different energy service needs)

[1]Eurostat https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20200211-1

# The core objective of this work

- The core objective of this work is downscaling European decarbonization scenarios[1] of the heating sector to the community/distribution grid level serving end-users in 2050.
- In particular, downscaling considers the highly efficient and local use of sustainable heat sources in centralized heat networks (e.g., co-firing hydrogen in cogeneration plants and large-scale waste utilization, etc.).
- In addition, the topography of district heating networks is of particular importance and plays a crucial role in applied downscaling.
- This allows estimates of realistic and cost-effective decarbonized district heating networks in 2050 to be obtained, which can be compared with existing networks. Thereby, the heat density of district heating networks serves as a comparative indicator and permits a rough estimation of the changes needed for centralized heating networks considering the 1.5°C climate target.
- An Austrian case study is conducted, downscaling the results of the heating sector in 2050 from the large numerical energy system model GENeSYS-MOD[2], from the country to the community/distribution grid levels.

[1]Developed in the European H2020 project openENTRANCE aiming for the 1.5/2.0°C global warming climate target

[2]Löffler et al., *Energies*, (2017). doi: 10.3390/en10101468

# Methodology

| NUTS classification | Description | Number | Example (population) |
|---|---|---|---|
| NUTS0 | Country level | 1 | AT Austria (8.86 millions) |
| NUTS1 | Major socio-economic regions | 3 | AT3 Western Austria (2.78 millions) |
| NUTS2 | Basic regions for the application of regional policies (federal states) | 9 | AT31 Upper Austria (1.48 millions) |
| NUTS3 | (Small) sub-regions for specific diagnoses (political/court districts) | 35 | AT312 Linz-Wels (529 thousands) |
| LAU (former NUTS4/5) | Subdivision of the NUTS 3 regions (communities) | 2095 | Enns AT312 Linz-Wels (11 thousands) |

- Three different scenario-independent downscaling techniques
  1. **Proportional downscaling** using population as a proxy (NUTS0 to the LAU level)
  2. **Sequential downscaling** algorithm using population density and infrastructure requirements of heat technologies/sources as additional criterion (NUTS0 to the NUTS3)
  3. **Iterative downscaling** algorithm based on graph-theory benchmarking (NUTS3 to the LAU level)

Reference technique

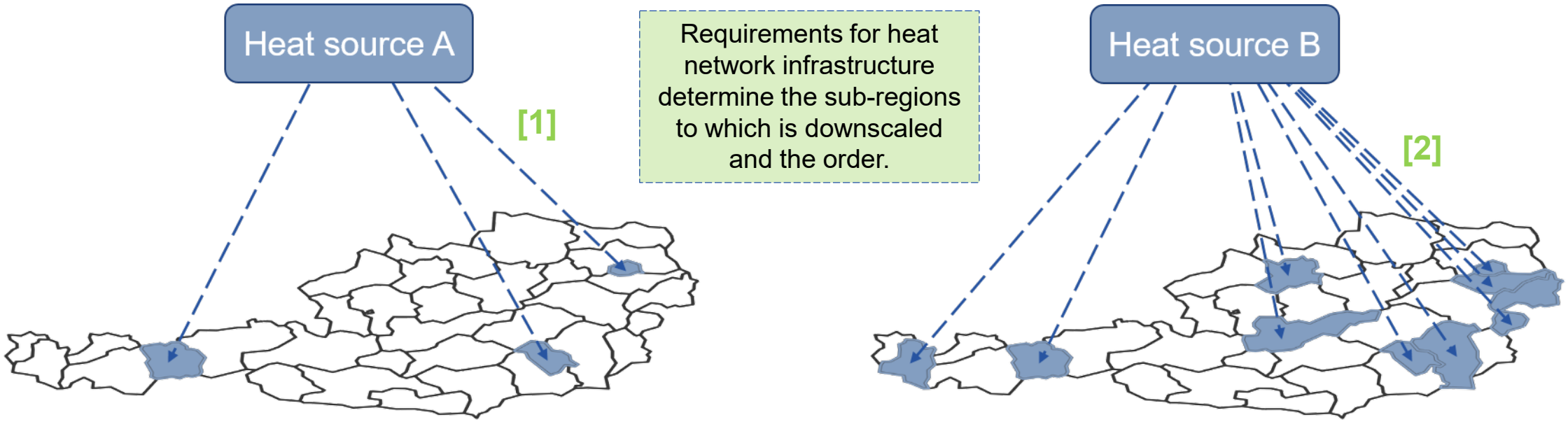
Techniques developed

The Nomenclature of Territorial Units for Statistics (NUTS) were created by Eurostat in order to define territorial units for the production of regional statistics across the European Union.

# Main concept of the sequential downscaling algorithm

Heat source A has **high requirements** for heat network infrastructure (e.g., hydrogen)

Heat source B has **median requirements** for heat network infrastructure (e.g., biomass)

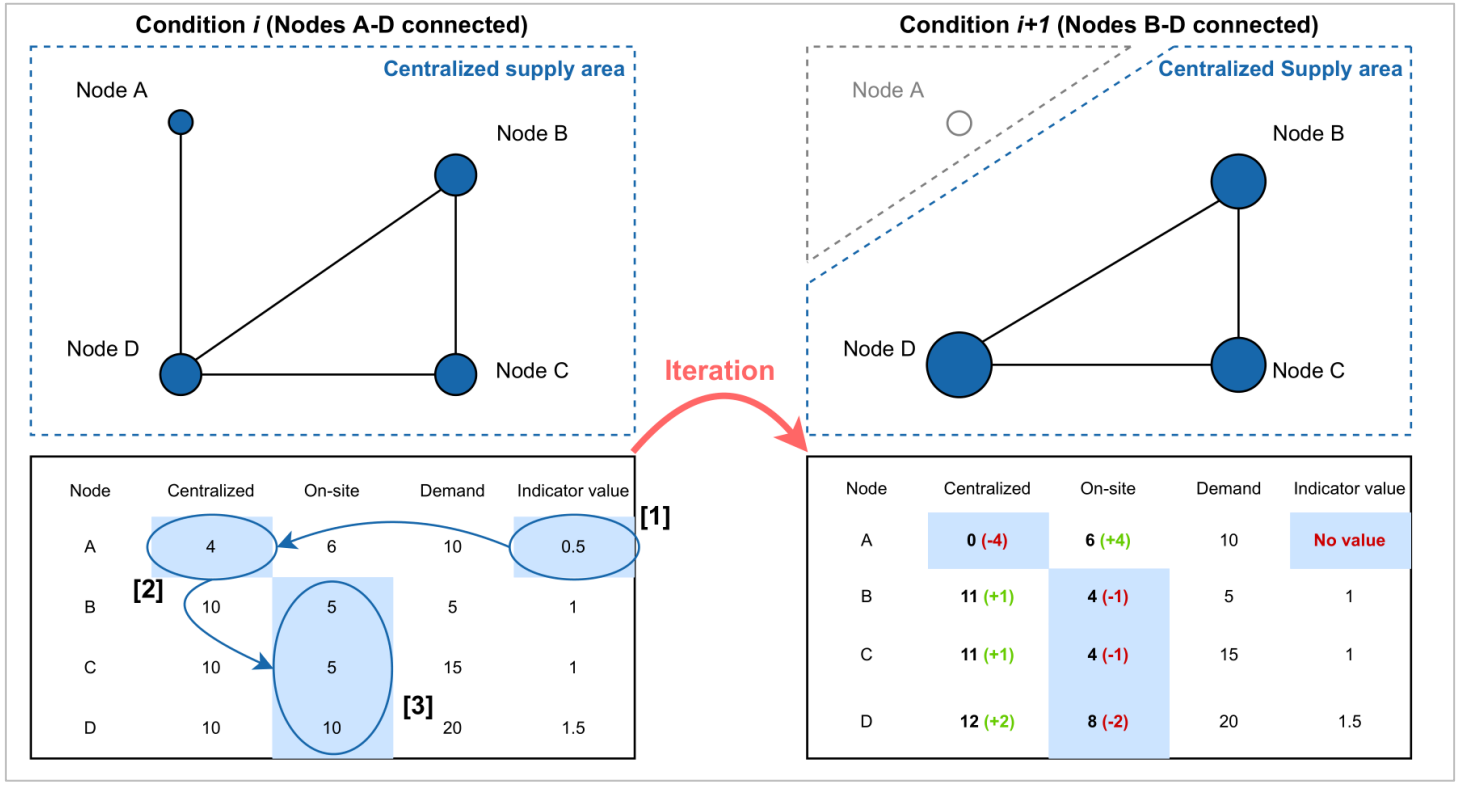



[3] Heat sources without requirements for heat network infrastructure are downscaled last. For example, direct-electric heating is disaggregated to all sub-regions proportionally.

# Main concept of the iterative downscaling algorithm

$$\underbrace{c_n = \frac{q_n}{q_{max}} \times \frac{\alpha_n}{\beta_n}}$$

Cluster(ing) coefficient *c*
=
*Indicator value*




(i) High connection rate to the centralized heat network at the nodes

(ii) Connection of those nodes with a high amount of heat demand and heat density respectively

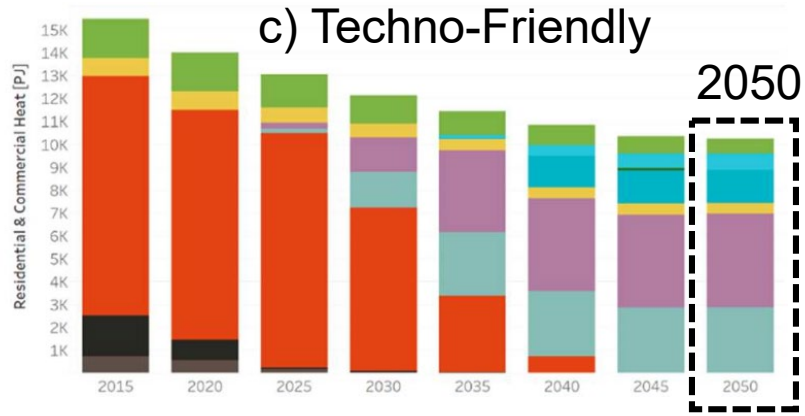


Cui, Y., Wang, X., & Li, J. (2014). Detecting overlapping communities in networks using the maximal sub-graph and the clustering coefficient. Physica A: Statistical Mechanics and its Applications, 405, 85-91.

# Numerical example and scenarios

- Four different decarbonization scenarios of the European energy system aiming for the 1.5/2.0°C global warming climate target[1]
  a) Directed Transition scenario (strong policy incentives)
  b) Societal Commitment scenario (strong societal acceptance, decentralized renewables)
  c) Techno-Friendly scenario (market-driven breakthrough of renewables)
  d) Gradual Development scenario ("little of each")

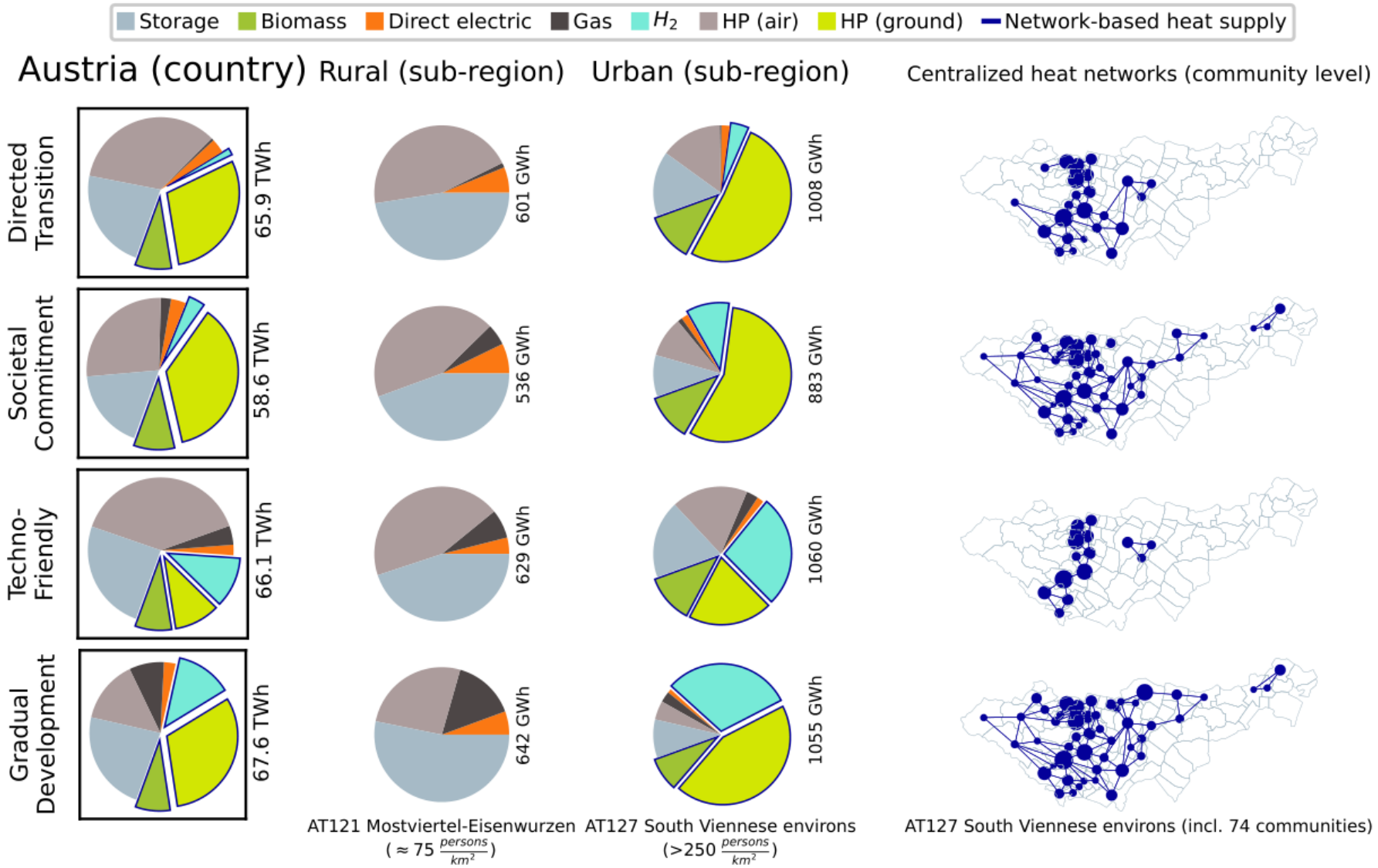
- Values of the decarbonized heating sector in Austria 2050 obtained by the large-numerical energy system model GENeSYS-MOD



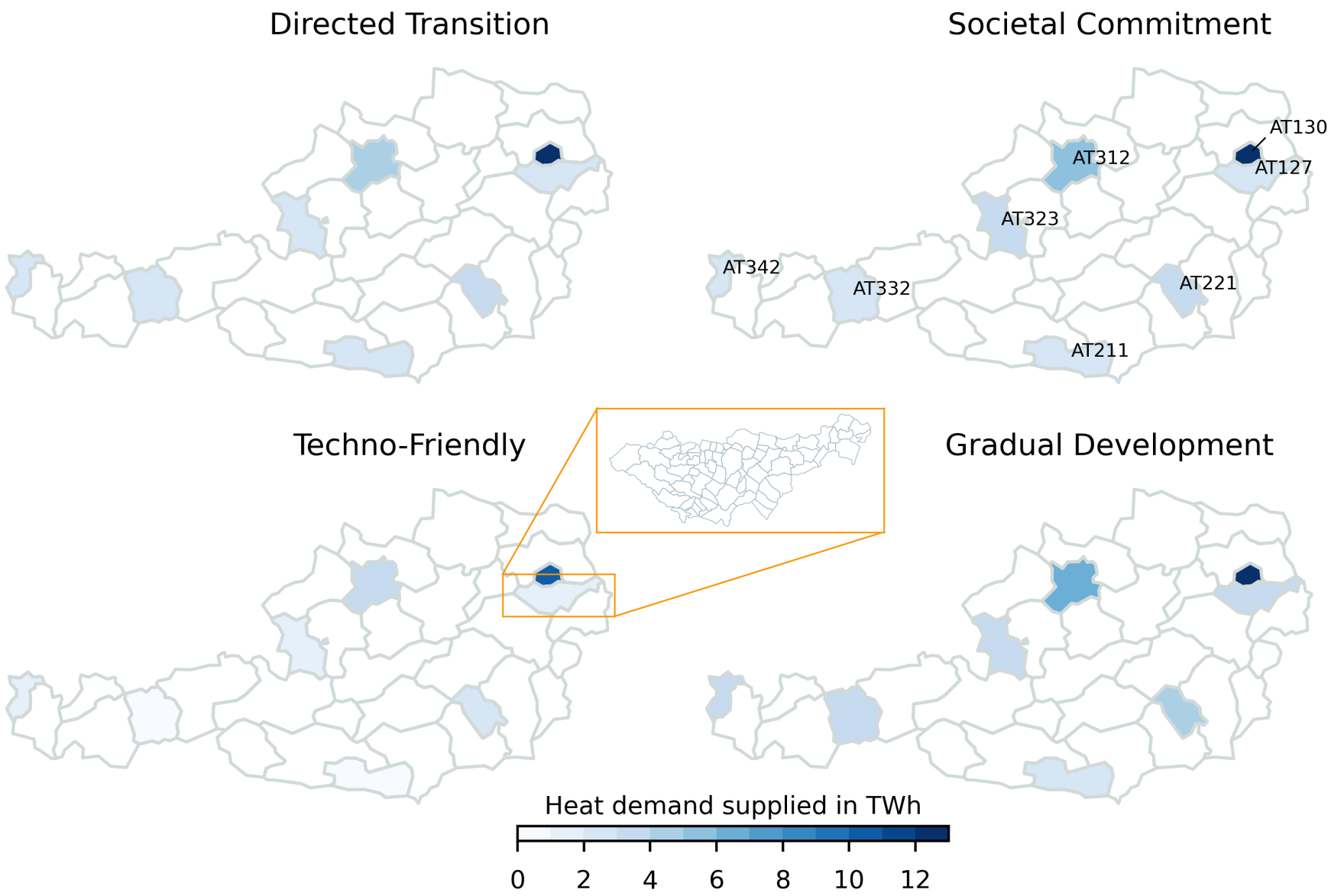


[1]Scenario a) to c) considers the 1.5°C global warming target and d) the less ambitious 2.0°C.

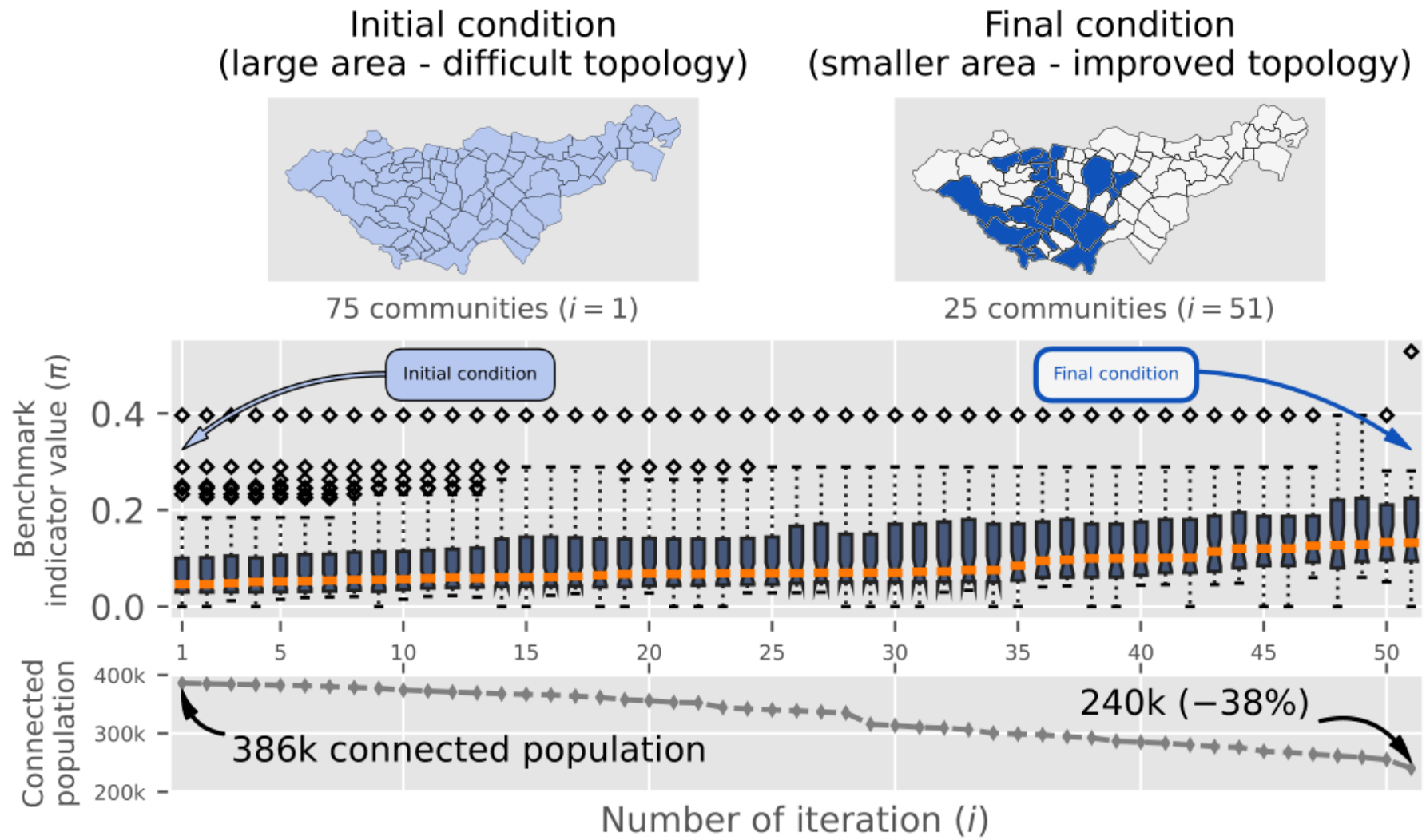
# Heat generation on the country, sub-region, and community level

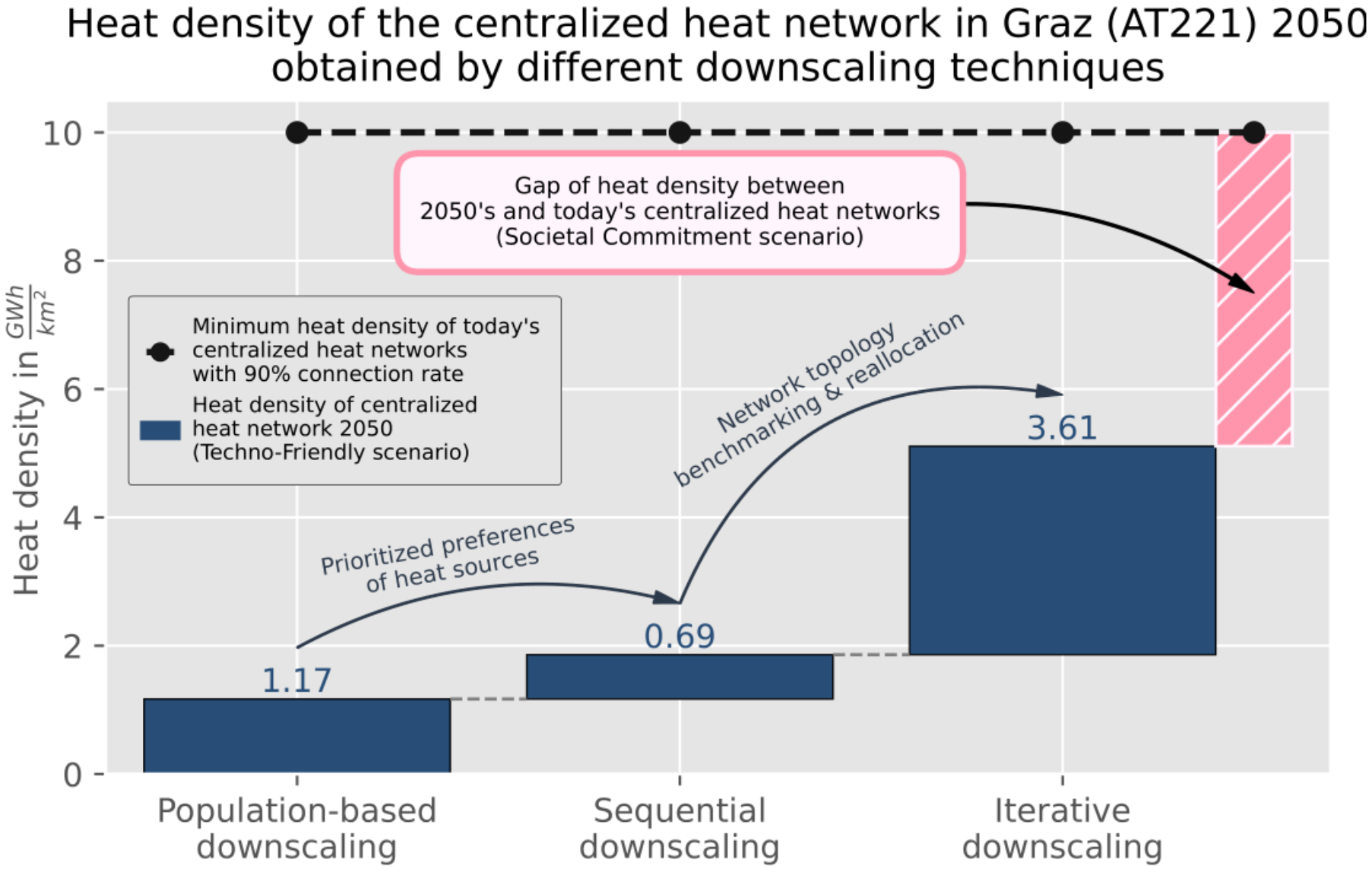


# Heat demand supplied by centralized heat networks in TWh



# Centralized heat network topology improves by reducing supply area






http://www.austrian-heatmap.gv.at/karte/

# Conclusions

- We found that the prioritized perspective of efficiency and local utilization of renewable heat sources implies substantial changes for the further development of district heating networks in the decarbonized Austrian heat supply toward 2050.
- The results demonstrate that particularly densely populated areas are still beneficial supply areas for district heating networks and offer adequate heat densities.
- Nevertheless, most district heating networks in 2050 (seven of eight) will not reach the heat density benchmarks of today's networks and have a significant heat density gap.
- However, considering the increasing importance of local renewable heat sources feeding into district heating networks, we assume that these centralized networks will become required in the future and crucial in the decarbonization of the heating sector.
- We anticipate our work as a starting point for discussing the role of centralized heat network infrastructure for enabling large-scale, highly efficient and local integration of renewable heat sources such as biomass/waste, hydrogen, ground-sourced heat pumps, or geothermal units.

# Acknowledgments / References

## Collaborators

Daniel Huppmann (International Institute for Applied Systems Analysis)
Antonia Golab (Energy Economics Group – Technische Universität Wien)
Hans Auer (Energy Economics Group – Technische Universität Wien)

## Further references

H. Auer et al. (2020). Development and modelling of different decarbonization scenarios at the European energy system until 2050 as a contribution to achieving the ambitious 1.5°C climate target – establishment of open source/data modelling in the European H2020 project openENTRANCE, *e&i Elektrotechnik und Informationstechnik*, 1-13. doi: 10.1007/s00502-020-00832-7

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