TECHNISCHE UNIVERSITÄT WIEN

ethink ENERGY RESEARCH

Energy mapping and data collection to identify long-term opportunities for district energy systems

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Typical questions of spatial energy planning

- Which shares of heat demand can/should be supplied by district heating?
- Which levels of heat savings are economically feasible?
- Which renewable energy and waste heat sources are economically feasible to use?
- What are conclusions for zoning policies?
- How can climate neutrality be achieved in the heating and cooling sector?

⇨ Requirement for mapping of current demand and supply and future options

Energy mapping

- The role of energy mapping in district energy planning
- Key steps in the development of energy mapping across various levels of detail
- How to use heat maps for strategy development
- Best case practices, strengths and limitations
- Lessons learned & recommendations

Project background of this presentation

- Hotmaps (H2020 project, completed, www.hotmaps.eu)

  Hotmaps develops, demonstrates and disseminates a toolbox to support public authorities, energy agencies and planners in strategic heating and cooling planning at local, regional and national levels, and in line with EU policies.

- Spatial energy planning (Austrian research project, ongoing, www.waermeplanung.at)

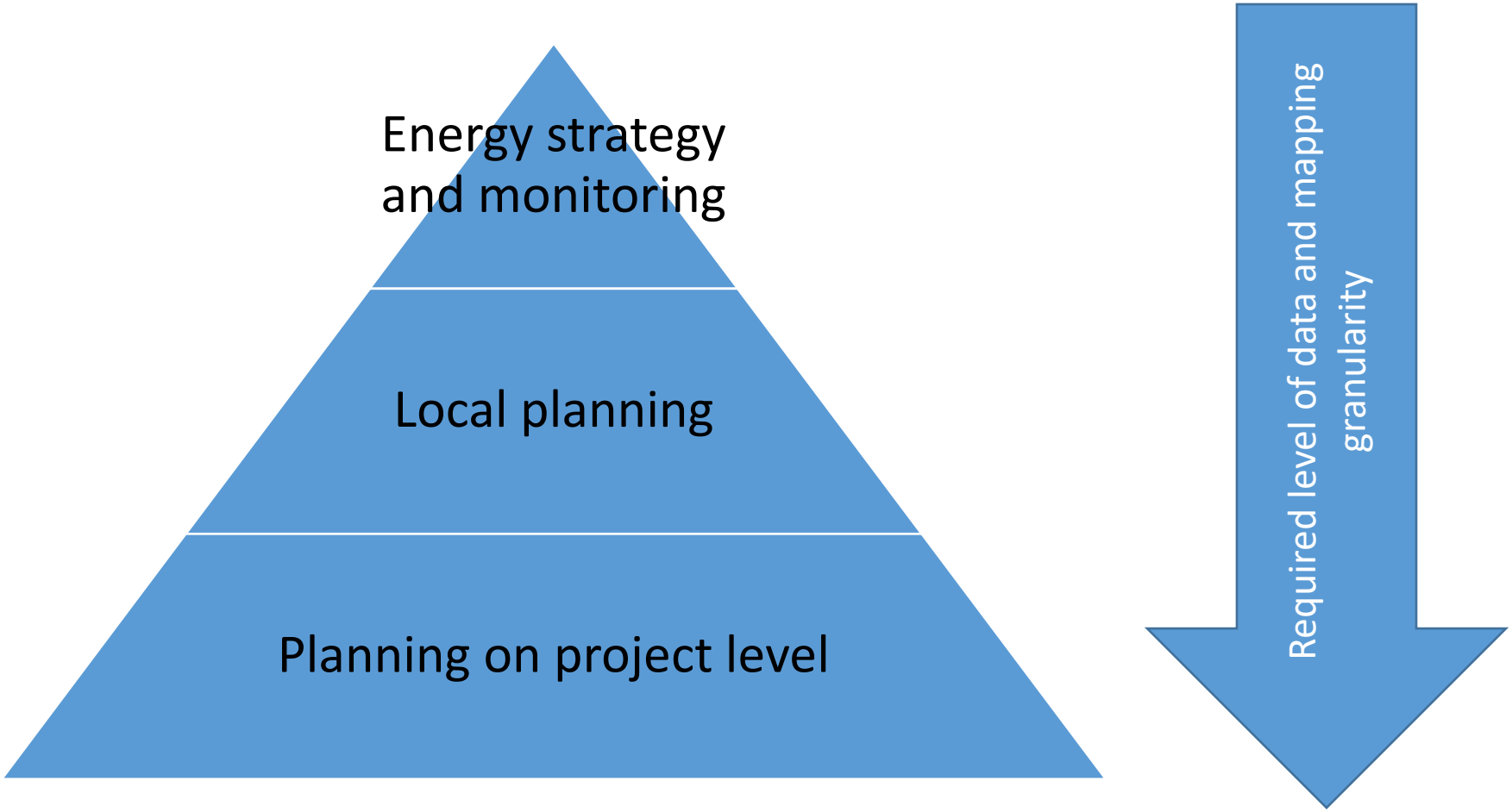
  The goal is to develop and provide the essential basis for a roll out of spatial heat planning in Austria. Up-to-date data on building block granularity is used to develop a HEATatlas showing heat demand, site specific RES potentials as well as energy zones as the foundation for instruments of public steering.

- Comprehensive assessment for efficient heating and cooling supply according to Art 14, Energy Efficiency Directive for the case of Austria (www.Austrian-heatmap.gv.at)

- Local case studies

Mapping is a means, not an end in itself

Levels of spatial energy planning




HOTMAPS
AAU
Aalborg
PLANENERGI
Kerry County
Milton Keynes
Frankfurt-am-Main
FRAUNHOFER ISI
E-THINK
TU WIEN
Bistrita
ENERGY CITIES
HES-SO
EURAC
CREM
Geneva
San Sebastian
Pilot areas
PARTNERS
www.hotmaps-project.eu

Kerry County Council (IE)

Status Quo

- Primarily oil, LPG and el. for heating. No natural gas grid.
- 1MW Biomass CHP in most dense area of largest town
- Large tourism industry = high heat demands in summer.
- Local energy groups investigating RE-possibilities

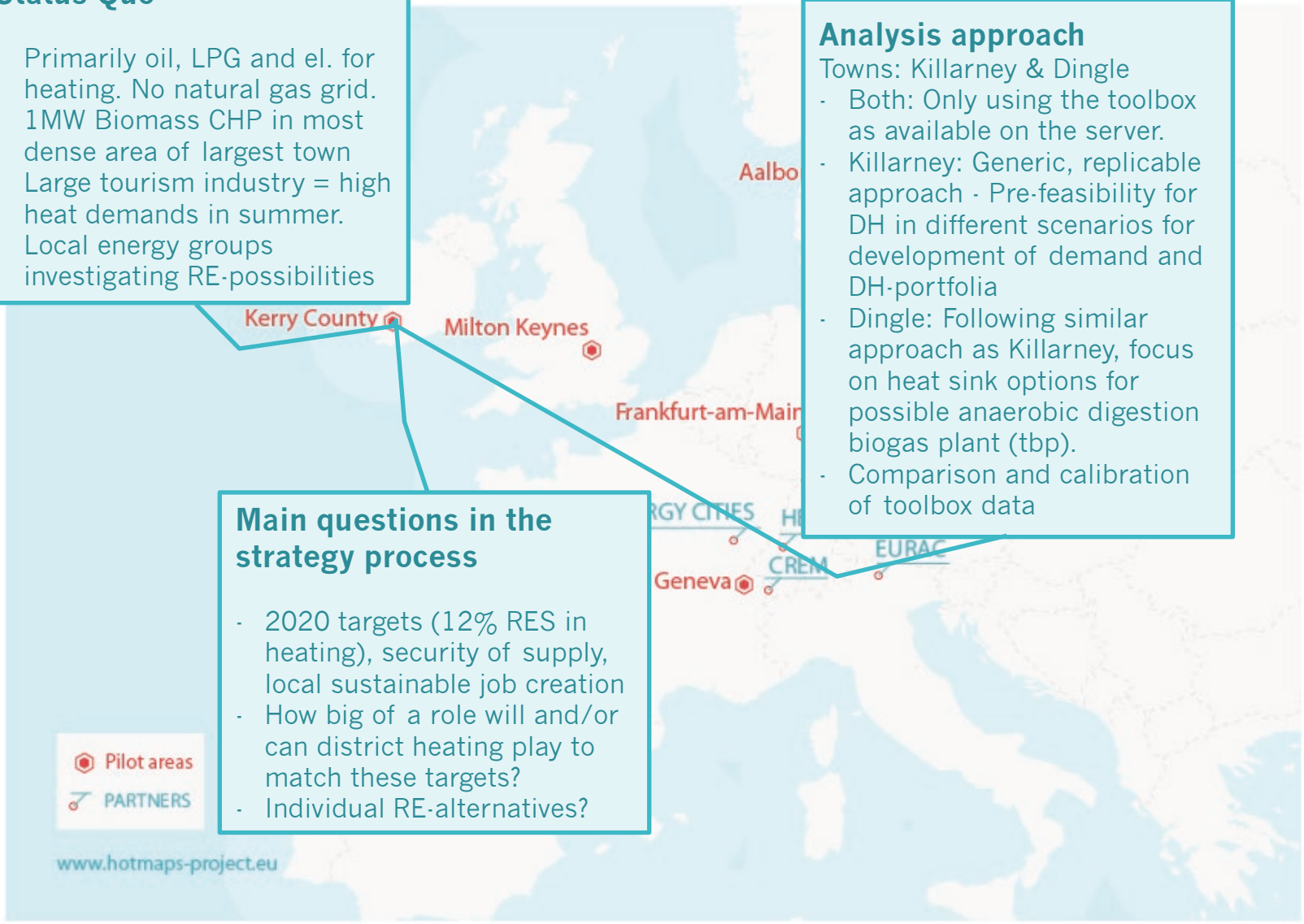
Analysis approach

Towns: Killarney & Dingle

- Both: Only using the toolbox as available on the server.
- Killarney: Generic, replicable approach · Pre-feasibility for DH in different scenarios for development of demand and DH-portfolia
- Dingle: Following similar approach as Killarney, focus on heat sink options for possible anaerobic digestion biogas plant (tbp).
- Comparison and calibration of toolbox data

Main questions in the strategy process

- 2020 targets (12% RES in heating), security of supply, local sustainable job creation
- How big of a role will and/or can district heating play to match these targets?
- Individual RE-alternatives?



Milton Keynes (UK)

Status Quo

- Primarily natural gas grid.
- Private DH (NGas CHP, bio) in Central Milton Keynes
- Densification and green-field-developments ongoing
- Currently no significant cooling needs

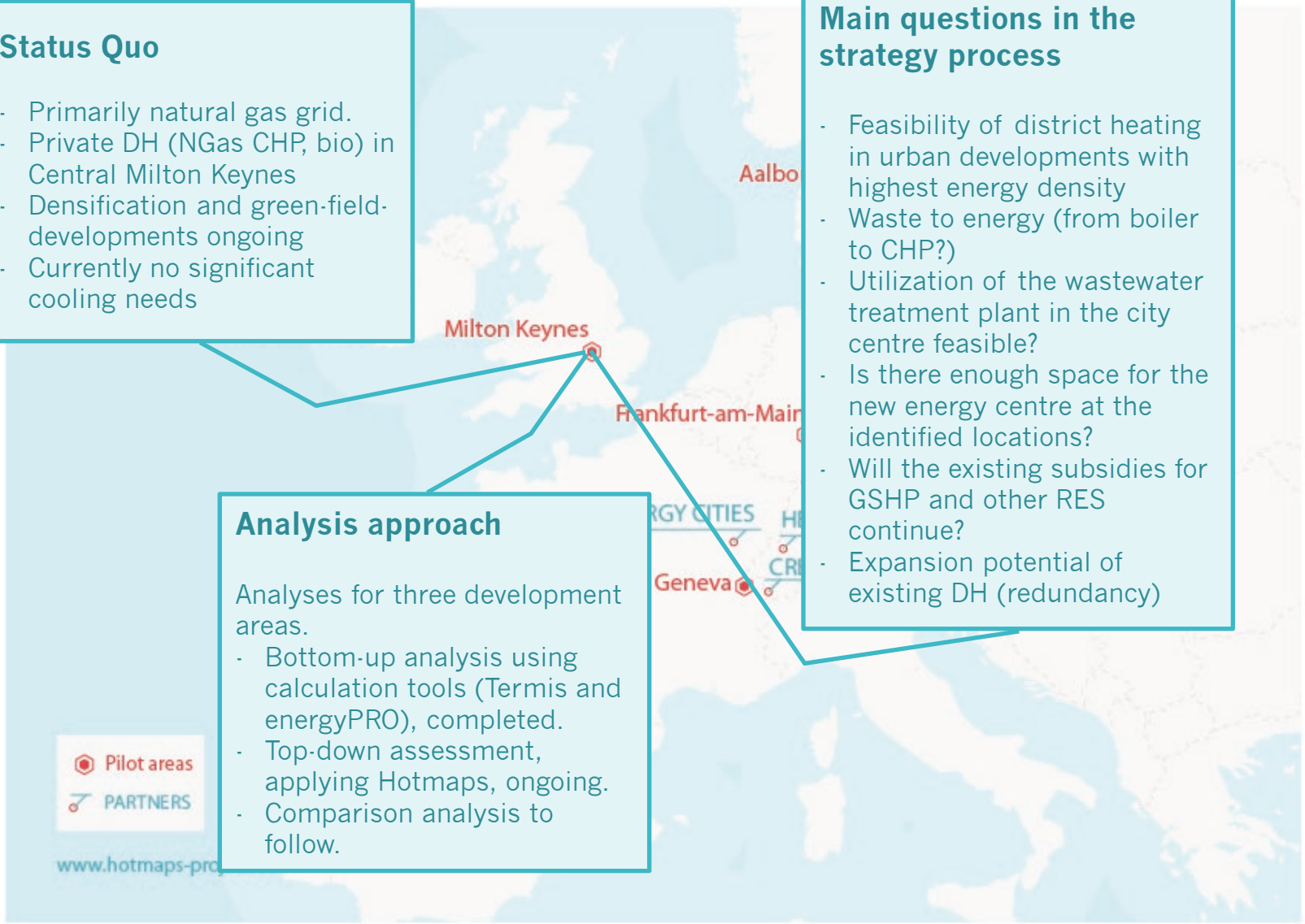
Main questions in the strategy process

- Feasibility of district heating in urban developments with highest energy density
- Waste to energy (from boiler to CHP?)
- Utilization of the wastewater treatment plant in the city centre feasible?
- Is there enough space for the new energy centre at the identified locations?
- Will the existing subsidies for GSHP and other RES continue?
- Expansion potential of existing DH (redundancy)

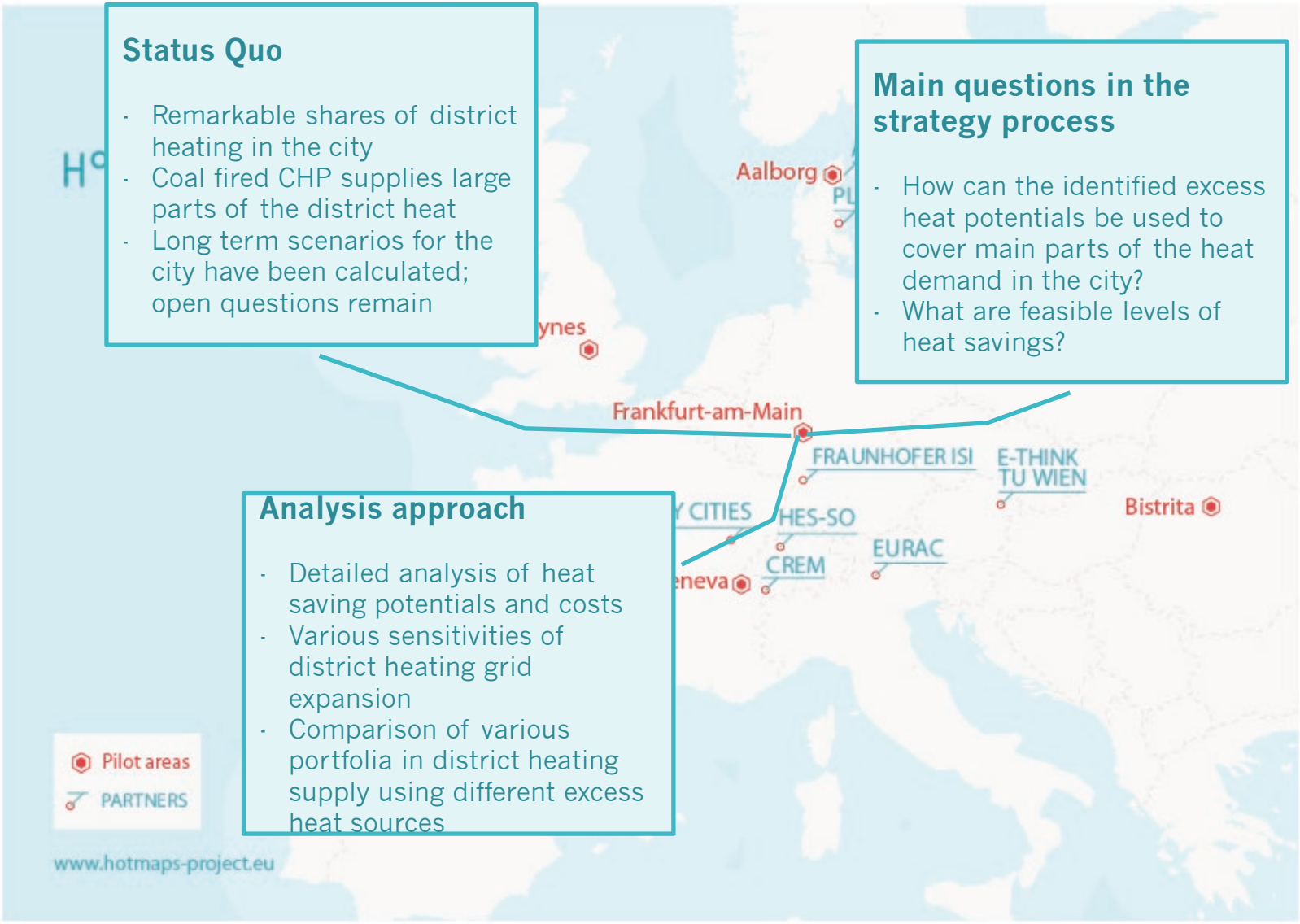
Analysis approach

Analyses for three development areas.

- Bottom-up analysis using calculation tools (Termis and energyPRO), completed.
- Top-down assessment, applying Hotmaps, ongoing.
- Comparison analysis to follow.



City of Frankfurt am Main (DE)



Status Quo

- Remarkable shares of district heating in the city
- Coal fired CHP supplies large parts of the district heat
- Long term scenarios for the city have been calculated; open questions remain

Main questions in the strategy process

- How can the identified excess heat potentials be used to cover main parts of the heat demand in the city?
- What are feasible levels of heat savings?

Analysis approach

- Detailed analysis of heat saving potentials and costs
- Various sensitivities of district heating grid expansion
- Comparison of various portfolia in district heating supply using different excess heat sources

City of Bistrita (RO)

Status Quo

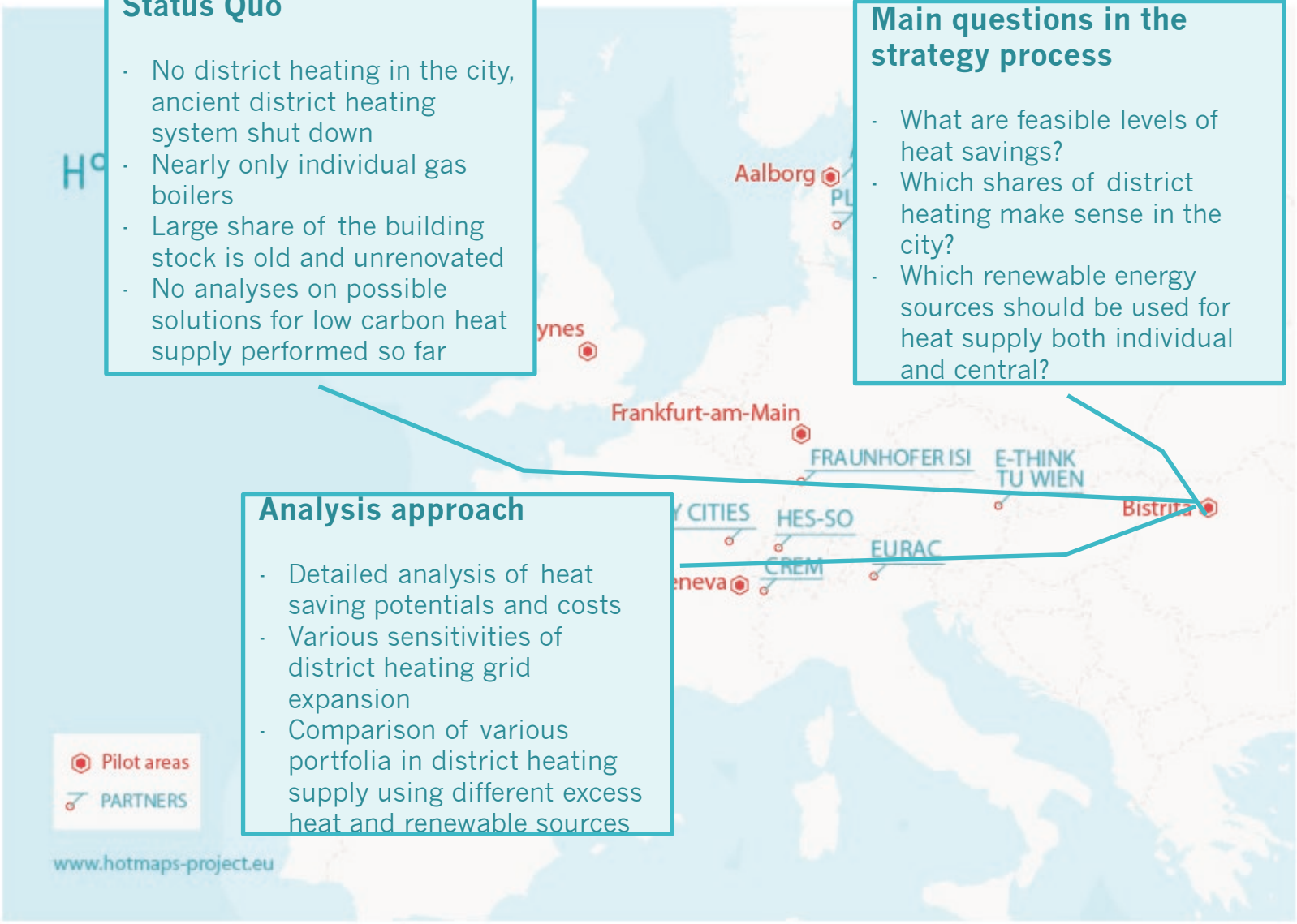
- No district heating in the city, ancient district heating system shut down
- Nearly only individual gas boilers
- Large share of the building stock is old and unrenovated
- No analyses on possible solutions for low carbon heat supply performed so far

Main questions in the strategy process

- What are feasible levels of heat savings?
- Which shares of district heating make sense in the city?
- Which renewable energy sources should be used for heat supply both individual and central?

Analysis approach

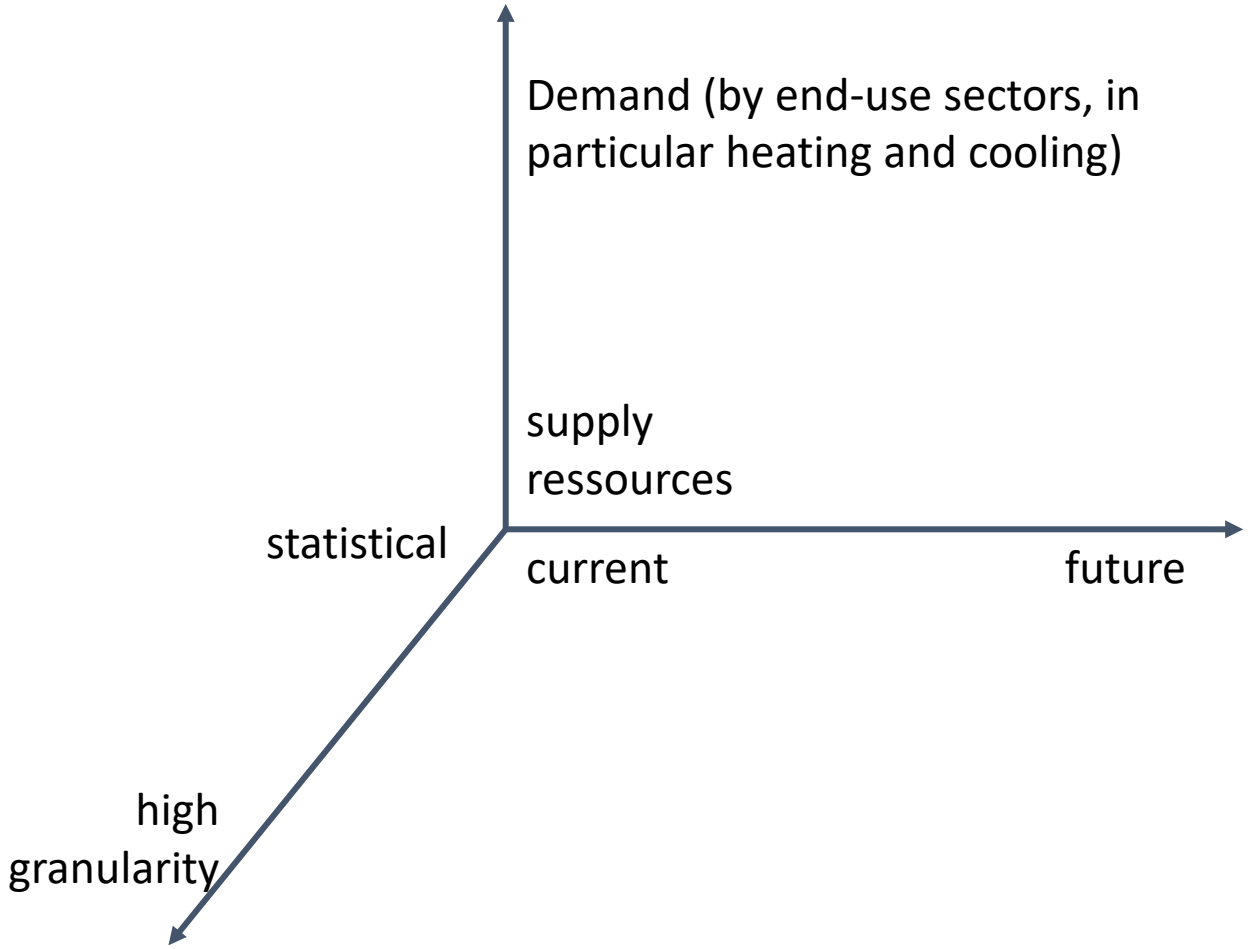
- Detailed analysis of heat saving potentials and costs
- Various sensitivities of district heating grid expansion
- Comparison of various portfolia in district heating supply using different excess heat and renewable sources



Strategy development process applied in Hotmaps

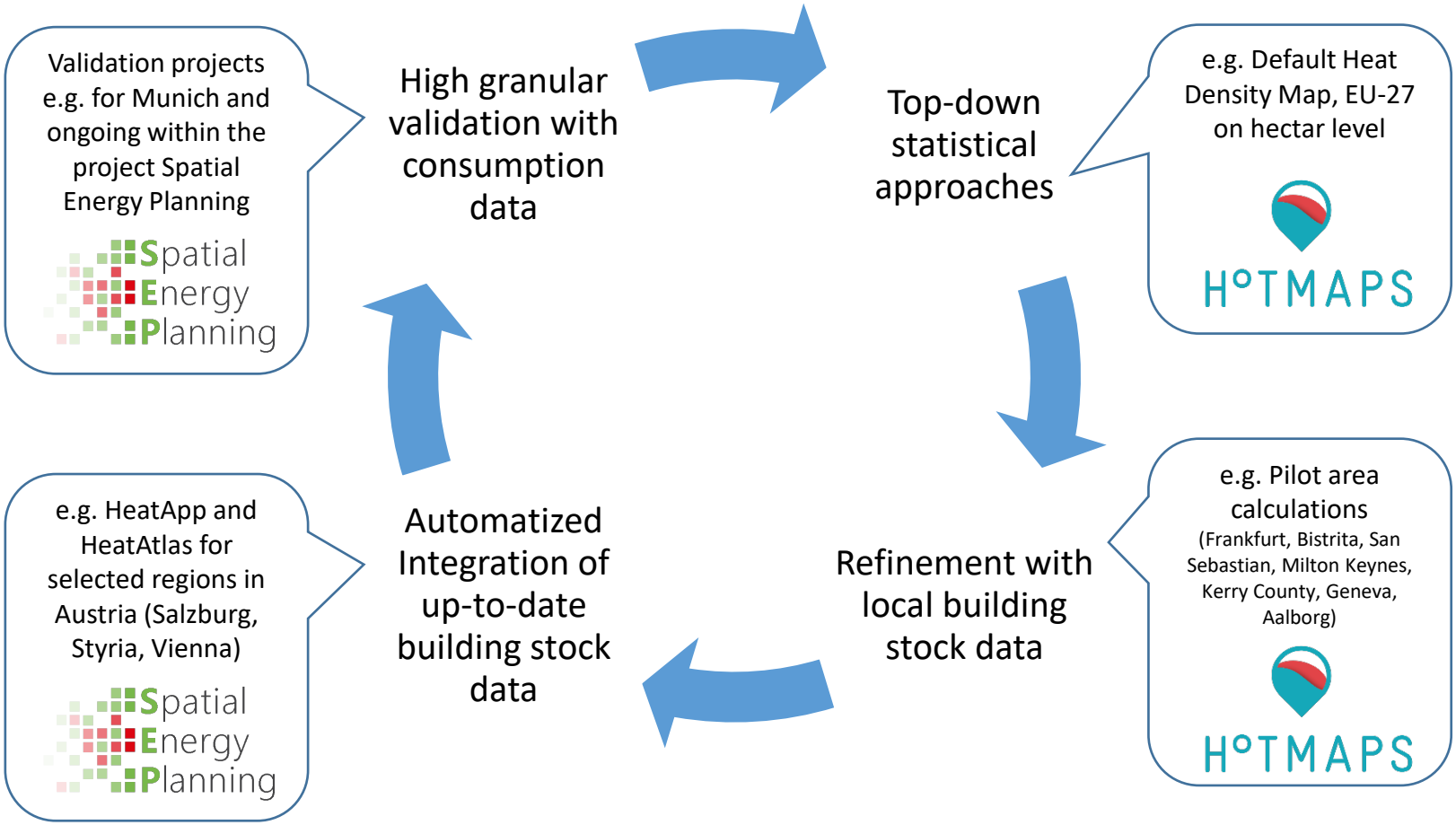
- Description of the city and analysis of stakeholders
  - Local, regional and national targets
  - Description of existing H&C system
  - Analysis of stakeholders
  - Analysis of barriers and drivers
- Mapping of demand, resources potentials and existing plants
- First stakeholder meeting
  - Discuss results of mapping and current state
  - Discuss method and scenarios to be calculated
- Setting up scenarios of future H&C
  - Compilation of economic input data
  - Calculation of various scenarios
  - Scenario assessment regarding relevant indicators
- Second stakeholder meeting
  - Discuss scenario results
  - Discuss recommendations for strategy and roadmap
- Strategy formulation

Dimensions of energy (heat) mapping

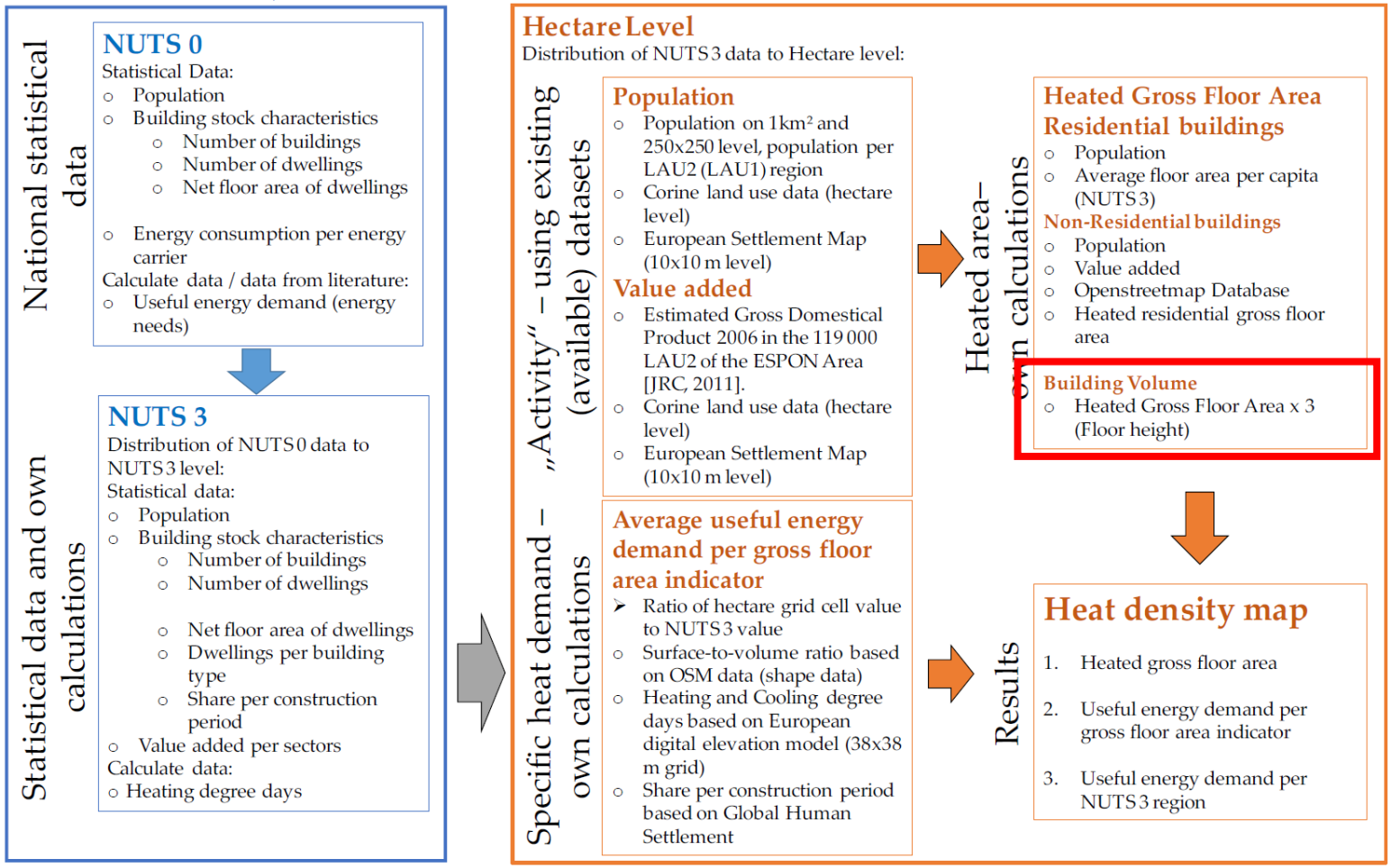


Heat mapping:

Top down approaches vs. high granularity heat maps



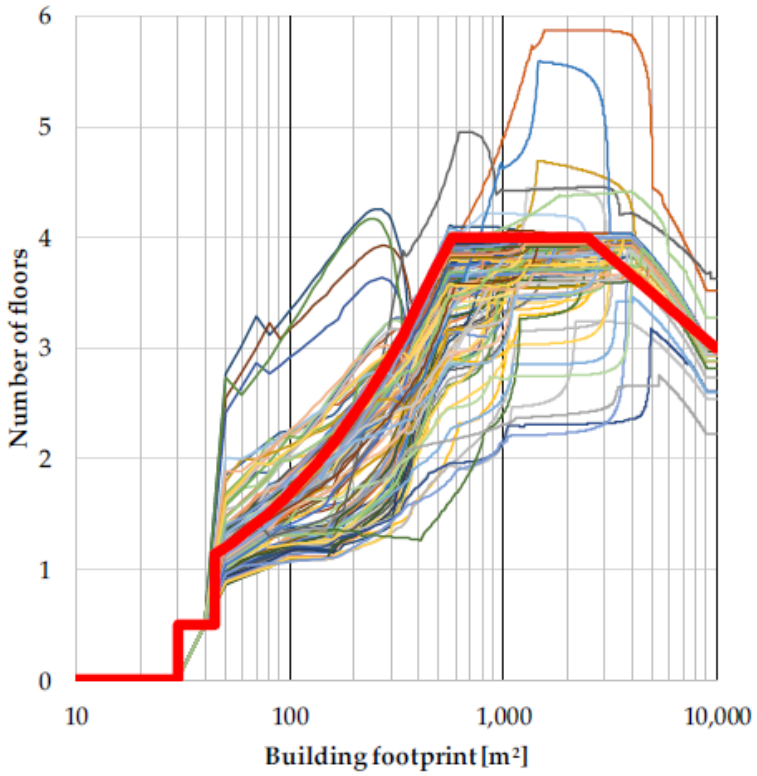
Schematic Hotmaps-process to derive data maps on hectar level for EU-28



Source: Müller, A., Hummel, M., Kranzl, L., Fallahnejad, M., Büchele, R., 2019. Open Source Data for Gross Floor Area and Heat Demand Density on the Hectare Level for EU 28. Energies 12, 4789. https://doi.org/10.3390/en12244789

Modelling building height

Calculated relationship (based on OSM data) between the average number of floors and the building footprint for 150 randomly chosen municipalities across Europe, as well as their generic functions (red line).



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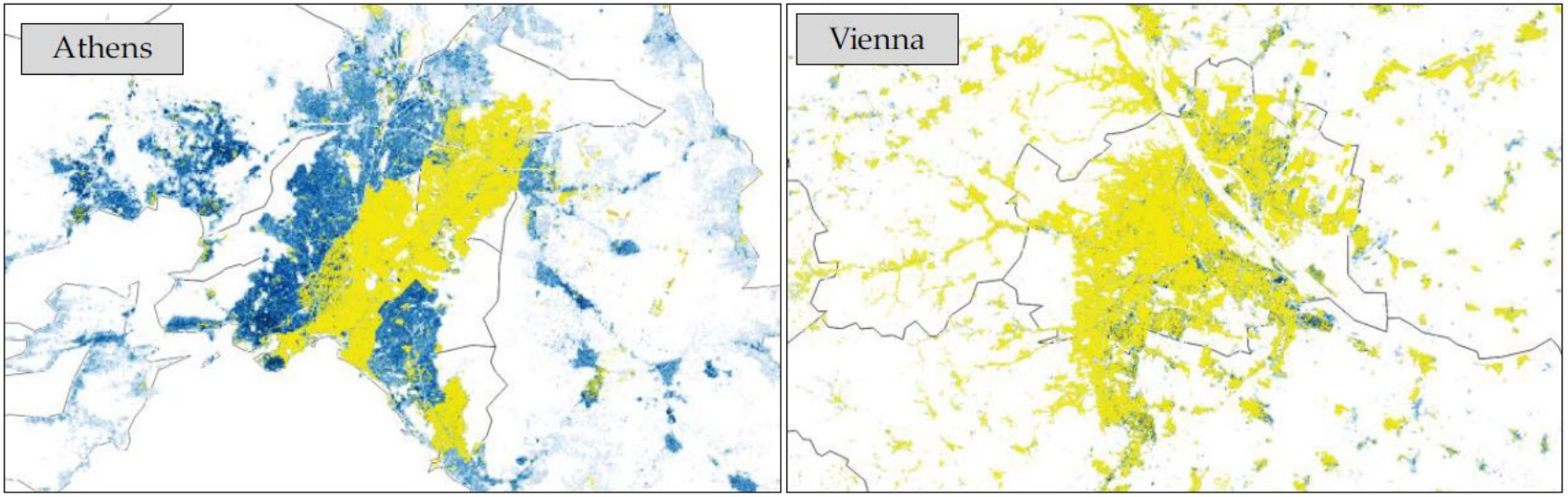
Open street map vs. Population based approach

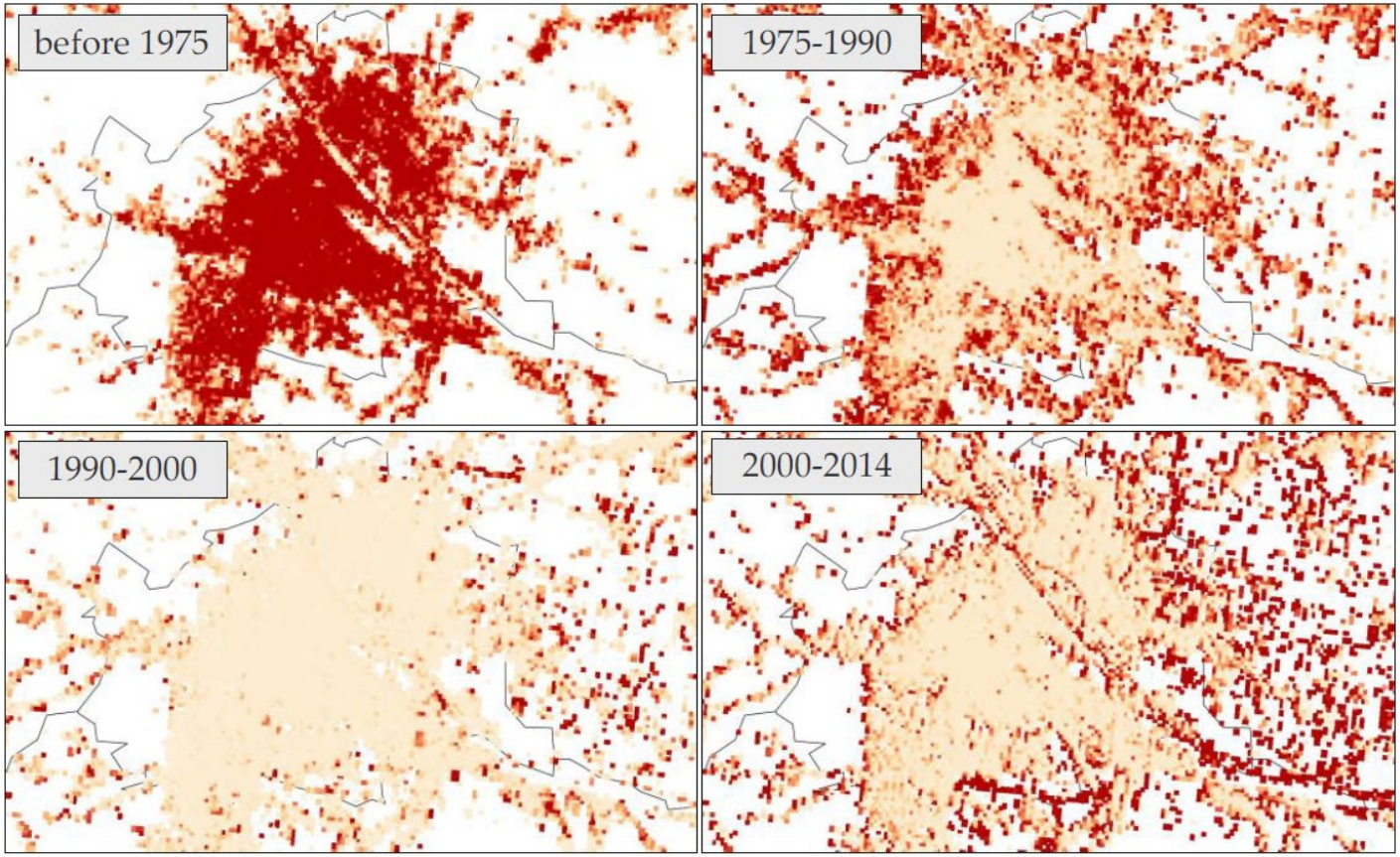
Completeness of the OpenStreetMap-building stock data: Comparison of the OpenStreetMap-data (yellow) with the European Settlement Map (blue) for the region of Athens (left map) and Vienna (right map)



Source: Müller, A., Hummel, M., Kranzl, L., Fallahnejad, M., Büchele, R., 2019. Open Source Data for Gross Floor Area and Heat Demand Density on the Hectare Level for EU 28. Energies 12, 4789. https://doi.org/10.3390/en12244789

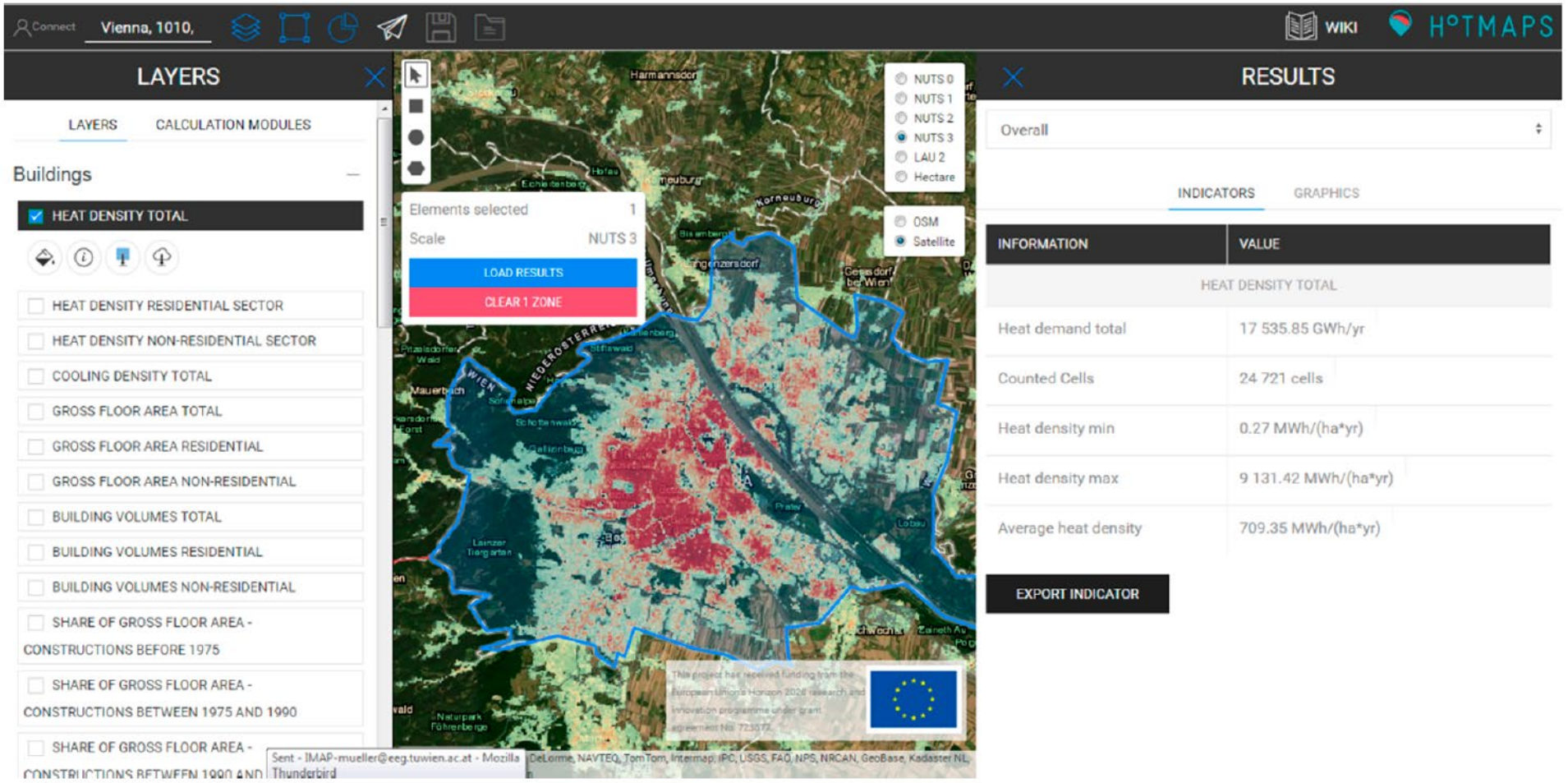
Construction periods of the building stock

Based on soil sealing data (Global Human Settlement project)



Source: Müller, A., Hummel, M., Kranzl, L., Fallahnejad, M., Büchele, R., 2019. Open Source Data for Gross Floor Area and Heat Demand Density on the Hectare Level for EU 28. Energies 12, 4789. https://doi.org/10.3390/en12244789

Heat demand density layer at the Hotmaps toolbox (www.hotmaps.eu)



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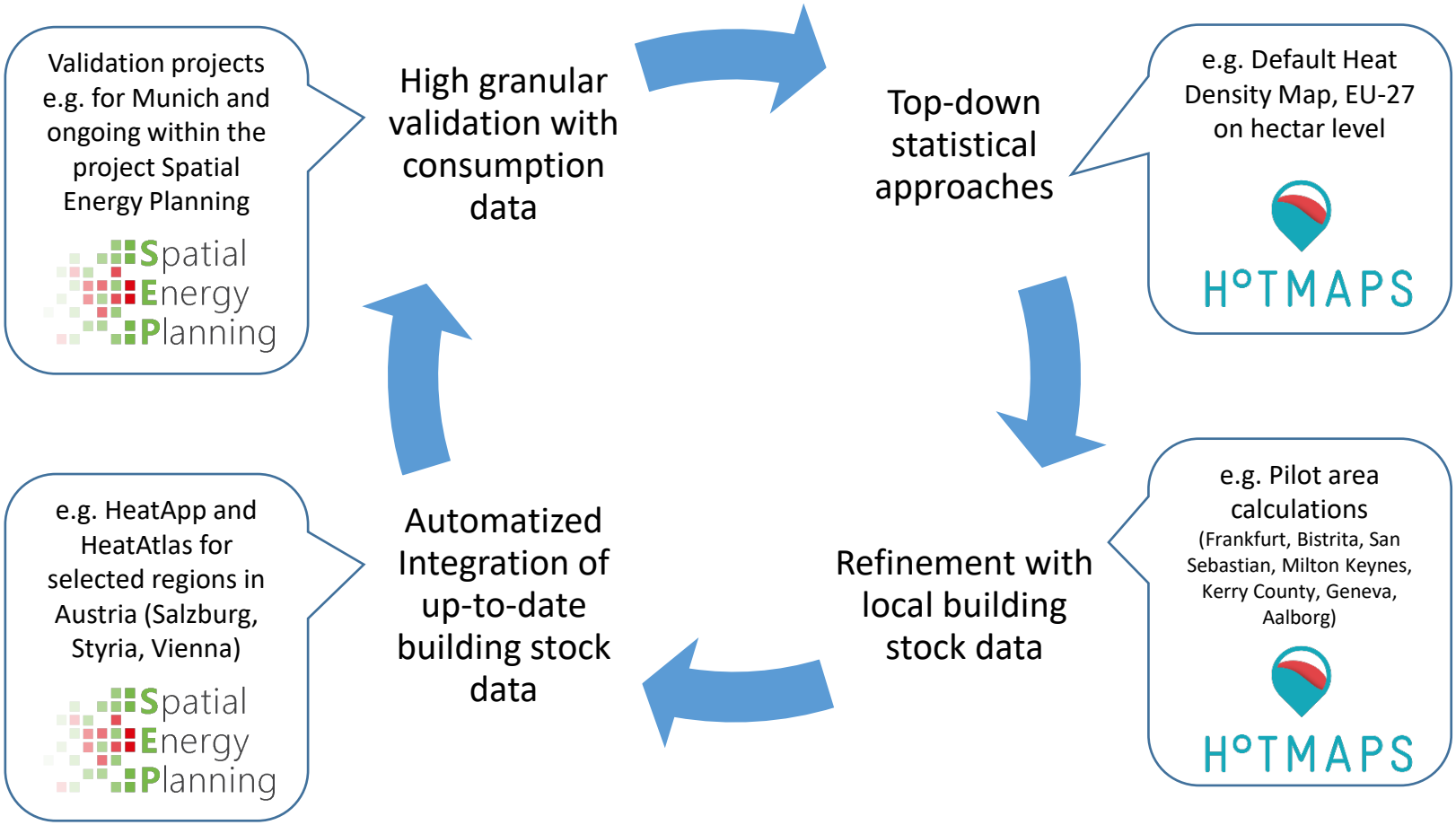
Top down approaches vs. high granularity heat maps



Available local data and comparison with default heat density maps

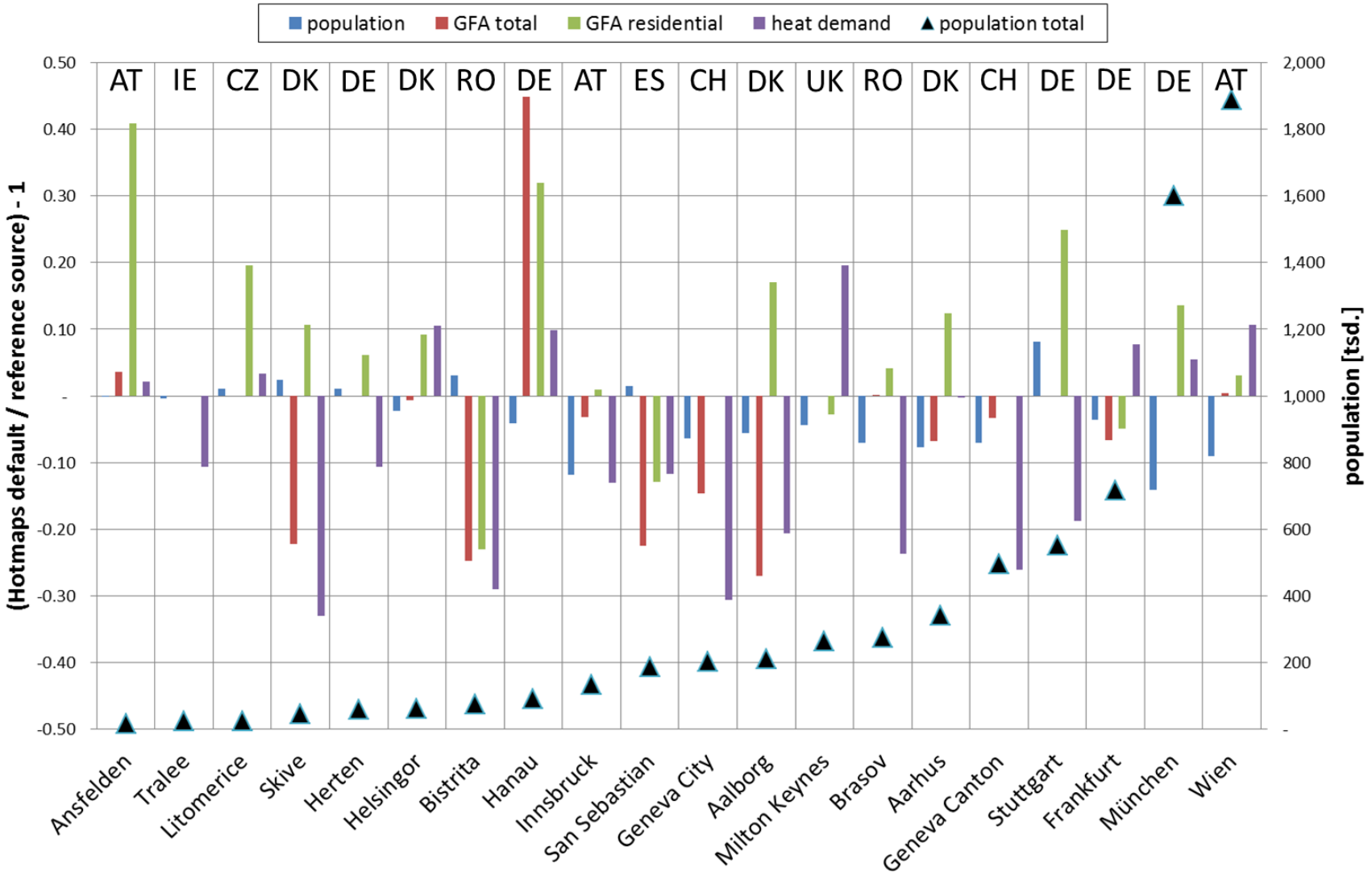
Available local data

- Knowledge available in all pilot areas
  - current energy balance at local level
  - Existing capacities in DH
- Large differences between pilot areas for several types of data: E.g.
  - Frankfurt has numerous data sets on many relevant data points
  - Bistrita has very detailed data on buildings in the city (type, age, status)
  - Milton Keynes doesn’t have detailed data of the buildings

Method for developing locally customized heat demand density layers

- Method used in Hotmaps for the cases Bistrita, Frankfurt and San Sebastian
- Shapefiles of all buildings in the city received from local public authorities
- These databases are joined with other data sources and further shaped to have same status of database on buildings level for all areas:
  - Type, GFA, age, location for all buildings
  - E.g. in San Sebastian with more detailed info for non-residential buildings DB
  - E.g. in Frankfurt with old version of the DB as well as with other DB on building ages
- These DBs then joined with heat demand per gross floor area values of typical building types of the respective countries (Invert/EE-Lab database), climate corrected to the PA location

Comparison of customized and default data – heat demand density



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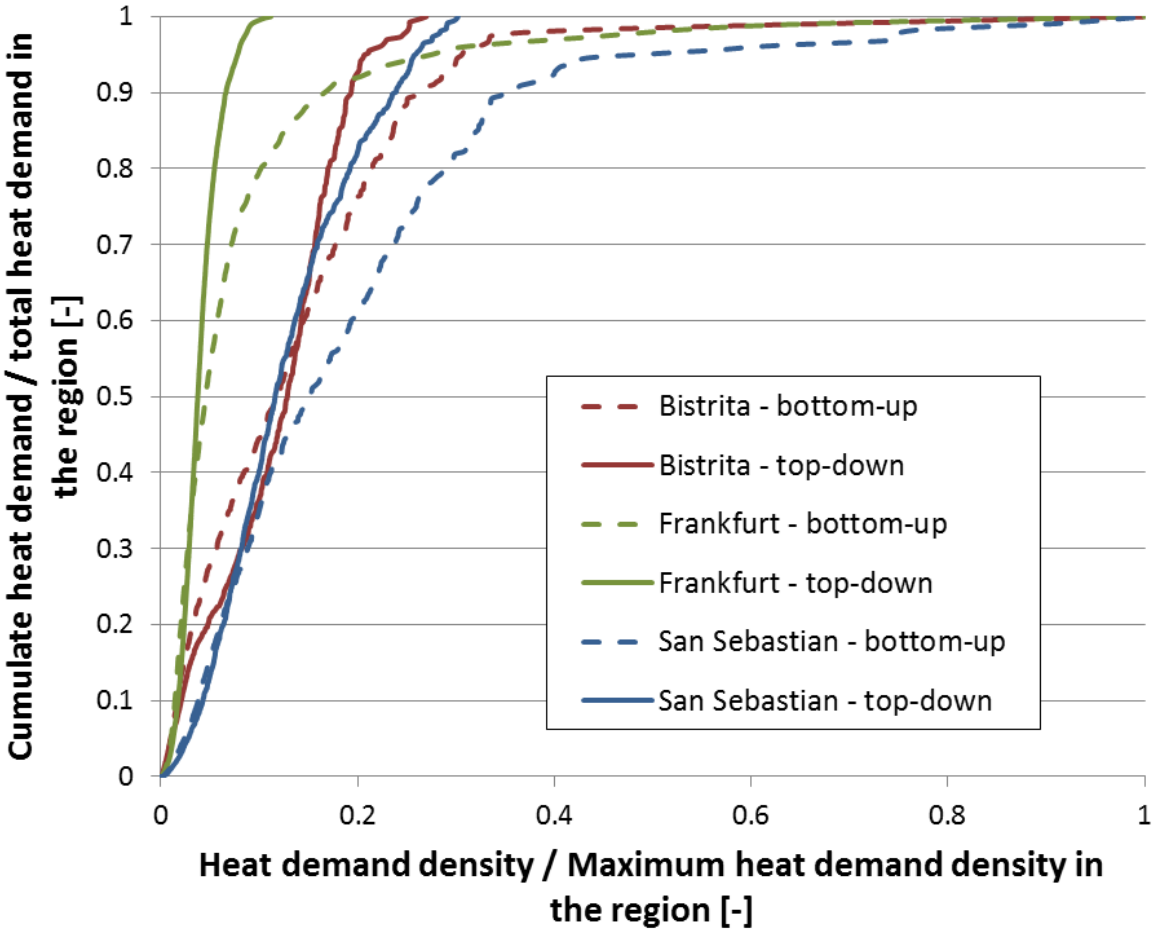

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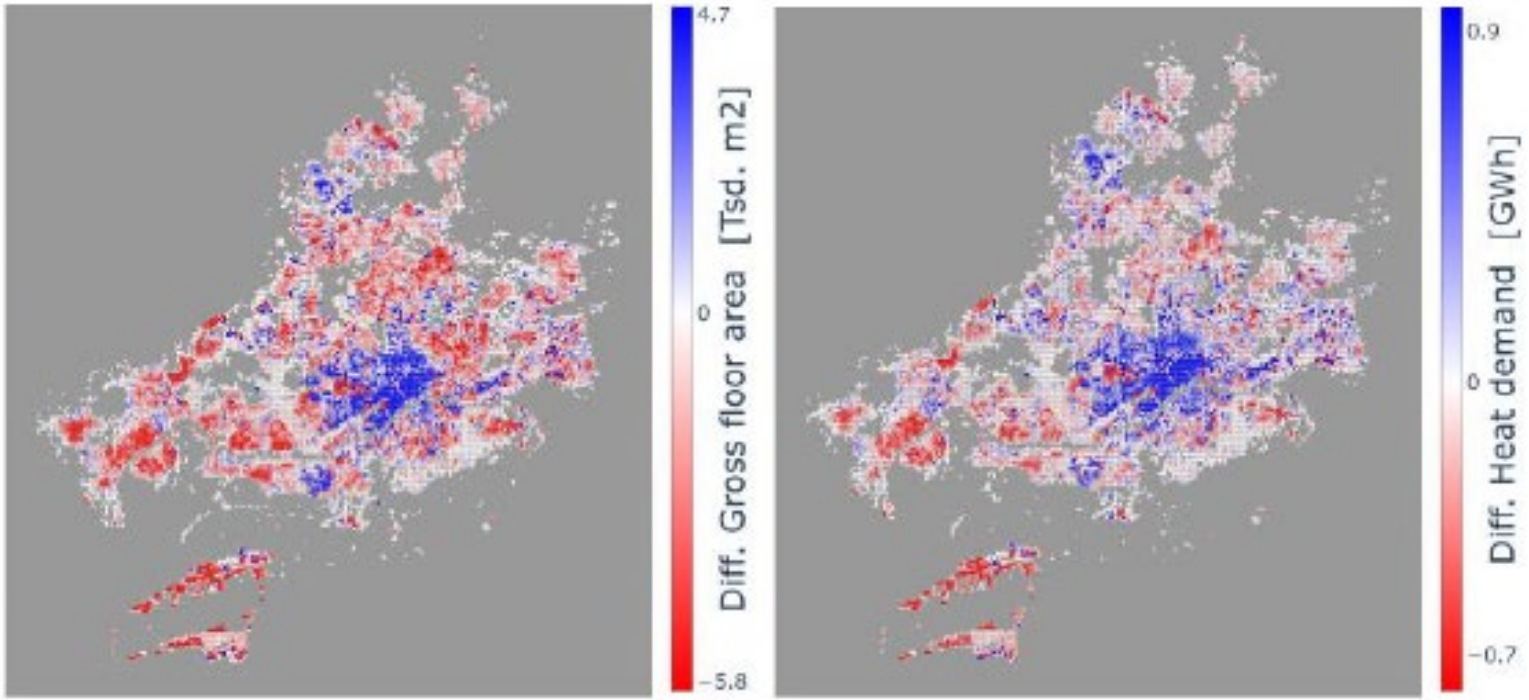


Source: Müller, A., Hummel, M., Kranzl, L., Falahnejad, M., Büchele, R., 2019, „Open source data for gross floor area and heat demand density on hectare level for EU 28", Energies

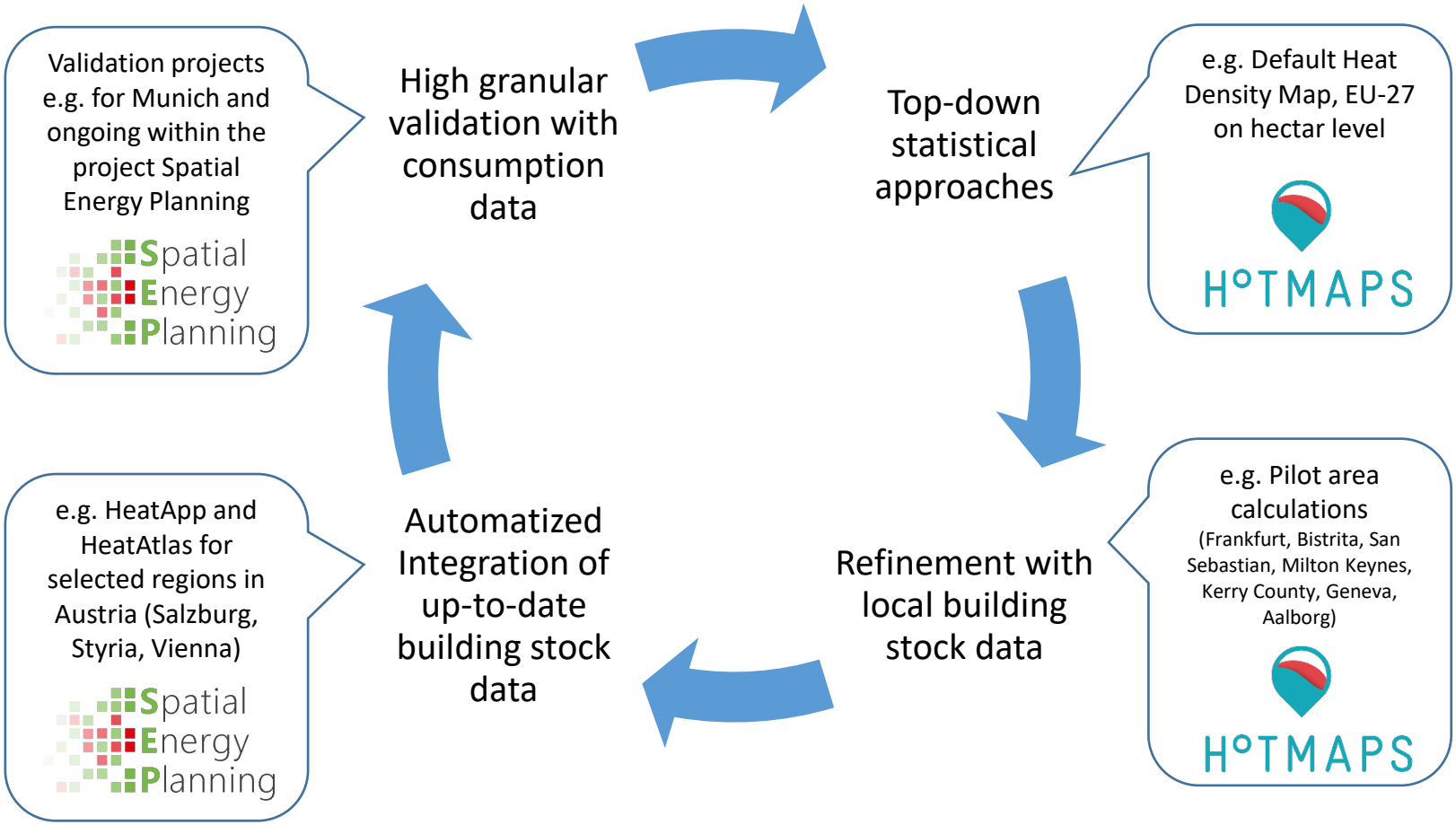
Conclusions on default data gross floor area and heat demand

- Default heat demand and gross floor area values are
  - useful for strategic purposes on aggregated level of larger regions and municipalities
  - especially valuable in locations where no detailed data is available

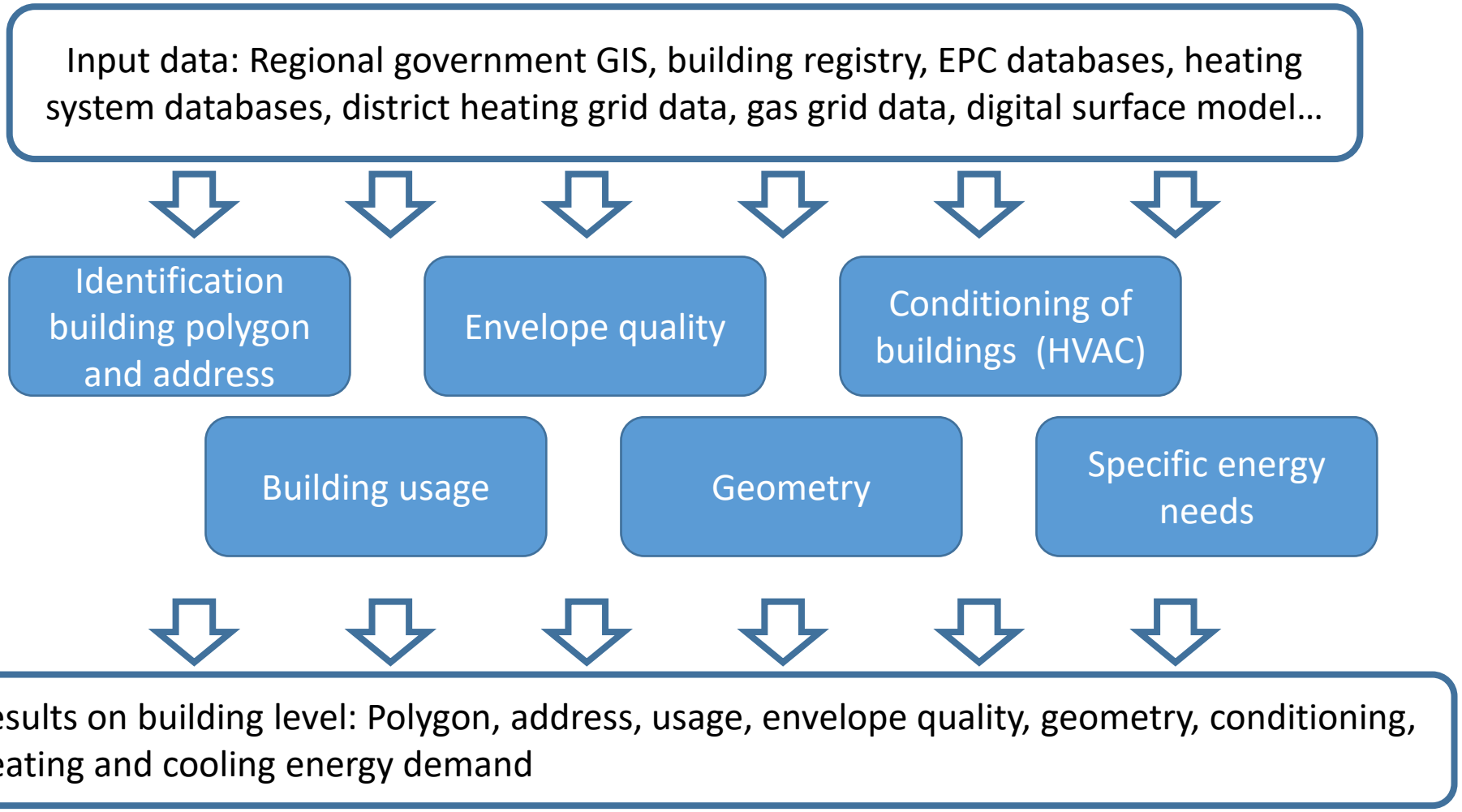
- For detailed planning of heating and cooling infrastructure, local, more specific data should be used

Heat mapping:

Top down approaches vs. high granularity heat maps

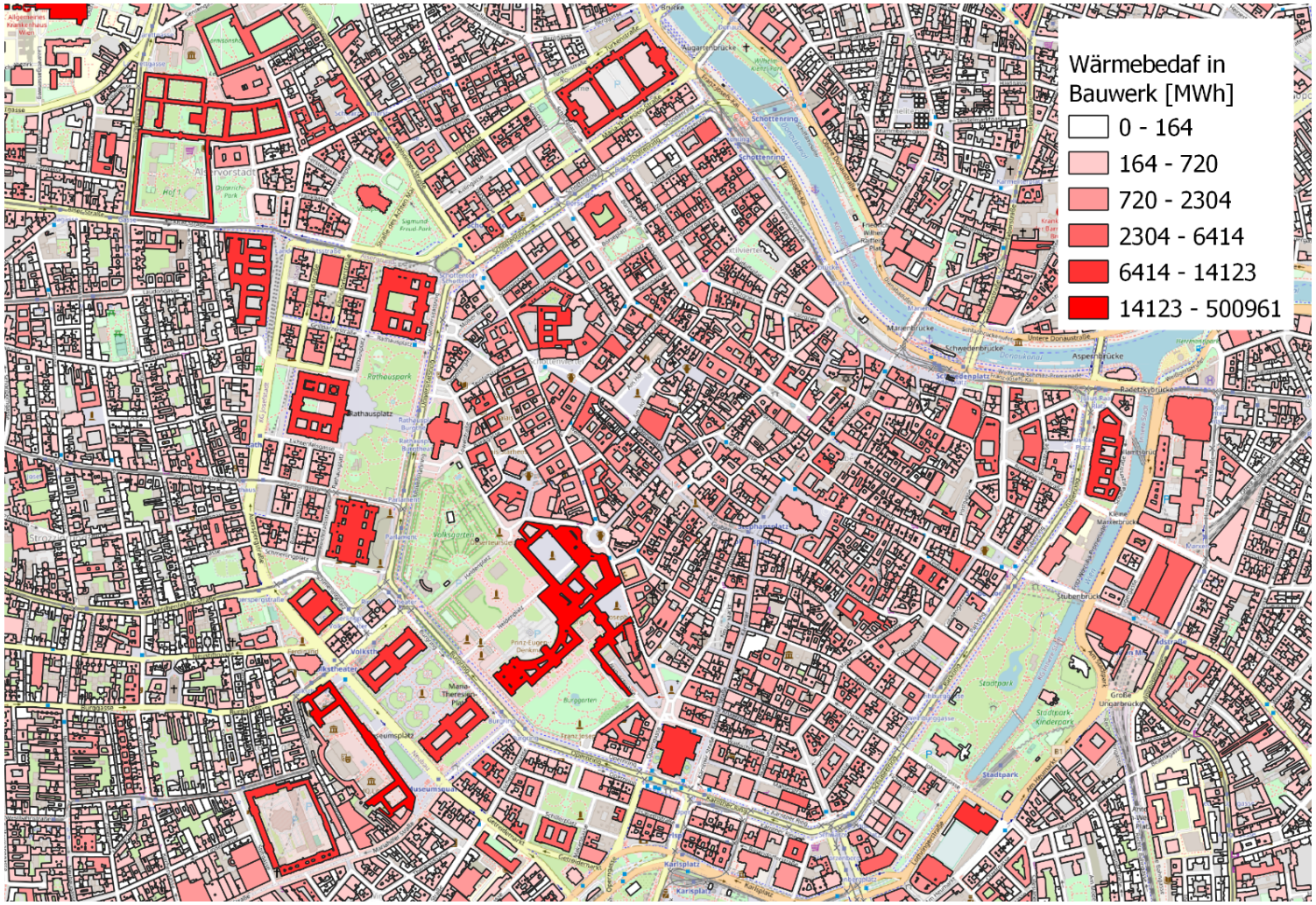


Overview of the process and the interaction of modules for determining building typology and heat demand maps on building level



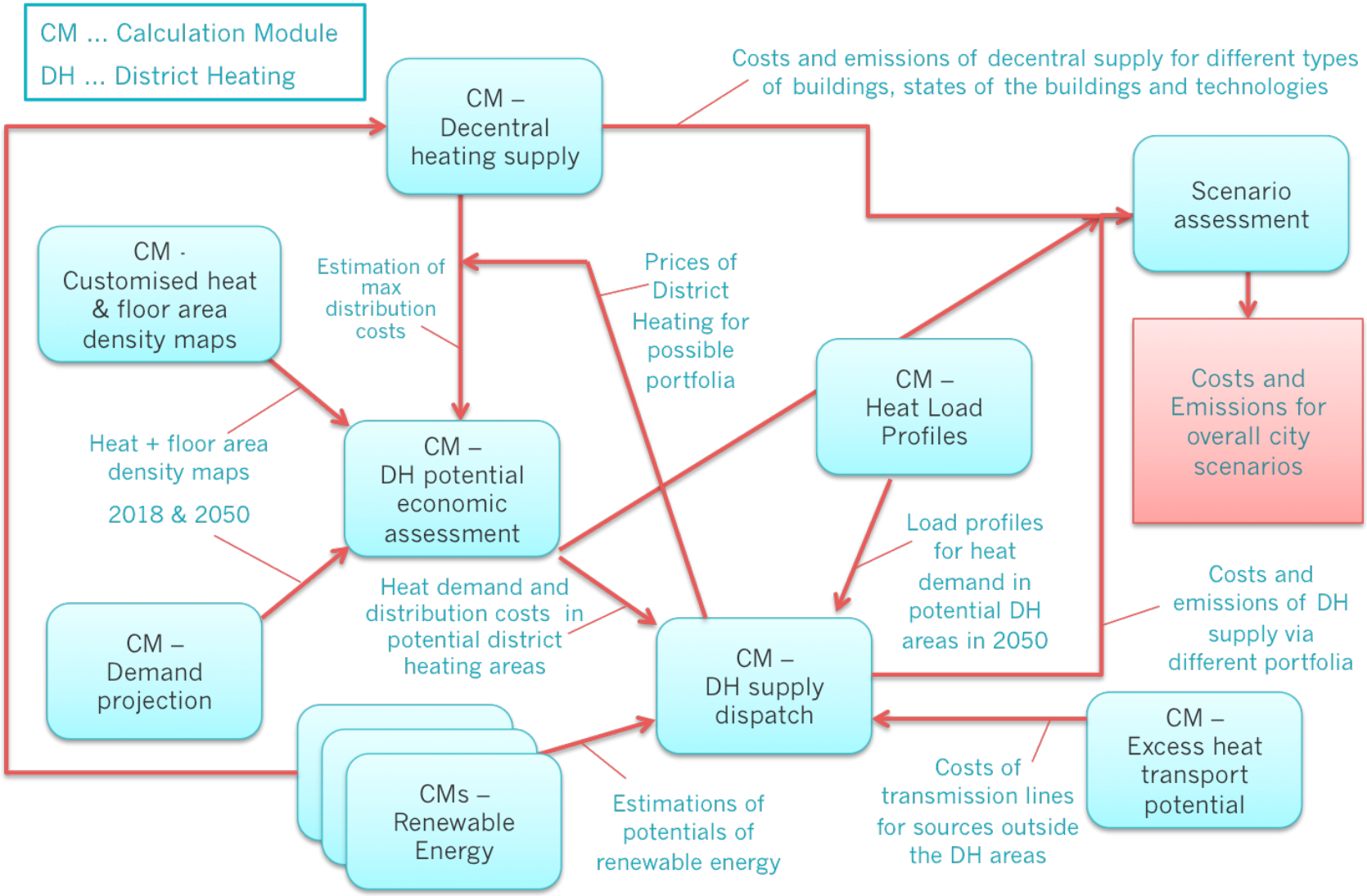
Source: Project Spatial Energy Planning (www.waermeplanung.at)

(Preliminary) results: heat demand map on building level to be regularly updated based on background data



Mapping is a means, not an end in itself

Hotmaps scenario toolchain

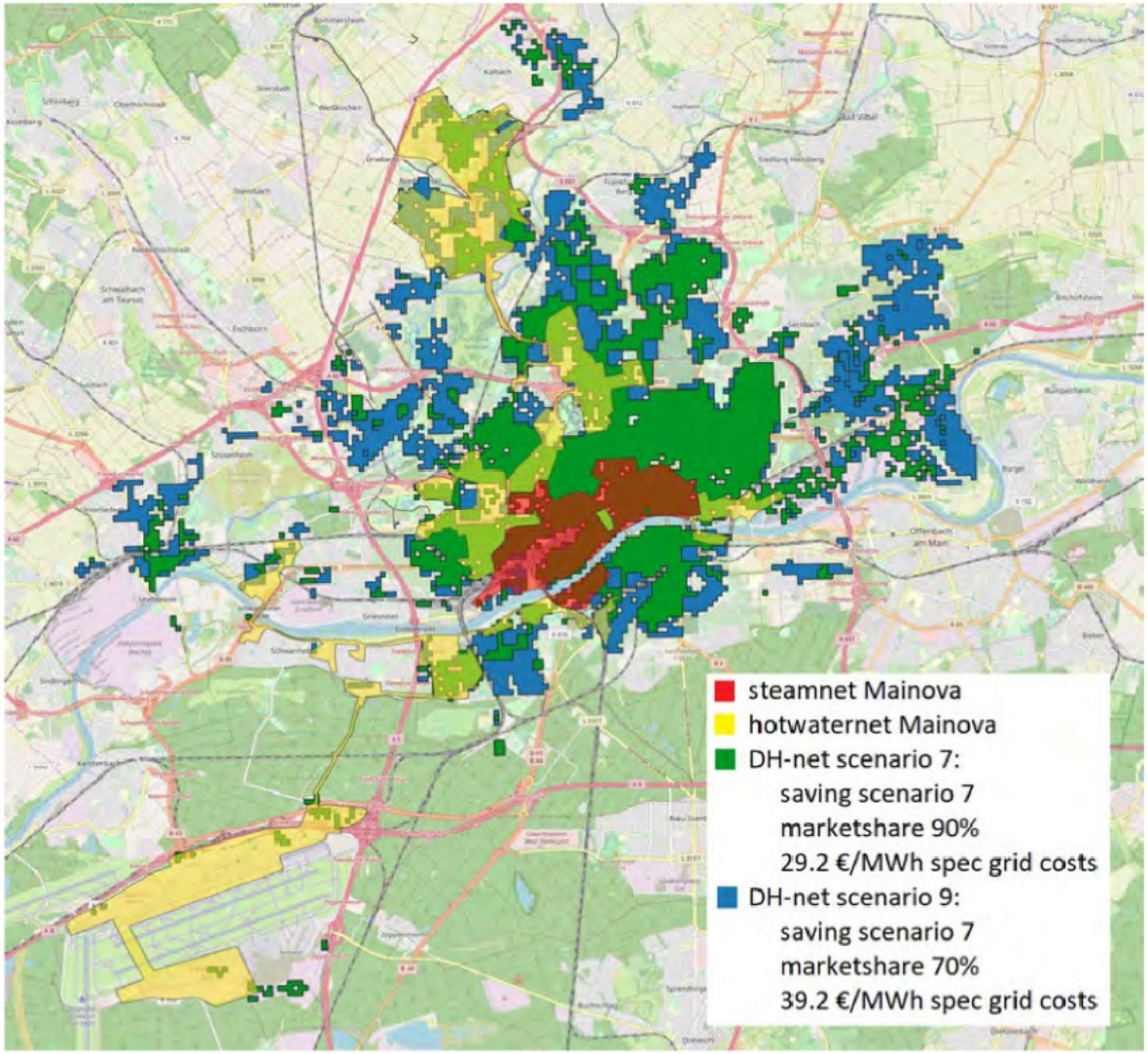


The case of Frankfurt: current and possible future heat maps

Heat demand density maps of Frankfurt for 2017 (top left),
2050 with 35% savings (top right),
2050 with 46% savings (bottom left) and
2050 with 53% savings (bottom right)

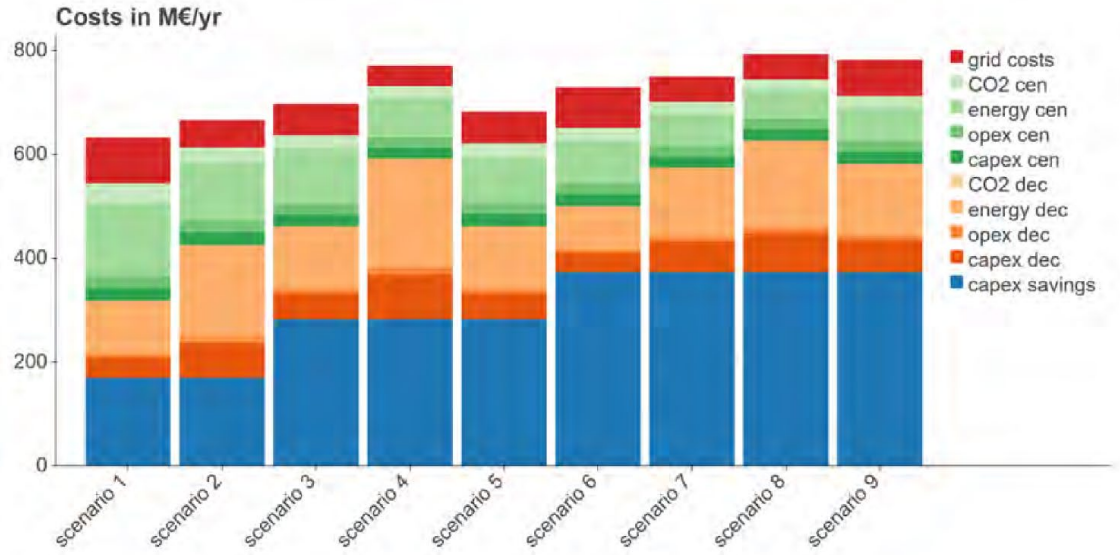
Source: https://www.hotmaps-project.eu/wp-content/uploads/2020/10/Hotmaps_D.6.3_Frankfurt-HC-Strategies_FINAL_reduced.pdf

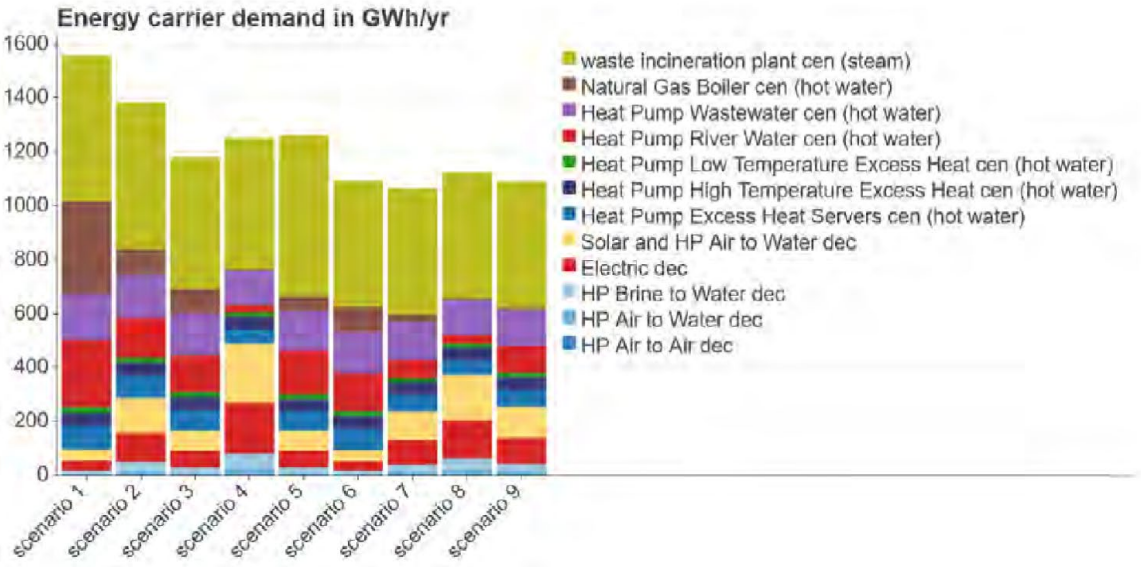
The case of Frankfurt: Current and potential future areas of district heating



Source: https://www.hotmaps-project.eu/wp-content/uploads/2020/10/Hotmaps_D.6.3_Frankfurt-HC-Strategies_FINAL_reduced.pdf

The case of Frankfurt: Comparing different possible scenarios of future heat supply and demand





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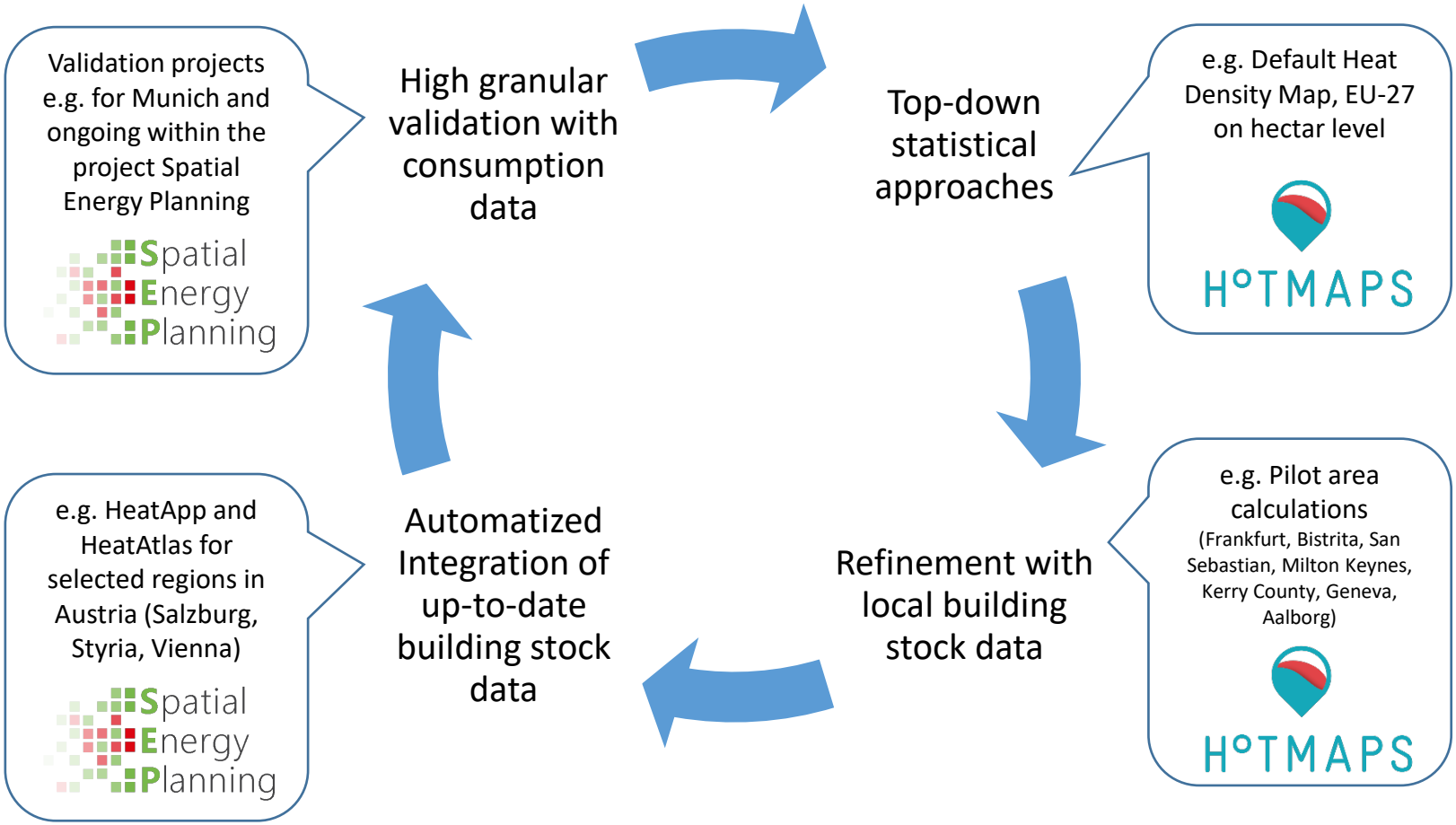

Summary and conclusions

- Key uncertainties
  - Building height
  - Number of floors (for large non residential buildings)
  - Specific energy needs
    - Insulation of buildings
    - Usage and user behaviour
  - Information on HVAC system (Type, age, efficiency)

- Need for linking existing data sources (chimney sweepers, installers, different public authorities, EPC databases, building registries, heating system databases …)

- Trade-off between required resources to set-up a consistent building stock model and the related heat map on the one hand and the uncertainties related with available default heat density maps

- Suitable approach depends on available data (and available resources to improve them) and the concrete policy aim, questions and needs

Thank you!

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Orig. Photo: Patrick Stargardt

Sources

- Hotmaps Toolbox, website, open data and open source modules:
  www.hotmaps.eu
  www.hotmaps-project.eu
  https://gitlab.com/HotMaps
  https://github.com/HotMaps

Müller, A., Hummel, M., Kranzl, L., Fallahnejad, M., Büchele, R., 2019. Open Source Data for Gross Floor Area and Heat Demand Density on the Hectare Level for EU 28. Energies 12, 4789. https://doi.org/10.3390/en12244789

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