GIS mapping and Heat Roadmap Europe

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Personal introduction

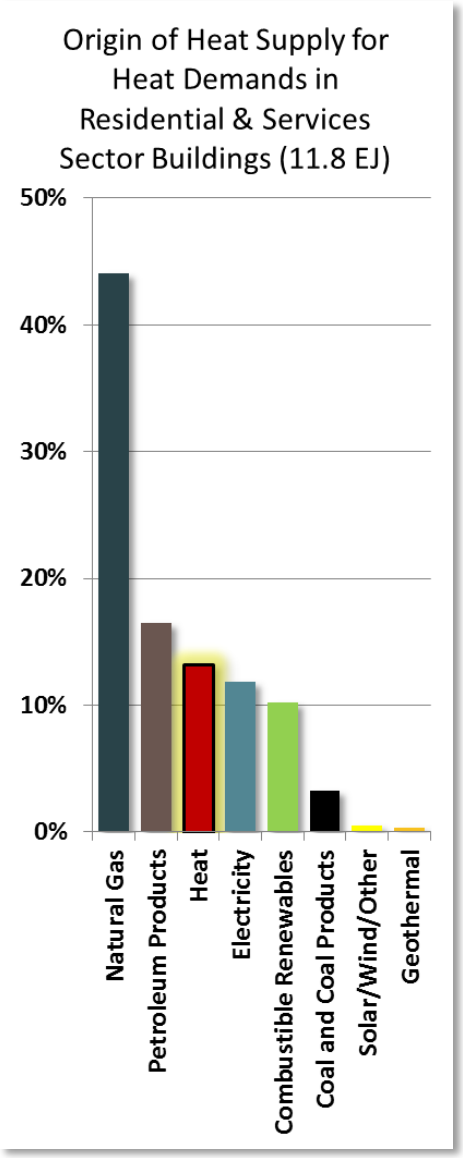
- Affiliation
  - School of Business and Engineering at Halmstad University
    - Main Supervisor: Prof. Sven Werner
    - Supervisor: Dr. Mei Gong
  - Energy Technology at Chalmers University of Technology
    - Examiner & Supervisor: Prof. Filip Johnsson
- Projects
  - Pathways: Swedish System Solutions (2008-2010)
  - IEA Annex X: Towards 4th Generation DH (2012-2013)
  - Heat Roadmap Europe 2050 project, PS 1&2 (2012-2013)
  - 4DH Strategic Research Center (2012 – 2017)
- Ph.D. studies
  - Planned doctoral dissertation in November, 2014

Overview

- GIS mapping and Heat Roadmap Europe
  - The EU energy balance
  - District heating in Europe today
  - Heat Roadmap Europe – Modelling and mapping
  - GIS mapping
  - Regional heat balances
  - Strategic heat synergy regions
  - Conclusions

The EU energy balance

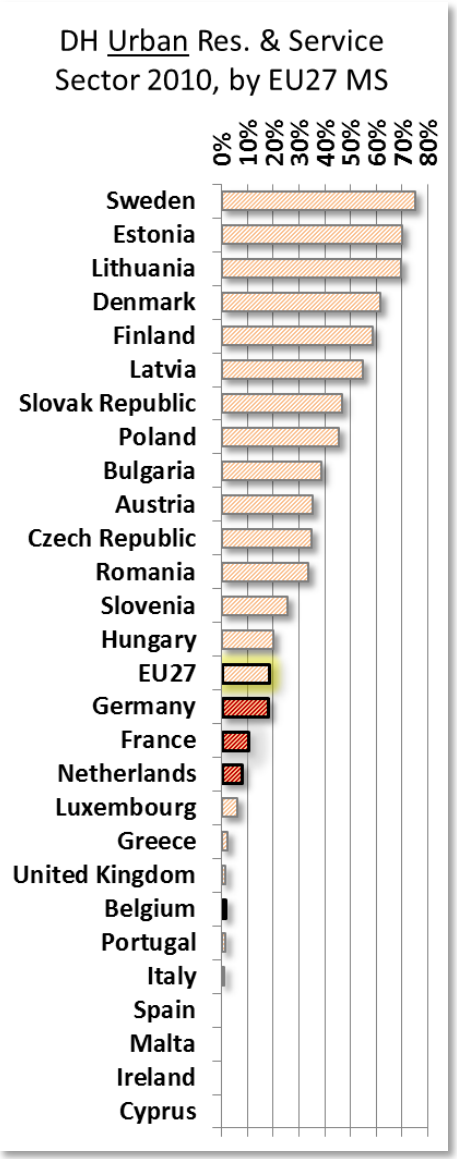
- Inefficient supply structures in Europe today
  - Primary energy supply: 72 EJ (2010)
  - Final consumption: 50 EJ
    - Heat losses in central conversion: 22 EJ (30%)
  - End use: 33 EJ (46%)
    - Heat losses in local conversion: 17 EJ (24%)
  - 54% of total PES in conv. heat losses (39 EJ)!
- Heat demands in buildings
  - Residential & service sector: 11.8 EJ
  - Fossil fuels dominate: ≈ ¾ of total supply
  - District heat: 13%
  - HRE vision: 50% district heating by 2050!



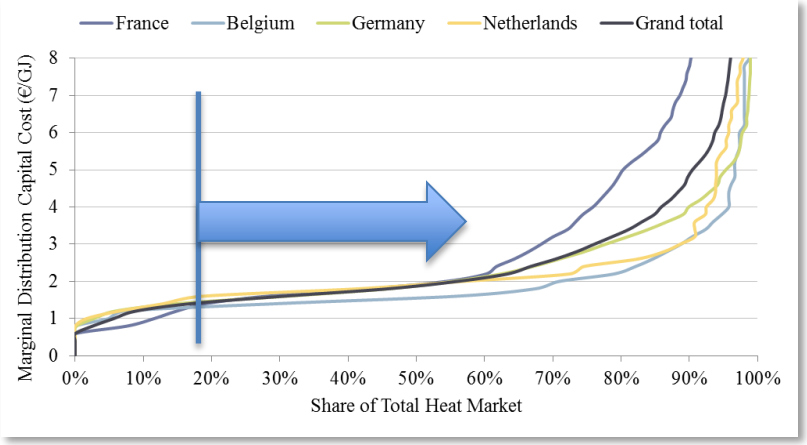
Source: IEA EB 2012 & Bertoldi et al. 2012.

District heating in Europe today

- Heat market shares
  - EU27 average: 13% of Res. & Service sector
  - EU27 average: 10% in Industrial sector
- Urban areas
  - District heating: a city thing!
  - EU27 average urban population share: 73%
  - EU27 average urban heat market share: 18%



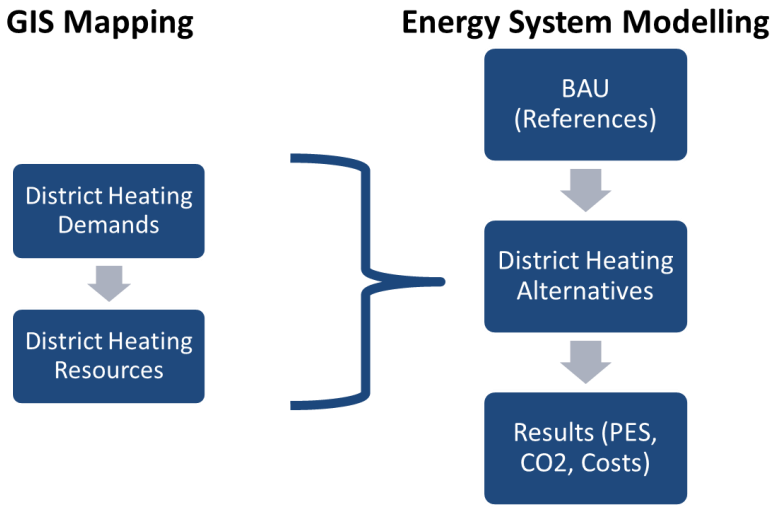
Previous studies: Three-fold directly feasible expansion possibility from current DH levels…



Source: U. Persson & S. Werner, 2011. Heat Distribution and The Future Competitiveness of District Heating. Applied Energy 88 (2011) 568–576. Source: Population Division, UN, 2010. 2012.

Heat Roadmap Europe – Modelling and mapping

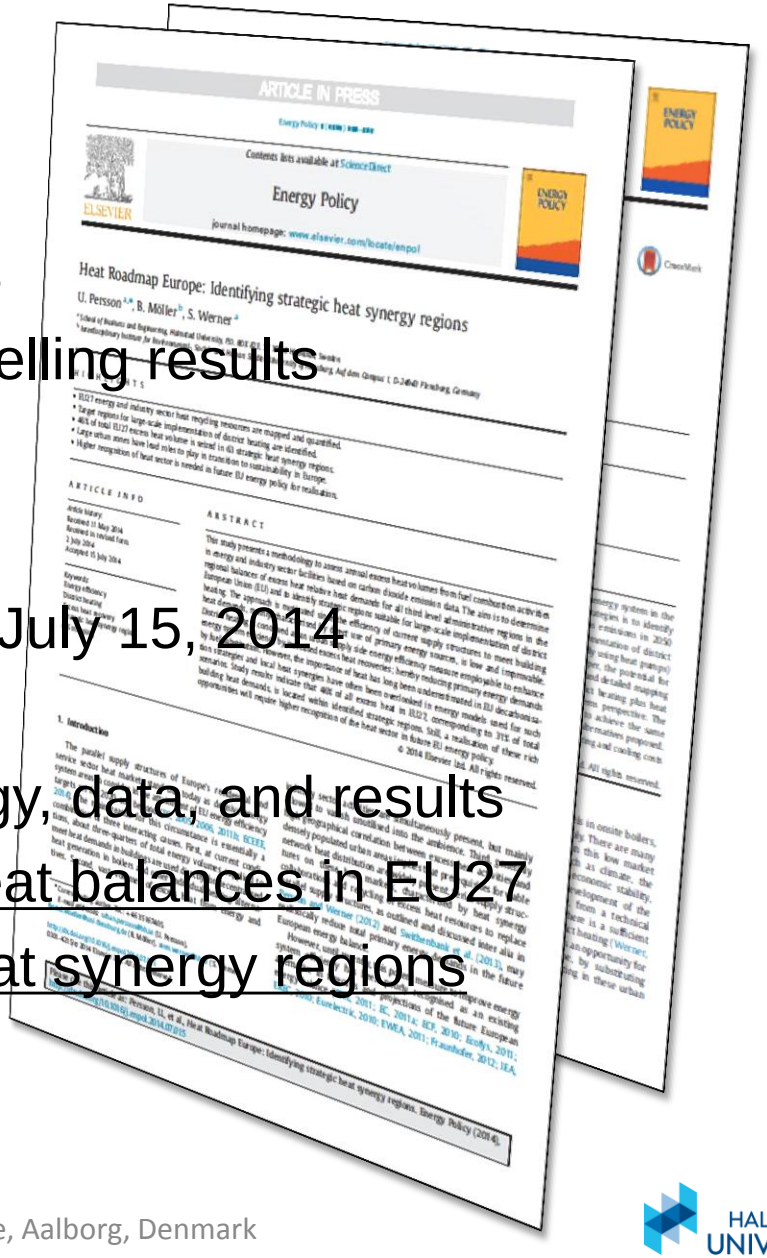
- Rationale
  - Energy modelling – at the heart of energy policymaking
  - Traditional energy modelling – bias on national perspective
    - Electricity & gas infrastructures – Supra-national
    - Heat infrastructures – Local!
- Combined use of modelling and mapping



Energy efficiency measures introduced on <u>both</u> supply and demand sides of the energy system results in <u>equal decarbonisation</u> as heat savings alone - but at <u>lower total energy system costs</u>!

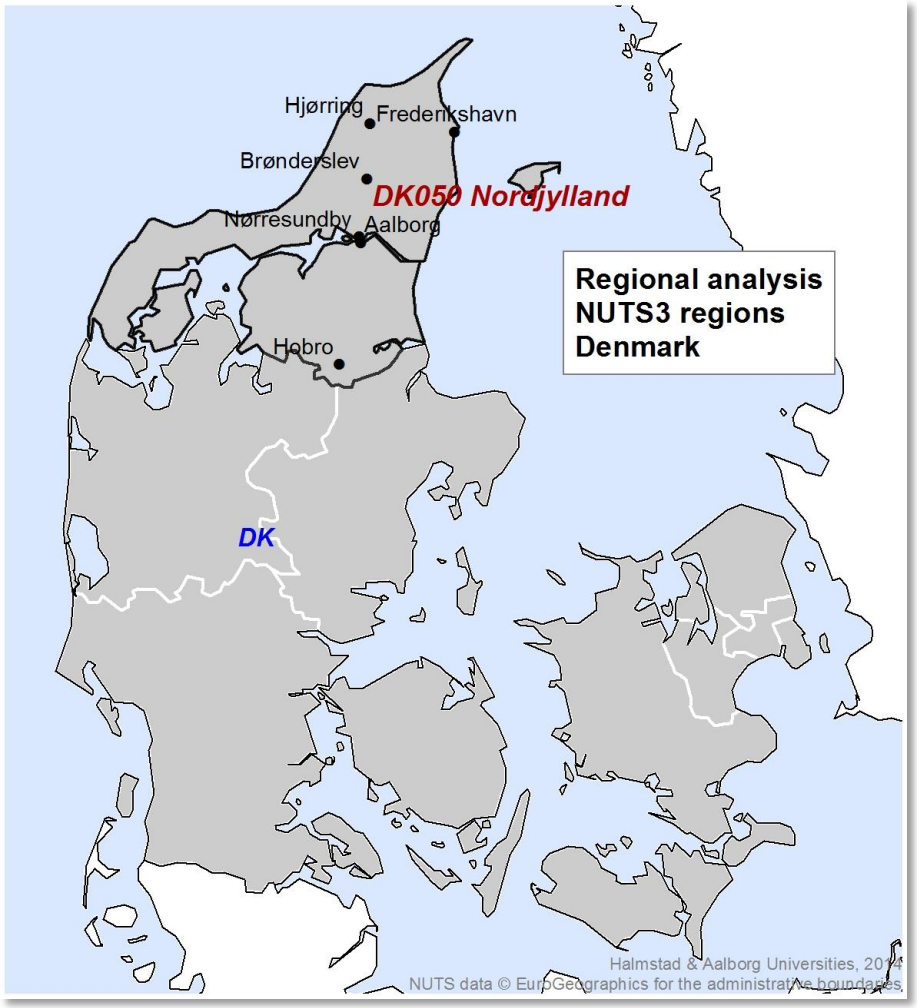
Heat Roadmap Europe – Modelling and mapping

- Journal publications
  - 1st paper
    - Published in February, 2014
    - Focus: Main study and modelling results
  - 2nd paper
    - Accepted for publication on July 15, 2014
    - In Press – available online!
    - Focus: Mapping methodology, data, and results
    - Quantification of regional heat balances in EU27
    - Identification of strategic heat synergy regions



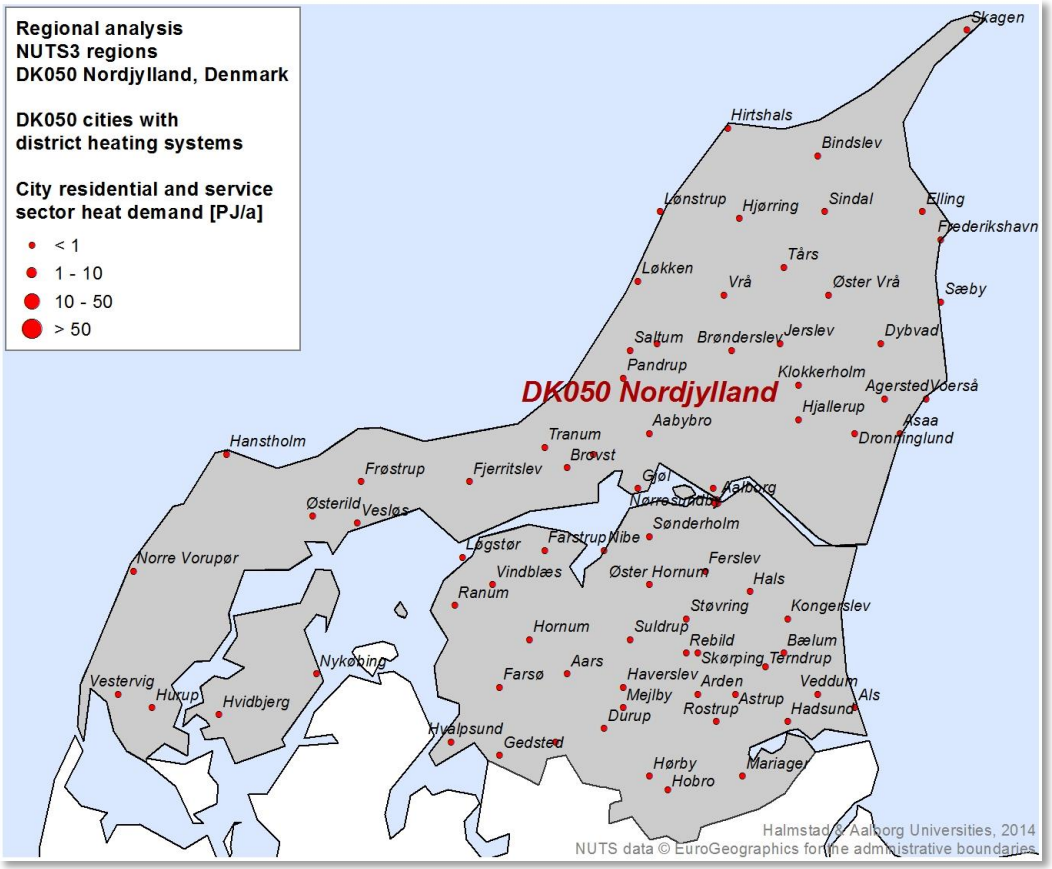
GIS Mapping

- Regional analysis: Denmark
  - 11 NUTS3 regions
  - DK050 Nordjylland



GIS Mapping

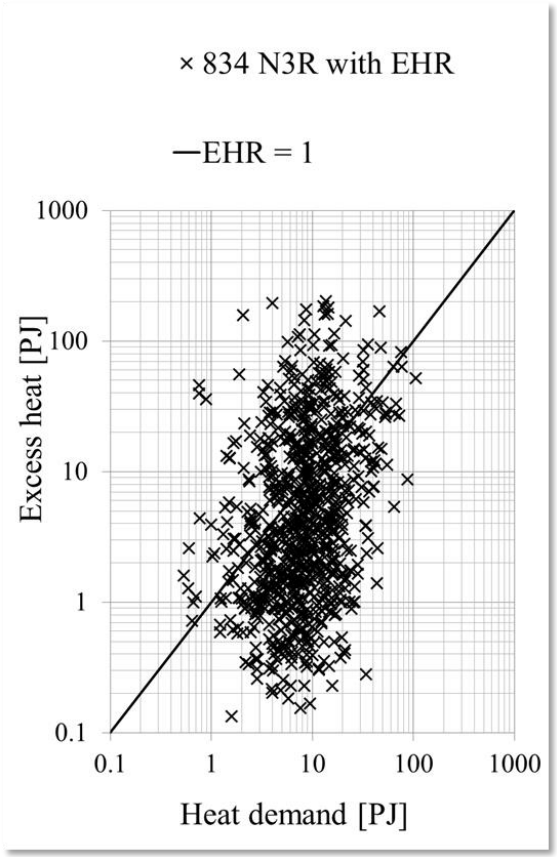
- Regional analysis: Denmark
  - 11 NUTS3 regions
  - DK050 Nordjylland
  - Spatial information
    - Geographical layers
  - Projection of data
    - Population density
  - Key study data
    - Heat demand density
    - Excess heat activities
    - District heating systems

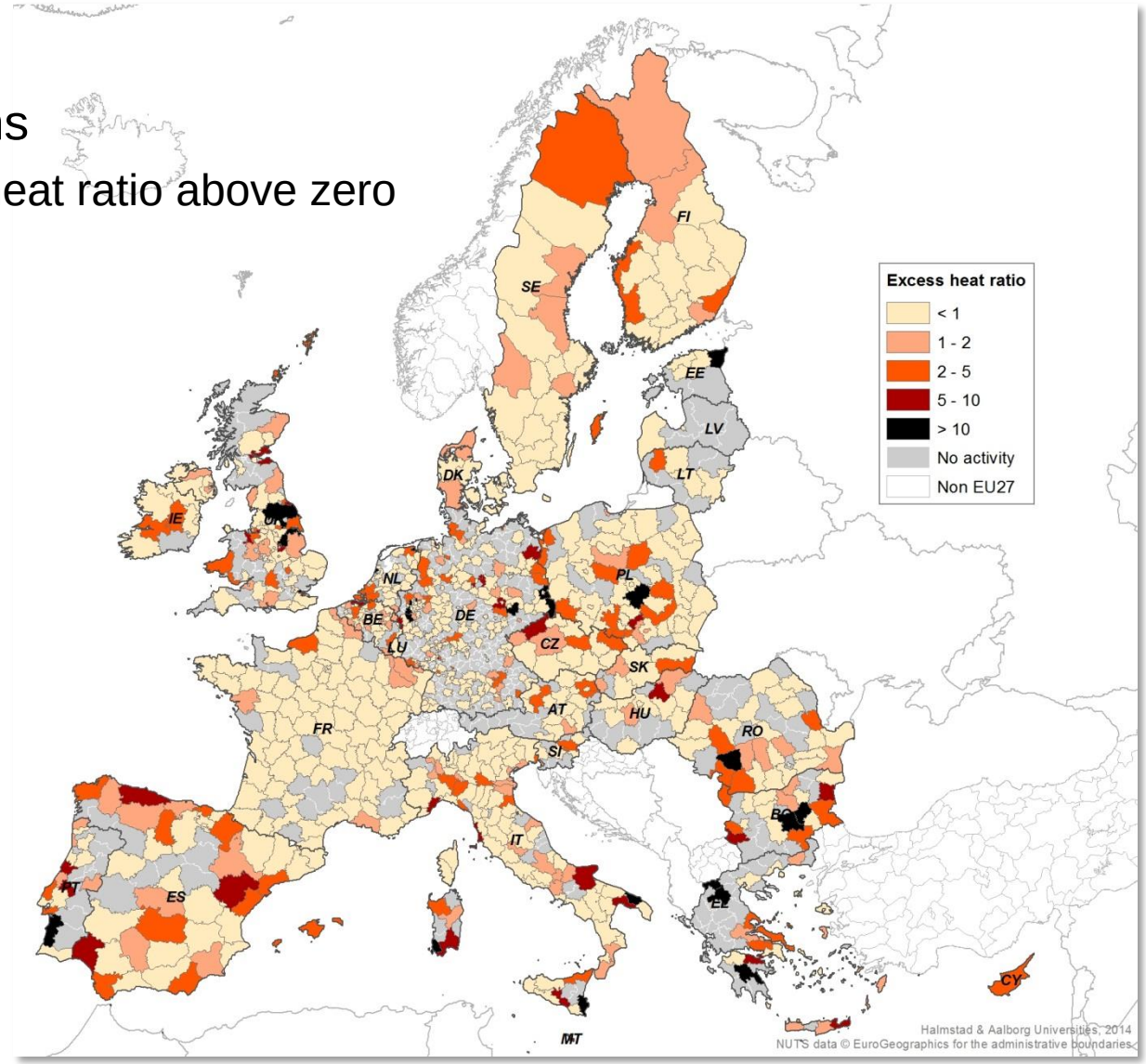


Population: 0.58 Mn	Pop. density: 73.1 n/km^2	Prim. energy supply: 55.4 PJ/a	Excess heat ratio: 1.05
Land area: 7933 km^2	Heat demand (R&S): 22.3 PJ/a	Excess heat (max): 23.5 PJ/a	District heating systems: 77

Regional heat balances

- Excess heat ratio
  - 1281 NUTS3 regions
    - 834 with Excess heat ratio above zero

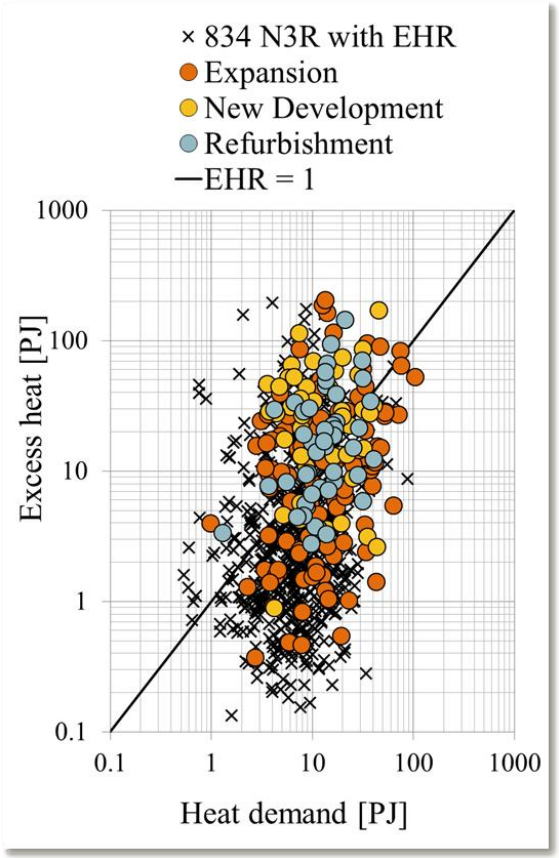


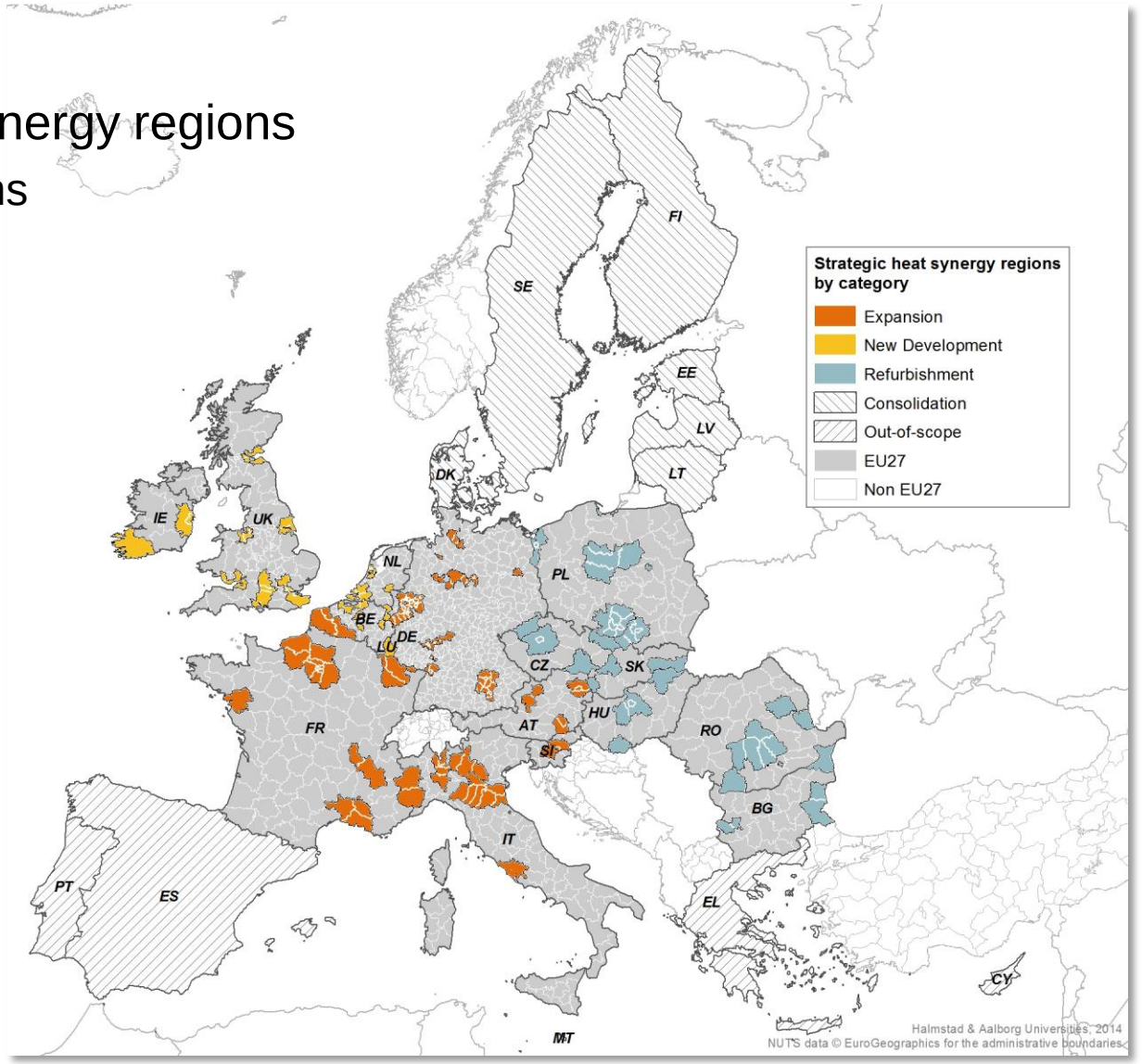


Source: Persson, U. et al., Heat Roadmap Europe: Identifying strategic heat synergy regions. Energy Policy (2014). In press.

Strategic heat synergy regions

- Comparative analysis
  - 63 Strategic heat synergy regions
    - 206 NUTS3 regions

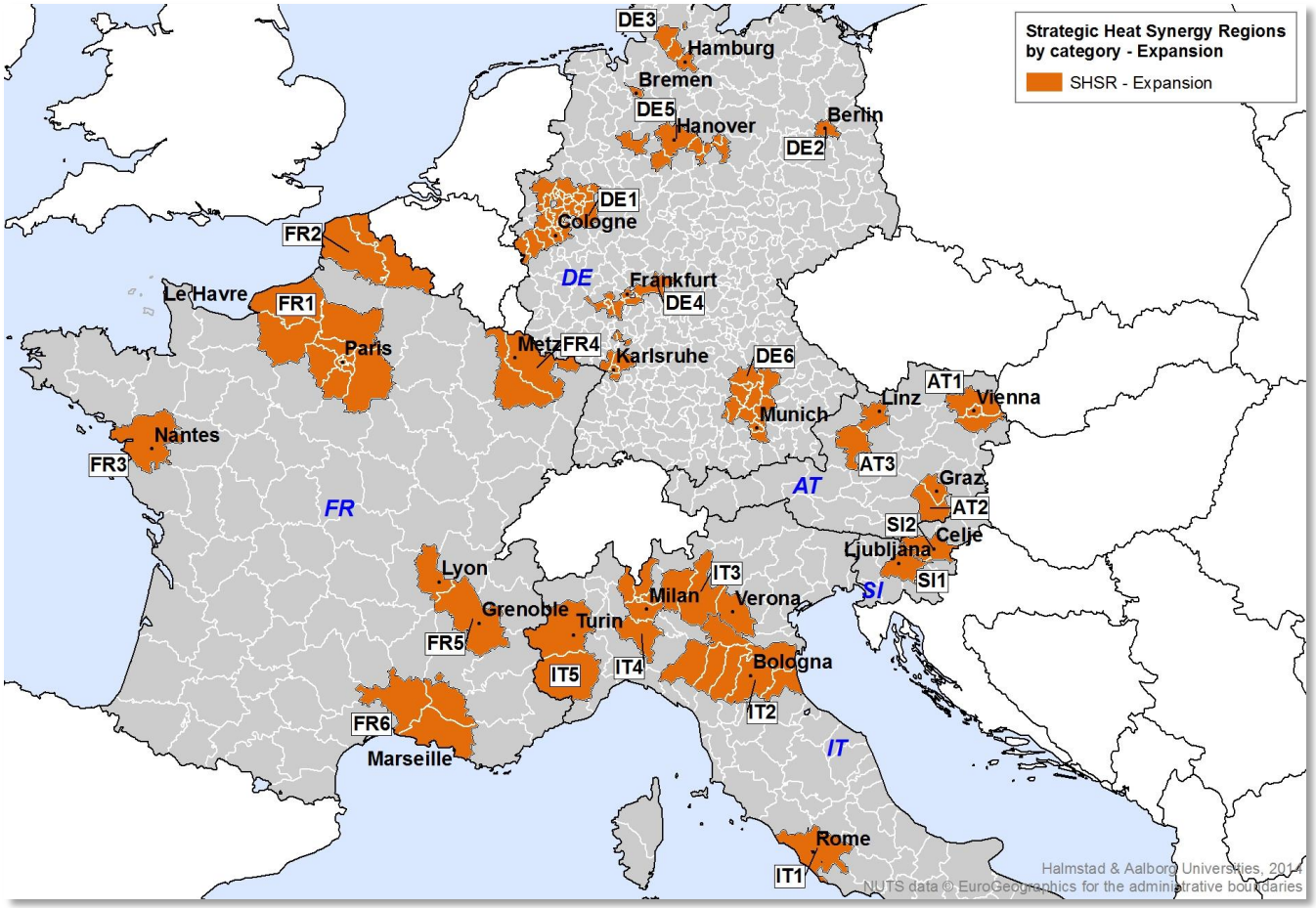


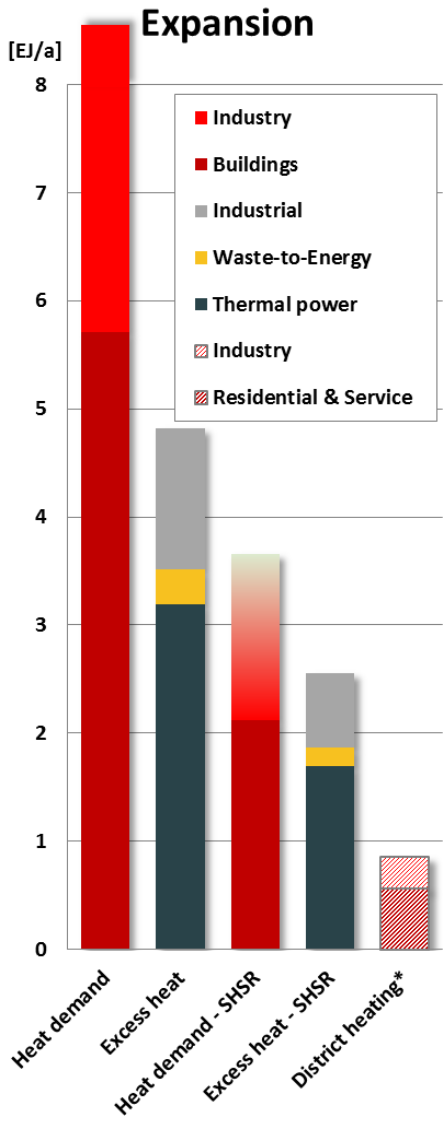


Source: Persson, U. et al., Heat Roadmap Europe: Identifying strategic heat synergy regions. Energy Policy (2014). In press.

Strategic heat synergy regions

- Expansion

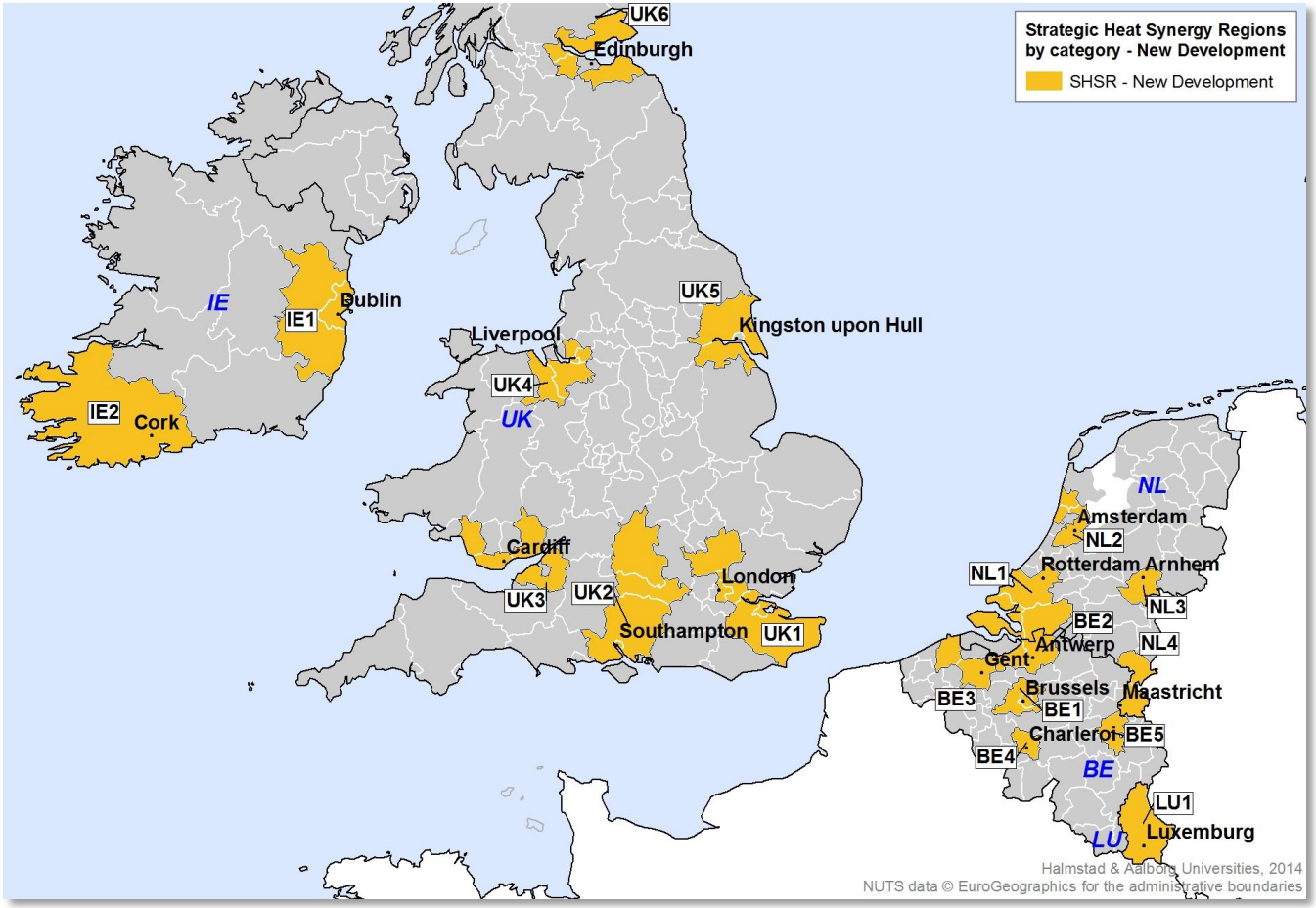


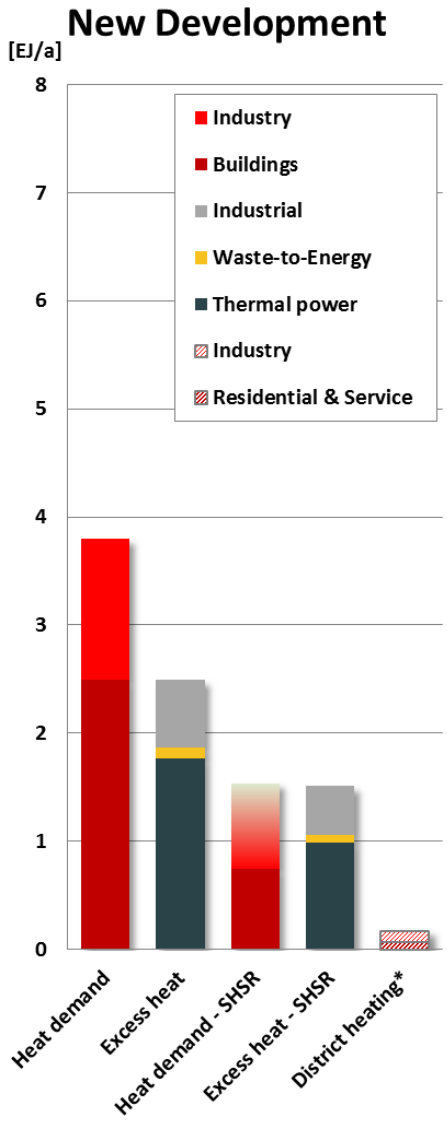


* Source: IEA EB 2012.

Strategic heat synergy regions

- New Development

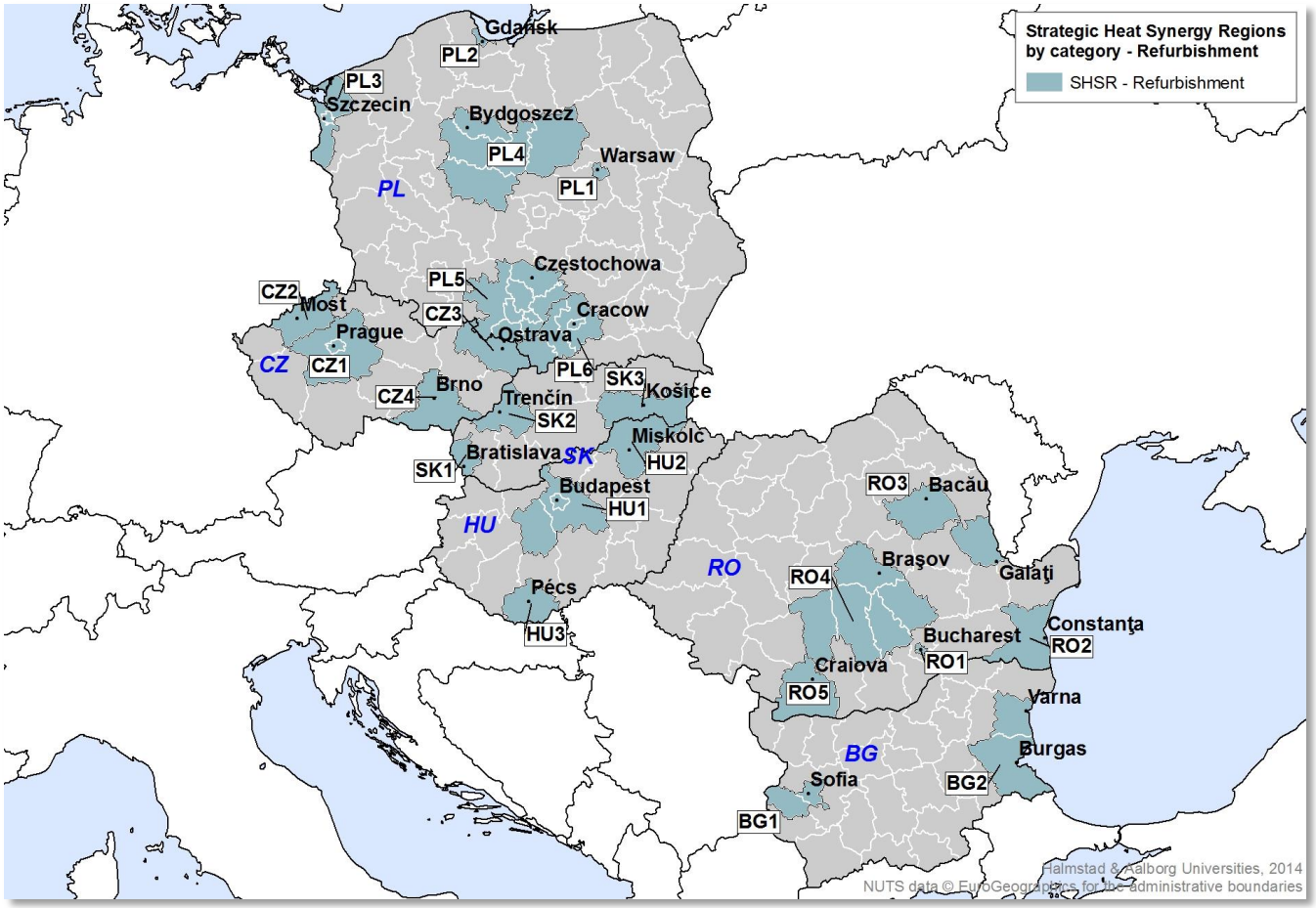


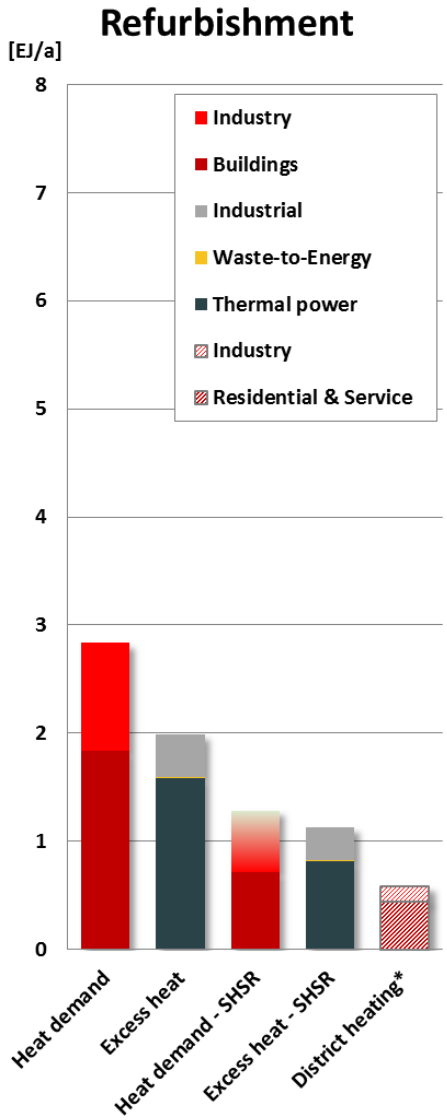


* Source: IEA EB 2012.

Strategic heat synergy regions

- Refurbishment

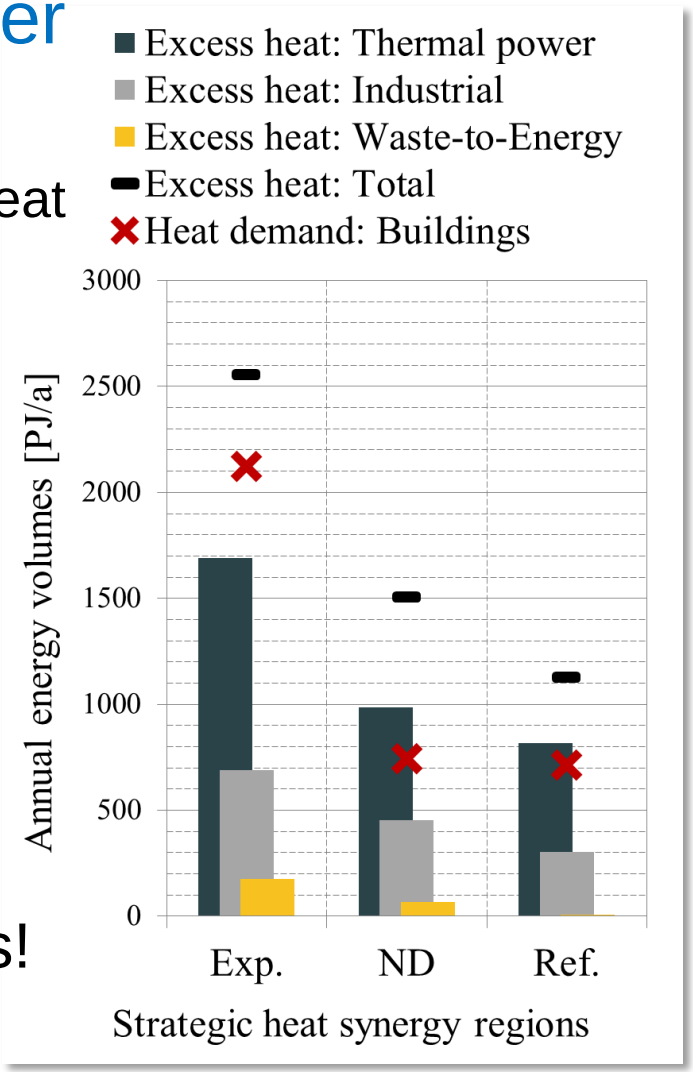




* Source: IEA EB 2012.

Conclusions

- Heat Roadmap Europe: 2nd paper
  - EU27 – Excess heat ratio
    - 65% of NUTS3 regions have excess heat
    - 22% with excess heat ratio above one
    - Avg. EU27 excess heat ratio: 1.19
  - Strategic heat synergy regions
    - 16% of all EU27 NUTS3 regions
    - 46% of all excess heat (5.2 EJ)
      - Expansion: ~2.6 EJ
      - New Development: ~1.5 EJ
      - Refurbishment: ~1.1 EJ
    - 31% of total heat demands (3.6 EJ)
  - Maximal potential – not a prognosis!
    - Local in-depth analyses required…



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Conclusions

- Heat Roadmap Europe: 2nd paper
  - District heating can realistically contribute to improved energy system efficiency
    - Excess heat recoveries from energy and industry sectors
    - Fuel substitution for the heating of buildings
  - District heating can support integration of renewable energy sources
    - Heat and electricity
  - Higher recognition in future EU energy policy
    - Flexibility: unique national circumstances and conditions

If the European community decides to follow this path to decarbonisation… The large urban zones of the EU have lead roles to play in the transition!

Thank You!