A GIS-based Assessment of the District Heating Potential in Europe

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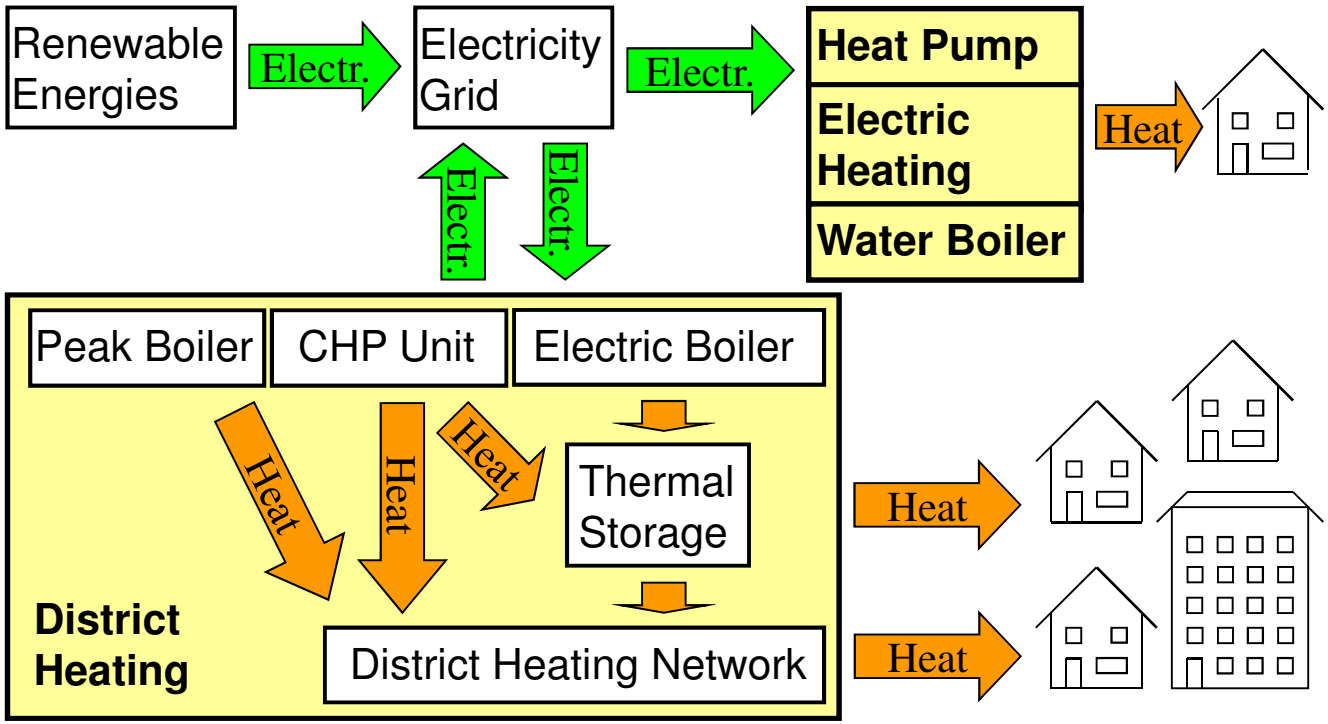
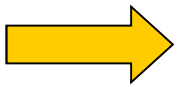
Research Focus: Coupling between Electricity and Heat Market

- Problem: balancing of intermittent renewable energies (RE) required
- Options: flexible generation, storage, network extension, flexible demand
- Coupling to heat sector provides flexible generation, flexible demand and storage



Motivation: Political Will to Extend the Use of Energy Efficient Cogeneration

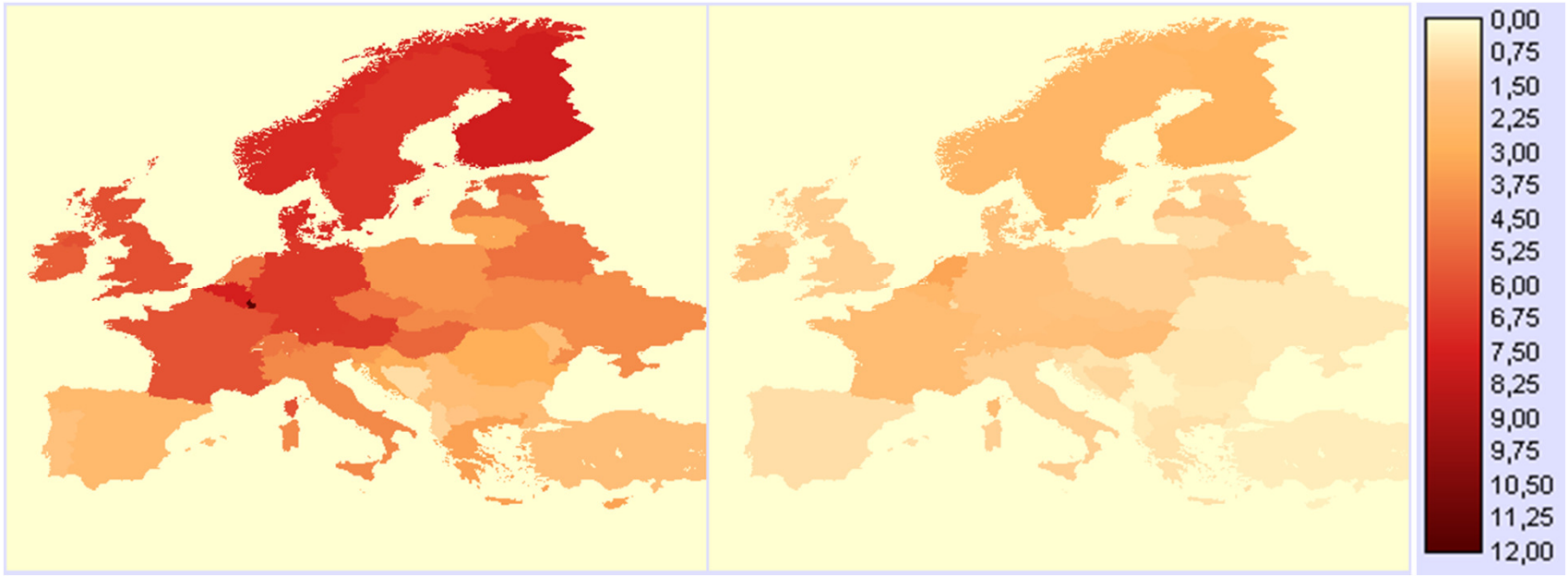
- Fuels can be used more efficiently in cogeneration plants (Combined Heat and Power, CHP)
- „Promotion of high-efficiency cogeneration (...) is a Community priority given the potential benefits (...) with regard to saving primary energy, avoiding network losses and reducing emissions (...).“
  (DIRECTIVE 2004/8/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL)
- Use of cogeneration for industrial process heat, district heating and single objects



Research goal: Development of a method that allows for the quantification of the district heating (DH) potential in Europe

District Heating: Specific Heat Demand,
Heat Demand Density, Demand Agglomerations

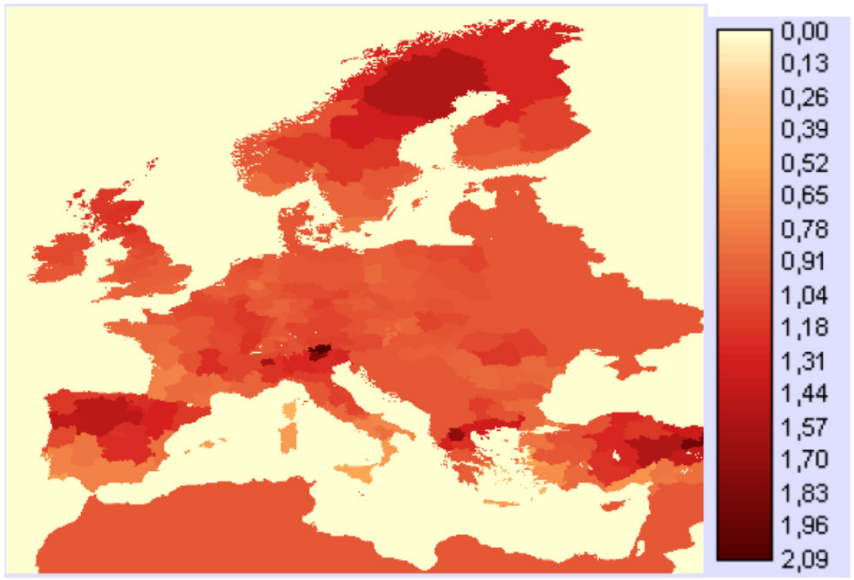
Energy demand | Energy use | Conversion efficiency → Per-capita demand of useful energy



Per-capita demand heat demand 2005 in MWh/a in the residential (left) and commercial sector (right), based on PRIMES

District Heating: Specific Heat Demand, Heat Demand Density, Demand Agglomerations

Per-capita demand → Higher in ...colder regions ...rural areas → Distribution according to ...population density ...residential/commercial areas → Demand density



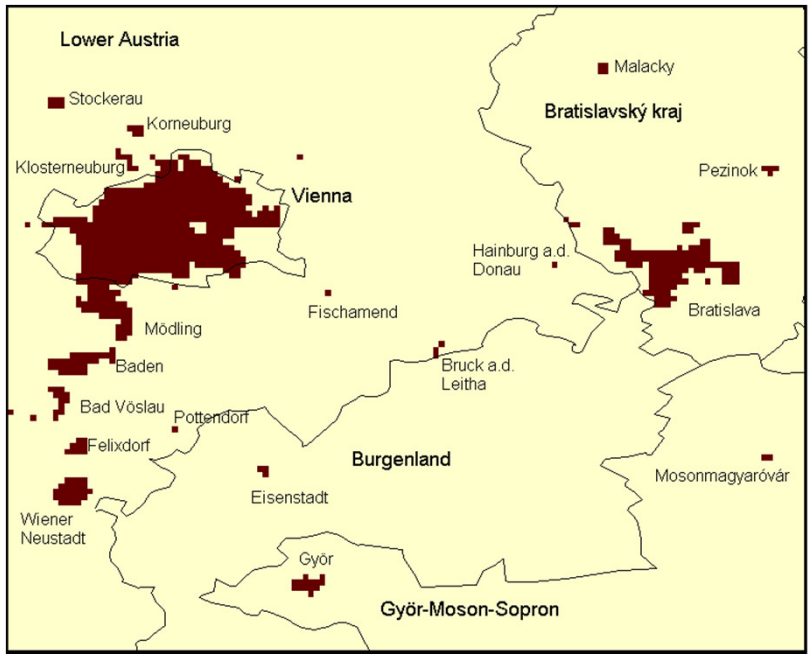
Per capita demand relative to national average, as a function of Heating Degree Days (NUTS-2)

Per capita demand relative to the national average, as a function of the population density

District Heating: Specific Heat Demand, Heat Demand Density, Demand Agglomerations

Demand density → Aggregation of pixels with high heat density → Potential DH areas

Heat demand density 2005 in the residential and commercial sector in MWh/km², based on PRIMES



Agglomerations with a heat demand density ρ ≥ 7 GWh/(km²*a) in the Vienna/Bratislava region

District Heating: Specific Heat Demand, Heat Demand Density, Demand Agglomerations

Per-capita demand

Demand density

Potential DH areas

Output

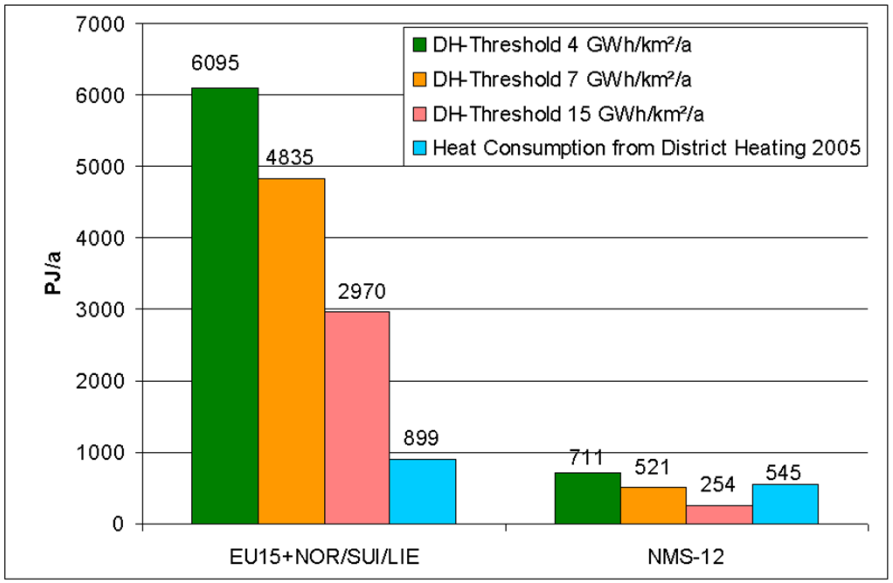
For each agglomeration:

- Total heat demand
- Average heat demand density
- Size of CHP unit/boiler
- Generated electricity
- Primary energy demand
- Investment + maintenance costs

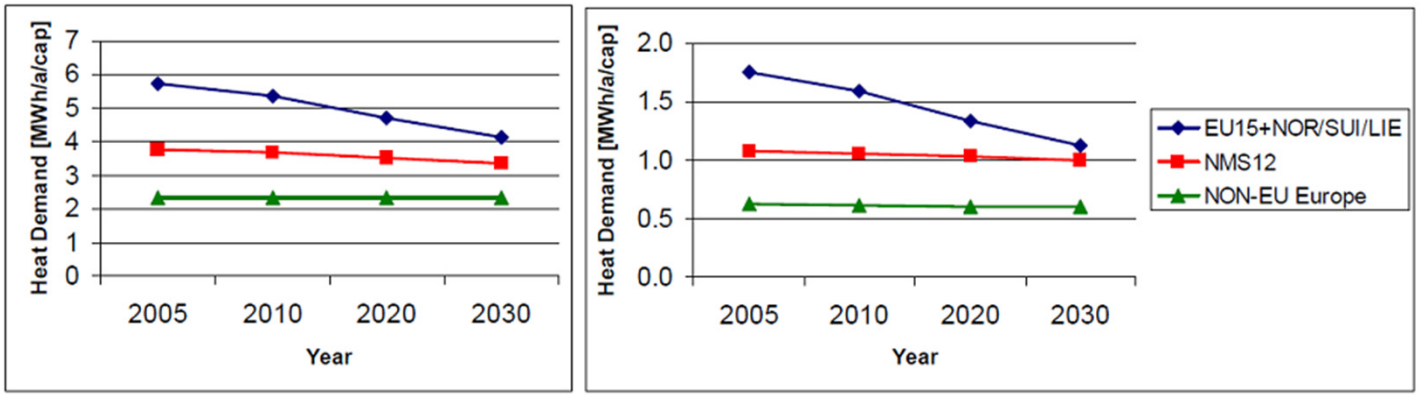
Results: DH Potential Depending on Density Threshold

- Significant DH potentials in most European countries, especially GER, UK, FRA
- Low or even negative potentials in others, e.g. DEN, FIN, BUL.
  Possible explanations:
  - Relative urban per-capita demand higher than assumed
  - Industry partially included in statistics
  - Lower DH threshold

Potential for heat from DH in PJ/a, depending on the demand density threshold

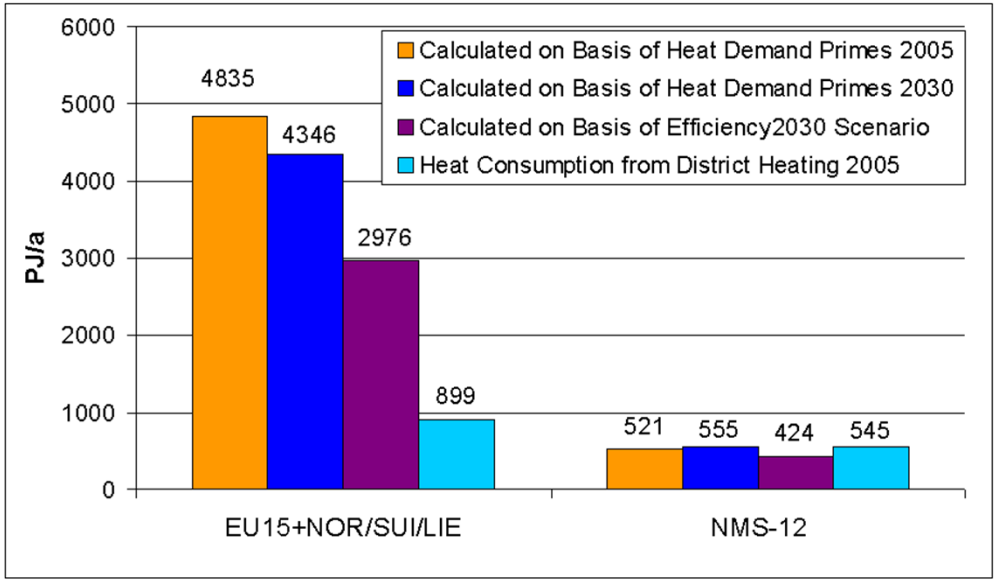


Results: Impact of Demand Reductions on DH Potential



Per-capita demand in the Efficiency2030 scenario for the residential (left) and commercial sector (right) in MWh/a.

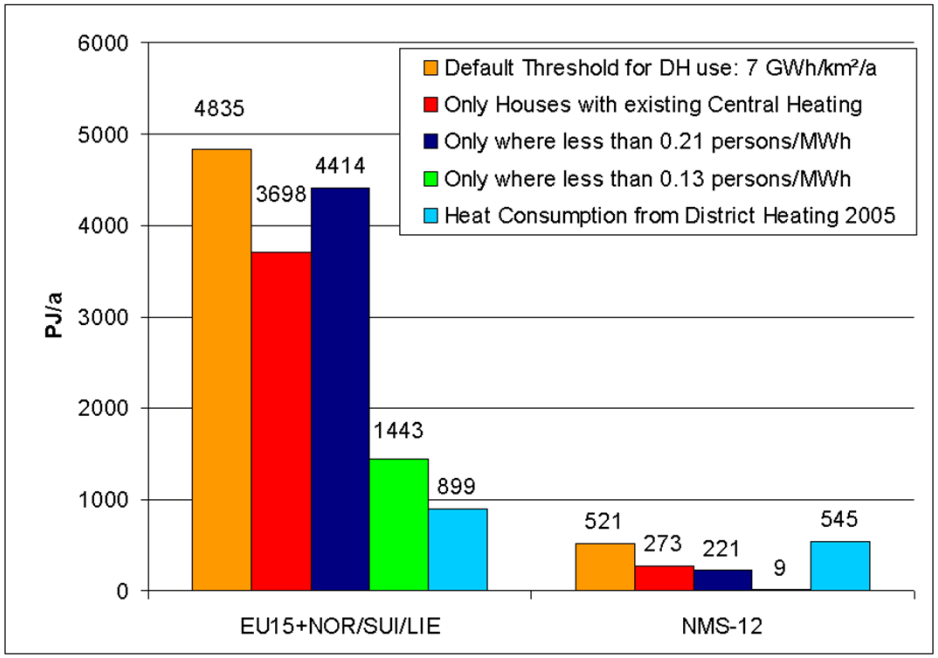
Potential for heat from DH in PJ/a depending on heat demand level



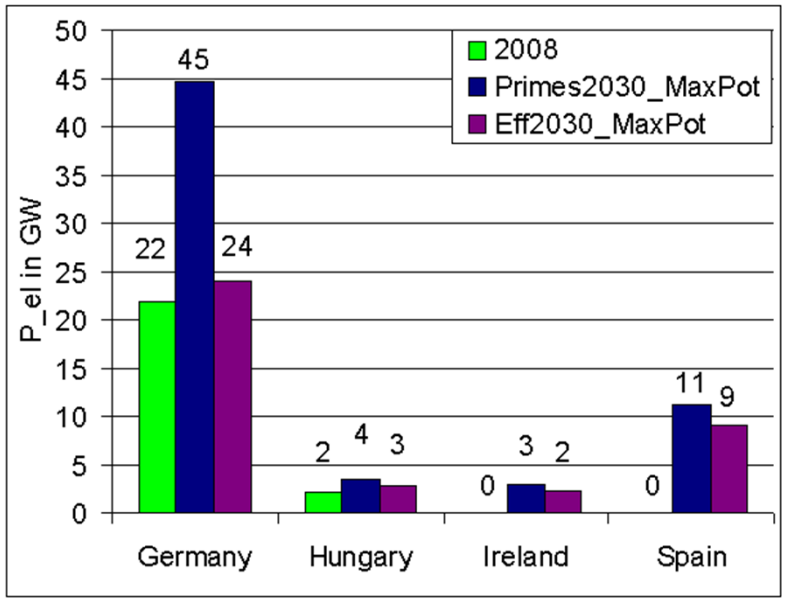
Results: DH Potential Depending on Technical and Financial Restrictions

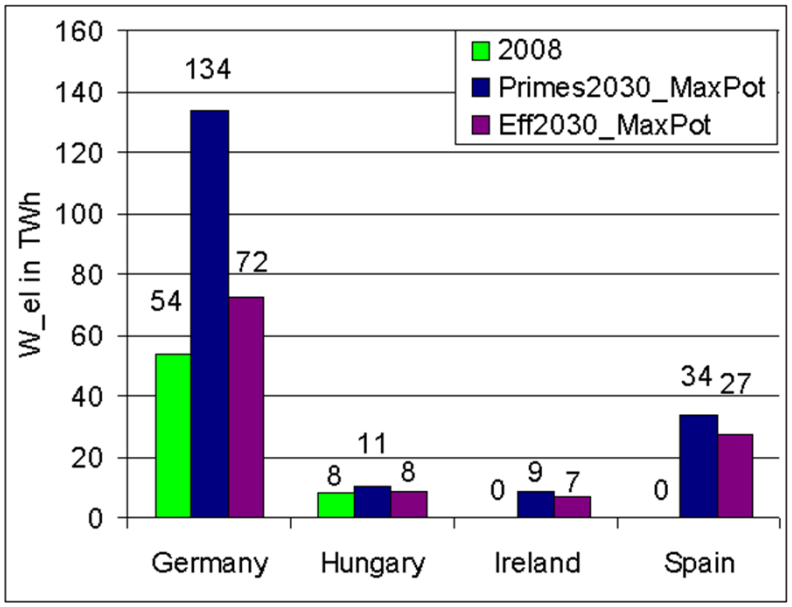
- DH network costs increase with the population density and may reduce potential
- Areas with high per-capita demand are favored over those with dense population
- Availability of central heating system required

Potential for heat from DH in PJ/a with different restrictions



Results: Estimated Electricity Supply from CHP





Electric capacity in GW (left) and **electricity generation in TWh** (right) of CHP units for selected countries in different scenarios. (Germany's 2008 capacity includes industrial CHP).

- CHP could cover relevant shares of the electricity demand
- Electrical capacity and electricity generation strongly depend on technology used
- Exemplary results for 3000 full load hours, 12 % network losses and $\sigma = 0.6$

Conclusions

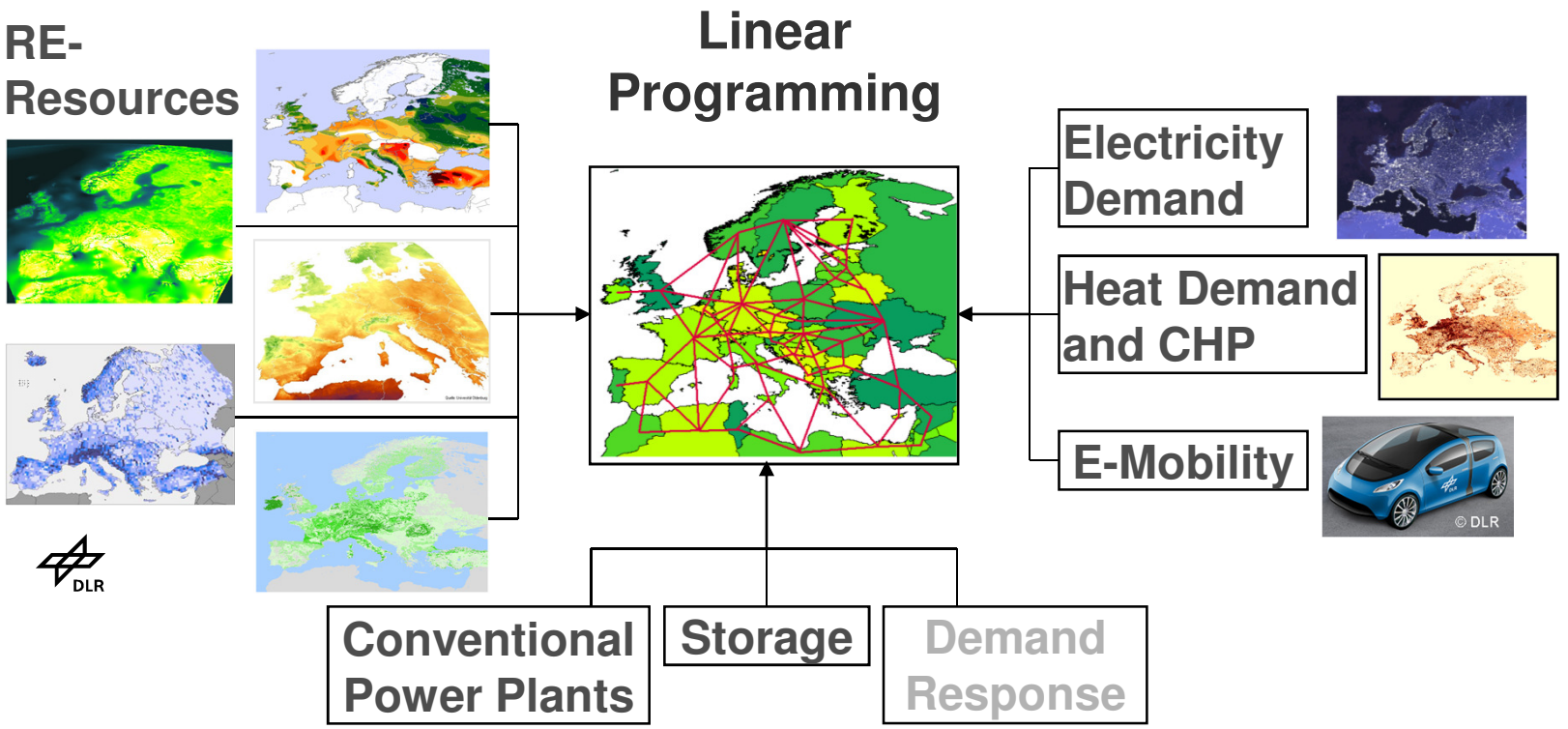
- Methodology provides reasonable results, its deficits were identified
- Application to other countries/regions possible

- Potentials for an increase of DH in most European countries exist
- Limited by demand reductions, distribution network costs, natural gas networks

- Possible role of CHP in energy systems with high RE shares needs to be analyzed, especially concerning:
  - Balancing of RE fluctuations
  - Thermal energy storage
  - Solar district heating, “wind heat”

Outlook: Integration into the Energy System Model REMix

- Further analysis of the possible future role of CHP in Europe's energy system
- Economic comparison to other balancing options
- Optimization output: minimum cost system



Outlook: Research Project for the German Federal Ministry of Economics and Technology (BMWi)

- “Opportunities and constraints for load balancing by energy storage, shiftable loads and electricity-driven CHP in energy systems with high RE shares”
- Quantification of the potential application of different balancing options and its dependency on the share of intermittent RE resources.
- Yvonne Scholz, Thomas Pregger, Hans Christian Gils (DLR)
- Collaboration with Fraunhofer institutes UMSICHT and IITB
- Participation in Annex 26 of the IEA Implementing Agreement “Energy Conservation through Energy Storage”
- Running 2011-2013

Thank you for your attention!

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