Grid investments as one option for load balancing – The case of REMix

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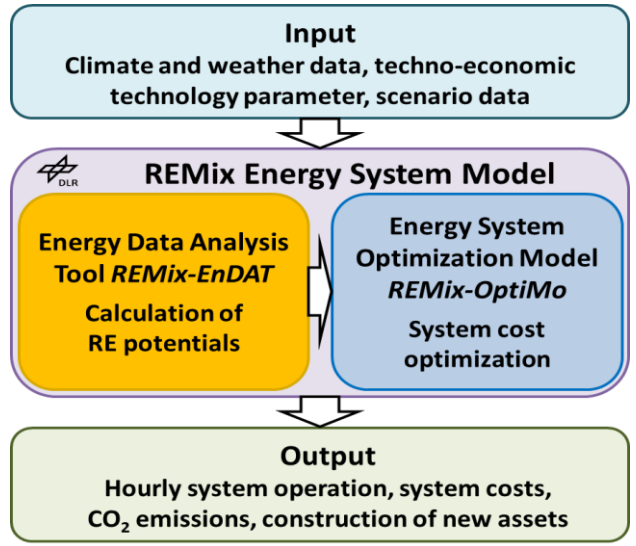
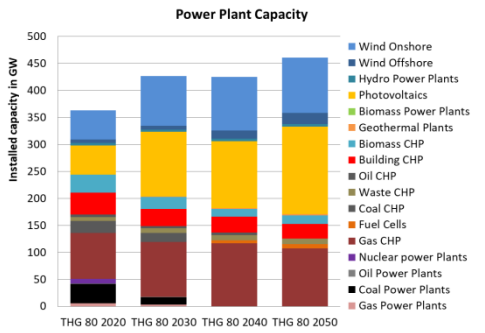
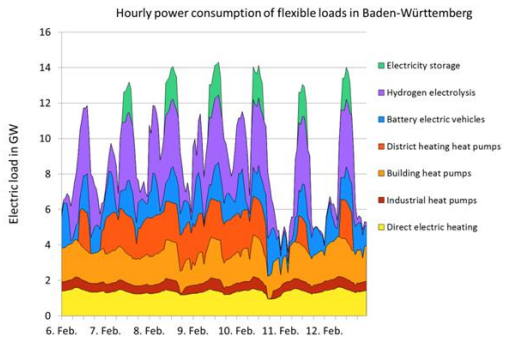
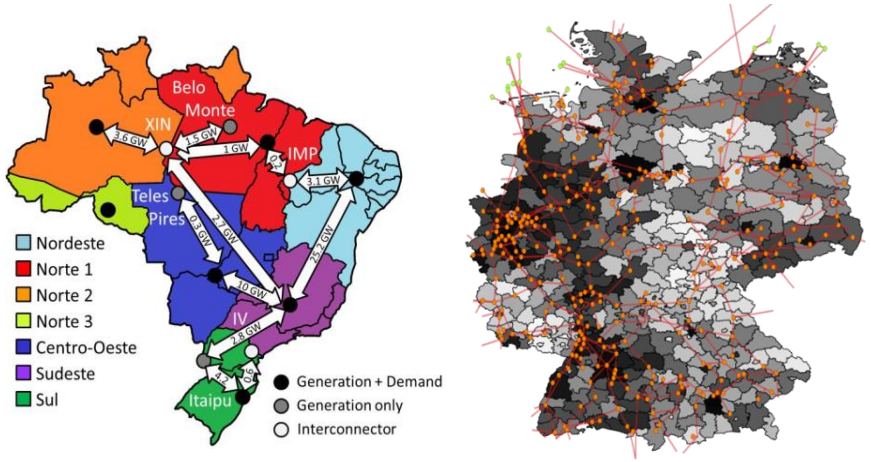
REMix – overview and representation of the power grid

- Cost-minimizing model from an economic planner's perspective
- Hourly resolution, typically perfect foresight for one year
- Simultaneous optimization of plant expansion and operation
- Evaluation of investment and dispatch strategies
- Not focused on grid, consideration of all flexibility options
- Typically aggregated representation of the power grid
- Increasing detail on high-voltage grid in Europe









Power transmission grids in REMix: data input and modelling method

Data requirements

- Existing infrastructures
  - → grid topology
  - → location of generators and consumers
- CAPEX projections (€/GW km)
- Assumptions on technical specification of transmission lines
  - → estimation of maximal transfer capacity
  - → estimation of transmission losses

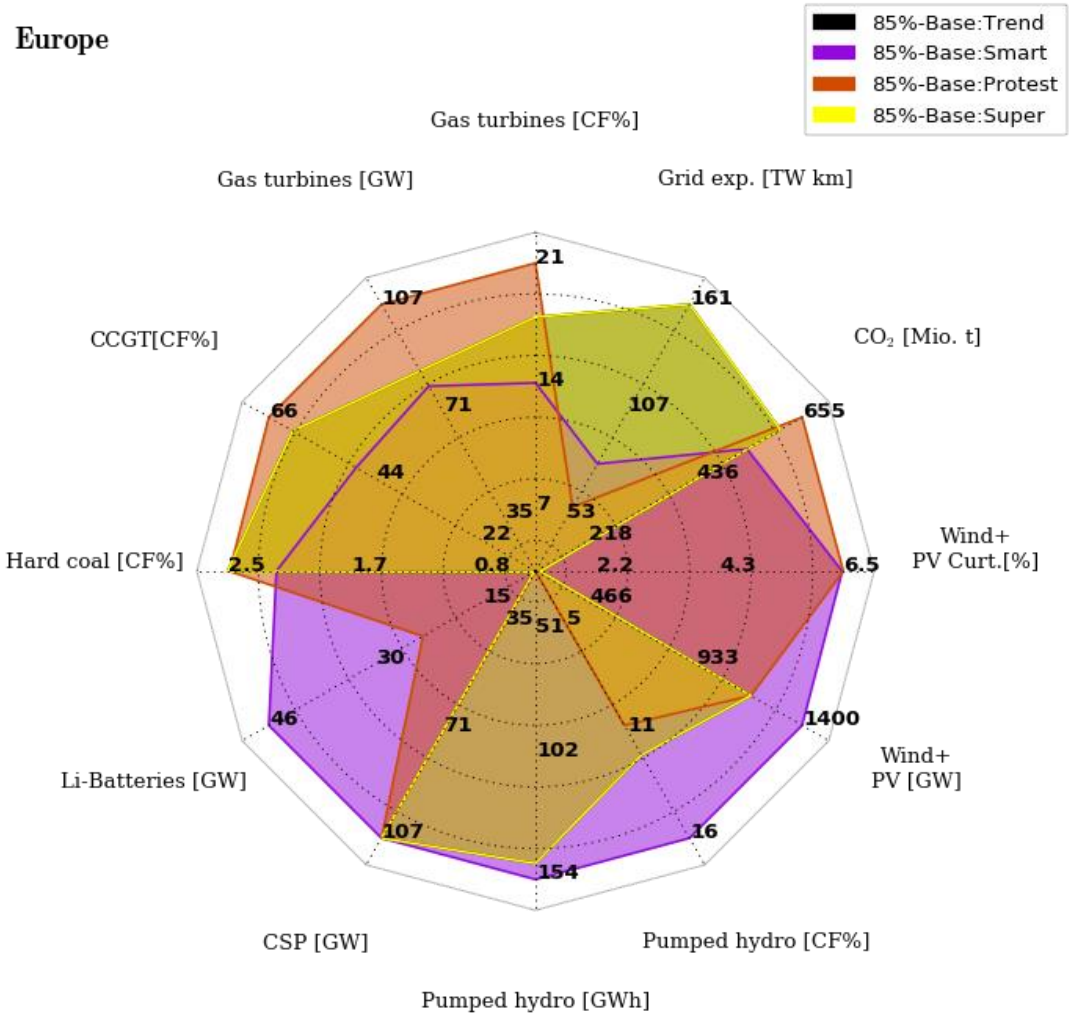
Methodology

- Annuity-based expansion of transmission capacities
- Linear power flow modeling either by
  - Transshipment model
  - DC-power flow approach (with/without PTDF based on presequent AC-power flow simulations)
- Line-specific length or cost-factors e.g. due to difficult terrain can be considered
- Differentiation between overhead lines, underground cables and sea cables

Case study for Europe with 85% GHG mitigation target considering different grid expansion scenarios (INTEEVER project)

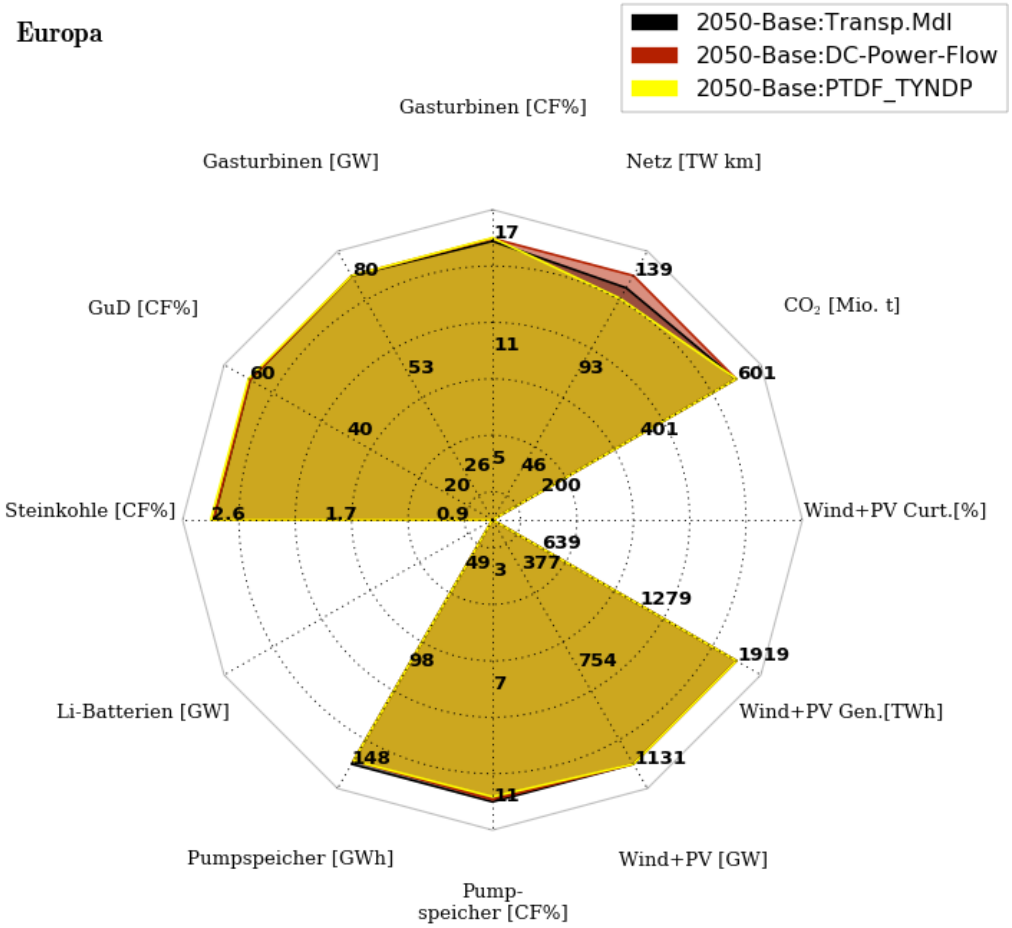
- Competitive investments into grid and storage
- Smart: investments also into wind/PV capacity
- Protest: Large scale infrastructures forbidden (caverns) or CAPEX 10 times more expensive (grid)
- Super: Extensive DC point-to-point grid expansion possible

→ Extensive investments into grid, however: mostly spatial resolution on national state level



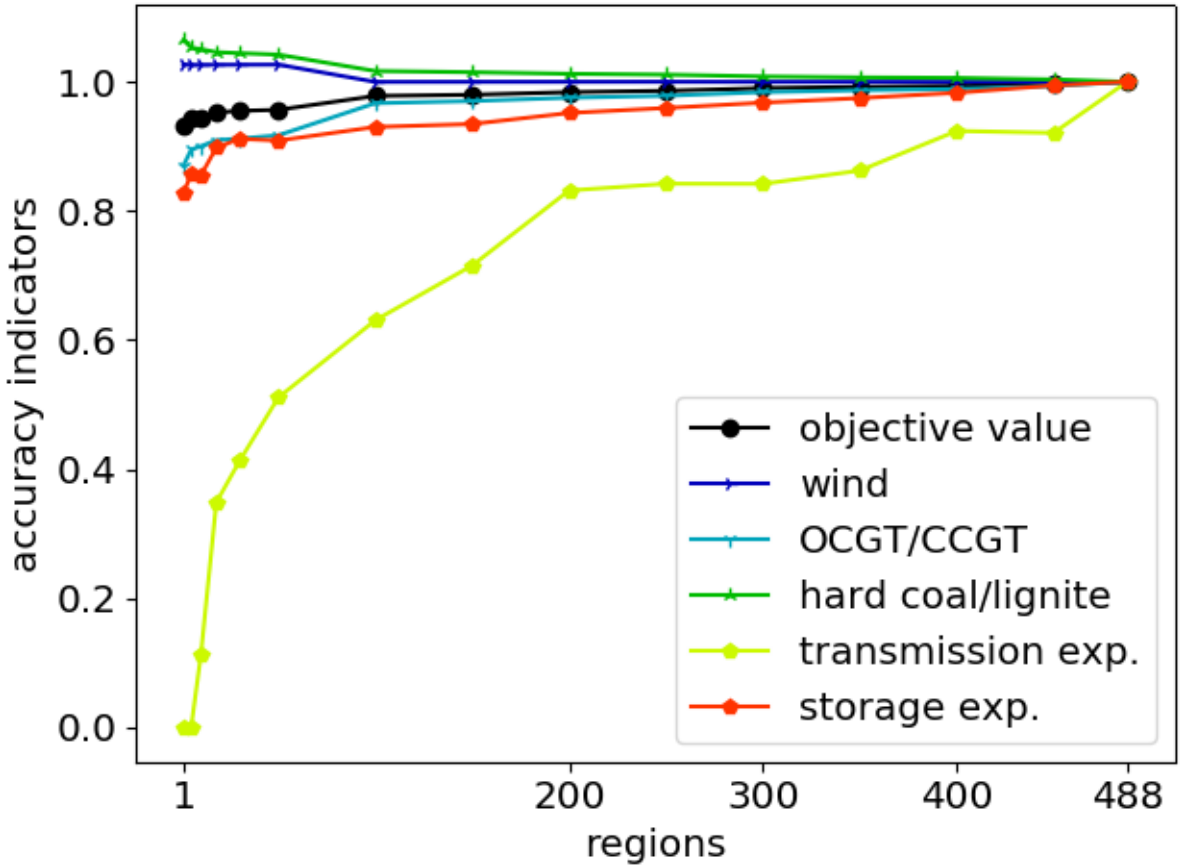
Influence of power flow modeling approaches on grid investments (INTEEVER)

→ For low spatial resolution only small differences when applying different power flow modeling approaches to the same modeling setup



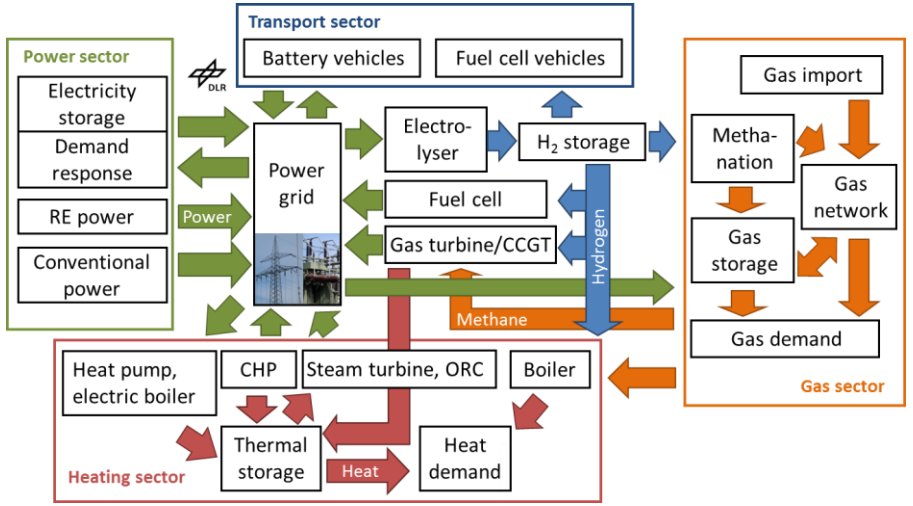
Systematic assessment of the influence of spatial resolution on investments into grid (BEAM-ME project)

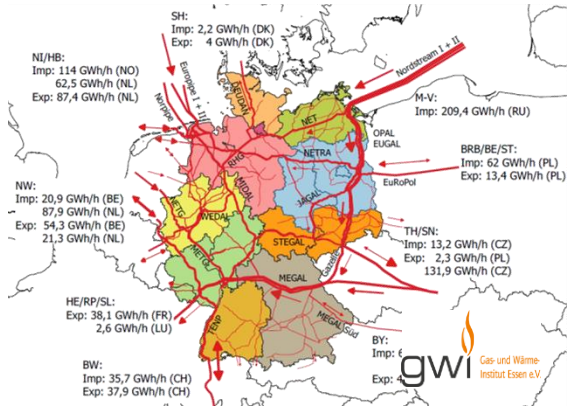
- Experimental set-up:
  - REMix resolved on transmission grid level
  - Investments into grid vs. storage
  - Different degrees of spatial aggregation
  - Scenario for Germany in 2030
- Accuracy indicates added capacity compared to full resolution of 488 regions
- Error in grid expansion costs caused by spatial aggregation can be quantified



Beyond the power grid: integrated optimization of integrated power, gas and transport systems with REMix (MuSeKo project)

- Simplified modelling of the gas system in REMix
  - Import, synthetic production
  - Pipeline transport
  - Large and small-scale storage
- Result for a 95% GHG reduction scenario
  - H_2 network and large scale storage complement the European power grid in seasonal balancing





Summary

- REMix includes different approaches for modelling power transmission grids
- Spatial resolution can be adjusted depending on project focus and data availability
- Interaction with energy storage and flexible sector coupling can be evaluated

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Grid investments vs. Storage investments in the INTEEVER project

- Multiple scenarios with 55% or 85% GHG reductions in the European power sector
- Numbers at data points indicate factor between investements into transmission and storage capacity (technologies aggregated)
- Protest (upwards triangles): although grid CAPEX increased by factor 10 investments into grid still significantly higher than into storage