Coupling the electricity and heat sectors - the key to the transformation of the energy system

Workshop on Renewables and Energy Systems Integration
Golden, CO September 2014

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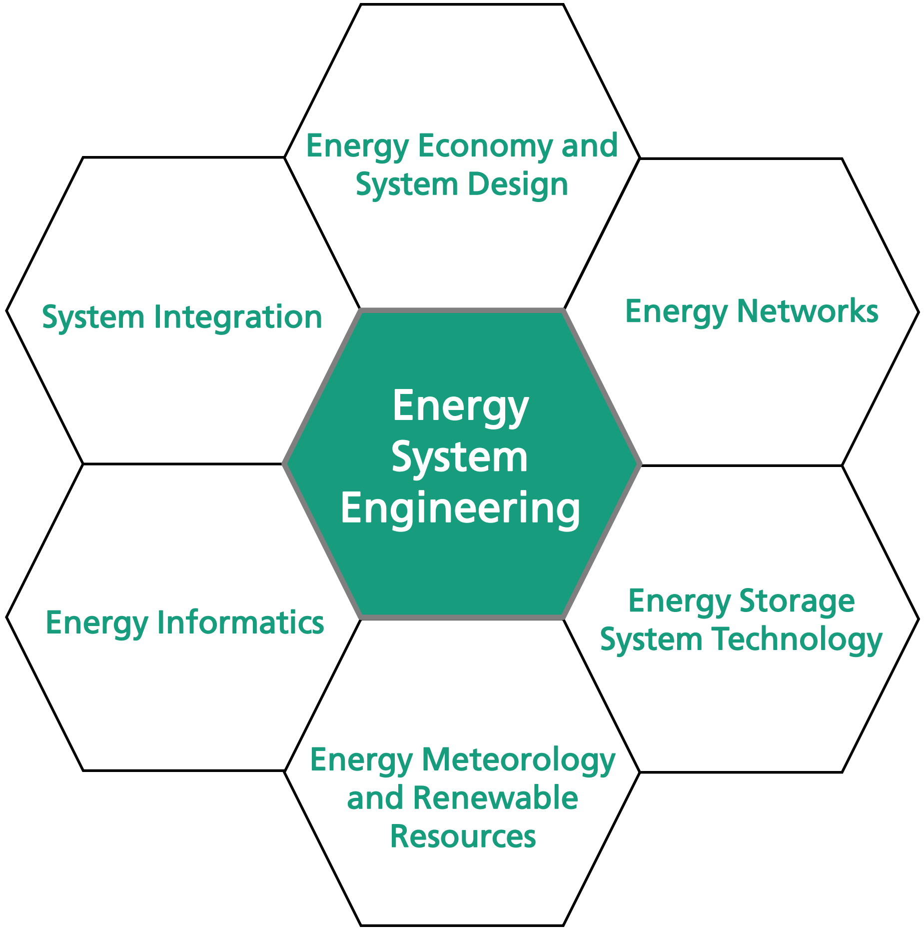
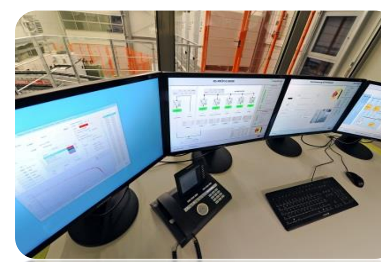
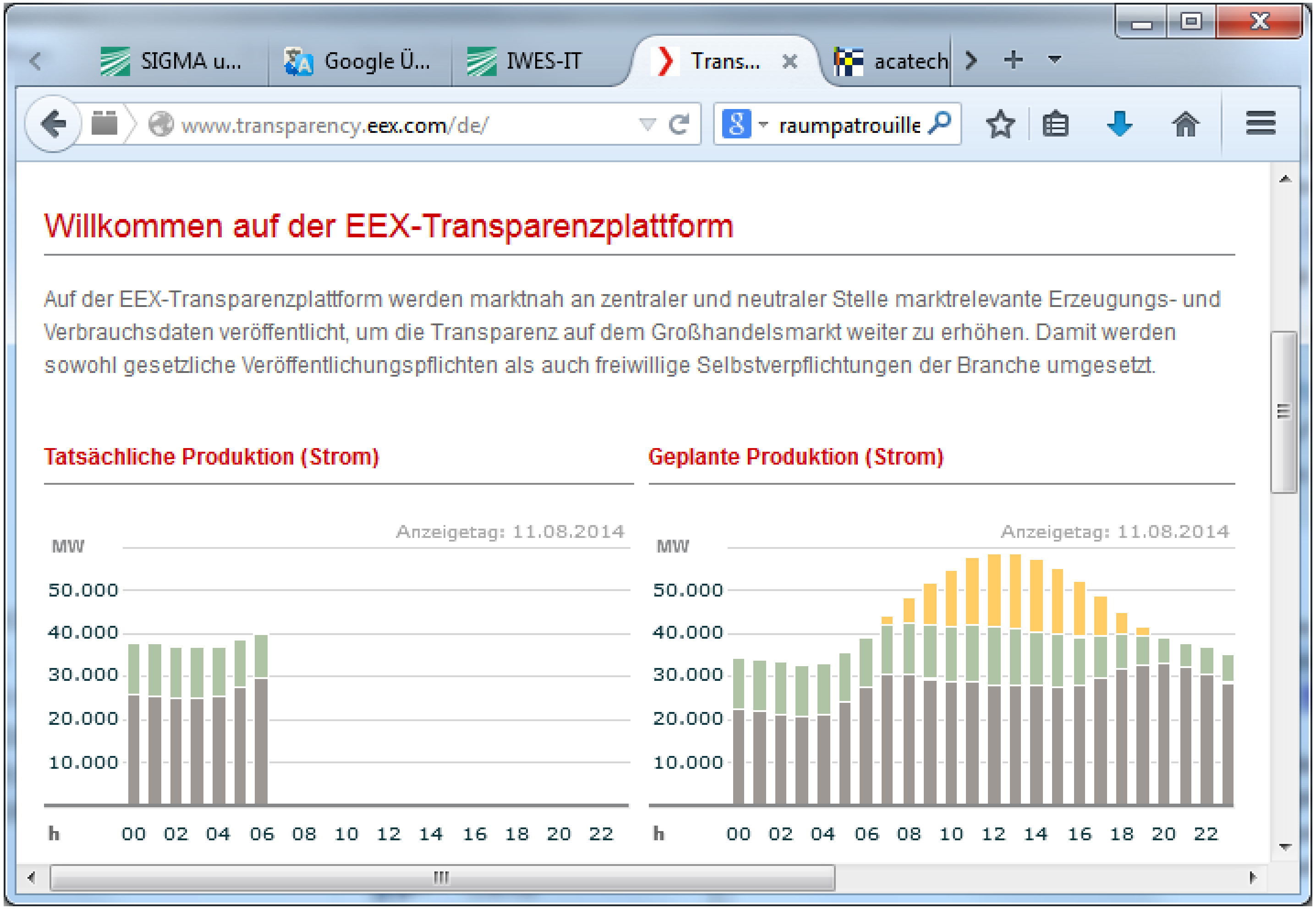
Fraunhofer IWES Kassel

Core Competences for Energy Systems Engineering





Introduction



Introduction

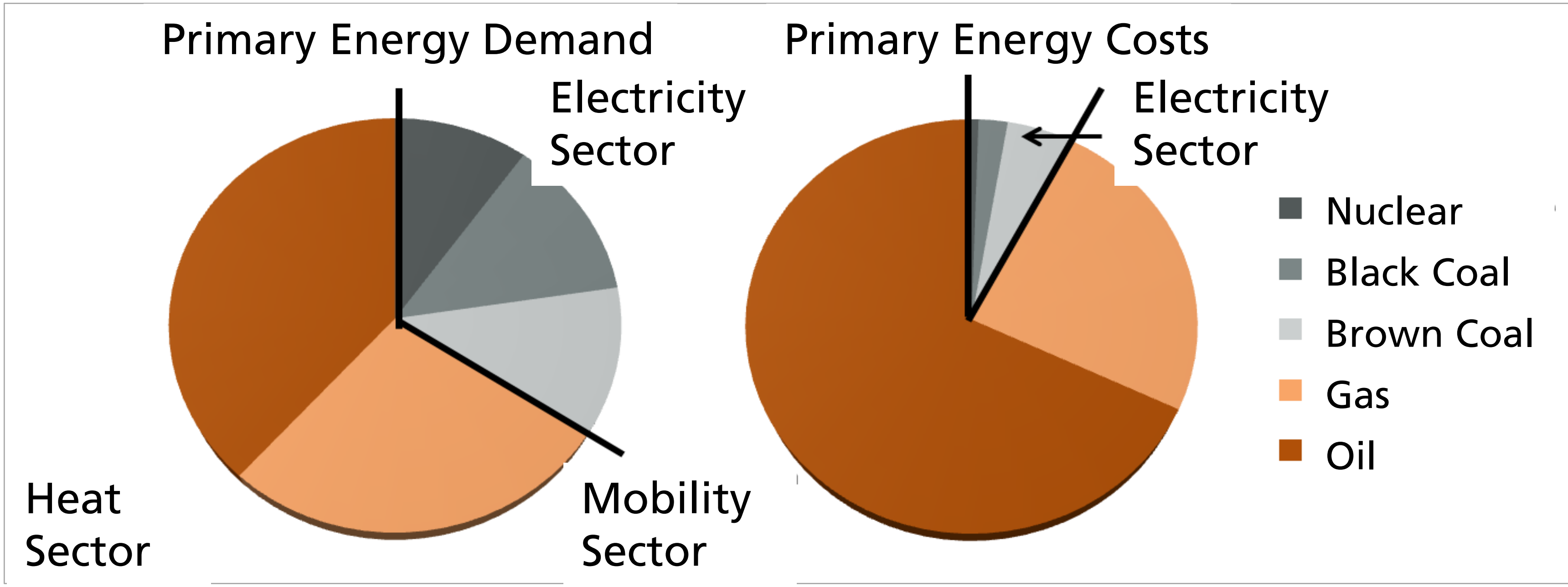
Two main reasons for the coupling of power and heat

- Reduce import of primary energy (oil and gas)
- Enlarge flexibility of the electric supply system

Needed actions to foster the coupling of the sectors

- Massive isolation of buildings
- Implementation of heat pumps and power-to-heat applications
- Development of new heating and cooling storage devices
- Improvement of (predictive) control strategies
- Business-models, business-models, business-models

Primary Energy Demand in Germany – 3600 TWh – 85 Bn Euro



Electricity: high share for primary energy
→ but import- and production-cost relative low

Oil and Gas: expensive and hardly to substitute
→ used in heat- and mobility-sector

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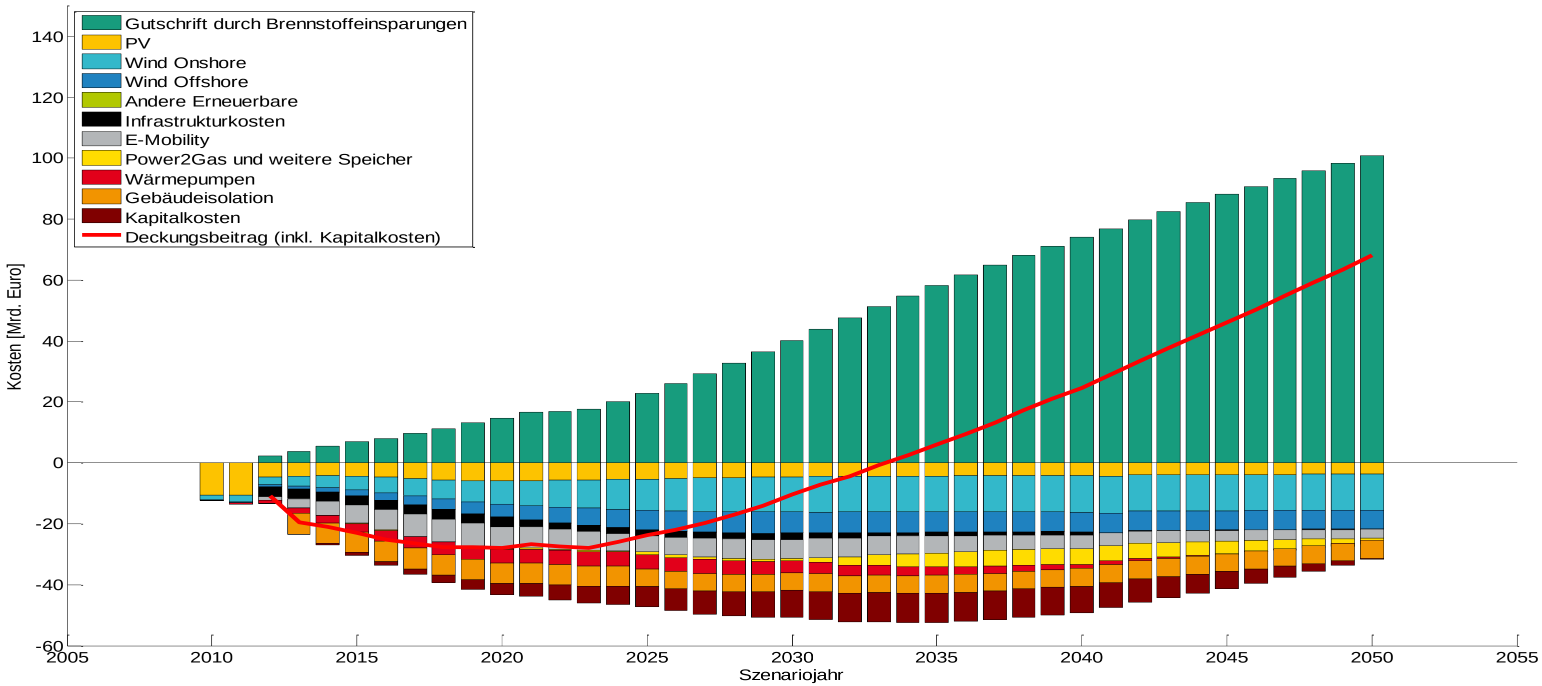

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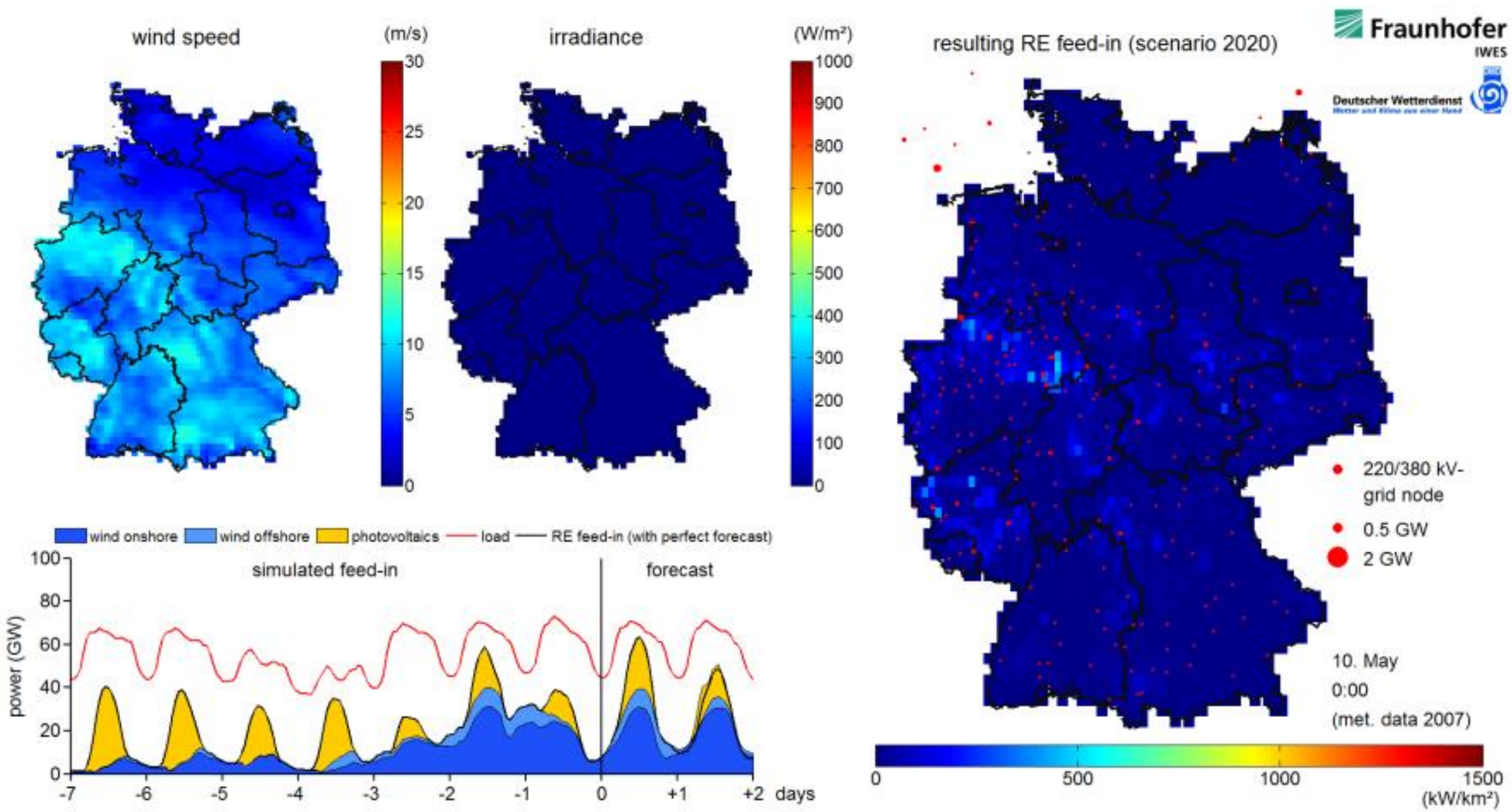
Transformation of Germany's Energy Supply System

Today		2050	
3570 TWh		1000 TWh by RES	
Electricity 1440 TWh		Electricity 1000 TWh	
Heating 1360 TWh	330 TWh Heat- pumps, Power2Heat	Heating 850 TWh	
Transport 770 TWh		Transport 330 TWh	120 TWh E-mobility 235 TWh Power2Gas

Core Competence: Energy Economy and System Design
Modelling and Simulation of all Components



We are trendsetters in dynamic simulations and future scenarios
for cross-sector aspects of energy supplies

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Core Competence: Energy Economy and System Design
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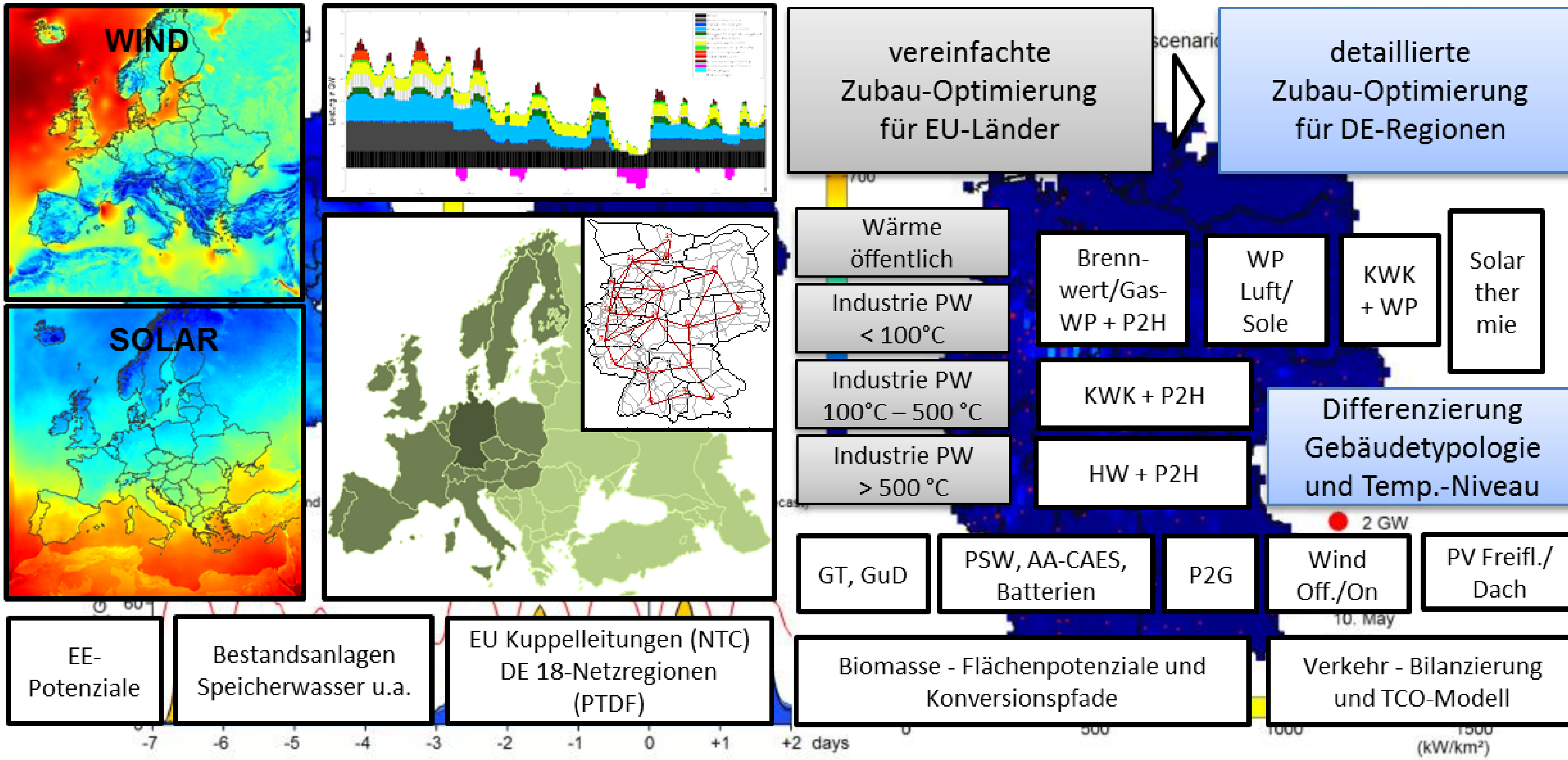

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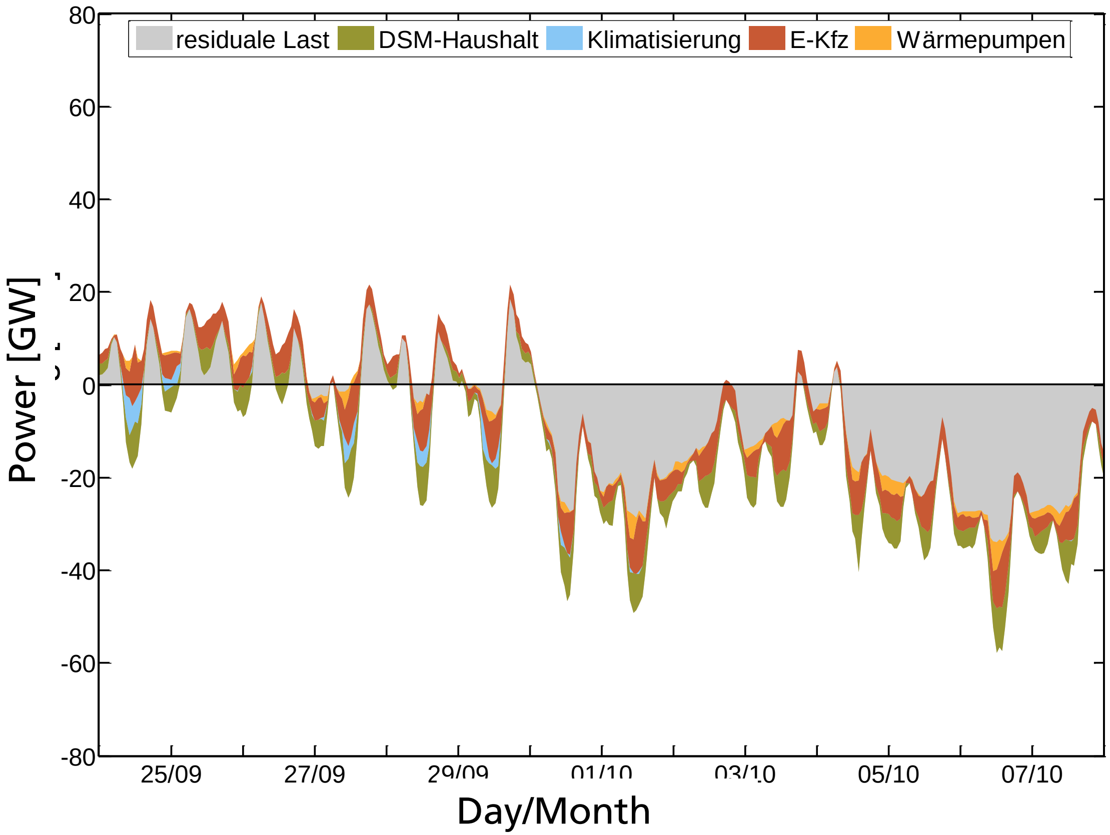
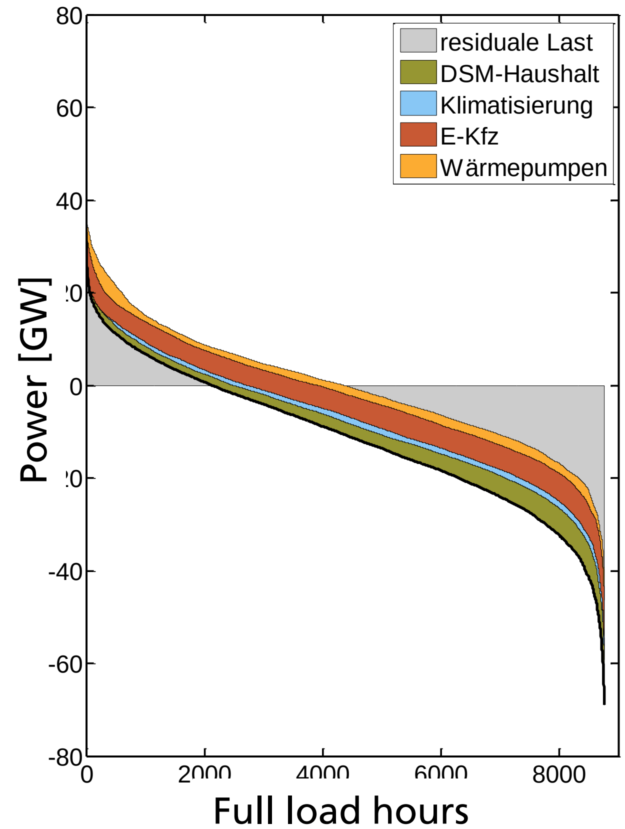
Flexibility by load management / demand side management

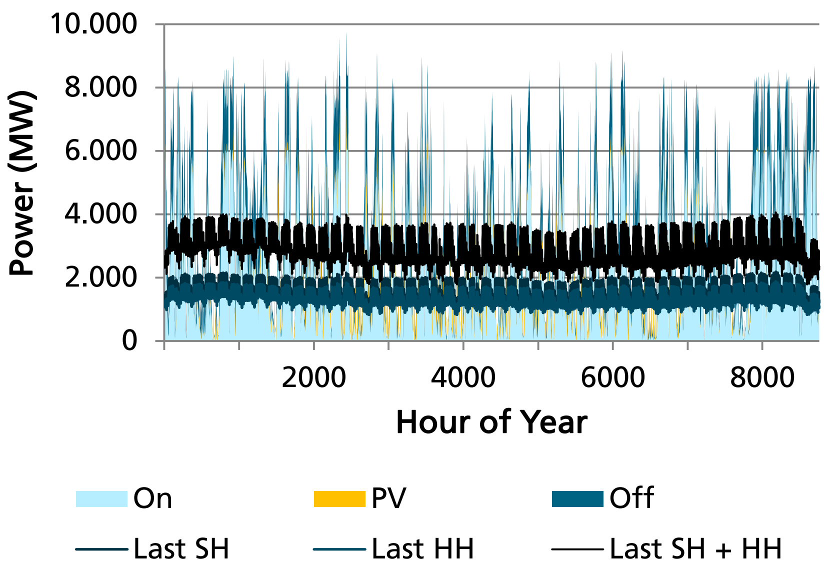


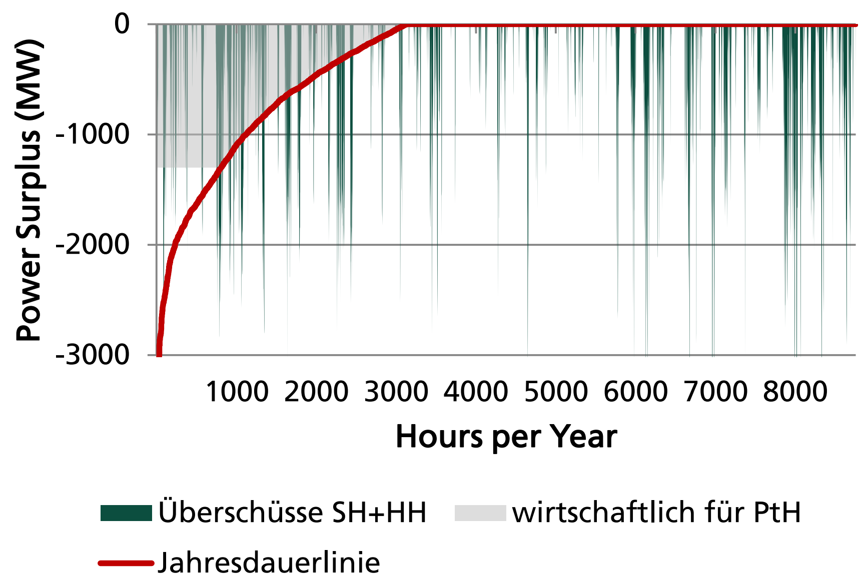


- Existing electric consumption (electric heating of water, refrigerator washing machine, dishwasher)
- New consumers (e-mobile, heat pump, air conditioner)
- Industrial load management

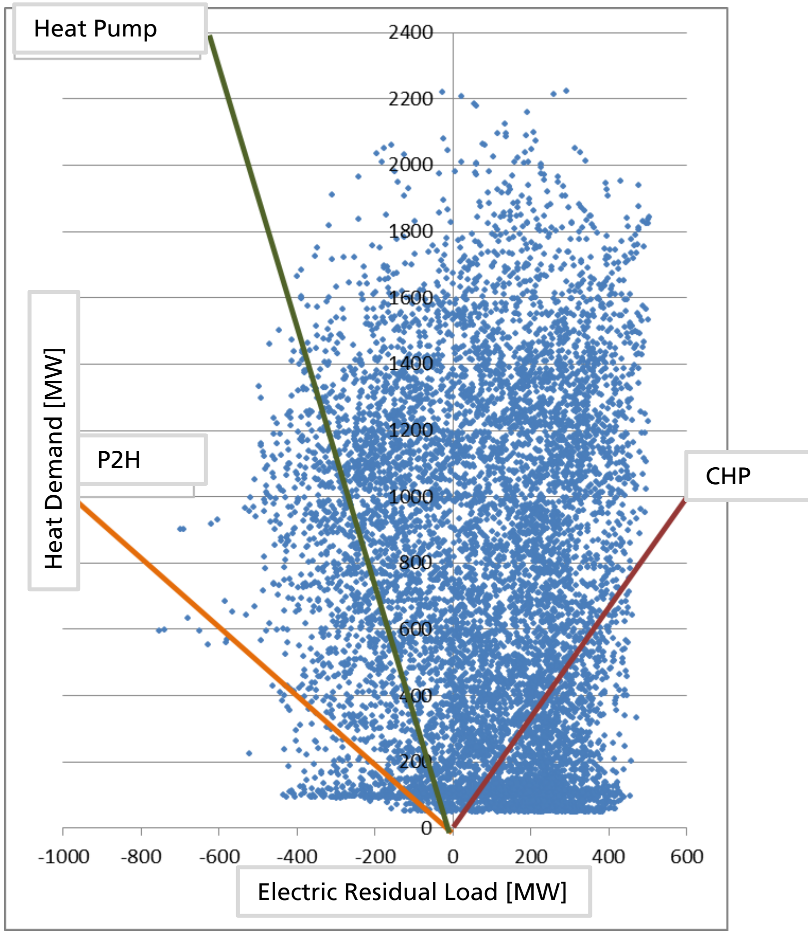
Need of Flexibility: Example Schleswig-Holstein / Hamburg

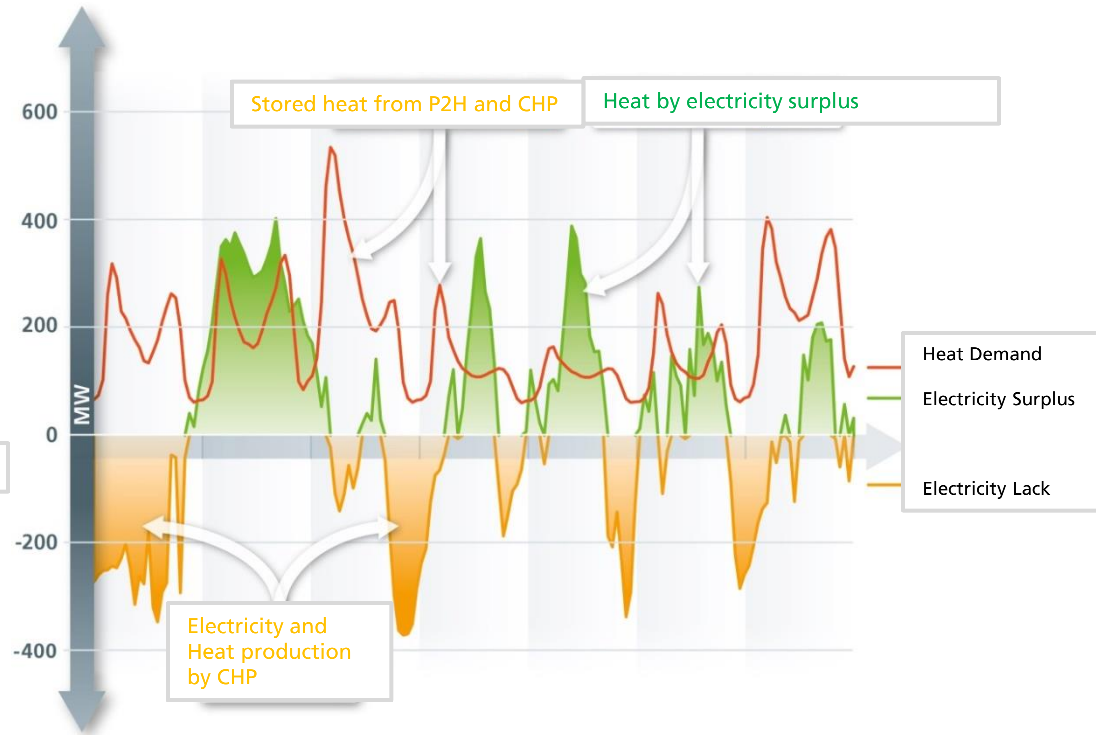
- **Limit – Extreme Case 2023 - no Expansion of Transmission Grid**
- RES-Curtailment for Schleswig-Holstein and Hamburg
  - → Total: 2,7 TWh
  - → Economic for P2H: 2,3 TWh and 1,3 GW P2H-Capacity
  - → 1. Grid, 2. P2H, 3. RES-Curtailment

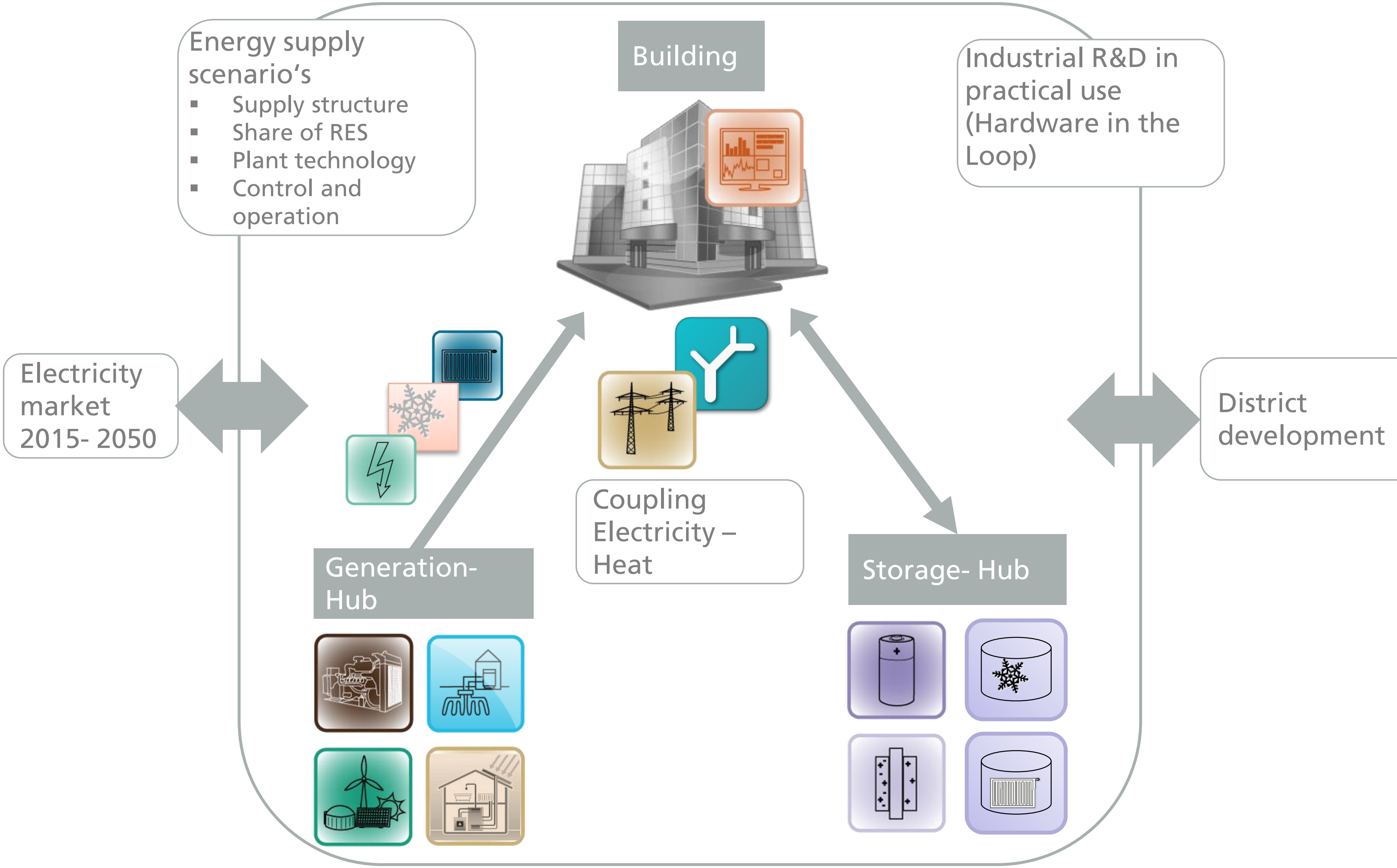




Flexibility option: coupling of electricity and heat - Kassel







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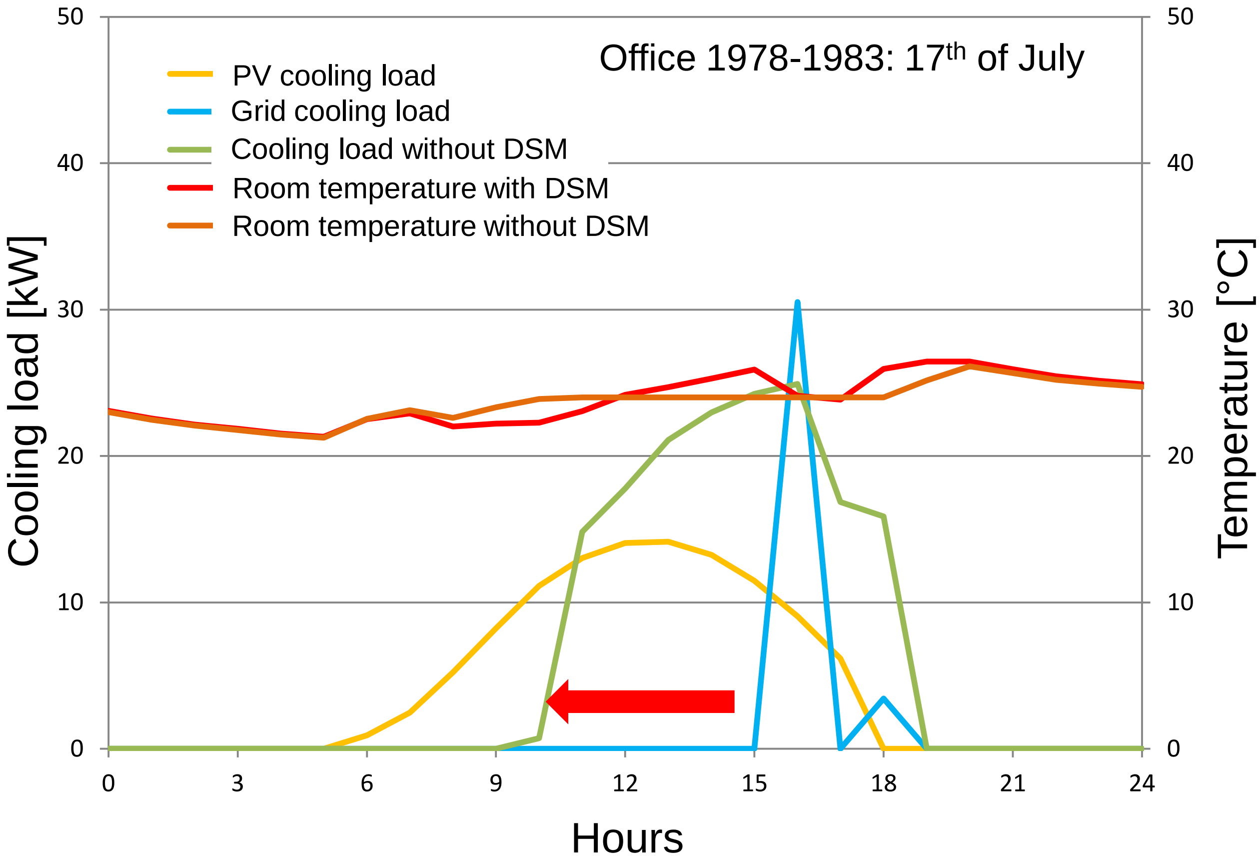
PV and cooling: demand site management



Cooling load shifting of 3 hours

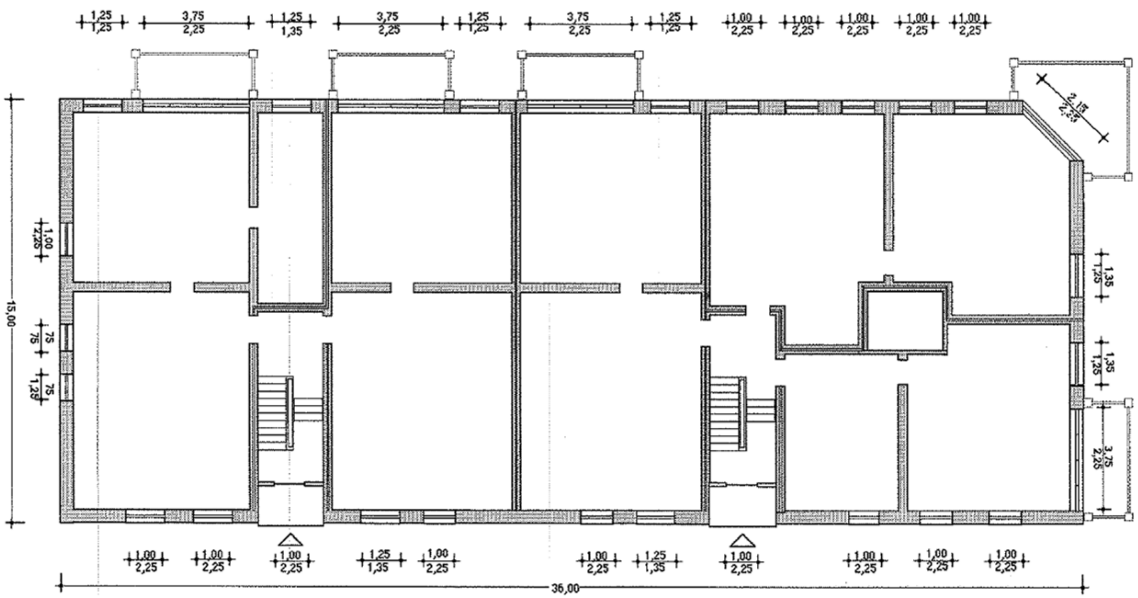
Pre-cooling to 22°C instead of 24°C

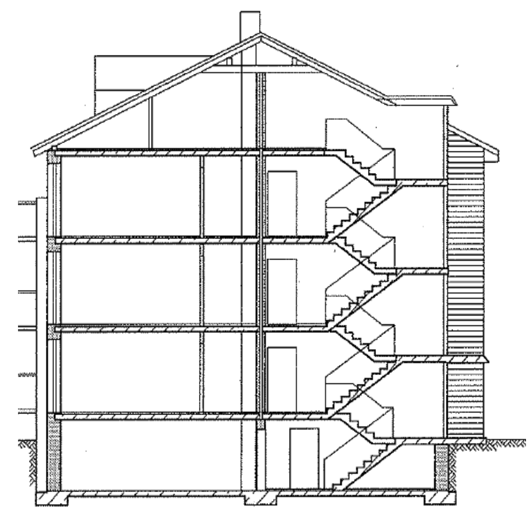
- Increased use of locally generated electricity
- Positive grid-interaction
- Reduced costs

Buildings as energy storages

1.09 TWh/K

1,090,000,000 kWh/K



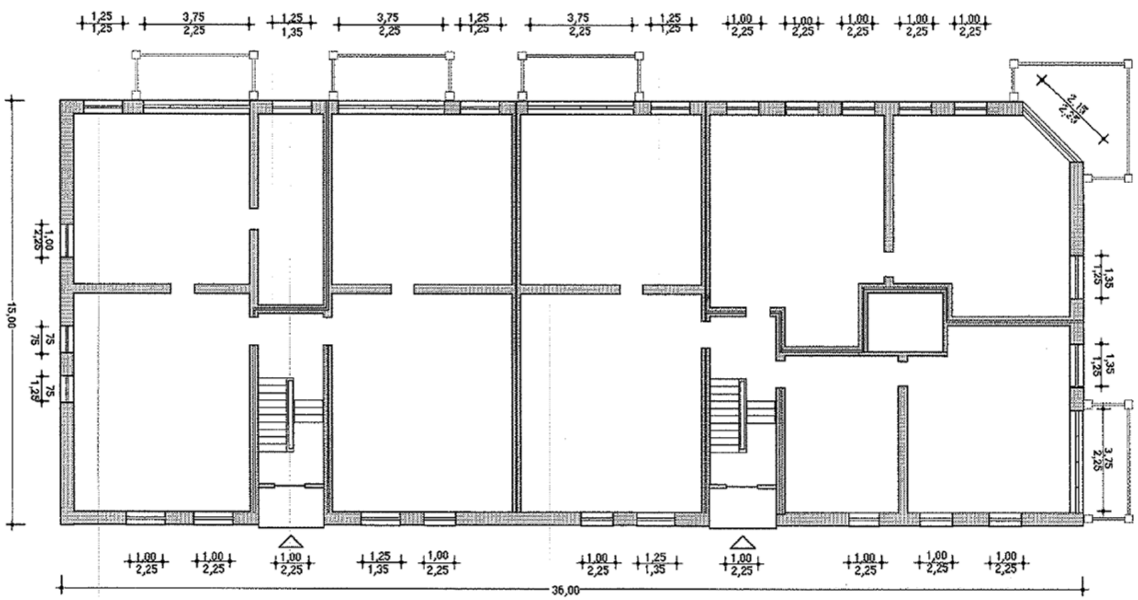


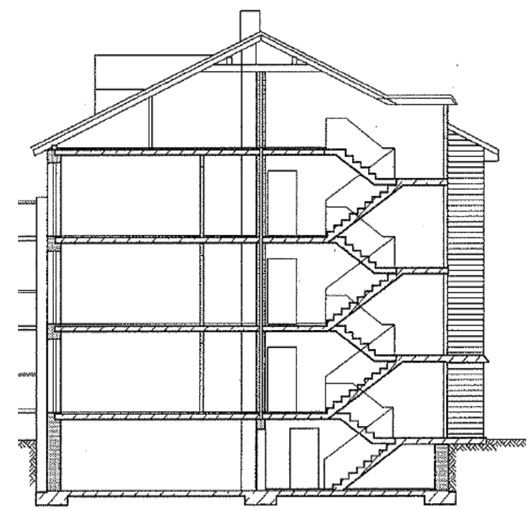
Future role of buildings

Energy producer

+

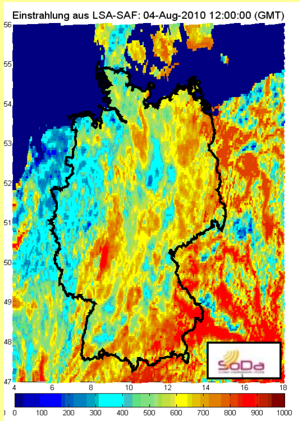
Energy storage = **Stakeholder in a flexible electricity market**





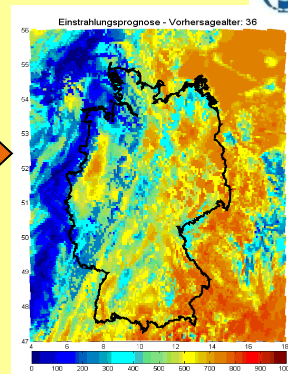
Key: Precise prediction of wind and solar power – local, regional

Satellite

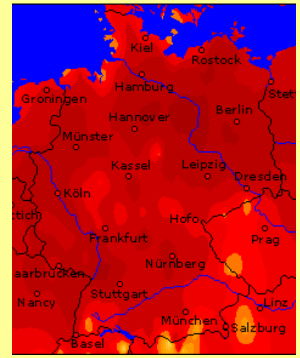


NWP (0 – 78 h) – Cosmo-EU

Radiation

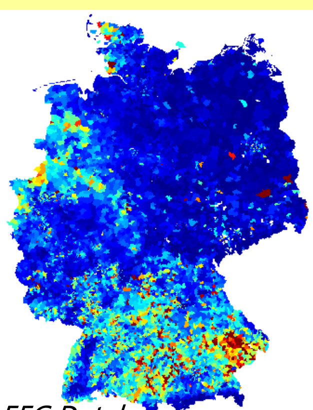


Temperature



Preprocessing

Installed PV-Capacity



- EEG Database
- PV Database (BNetzA)

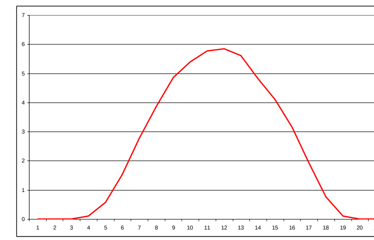
Classification by age, power

Statistical information of :

-inclination, orientation, -
WR- und efficiency factor
- losses

Physical Simulation of all PV plants

MOS ANN



PV-forecast

Conclusion

- **The transformation of the energy supply system requires a co-ordinated interaction of the sectors electricity, heat and mobility**
- **The coupling of the sectors increases the flexibility of the system and decreases the cost for fossil primary energy**
- **The coupling of electricity and heat requires a massive implementation of heat pumps, power-to-heat applications, CHP and a large effort for isolation of buildings**
- **The interaction is supported by smart solutions in system technology for demand side management and grid management**
- **The feed-in of wind and solar energy into the supply system will be increased by precise prediction systems – on local and regional level – and adapted to energy management systems**

Fraunhofer Institut for Wind Energy and Energy System Technology

Research Spectrum:

- Wind Energy from Materials to Grid Integration
- Energy System Technology for all Renewables

- **Fraunhofer IWES | Kassel**

  Direktor: Prof. Dr. Clemens Hoffmann

- **Fraunhofer IWES | Nordwest**

  Direktor: Prof. Dr. Andreas Reuter

- **Anual Budget:** ca. 32 Mio. Euro

- **Staff:** ca. 500

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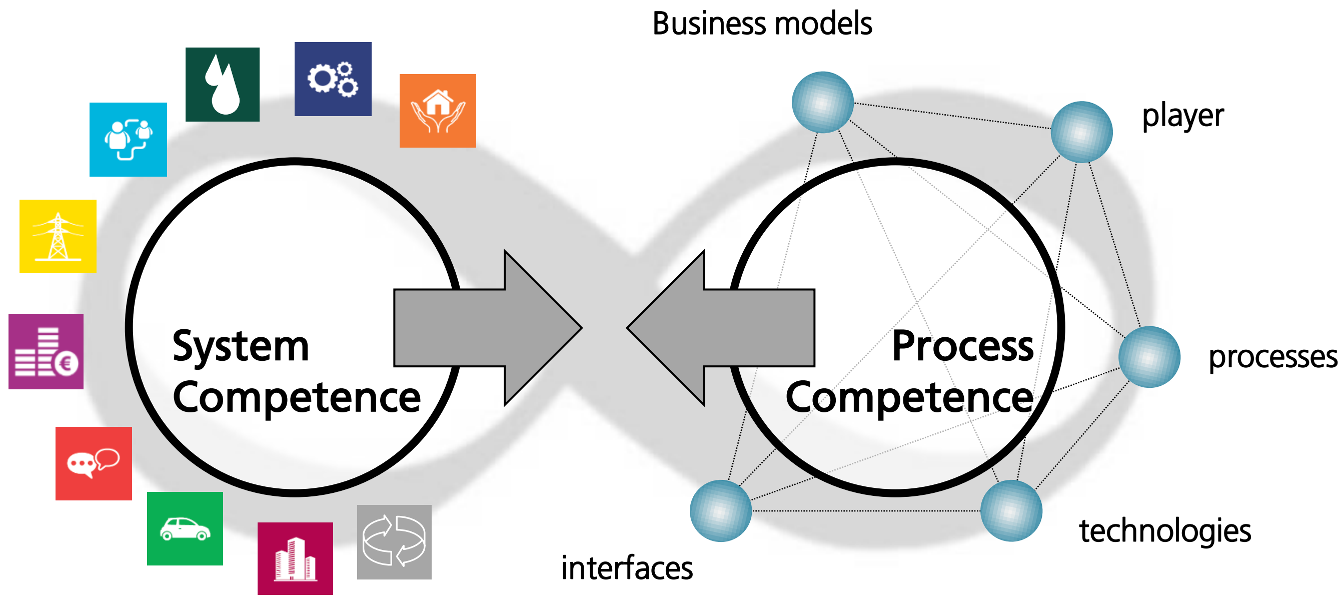
Systemic approach for innovative urban development

With 10 Fraunhofer-Institutes and value-partners



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