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

Workshop on Renewables and Energy Systems Integration
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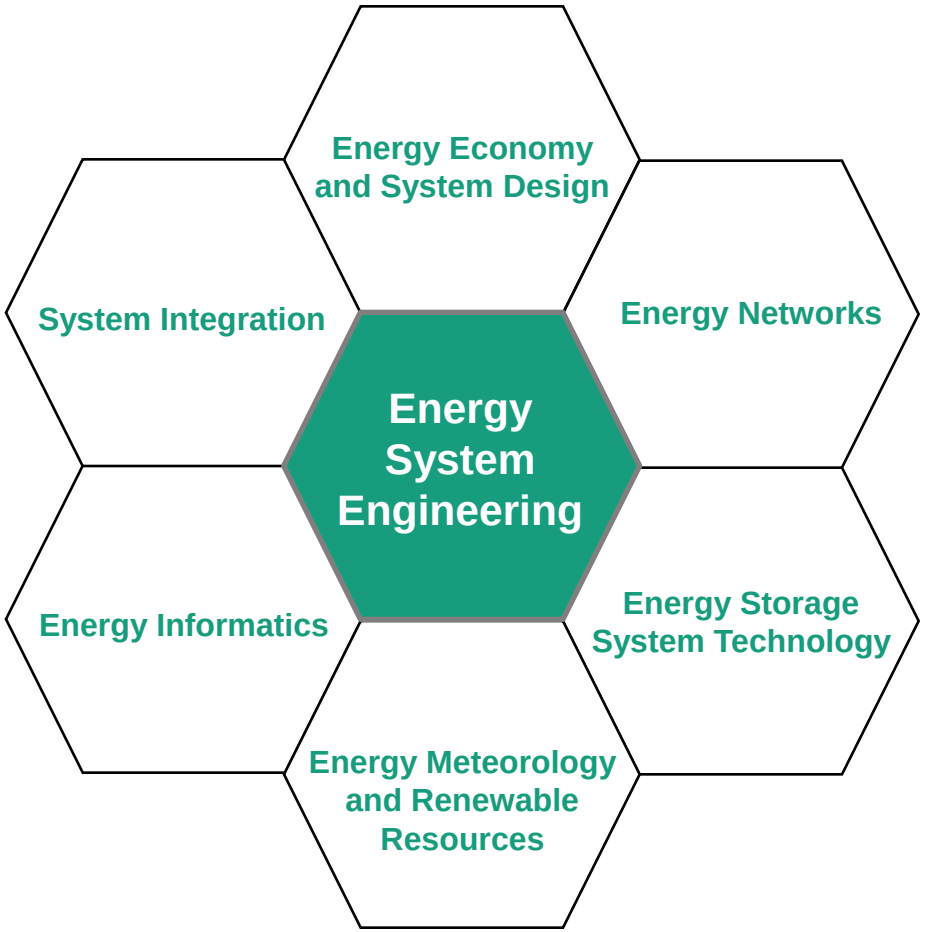
Fraunhofer IWES Kassel

Core Competences for Energy Systems Engineering



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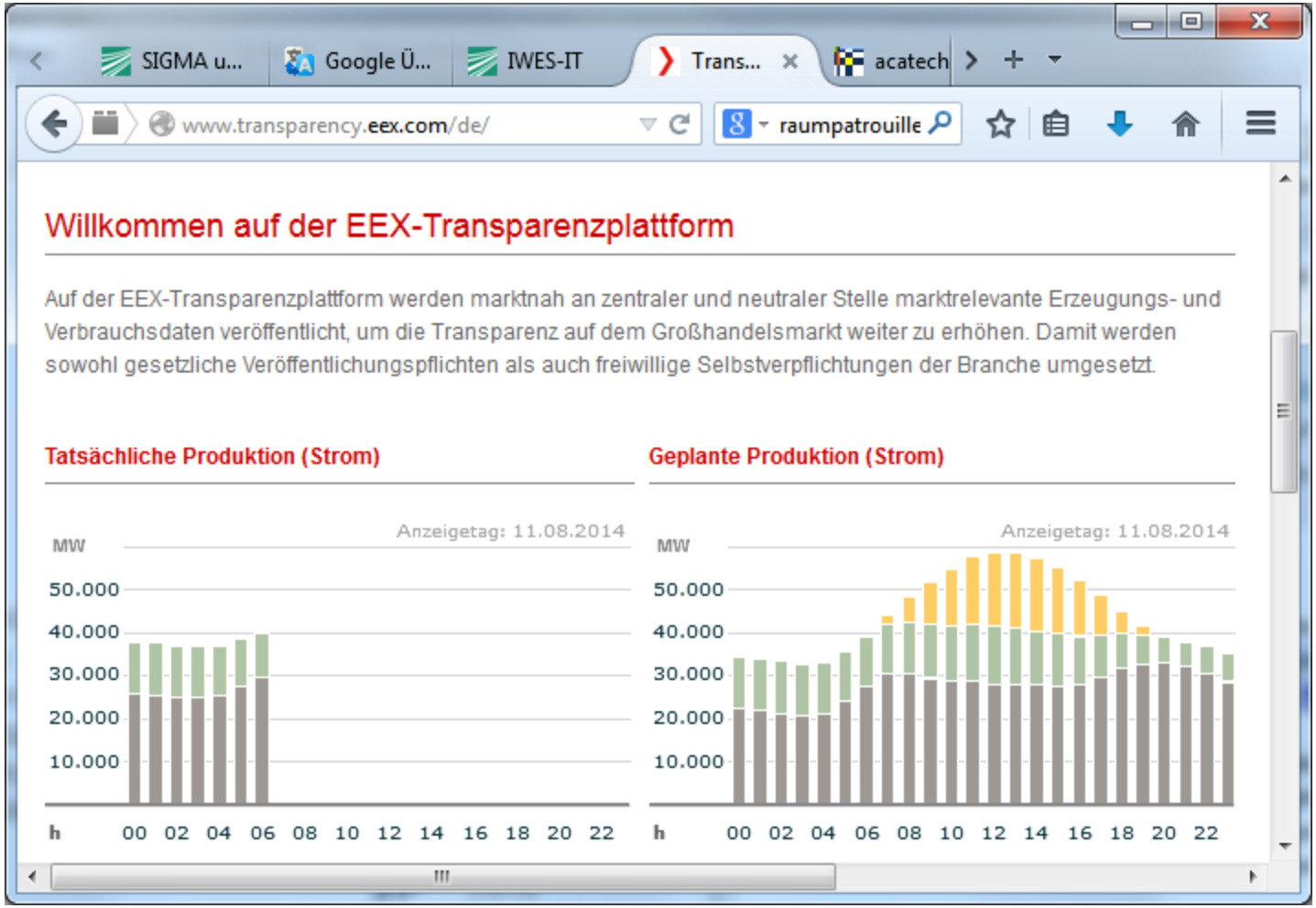
Introduction



Introduction

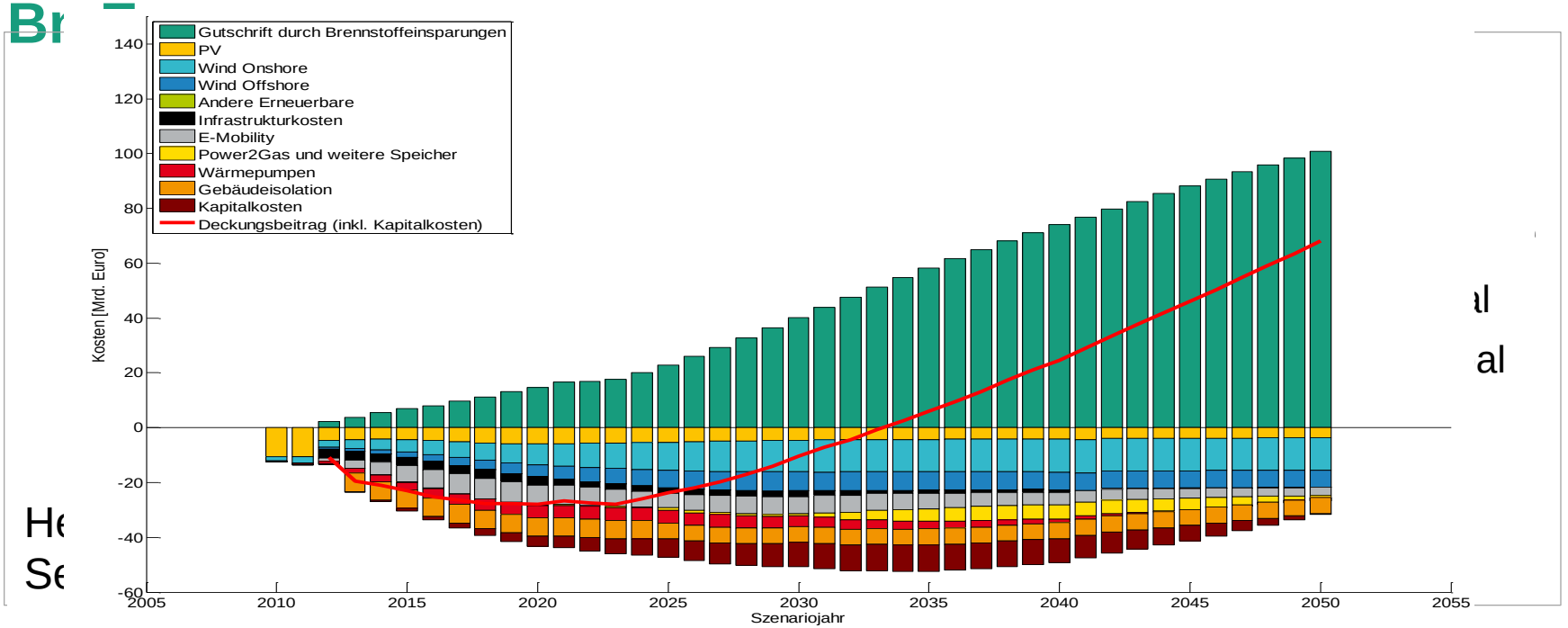
Two main reasons for the coupling of power and heat

- 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

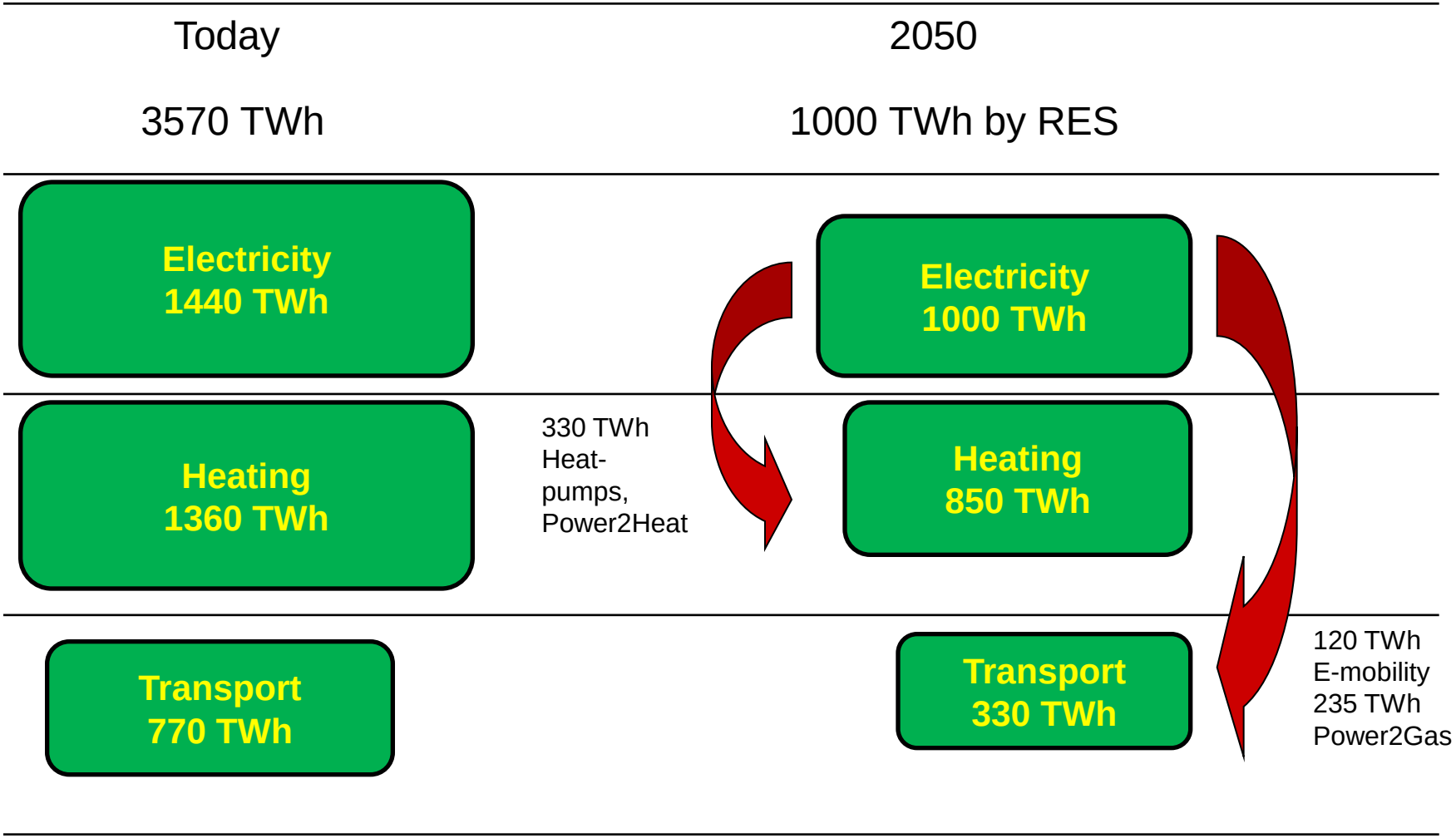
Primary Energy Demand in Germany – 3600 TWh – 85 Br –



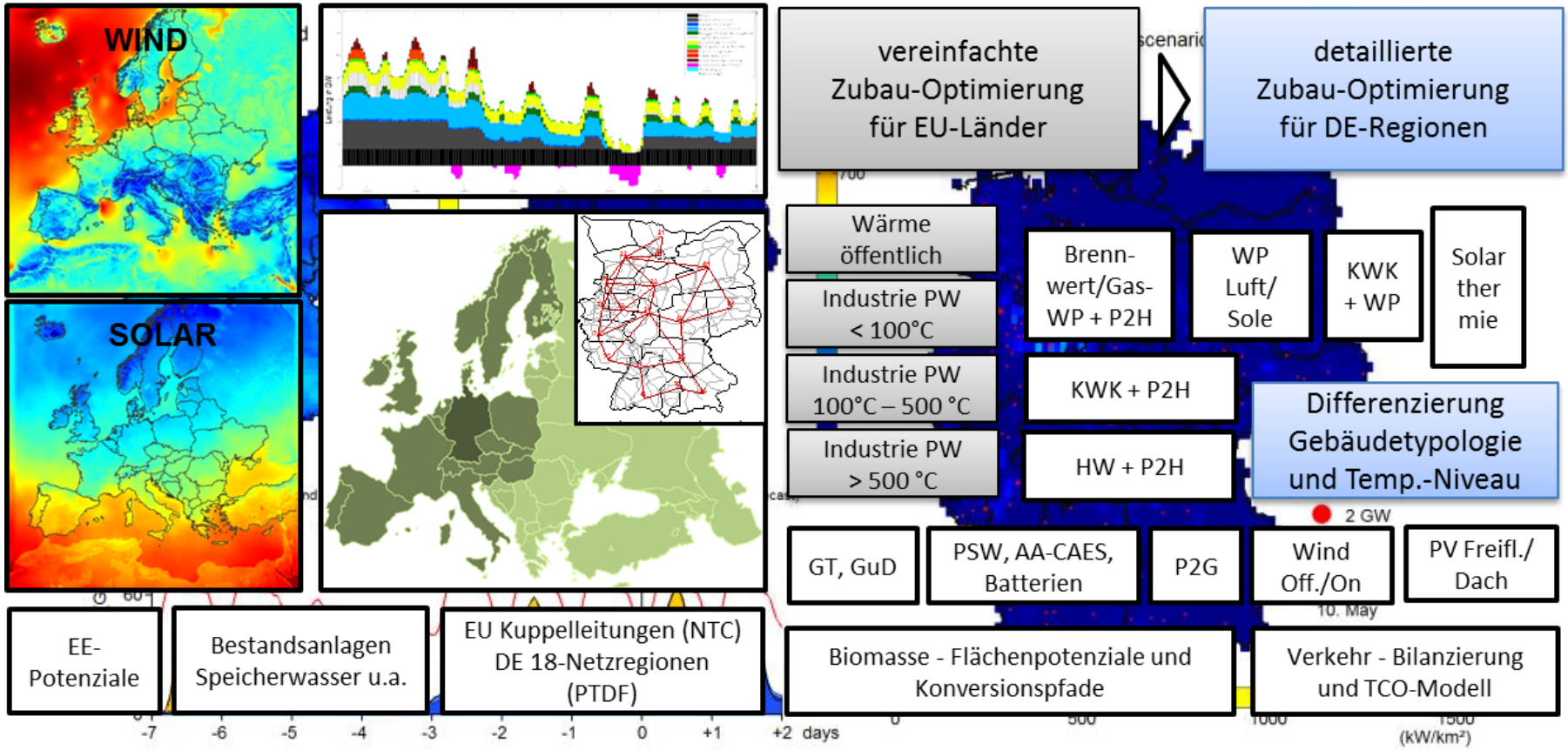
Electricity: high share for primary energy
→ but import- and production-cost relative low

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

Transformation of Germany‘s Energy Supply System



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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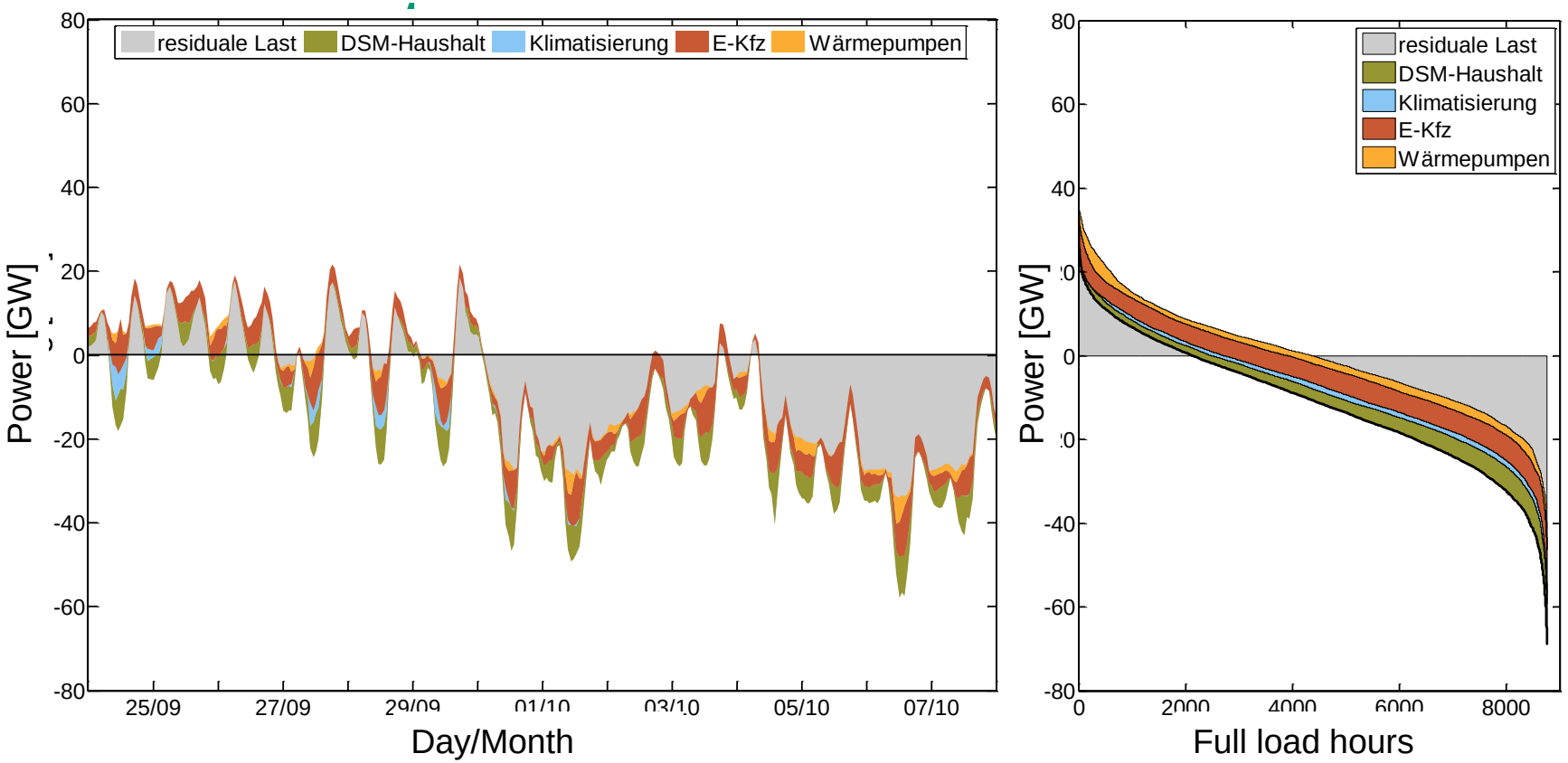
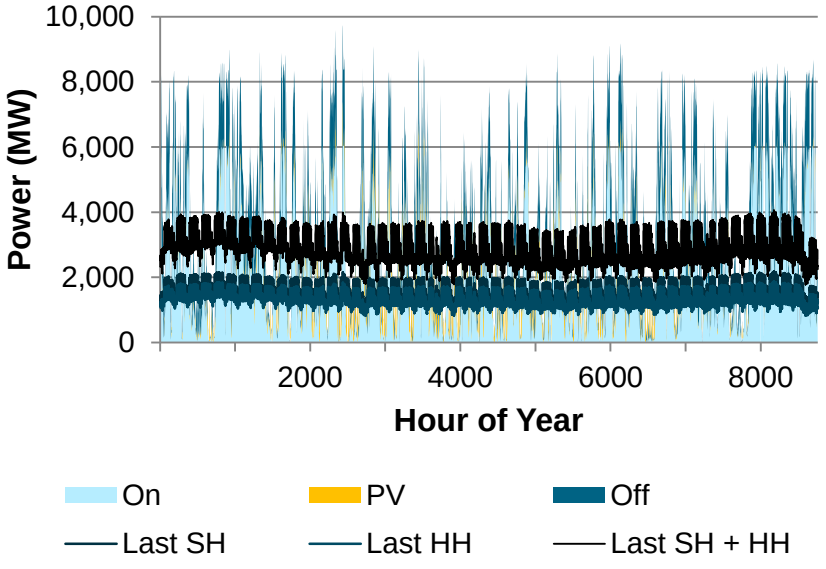
Flexibility by load management / demand side

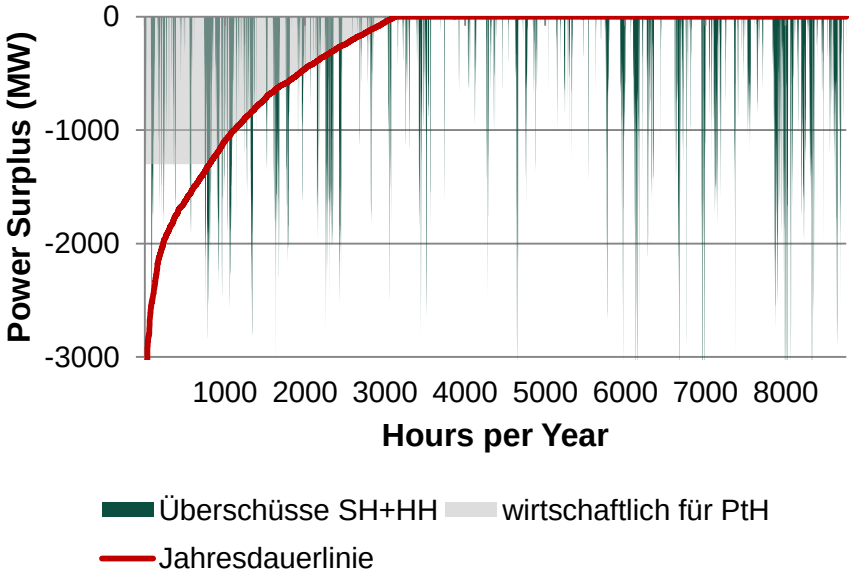


- Existing electric consumption (electric heating of water, refrigerator washing machine, dishwasher)
- New consumers (e-mobile, heat pump, air conditioner)
- Industrial load management

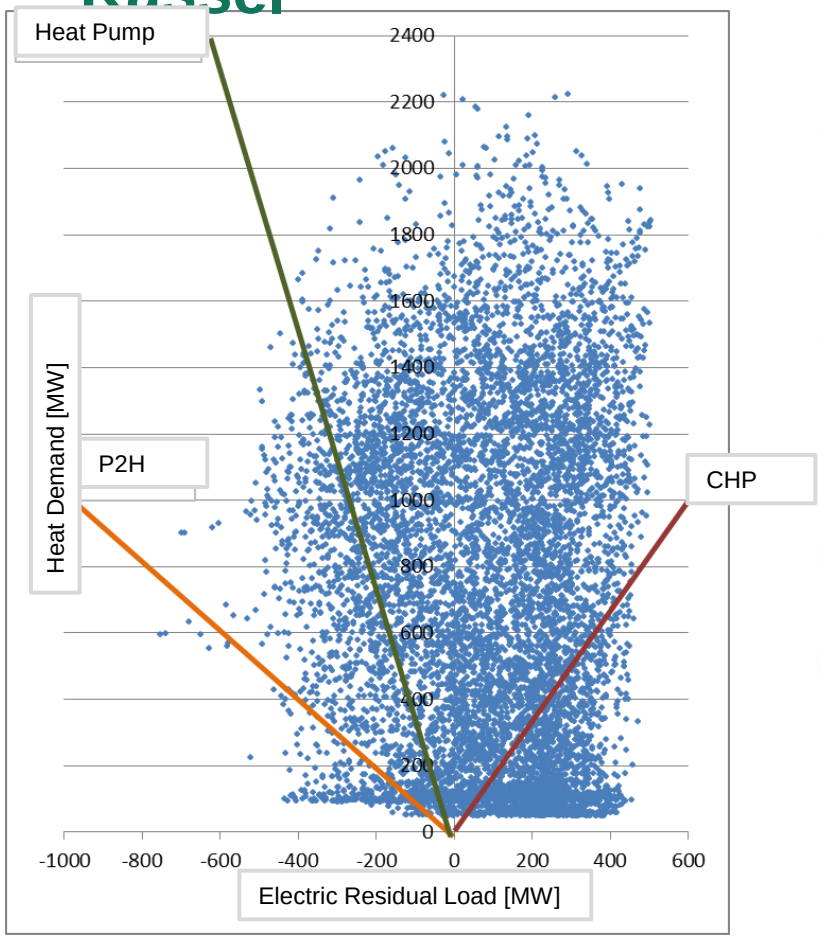
Need of Flexibility: Example Schleswig-Holstein / Hamburg

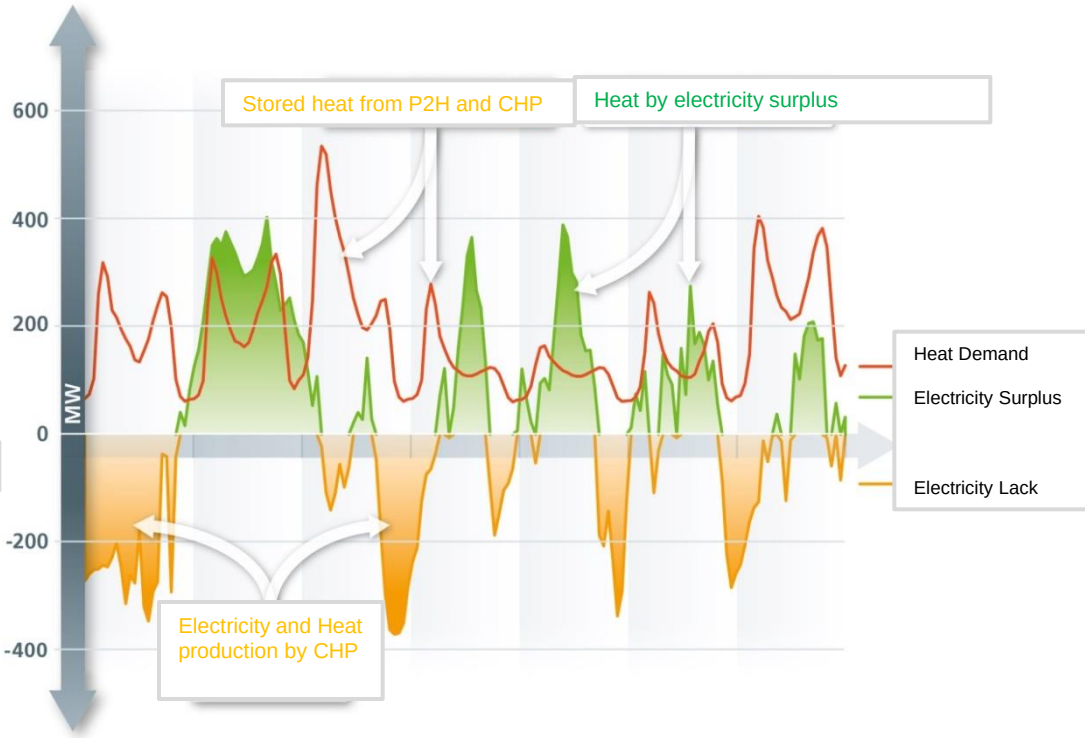
- **Lamit – Extreme Case 2023 - no Expansion of Transmission Grid**
- RES-Curtailment for Schleswig-Holstein and Hamburg
  - → Total: 2,7 TWh
  - → Economic for P2H: 2,3 TWh and 1,3 GW P2H-Capacity
  - → 1. Grid, 2. P2H, 3. RES-Curtailment

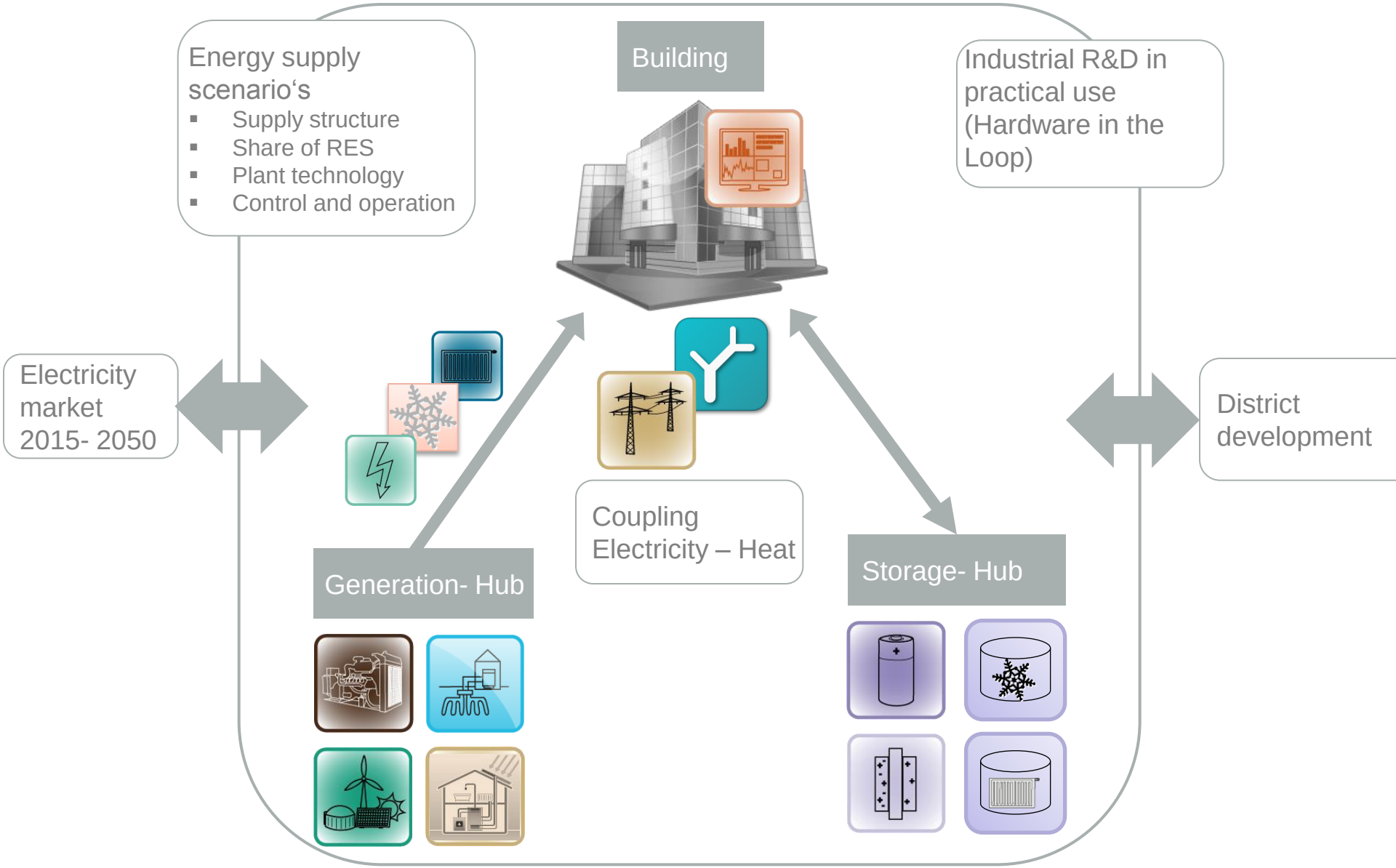




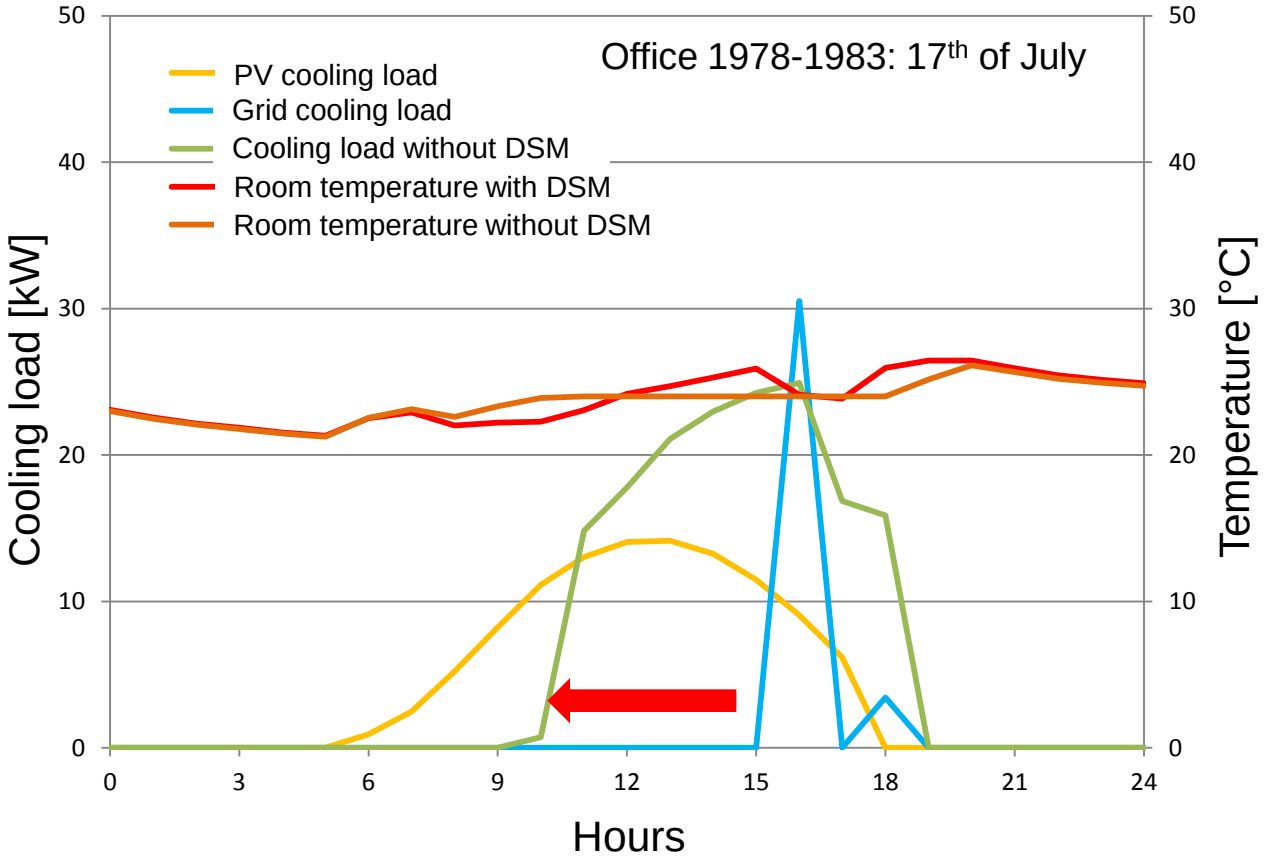
Flexibility option: coupling of electricity and heat - Kassel






Energy supply scenario‘s
Supply structure
Share of RES
Plant technology
Control and operation
Building
Industrial R&D in practical use (Hardware in the Loop)
Electricity market 2015- 2050
District development
Coupling Electricity – Heat
Generation- Hub
Storage- Hub

PV and cooling: demand site management



Cooling load shifting of 3 hours

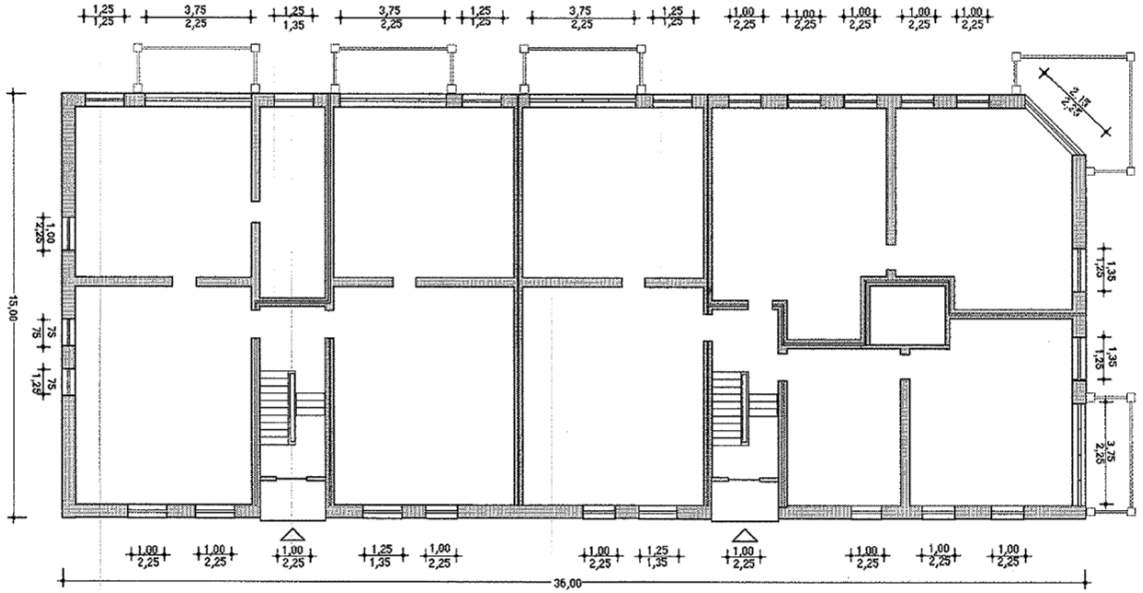
Pre-cooling to 22°C instead of 24°C

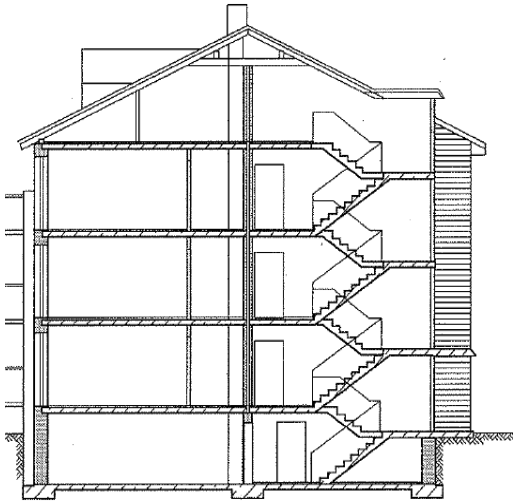
- Increased use of locally generated electricity
- Positive grid-interaction
- Reduced costs

Buildings as energy storages

1.09 TWh/K

1,090,000,000 kWh/K



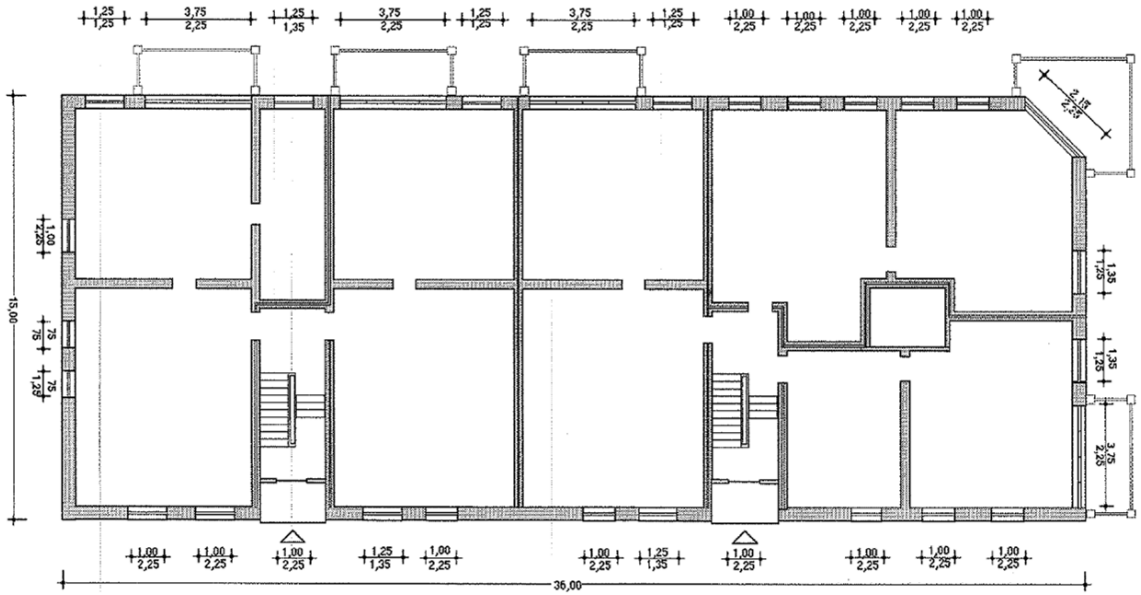


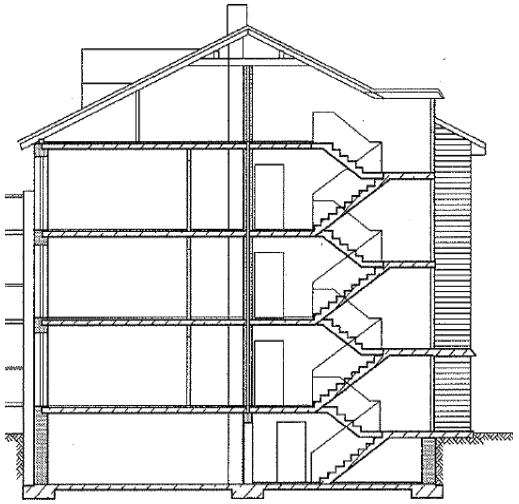
Future role of buildings

Energy producer

+

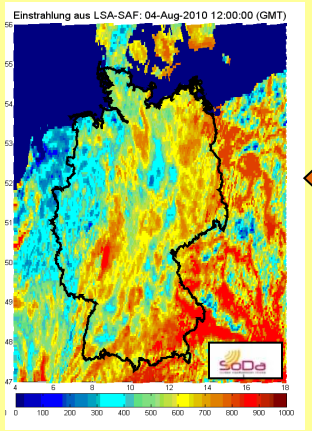
Energy storage = **Stakeholder in a flexible electricity market**





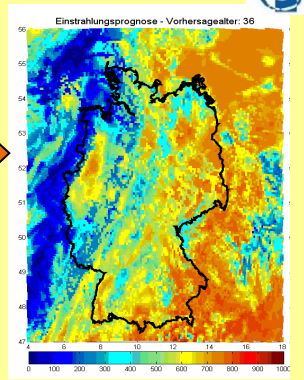
Key: Precise prediction of wind and solar power – local, regional

Satellite

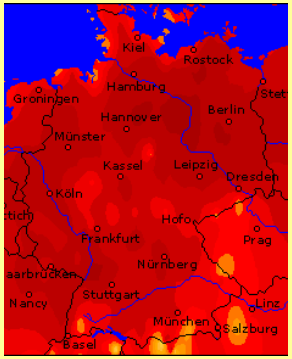


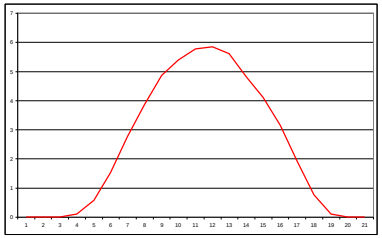
NWP (0 – 78 h) – Cosmo-EU

Radiation



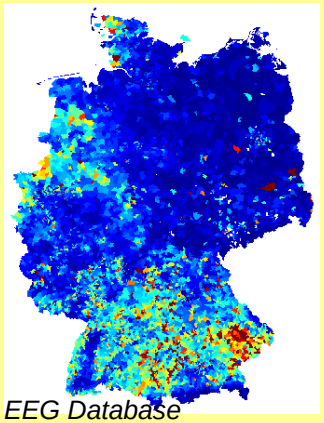
Temperature





PV-forecast

Installed PV-Capacity



- *EEG Database*
- *PV Database (BNetzA)*

Preprocessing

Classification by age, power

Statistical information of :

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

Physical Simulation of all PV plants

MOS ANN

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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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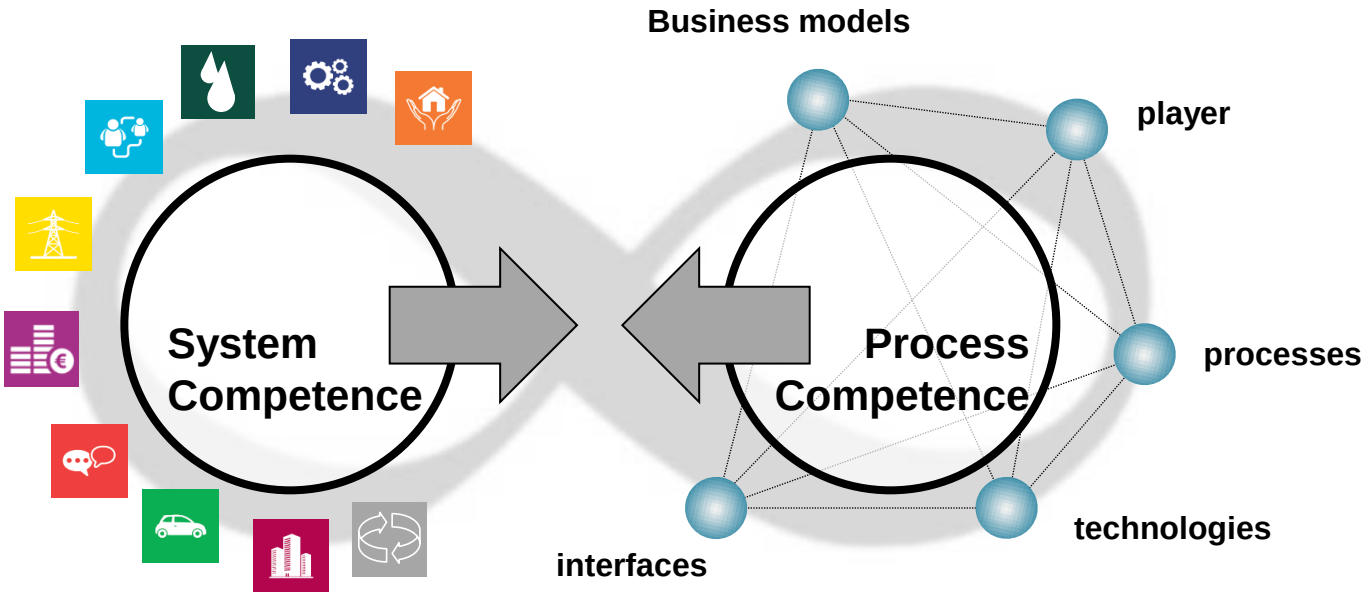
Systemic approach for innovative urban development

With 10 Fraunhofer-Institutes and value-partners



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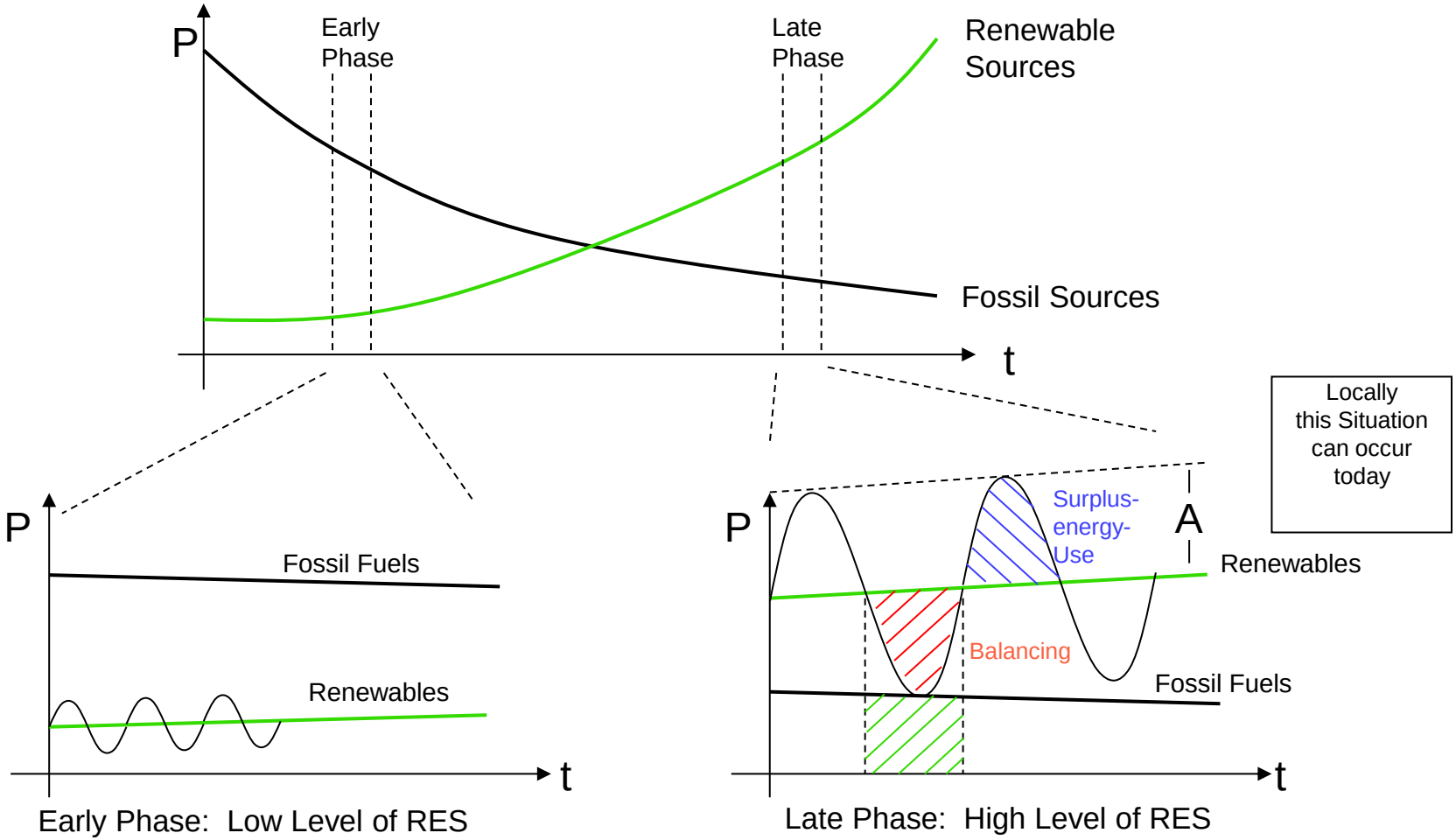
At the Threshold to the Age of Electricity Transport and Storage



Surplus and Deficits Characterize Energy Supply

Concluding remarks

- Energy efficiency is our biggest energy source
- Think renewable energies and energy efficiency always together
- Integration of all subsystems is our future task!