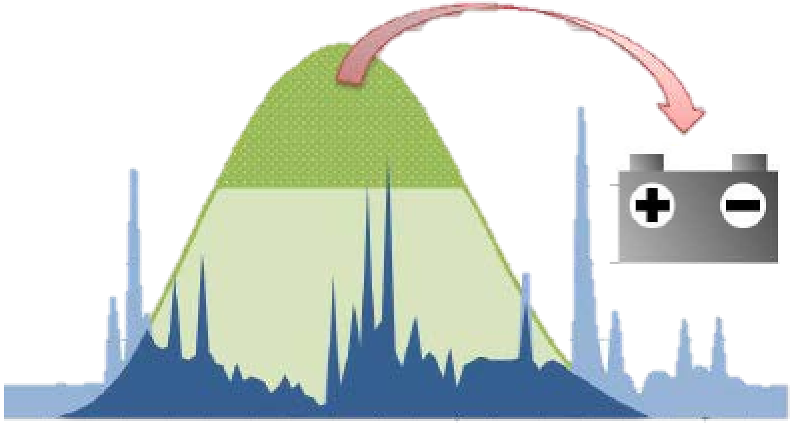
How energy storage solutions can help to stabilize the grid

Transatlantic energy politics:
Latin-America and Germany

11/6/2015

J. Badeda, D. U. Sauer,
B. Lunz, P. Stoecker



Motivation
Why are we thinking about storage

Today

Centralized

Unidirectional

Separate markets:

Heat, Transport, Electricity

Future

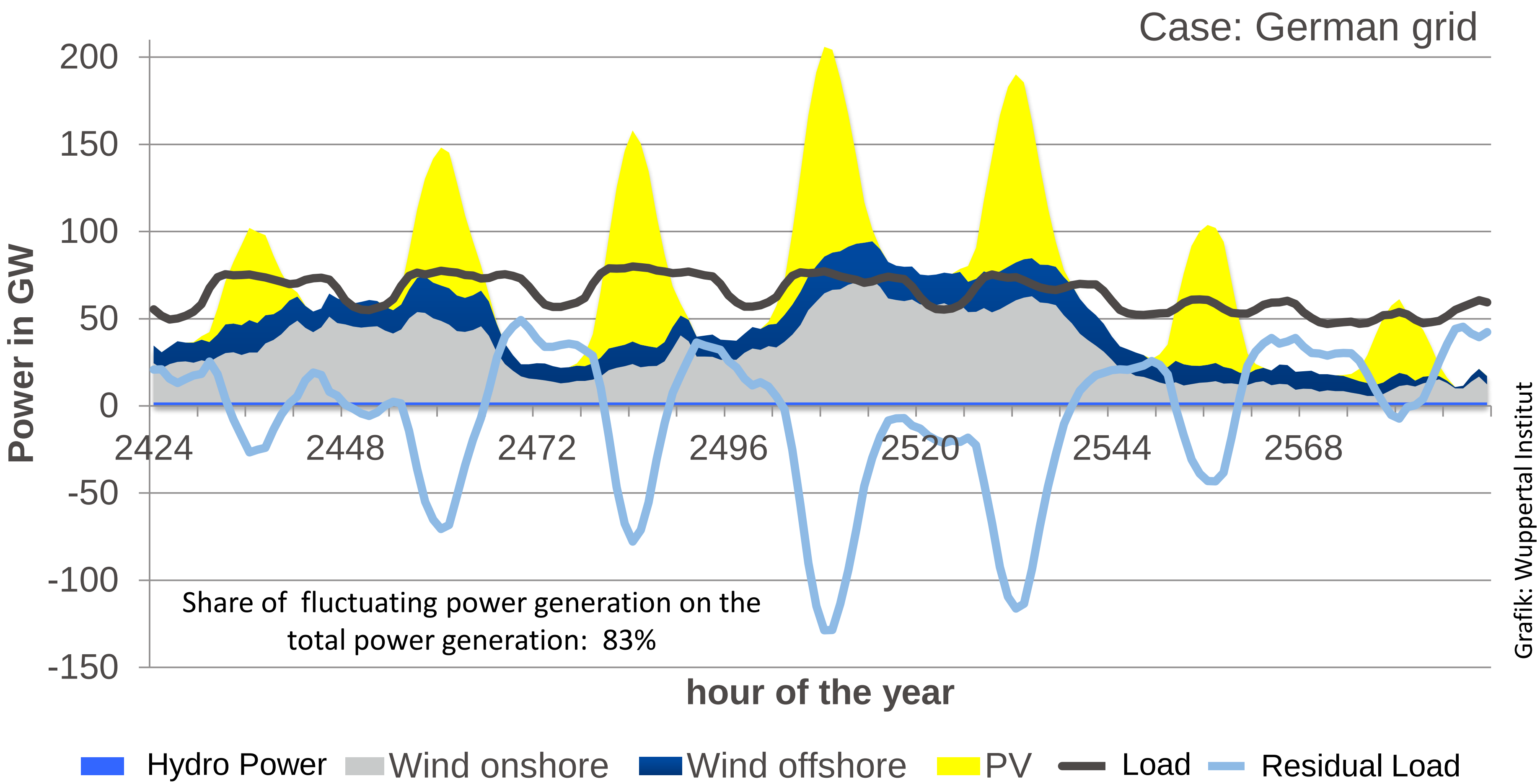
Decentralized

Bidirectional

Higher market interconnection

Reduction of CO_2 by 80-90%

Motivation
Why are we thinking about storage



PV: 151 GW, Wind onshore: 82 GW, Wind offshore: 20 GW, Power consumption: 602 TWh/year, FEE-share: 83 %

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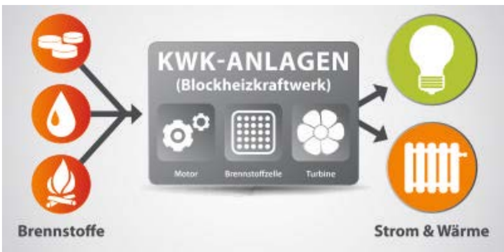
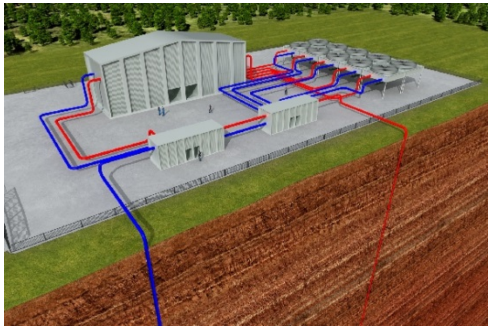
Flexible power generation technologies (net power production)

Concentrated Solar Power with thermal storage

Flexible conventional power plants



Demand-controlled CHP units



Geothermal with thermal storage

Demand-controlled biogas plants

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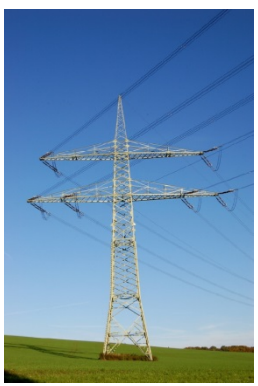
Flexibility technologies for areal and time shifting of energy

Demand Side Management (private households)

Demand Side Management (industry)

Double use storage system

Power-to-Gas (Chemicals)

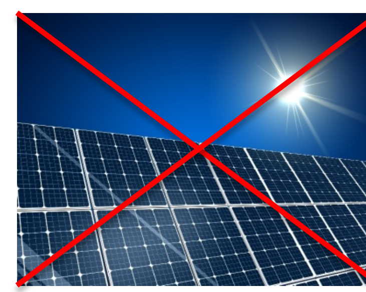


Grid extension

Power-to-Heat

Energy storage systems

Smart grids



Shut-down of renewable power generators

J. Badeda, D. U. Sauer, B. Lunz, P. Stoecker

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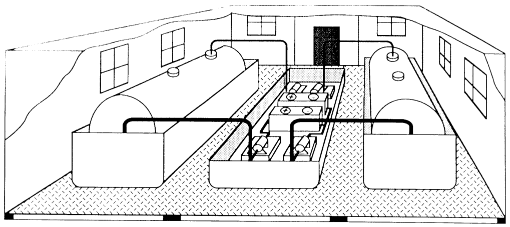
Technology
Energy storage in the electricity market



Redox-Flow Battery

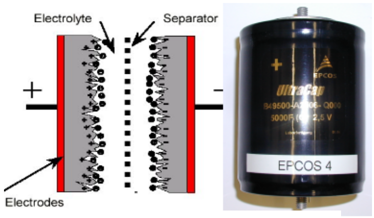
Hydrogen Storage

Pumped Hydro

Ultraconductive Coils

Batteries-
Lead-Acid, Lithium, NaNiCl, ...

Flywheel



SuperCaps

Compressed Air

Research Study „ESYS“ Background

- ESYS = Energy Systems of the Future
- Financed by the German Ministery of Education and Research
- Three German Academies of Science

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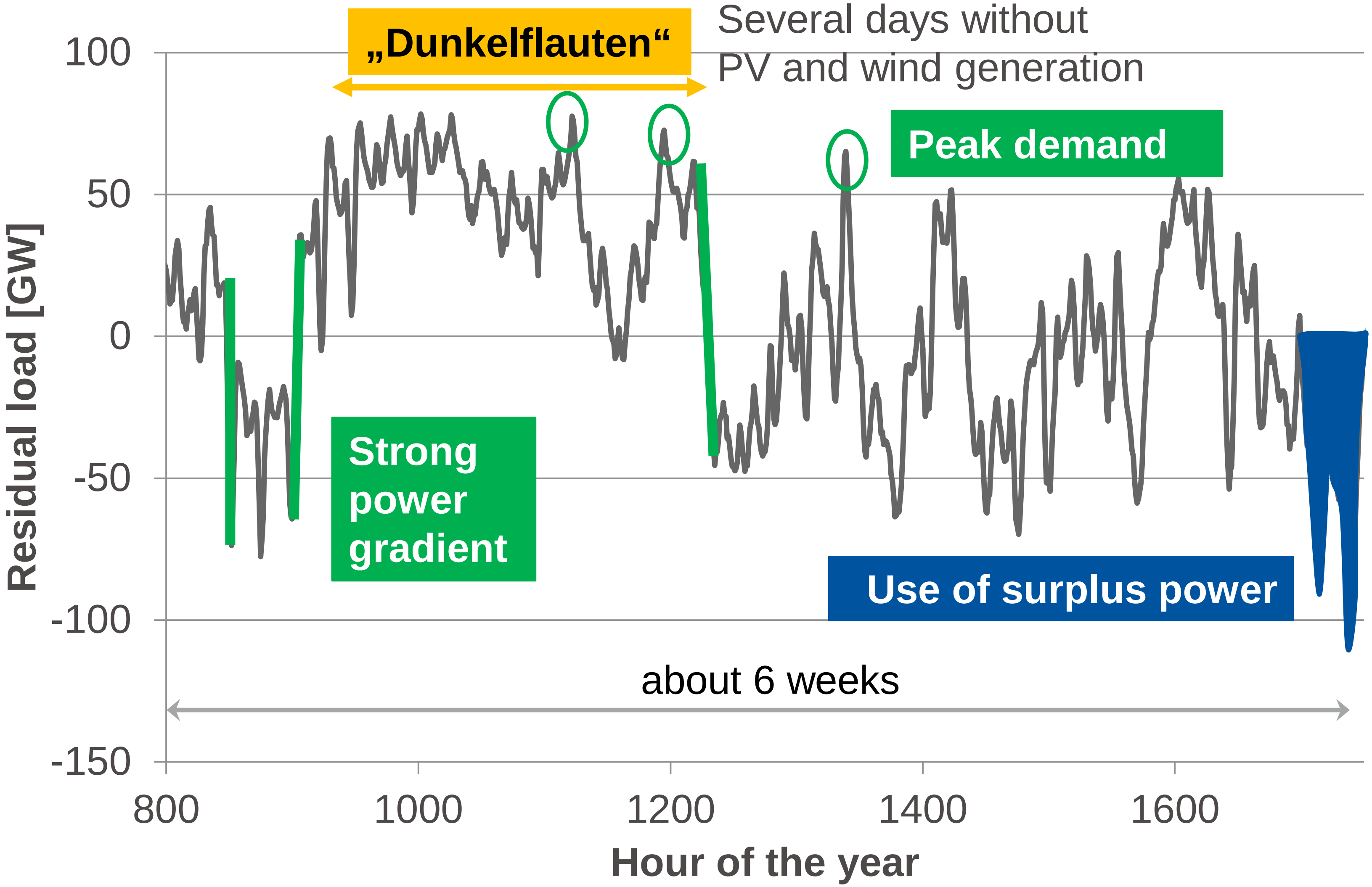
- Task force of hundreds of experts from technology, economics, material resources, social science and law

- Aim: Counseling of government and society
- Subproject: Flexibility technologies

→ Calculate cost optimum under given restrictions

Research Study „ESYS“
3 challenges in the future energy system



PV: 151 GW, Wind onshore: 82 GW, Wind offshore: 20 GW, Stromverbrauch: 602 TWh, FEE-Anteil: 83 %

Research Study „ESYS“
Options for the 3 challenges

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Short term flexibilities

Peak demand

Strong power gradient


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Flexible
power plants


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Energy storage
systems

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Demand Side
Management

Long term flexibilities

„Dunkelflauten“


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Hanno Böck / https://hboeck.de/

Options use gas turbines, capacity approx. 40-60 GW

Flexible power plants	Biogas plants	Hydrogen
Development of CO2 certificate	Availability of biomass	If surplus sufficient to fill storage

Options for the 3 challenges

Use of surplus power

Energy storage systems

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Biggest push from PV-storage and EV

Power-to-Heat

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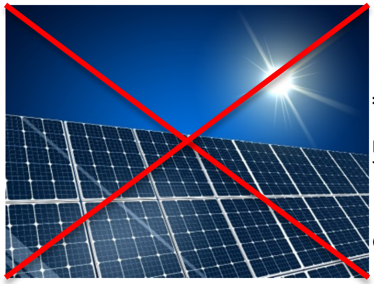

Shut-down of renewable power generators

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Economics:
High number of operation hours necessary
>80% PV and Wind

Power to X
Esp. Chemicals

.de/ Hanr

Summary

- Study has been performed for the German electricity grid with a high share of renewable energies
  - Restrictions were given by political agenda and social acceptance

- With a high share of renewables come new challenges
  - Cover peak demands and strong gradients
  - „Dunkelflauten"
  - Negative residual load = surplus of power

- There are technological solutions for future challenges available

- Depending on the challenge different technologies should be utilized

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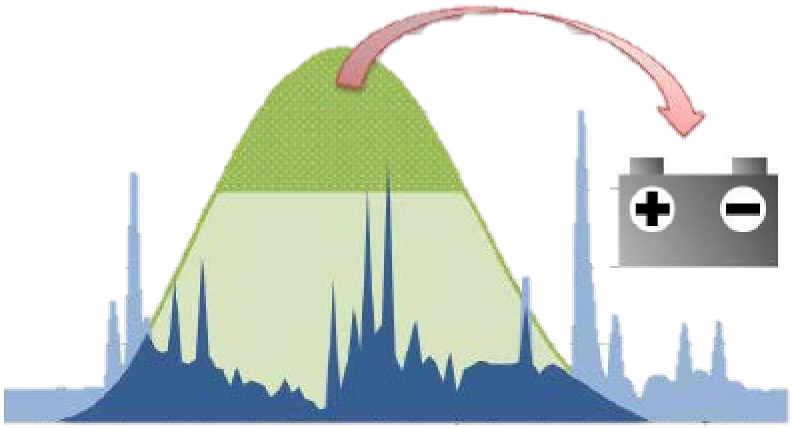

Projects to follow

- SolarPaces project
  - ESYS for CSP opportunities in Spain and South Africa

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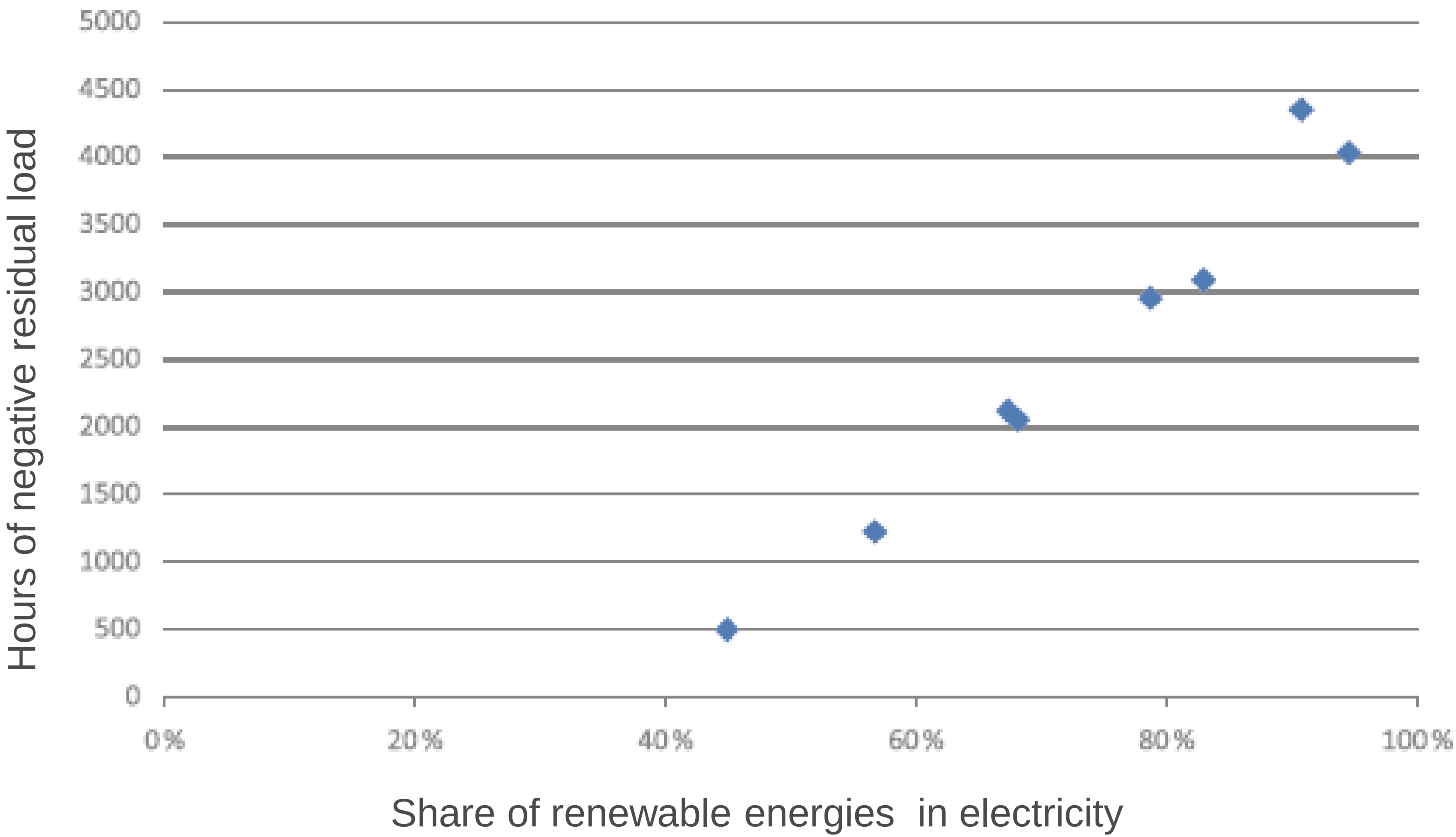
- Storage monitoring program
  - Monitoring of PV-home applications in Germany
  - Over 17.000 systems installed
  - www.speichermonitoring.de

- M5Bat
  - 5MW hybrid storage system (5 technologies)
  - In operation by mid of 2016
  - www.m5bat.de

Development of residual load with share of renewable energies



“Power to gas” – yes, but through „power to heat“

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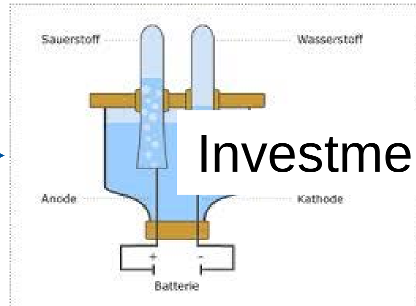
Hydrogen generation | Methanisation | Methane / natural gas

→



Investment > 1000 €/kW

→

Efficiency ~ 60%

fluctuating
power generation
(Wind or PV)

→

investment < 50 €/kW

→

Efficiency ~ 93%

Power grid

Hybride heating system
natural gas & electrical power

Development of system costs

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