Multi Grid Storage – Using Gas- or Heat Networks to Improve the Flexibility of the Electricity Sector

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(formerly Bremer Energie Institut)

Content

- **Introduction and Background**
  - the need for balancing
  - research project MuGriSto
- **Comparison of Energy Conversion Chains**
  - exergetic storage efficiencies
  - Storage costs
- **Energy Model MuGriFlex**
  - Introduction
  - Sample scenarios

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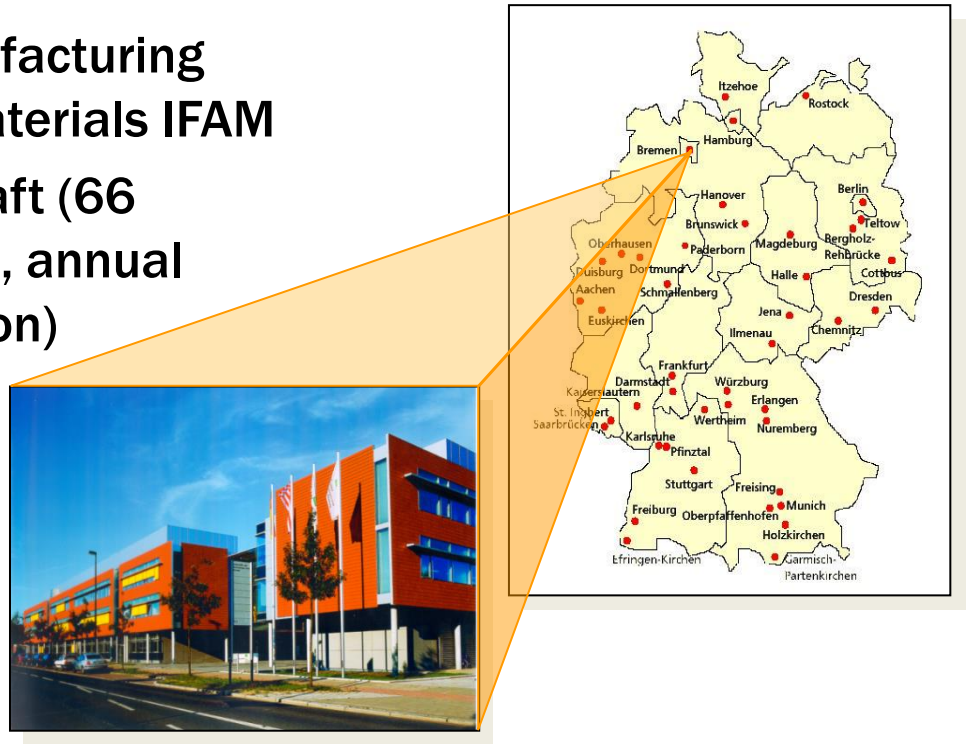
Fraunhofer-IFAM

- Fraunhofer Institute for Manufacturing Technology and Advanced Materials IFAM
- Part of Fraunhofer Gesellschaft (66 Institutes, 22,000 employees, annual research volume of €1.9 billion)
- IFAM: 500 Employees

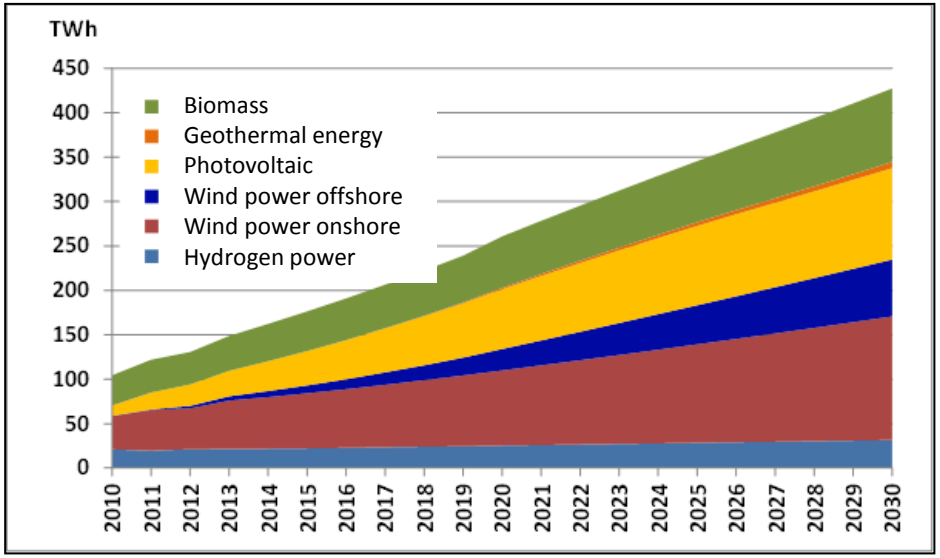


- Division of Energy Systems Analysis (formerly Bremer Energie Institute)
  - System Analysis
  - Energy Efficiency
  - Energy Economics
  - Renewable Energy

Background: need for balancing I

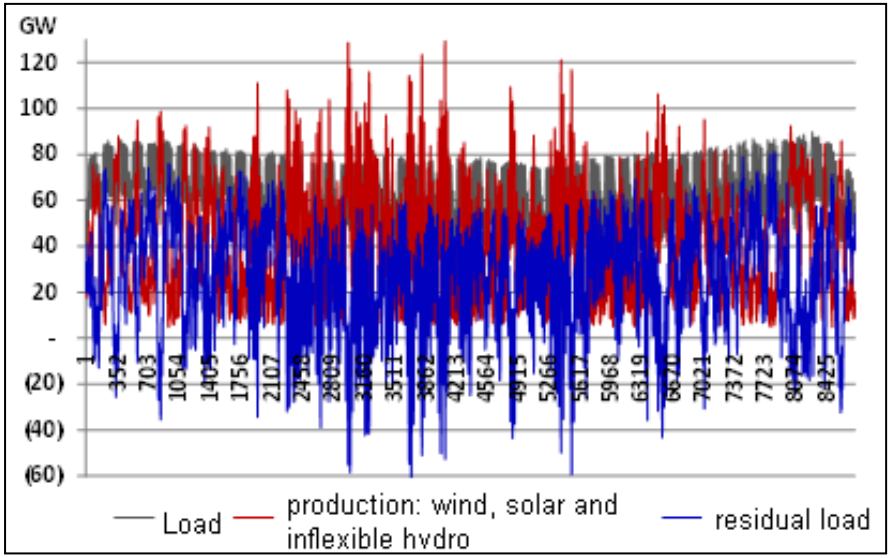
- German Electricity supply to be based on wind and solar power
- 80% from renewable sources in 2050
- Residual load to be very fluctuating

Predicted renewable electricity production



[Krzikalla et al. 2013]

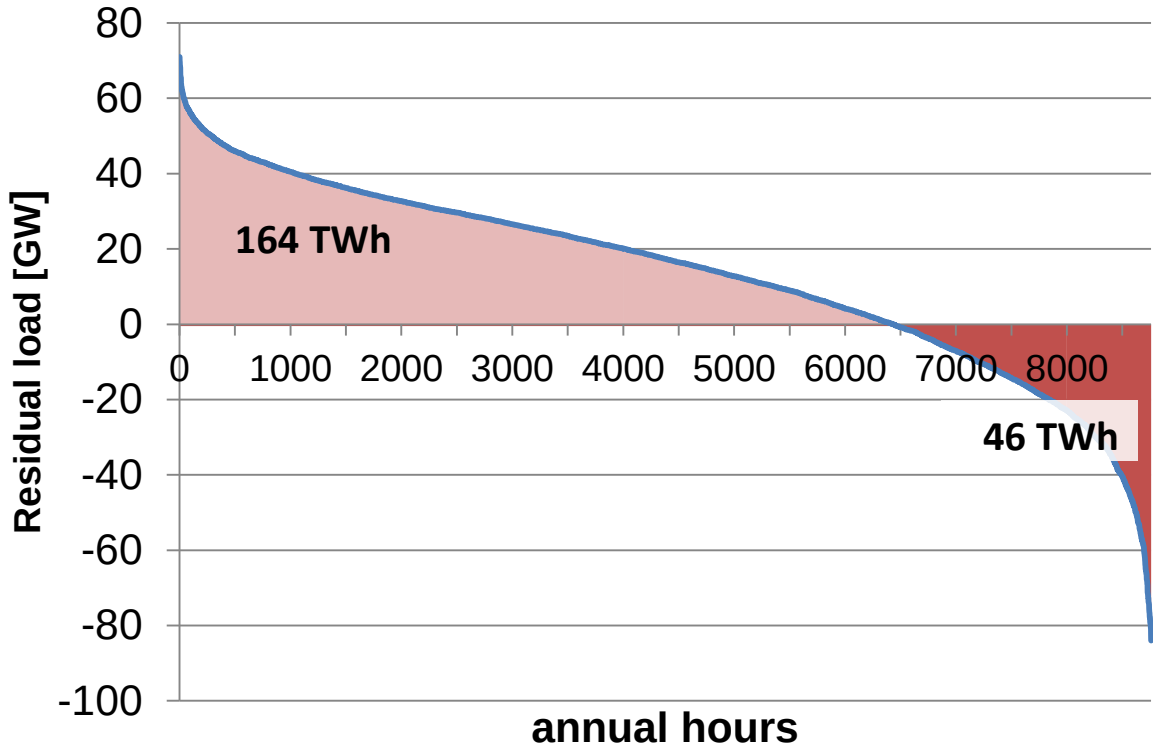
Predicted load, production and residual load in 2030



[Krzikalla et al. 2013]

Background: need for balancing II

- Predicted sorted residual load duration curve for 2030



Based on: [Krzikalla et al. 2013]

- pos. Residual load (electricity demand)
  - 6.384 h/a
  - 164 TWh/a
  - max. 71 GW
- neg. residual load (excess electricity)
  - 2.286 h/a
  - 46 TWh/a
  - max. -84 GW

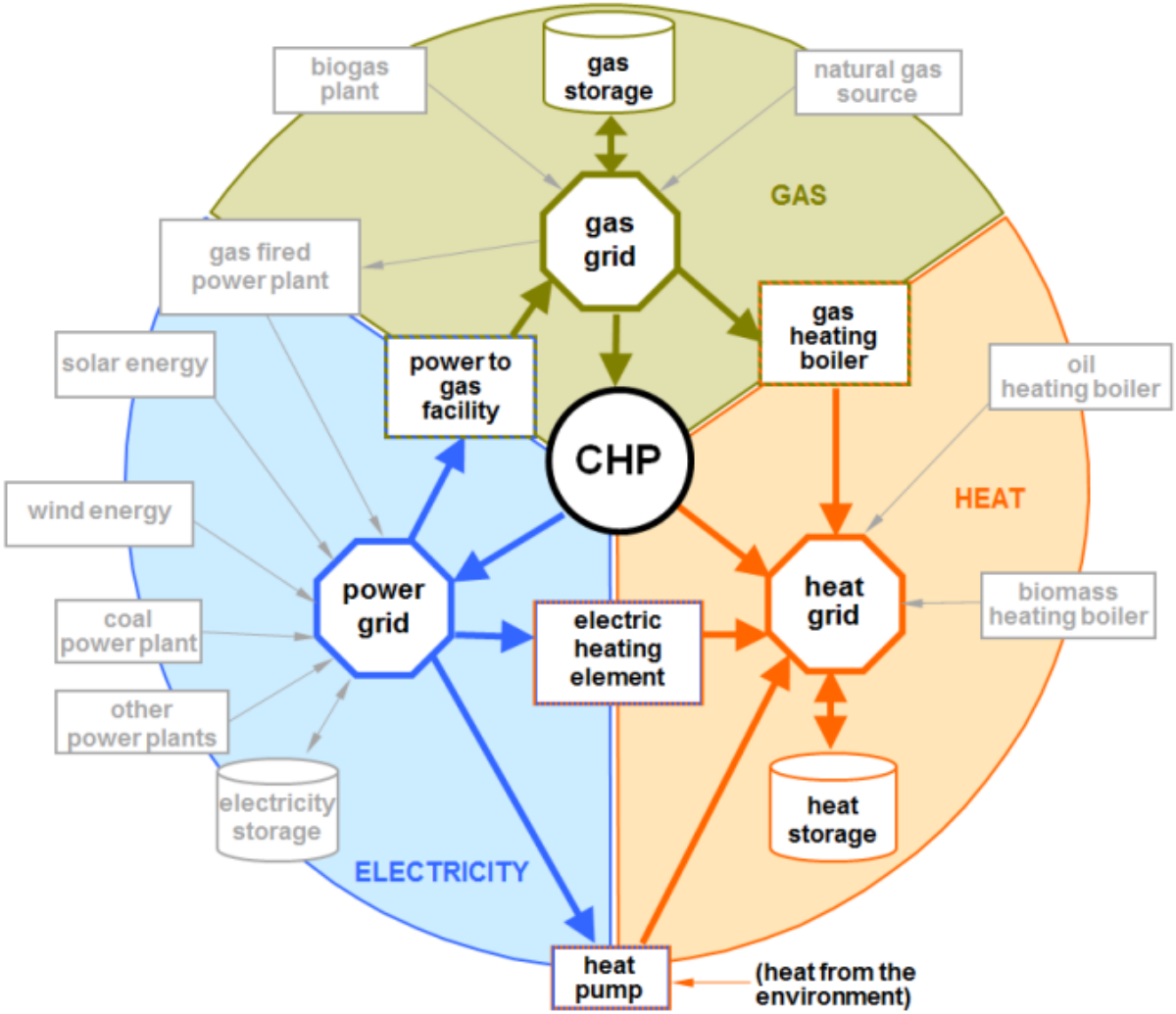
Research Projekt MuGristo

Title: Multi Grid Storage - MuGriSto

”Analysis of Measures to balance inflexible electricity generation by linking electricity-, gas- and heat networks in comparison to other storage mechanisms“

- Supported by the 200 million € Program “Energy Storage funding initiative” of the federal government

Interactions between electricity- gas- and heat grids



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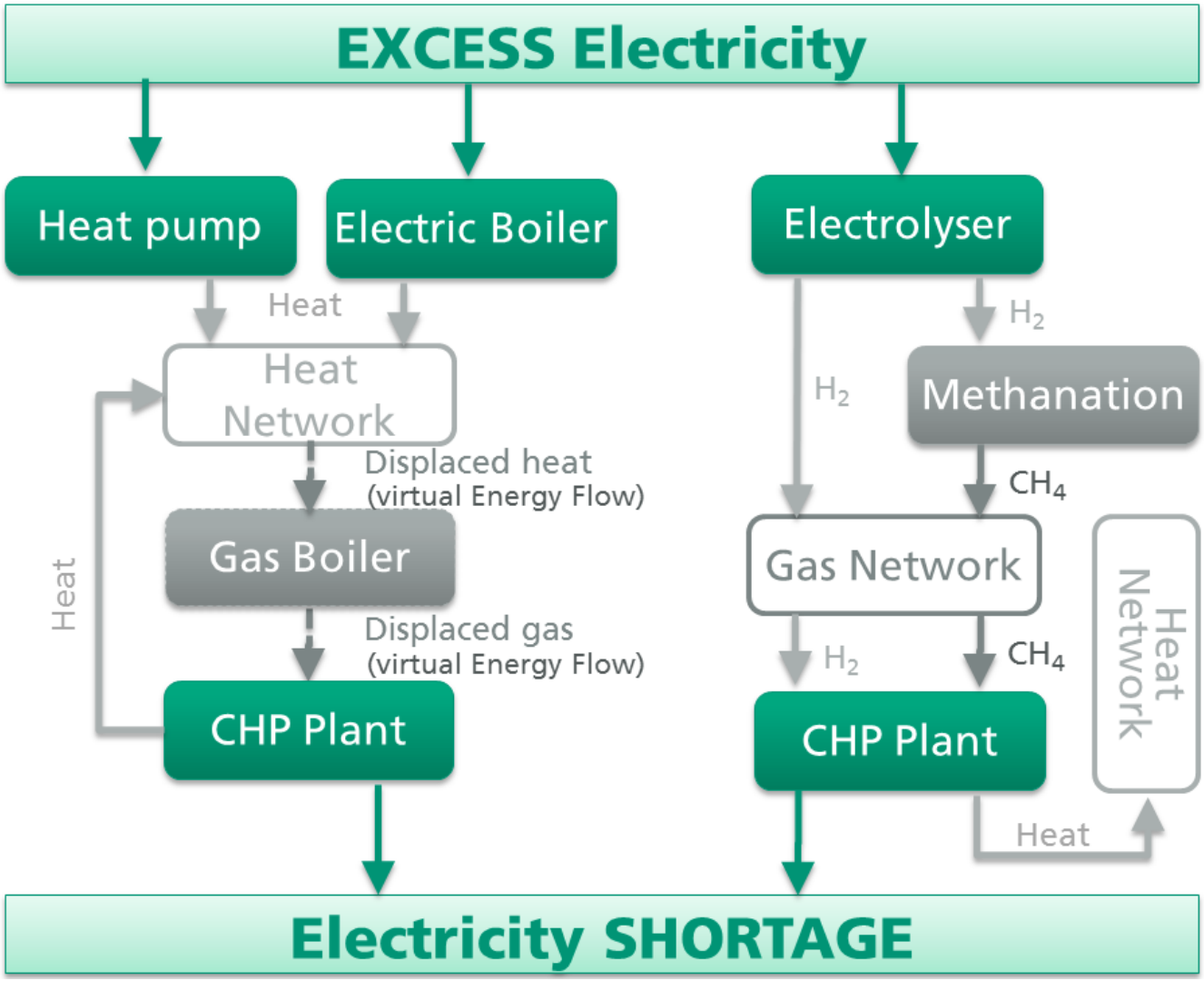
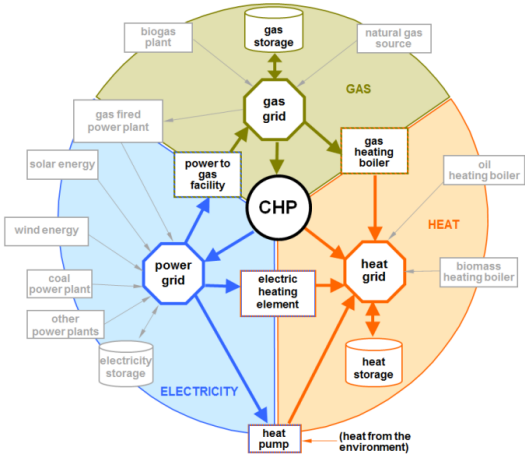
Energy conversion chains investigated

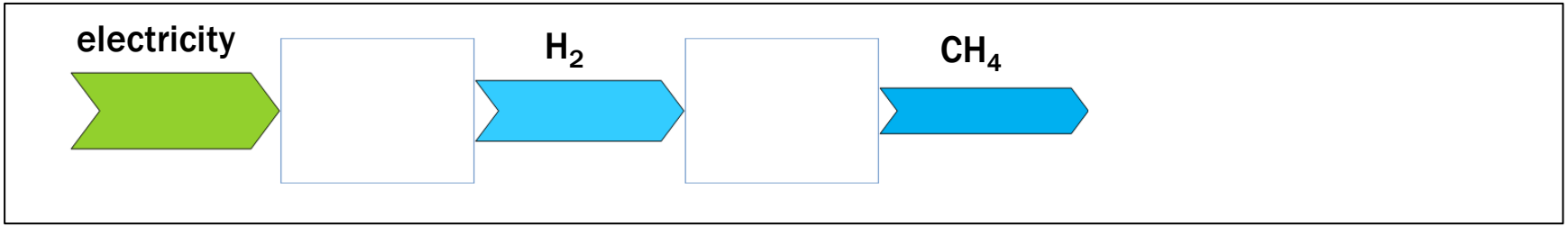




Comparison of energy conversion chains

- Challenge: P2G and P2H difficult to compare on the same basis

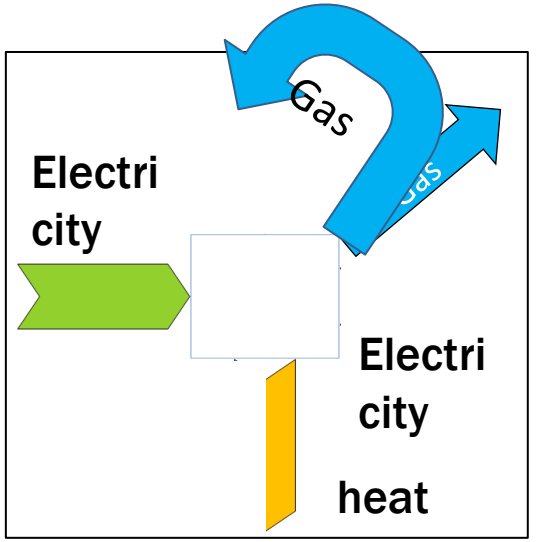
Power to Gas:



  - Direct "recovery" of electricity possible (optional heat generation)

Power to Heat:

  - Direct „recovery" of electricity not possible
  - Requirement for heat usage
  - Heat use is saving gas in a gas boiler
  - This "virtual gas" is converted in times of electricity demand
  - optional heat generation during times of electricity demand

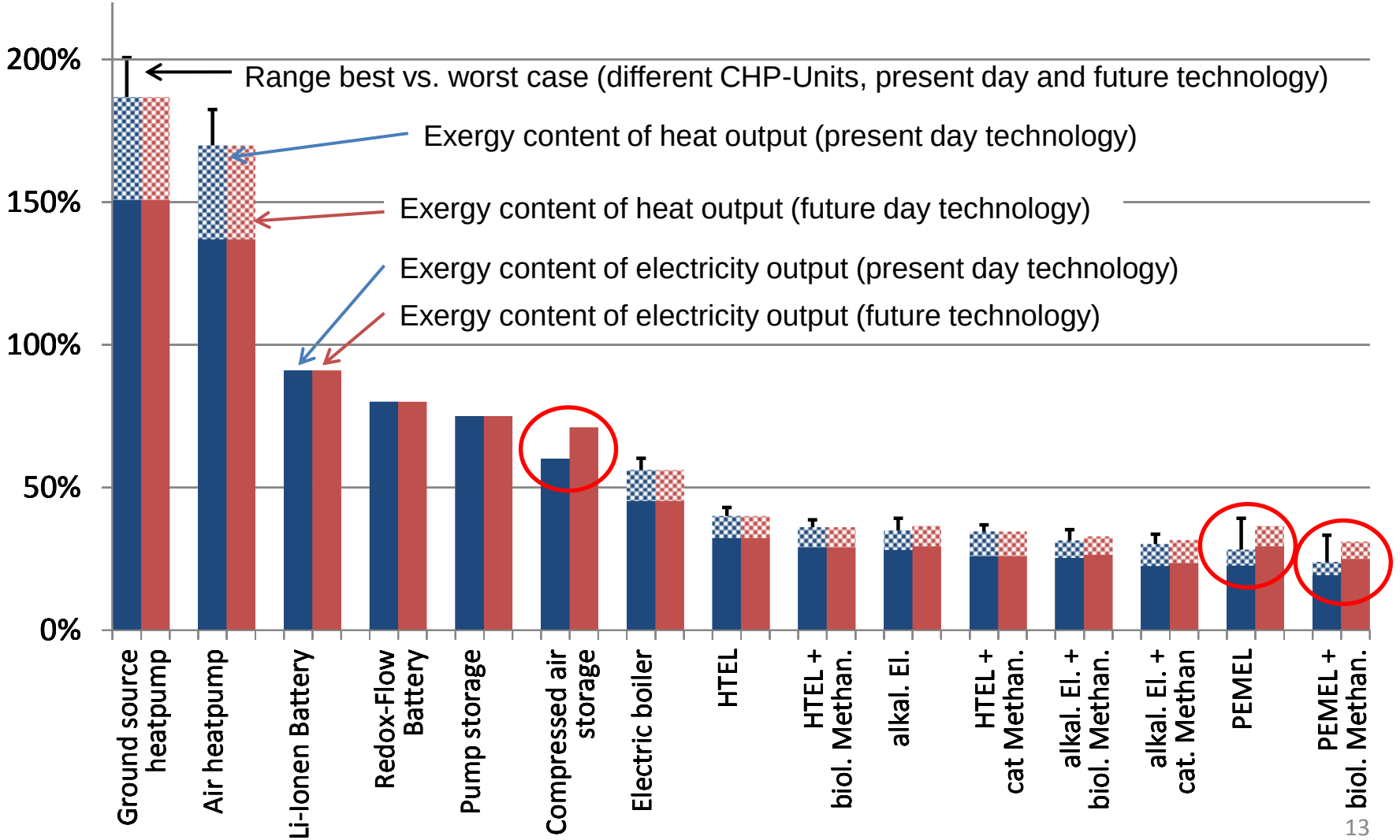


Analysis of exergetic storage efficiencies I

Assumptions

- Exergy content:
  - Electricity: 100%
  - Gas: 60% (H_2 and CH_4)
  - Heat (90 °C): 22%

Some results of exergetic storage efficiencies



Analysis of storage costs I

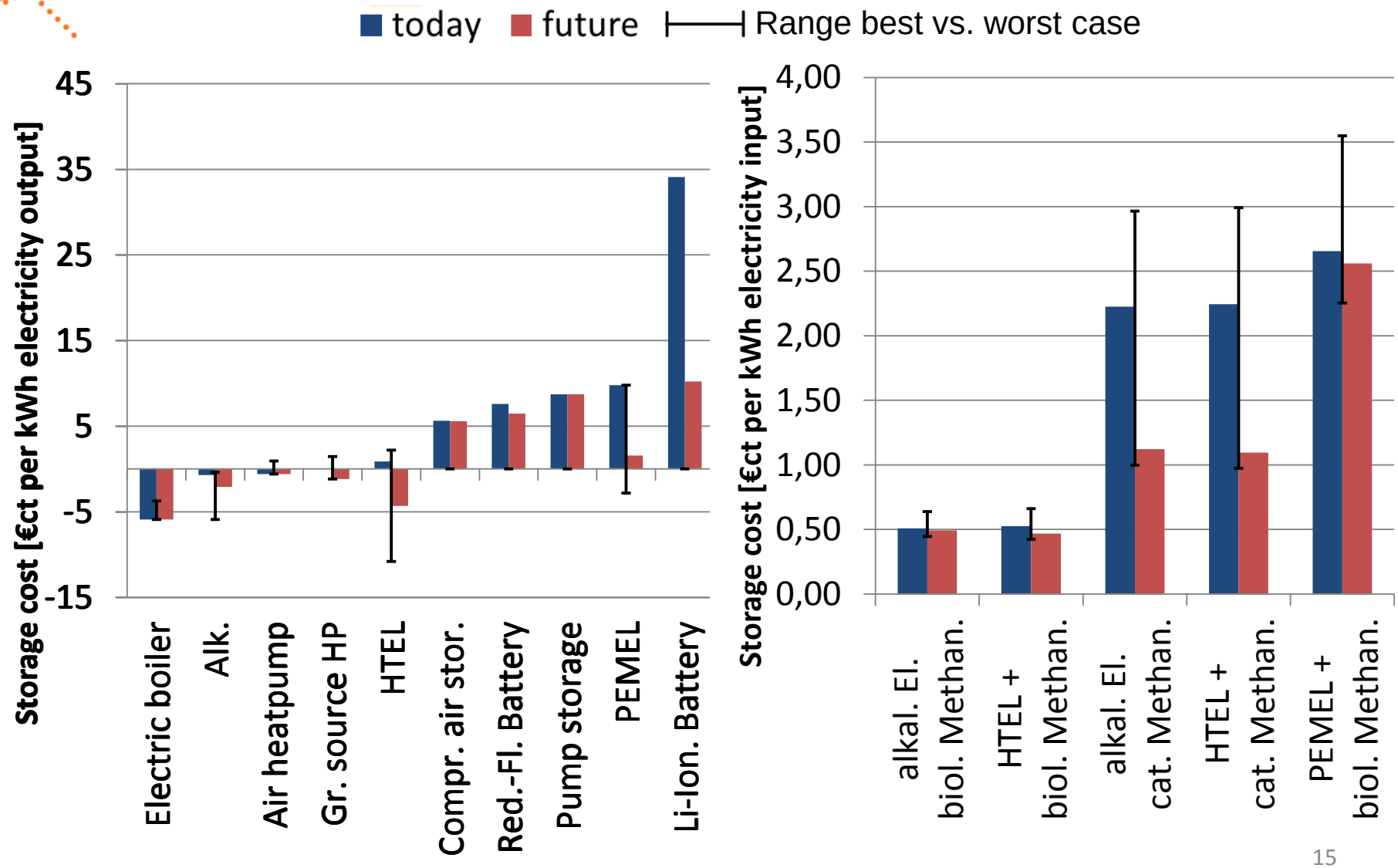
Applications for energy storage devices vary greatly.

Example: balancing of electricity market cannot be compared with other applications like e.g. batteries for electric cars or solar home systems

Assumptions:

- 2.500 hours of operation per year (→ capital costs per kWh)
- CHP-units already installed (→ only extra costs for heat storage and increased rating to allow for electric load following rather than heat lead operation [Schulz, W., Brandstätt, C., 2014])
- Credit for generated heat (using the cost of heat from a gas boiler)

Analysis of storage costs II



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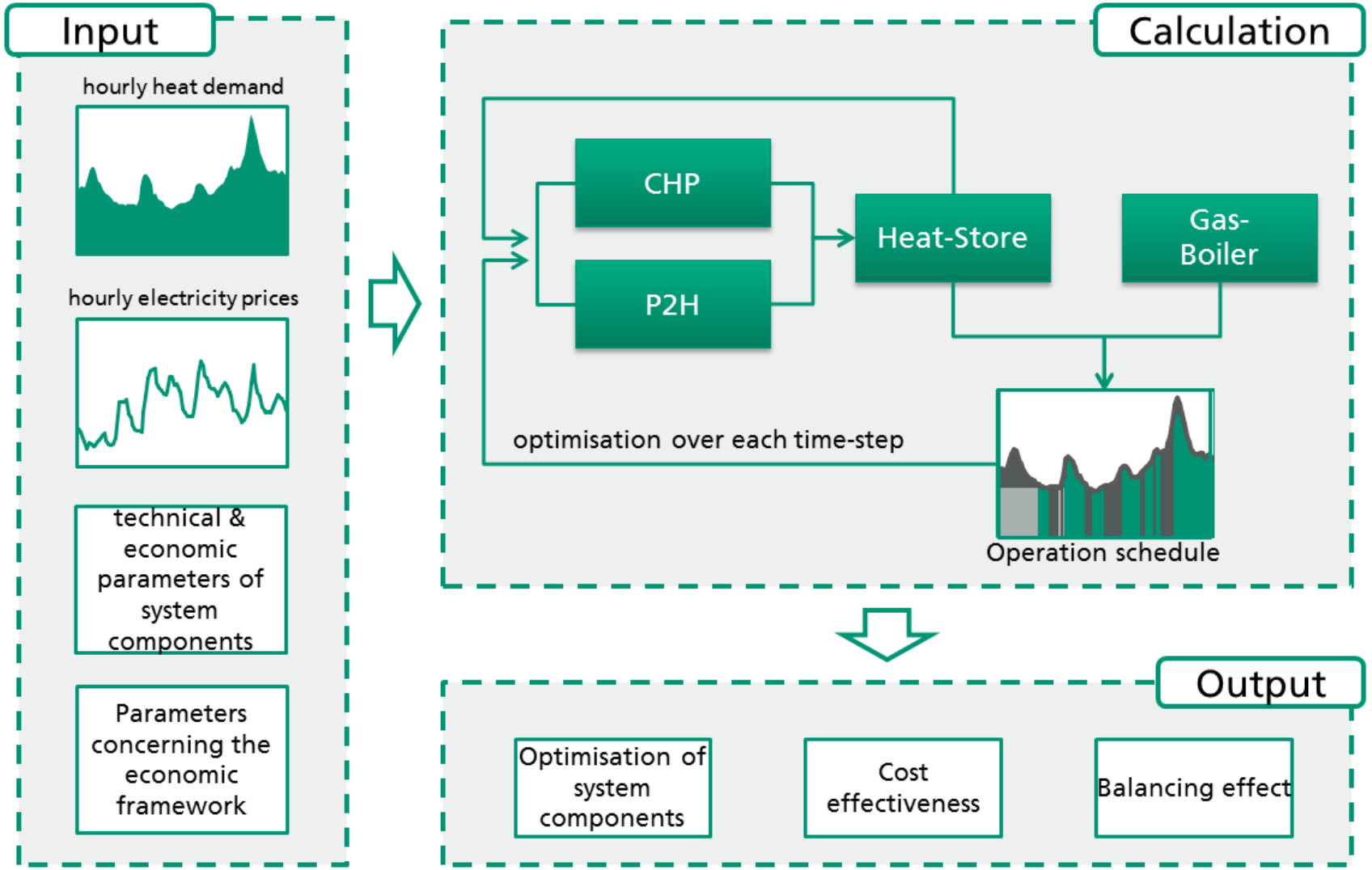
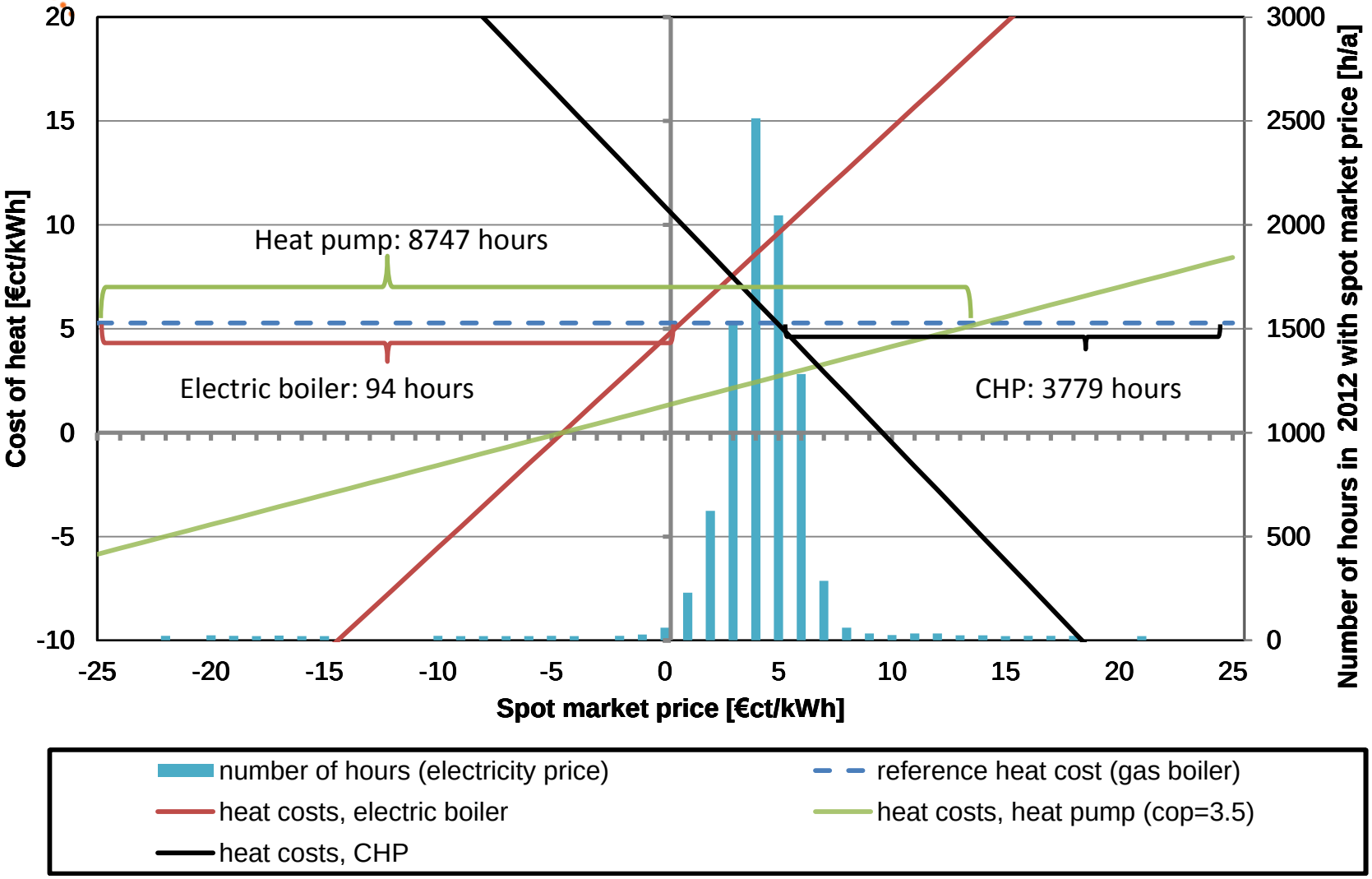
Model-Structure of MuGriFlex-Model (example P2H)

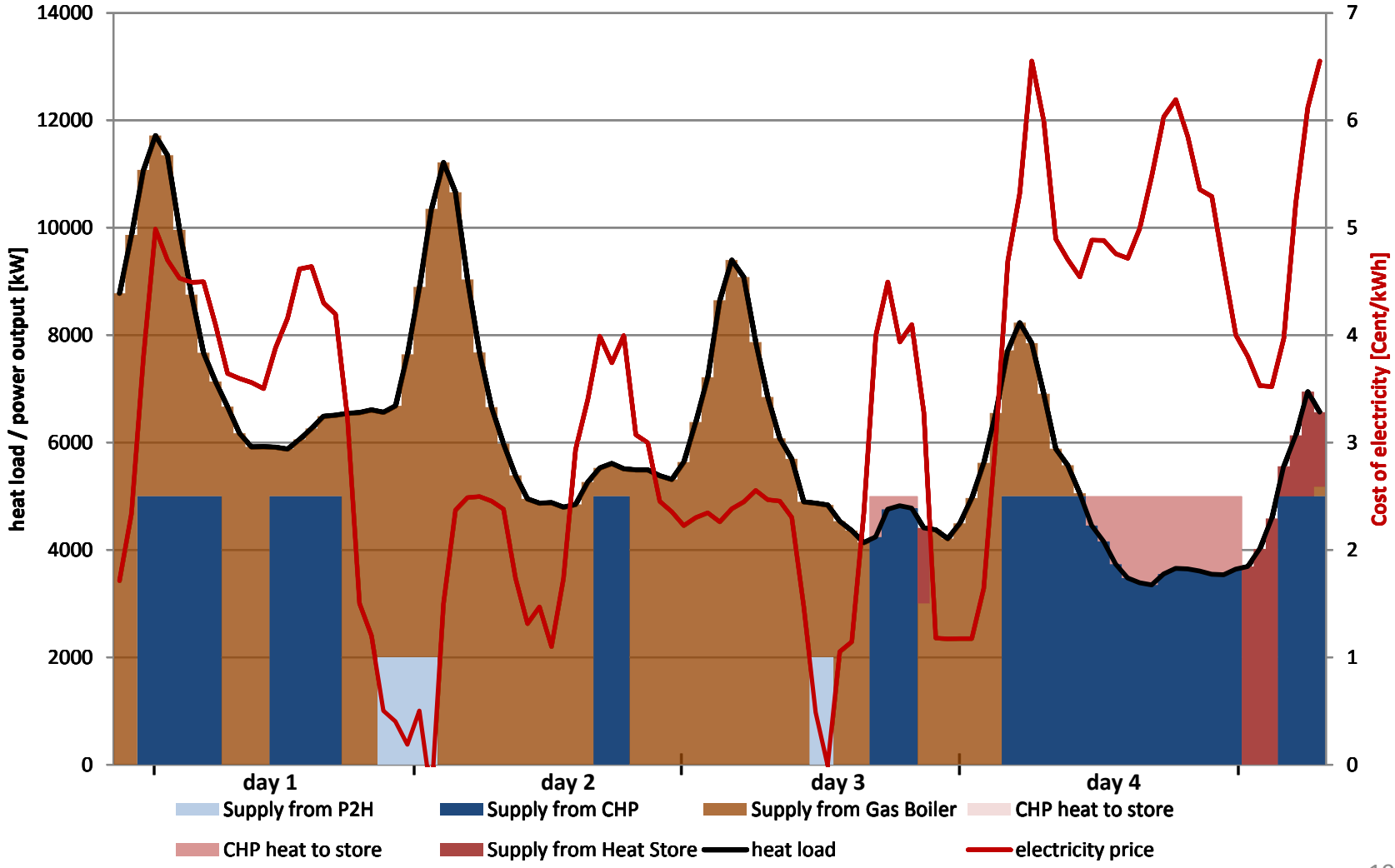


Operation of different heat generators

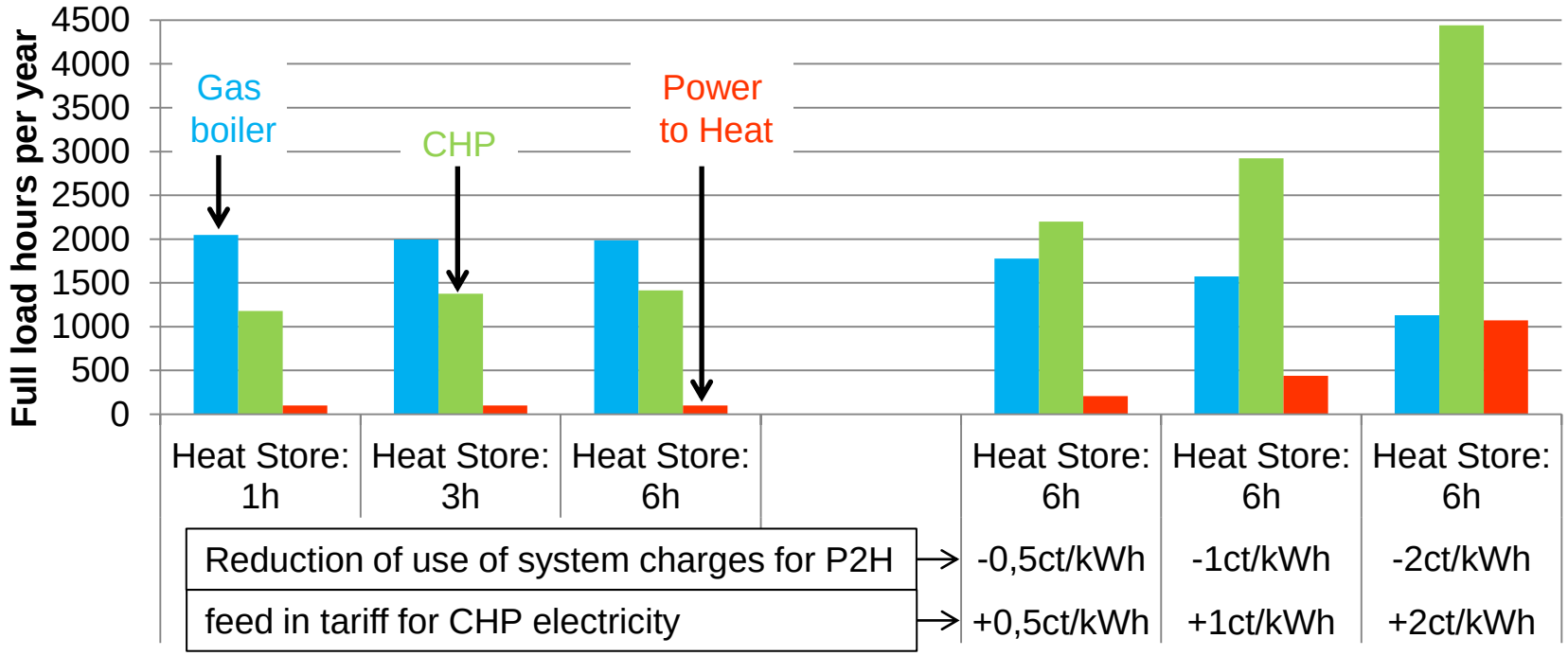


Input: renewable energy act levy: 0 €ct/kWh, CHP act levy: full amount

Operation schedule (example P2H)



Sample scenarios of a P2H chain



References

[Krzikalla, N. et al., 2013] Krzikalla, N., Achner, S., Brühl, S.: „Opportunities to balance the feeding in of fluctuating renewable energy“ („Möglichkeiten zum Ausgleich fluktuierender Einspeisungen aus Erneuerbaren Energien“), 2013, German Renewable Energy Federation BEE

[Schulz, W., Brandstätt, C., 2014] “Flexibility reserves from the heat market” (“Flexibilitätsreserven aus dem Wärmemarkt”) 2013, German Renewable Energy Federation BEE

Thank you for your Attention!

Any Questions?

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http://www.ifam.fraunhofer.de/en/Bremen/Shaping_Functional_Materials/Energy_Systems_Analysis.html

MuGriSto Homepage:

http://www.bremer-energie-institut.de/mugristo/de/home