Batteriealterung • Batteriemodelle • Batteriediagnostik • Batteriepackdesign • Elektromobilität • Stationäre Energiespeicher • Energiesystemanalyse

# The significance and potential of storage for today's and tomorrow's energy systems

Konferenz zum Thema Speicher als Vektor für die Flexibilität der Energiewende

25.09.2019, Berlin

Dr. Kai-Philipp Kairies, Jan Figgener, David Haberschusz, Univ. Prof. Dr. rer. nat. Dirk Uwe Sauer

**Lehrstuhl für Elektrochemische Energiewandlung und Speichersystemtechnik**

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# A clean energy future needs new flexibilities

Security of supply vs. volatile generation

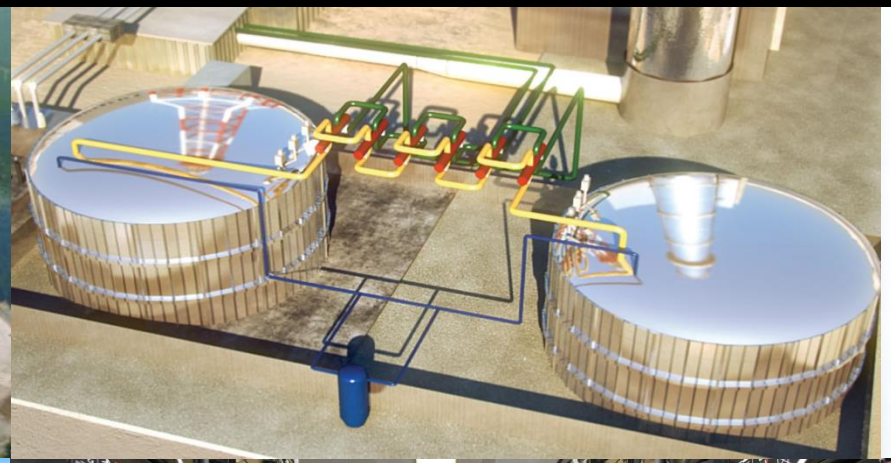
**Power grids**

offer spatial flexibility

**Storage systems**

offer temporal flexibility

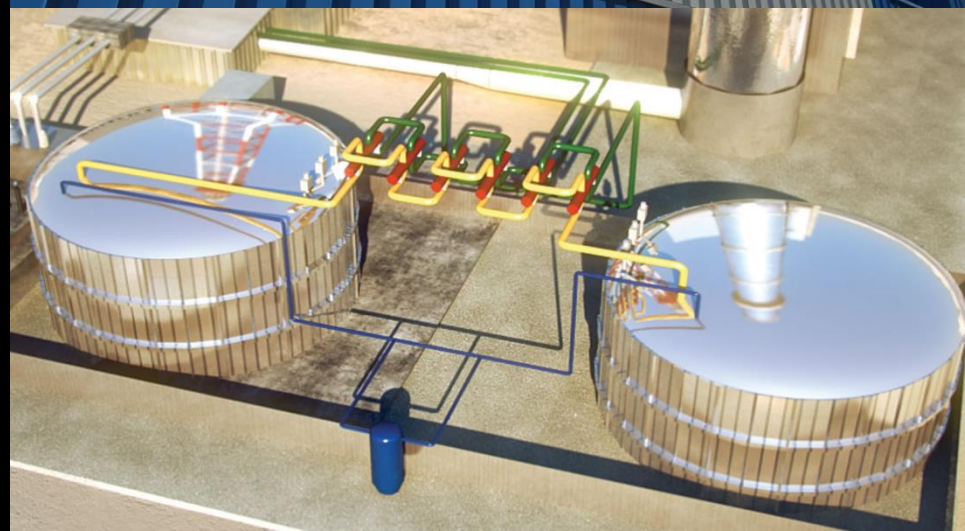
# A variety of storage technologies…



# …for a variety of applications

# Storage applications

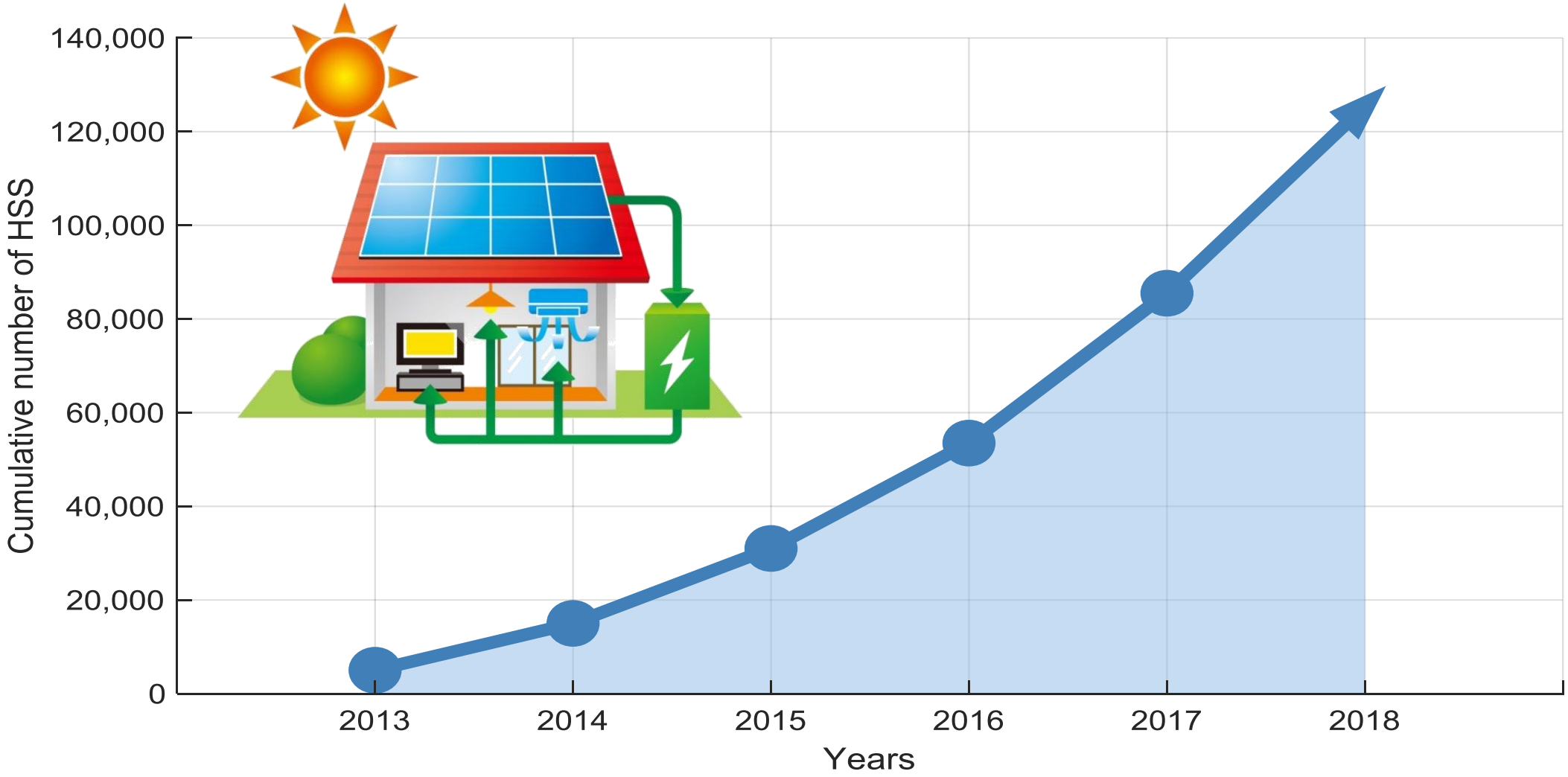
10 kWh – Home storage
10 MWh – Grid services
100 MWh – Generation dispatch



# Residential home storage

The DIY energy transition

# Residential Home Storage: A Booming Market, in Germany and Beyond



# Residential Home Storage: Requirements

**Typical sizing**

- 2…5 kW
- 2…20 kWh

**Typical load profile**

- ~220 eq. full cycles per year

**Additional requirements**

- Compact systems
- High safety
- Maintenance free

**Storage Technologies**

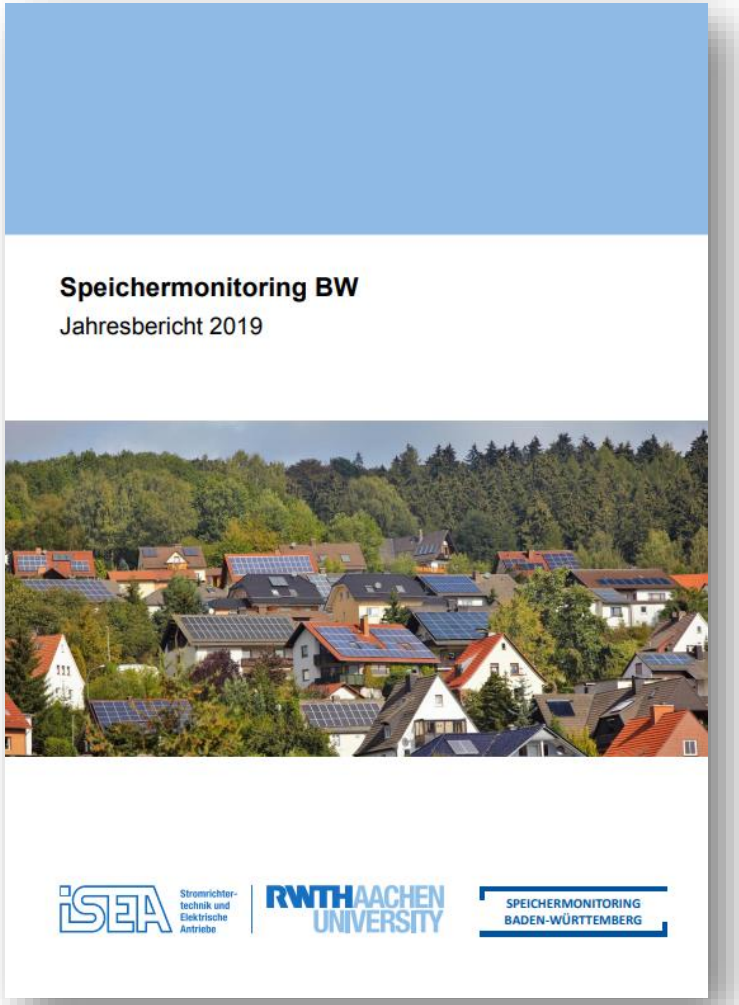
- Lead-Acid Batteries
- Lithium-Ion Batteries
- Redox-Flow Batteries
- High-Temperature Batteries
- Pumped Hydro Storage
- Flywheel
- Thermal Storage
- Power-to-gas

# Residential Home Storage: In Baden-Württemberg

- Baden-Württemberg is one of the leading federal states in adoption of home storage systems.

- The latest monitoring report was published in August 2019, including
  - Retail prices
  - Market shares
  - Typical system design
  - Purchase motives

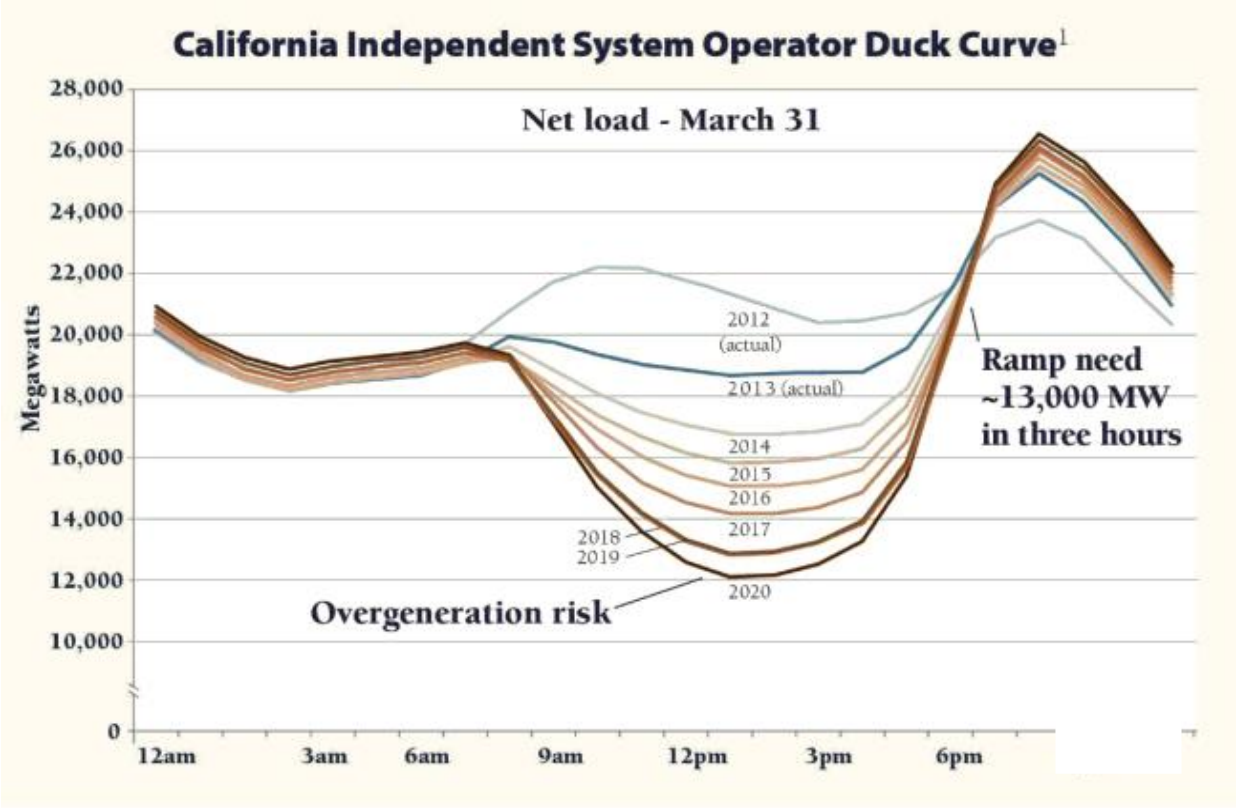
- The report is available online: [www.speichermonitoring-bw.de](http://www.speichermonitoring-bw.de)



# Grid services

Utility-scale disruption

# Grid Services: Disrupting a 500 Billion Dollar Market




- Grid services are highly regulated and highly individual
  - Frequency response
  - Ramping
  - Black start capability
  - …
- Already about 600 MW of utility-scale BSS in Germany (worldwide ~ 9GW)
- Worldwide potential: >200 GW/a by 2029

# Grid Services: Requirements

**Typical sizing**

- 10…100 MW
- 10…100 MWh

**Typical load profile**

- ~200 eq. full cycles per year

**Additional requirements**

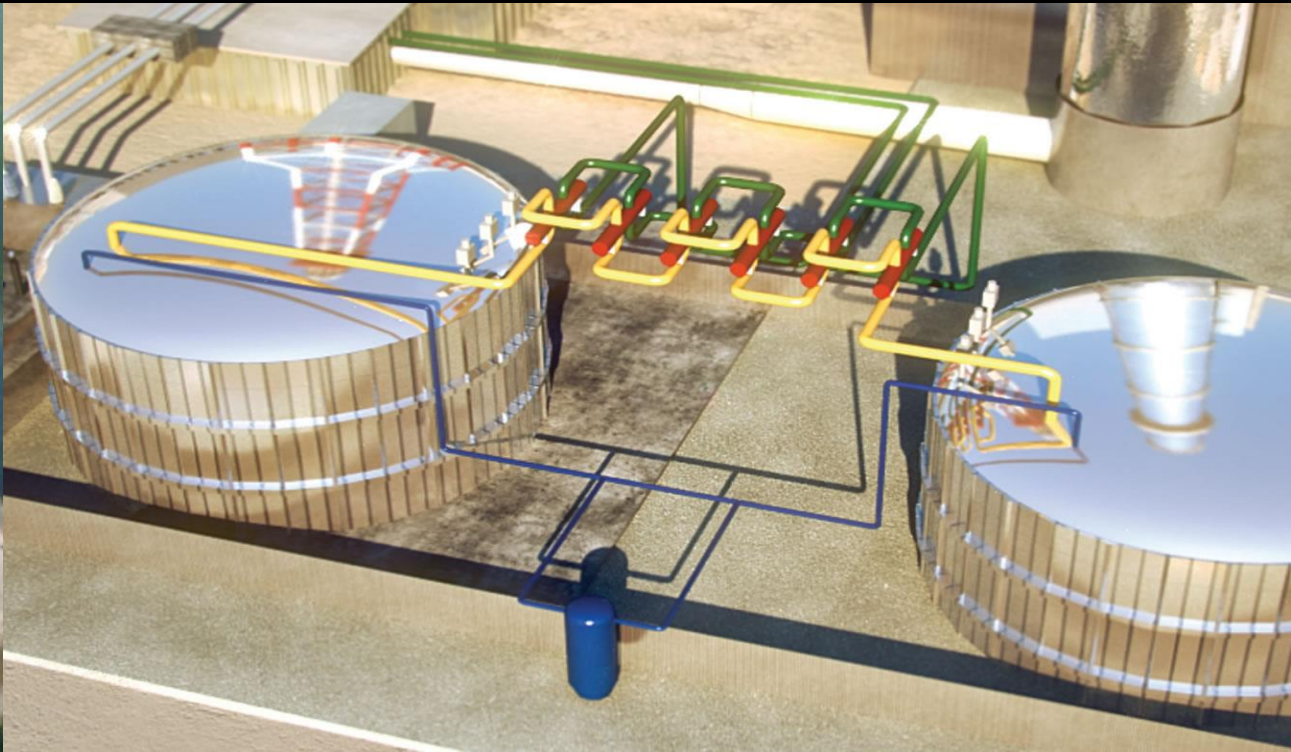
- (Very) fast response
- Very high reliability

**Storage Technologies**

- Lead-Acid Batteries
- Lithium-Ion Batteries
- Redox-Flow Batteries
- High-Temperature Batteries
- Pumped Hydro Storage
- Flywheel
- Thermal Storage
- Power-to-gas

# Generation dispatch

24/7 renewable energies



# Generation dispatch: Requirements

**Typical sizing**

- 100…1,000 MW
- 100…100,000 MWh

**Typical load profile**

- 50..350 eq. full cycles per year

**Additional requirements**

- Costs
- Costs
- Costs

**Storage Technologies**

- Lead-Acid Batteries
- Lithium-Ion Batteries
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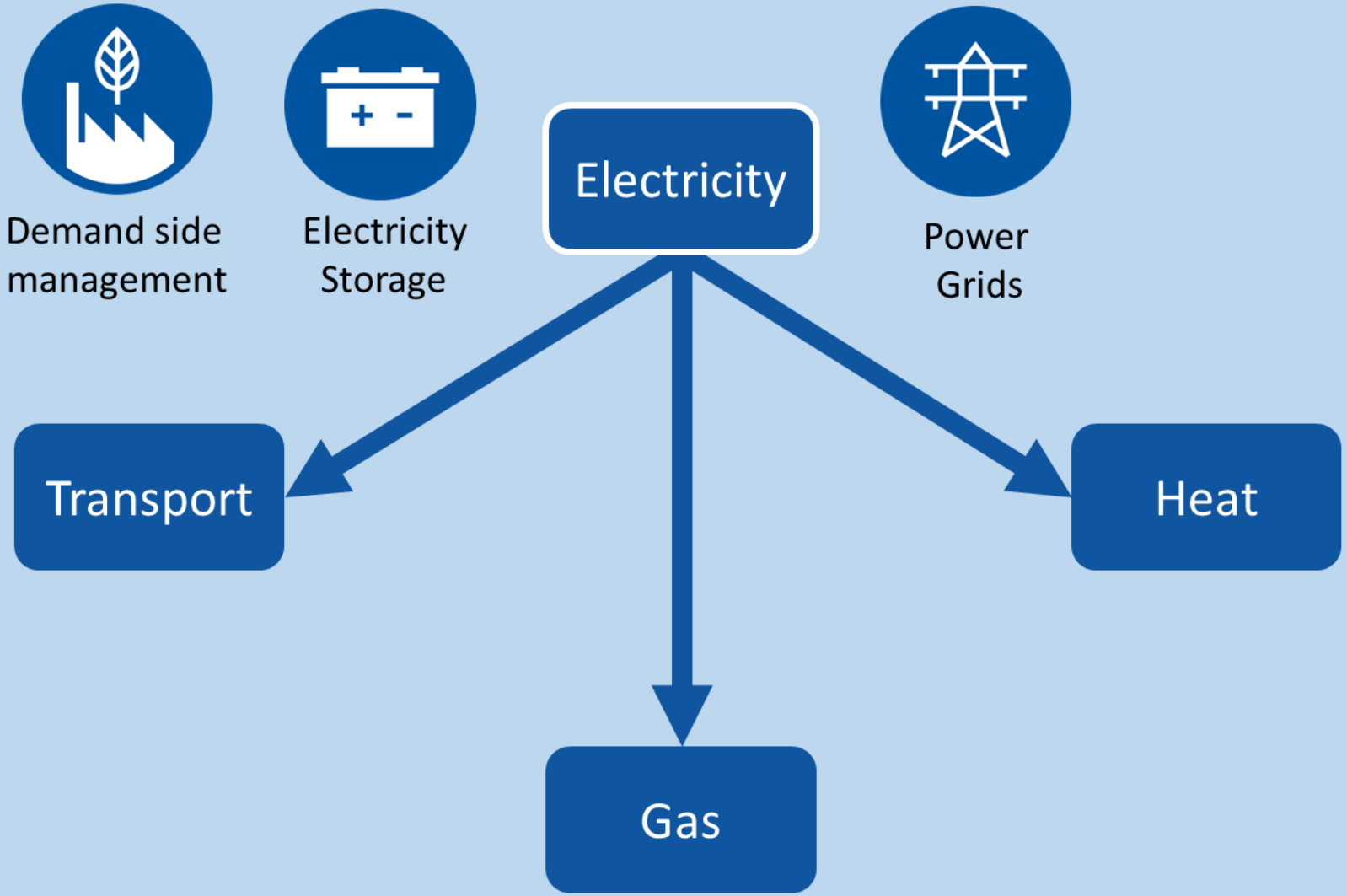
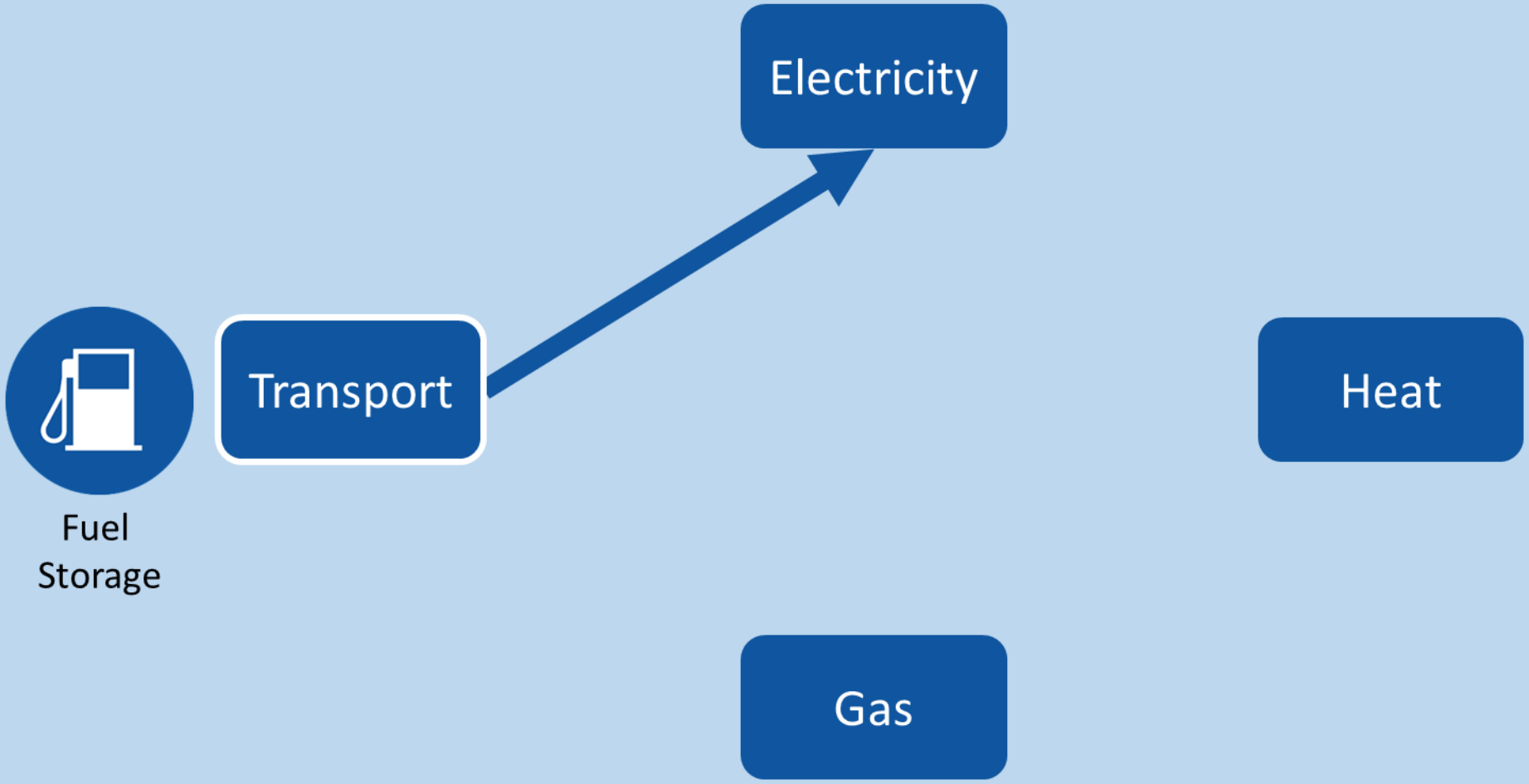
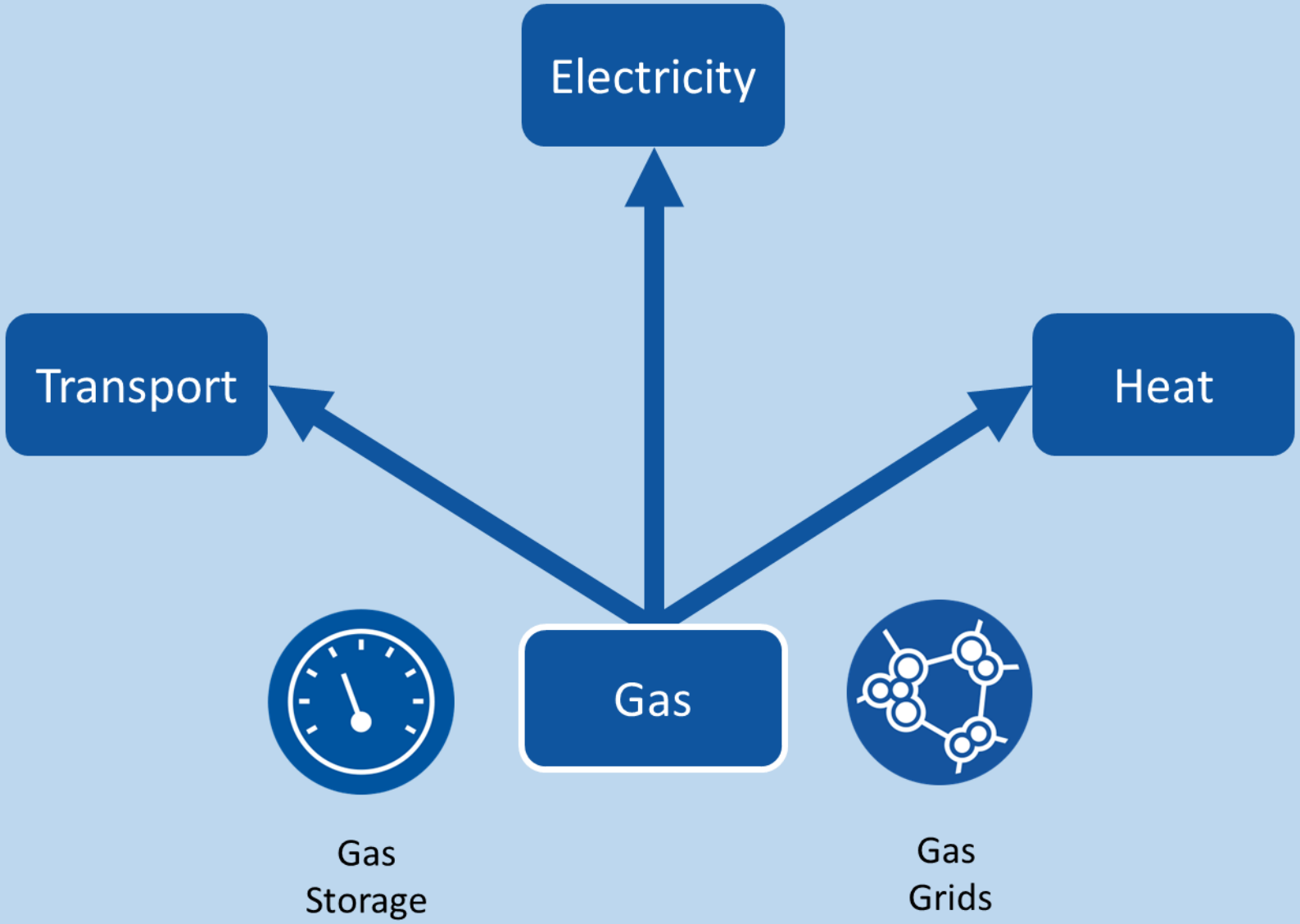
# Sector Coupling


Demand side management
Electricity Storage
Electricity
Power Grids
Transport
Heat
Gas


Electricity
Transport
Heat
Fuel
Storage
Gas


Electricity
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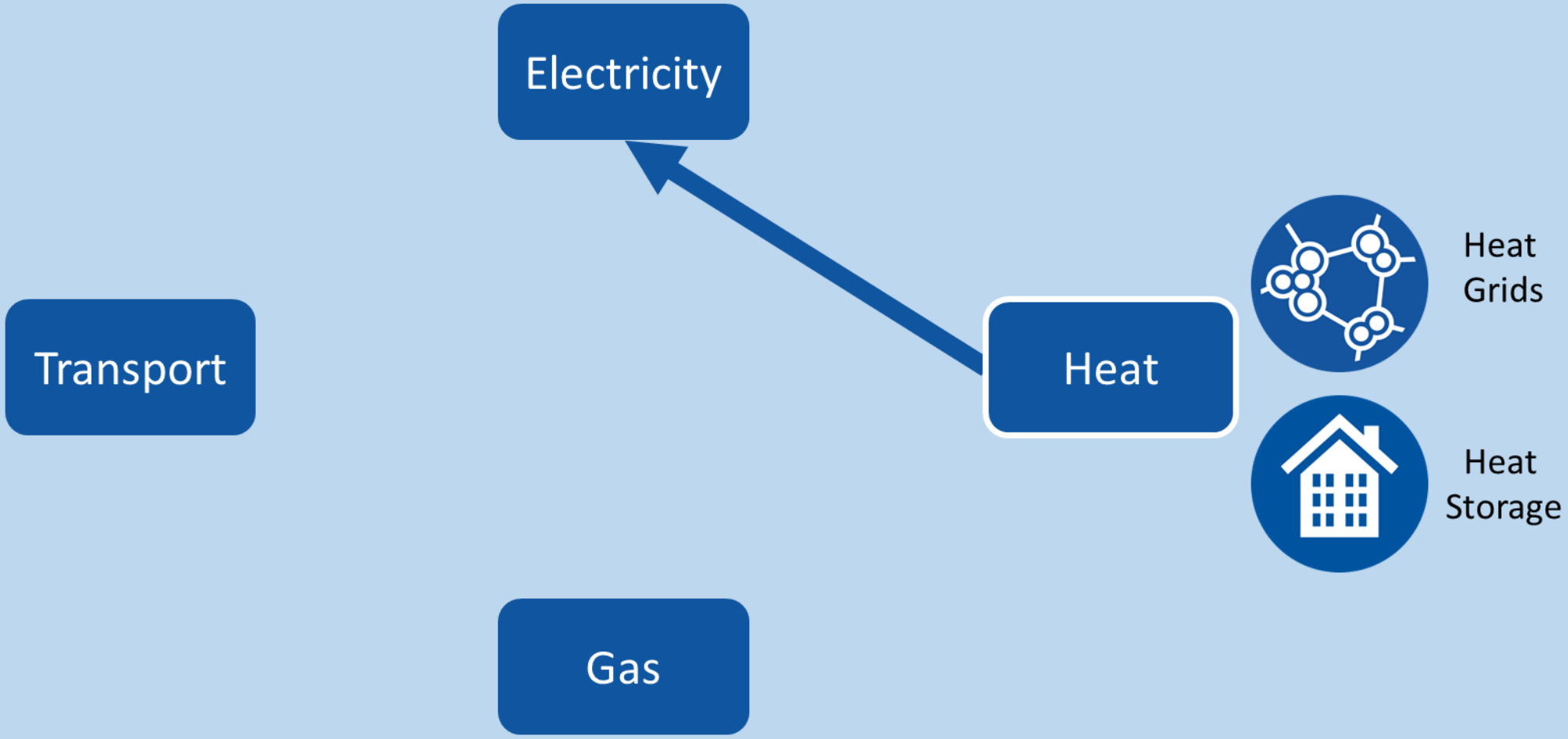
Gas
Gas
Storage
Gas
Grids


Electricity
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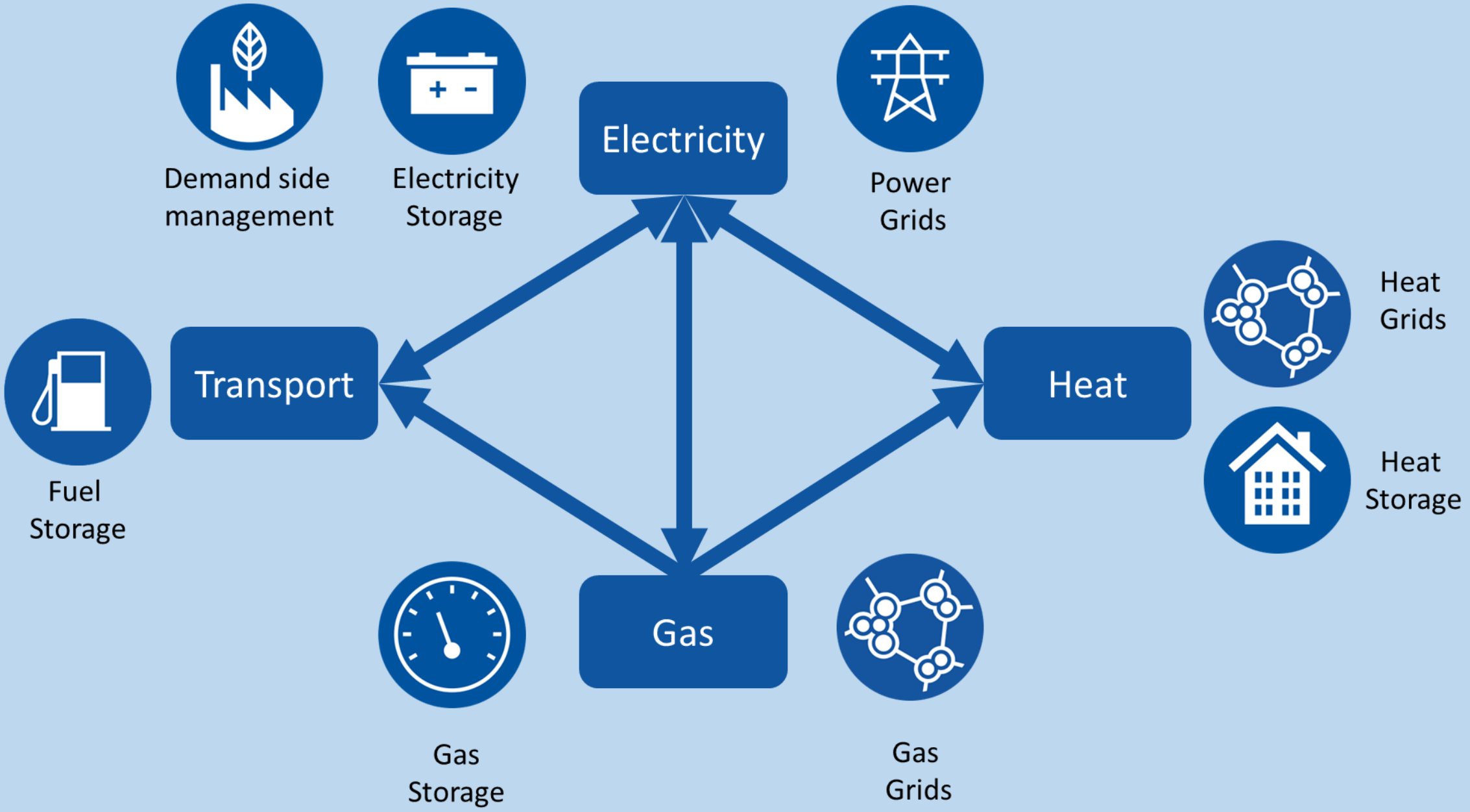
Heat Grids
Heat Storage
Gas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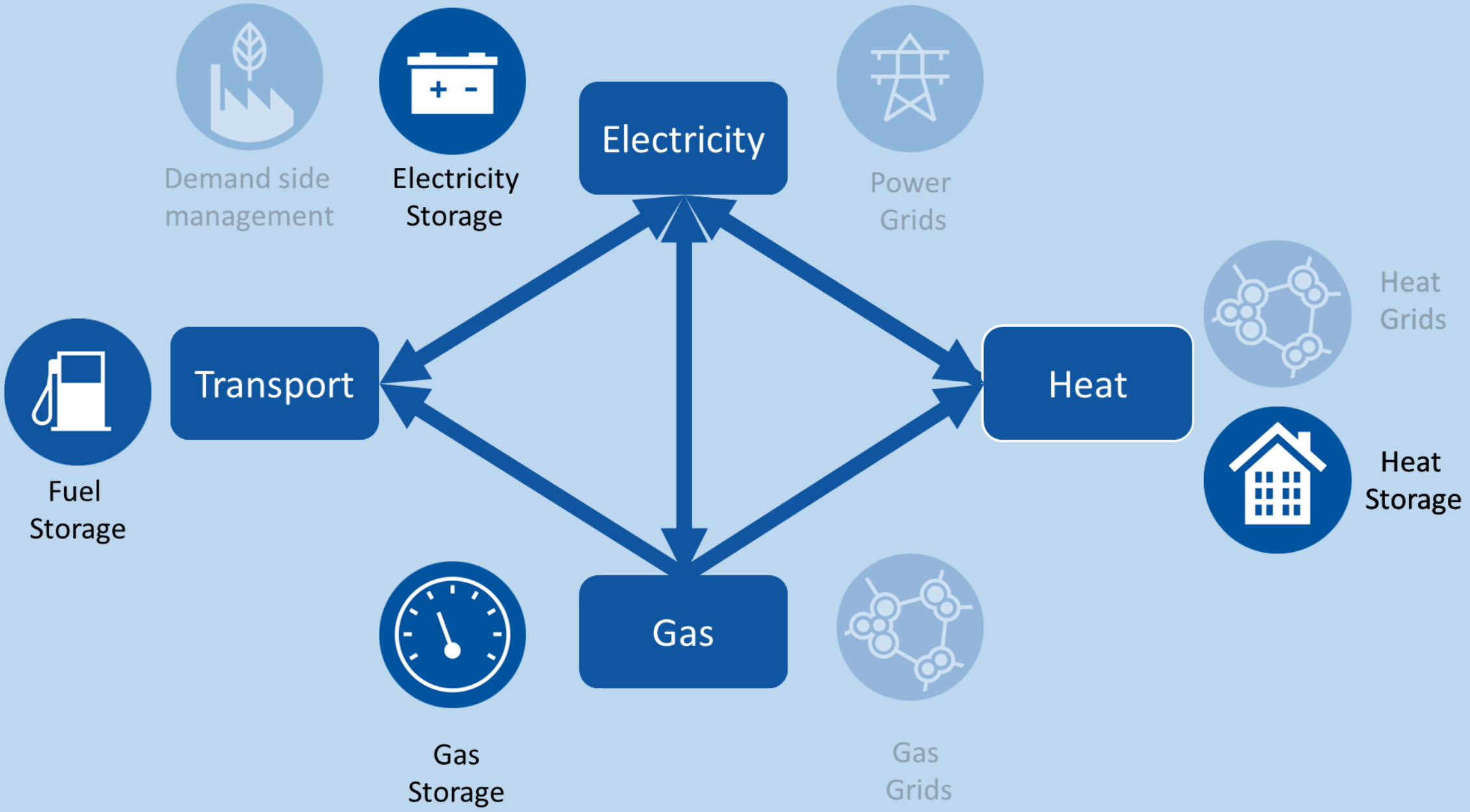
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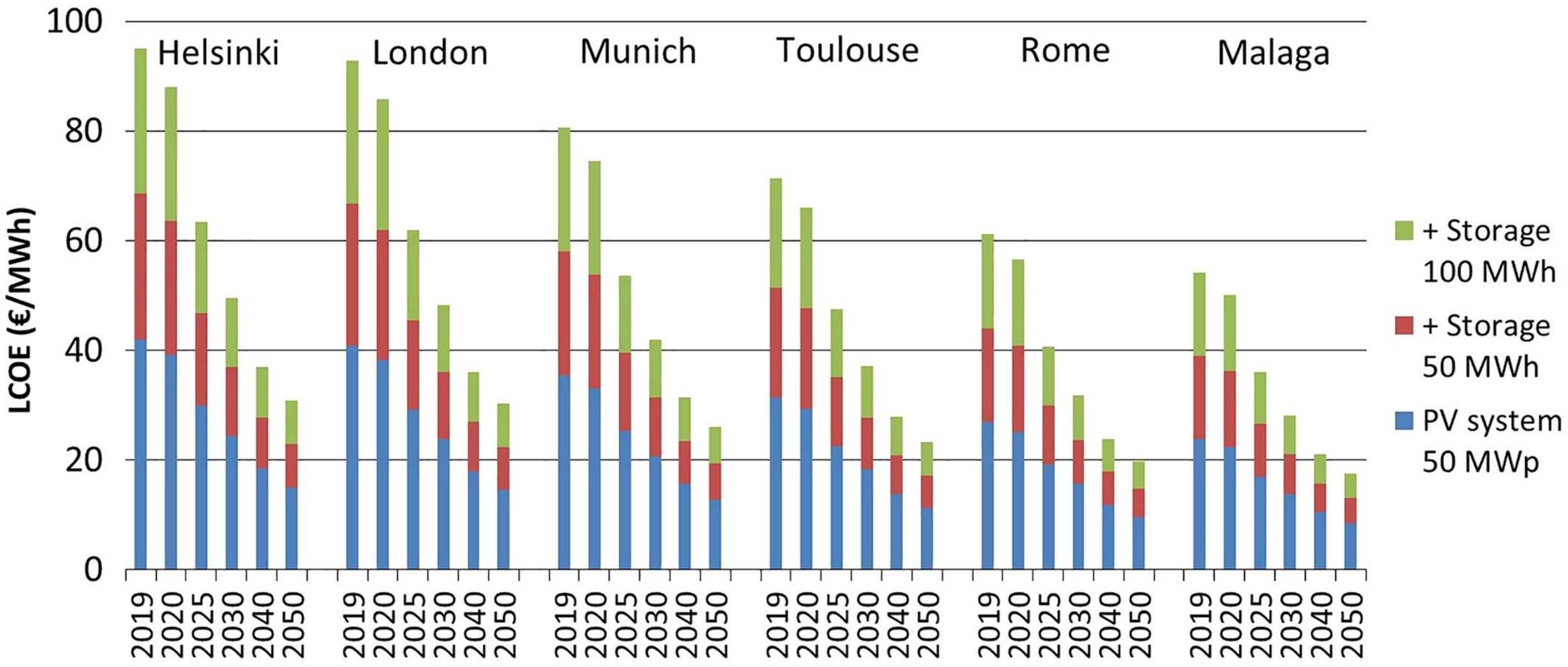
# Generation dispatch: Costs of PV + storage in Europe

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