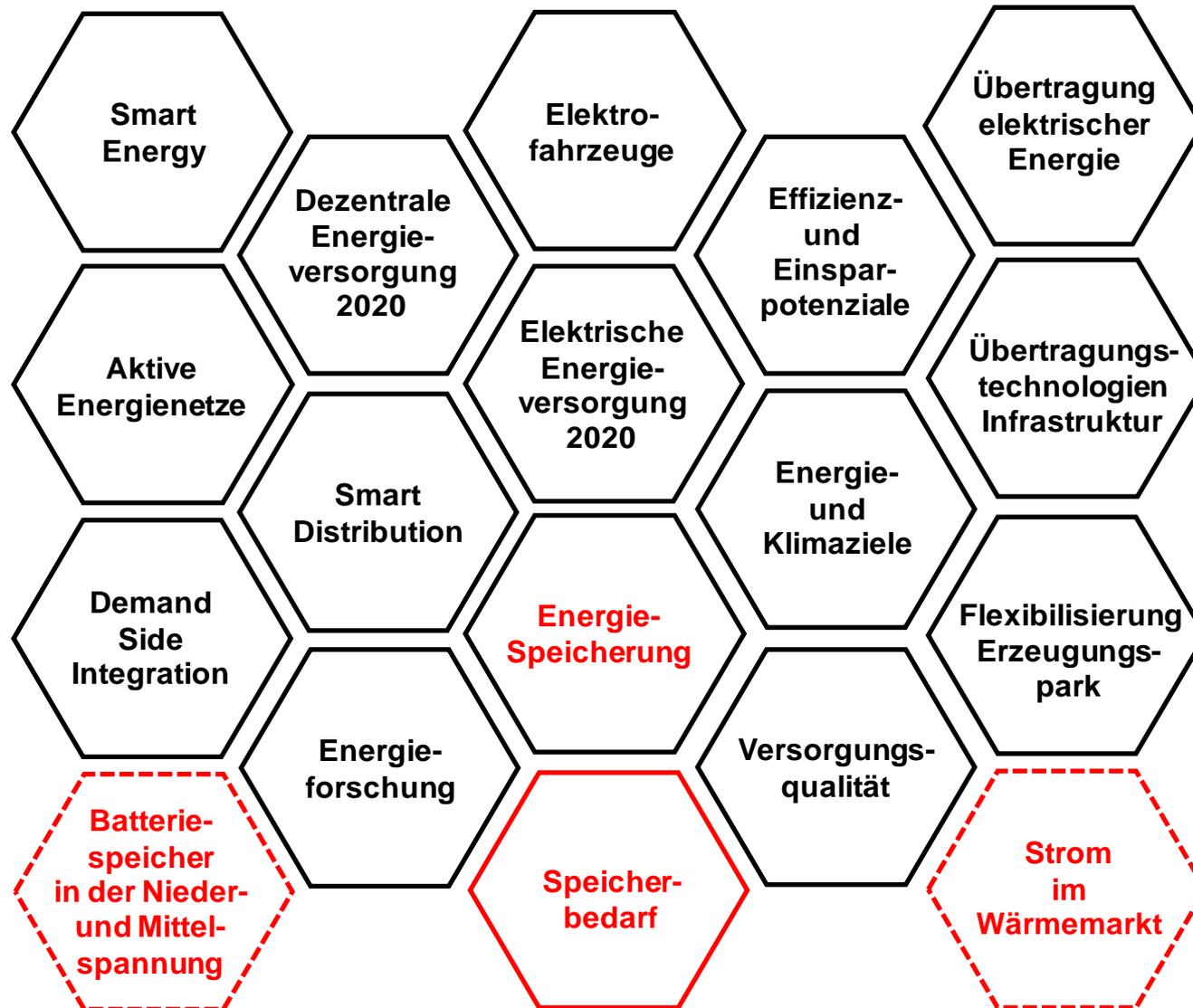


Power-to-heat

DIW - Forum on Flexibility Options
Berlin, 21.09.2015



Background and Motivation

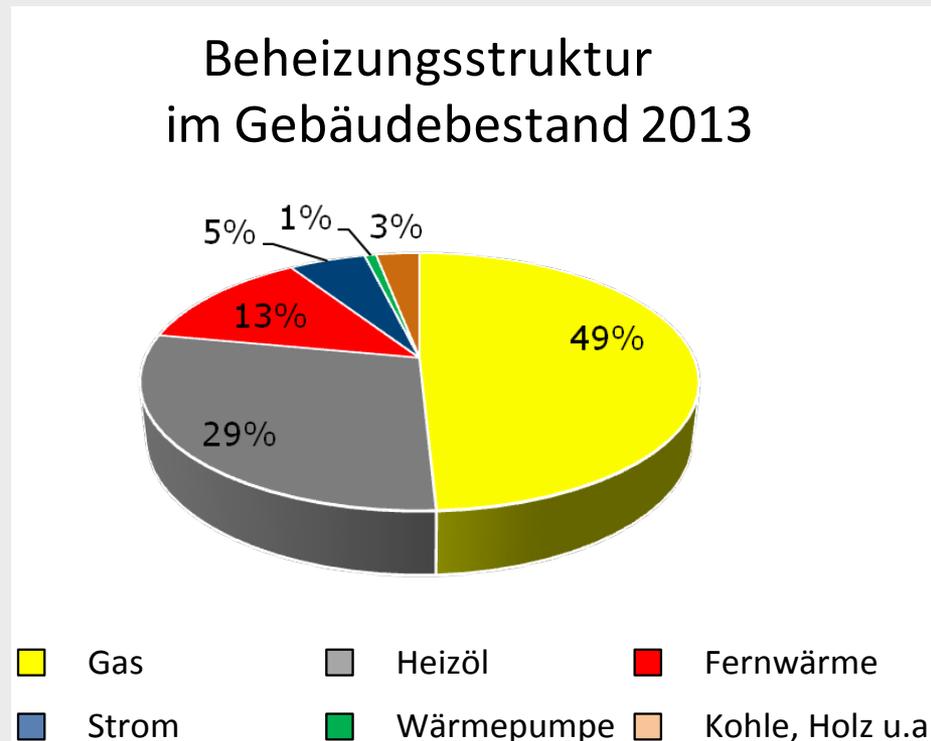
Goal of the Energy Concept of the German Government:

- **Reduction of Greenhouse-Gas-Emissions by 80% until the year 2050**
(in relation to the reference year 1990)
 - ➔ Requires substitution of fossil fuels by Renewable Energies (RE) to a large extend (decarbonisation) **and** improvement in efficiency in all sectors
 - ➔ Most of Renewable Energies are made accessible directly via electric power (solar, wind, water)
 - ➔ Paradigm change: electric power generated from these renewable energy resources can be considered as primary energy sources (no lossy energy transformation is needed)
 - ➔ Strong influence on the development of the heat supply sector

The heat supply is going electric

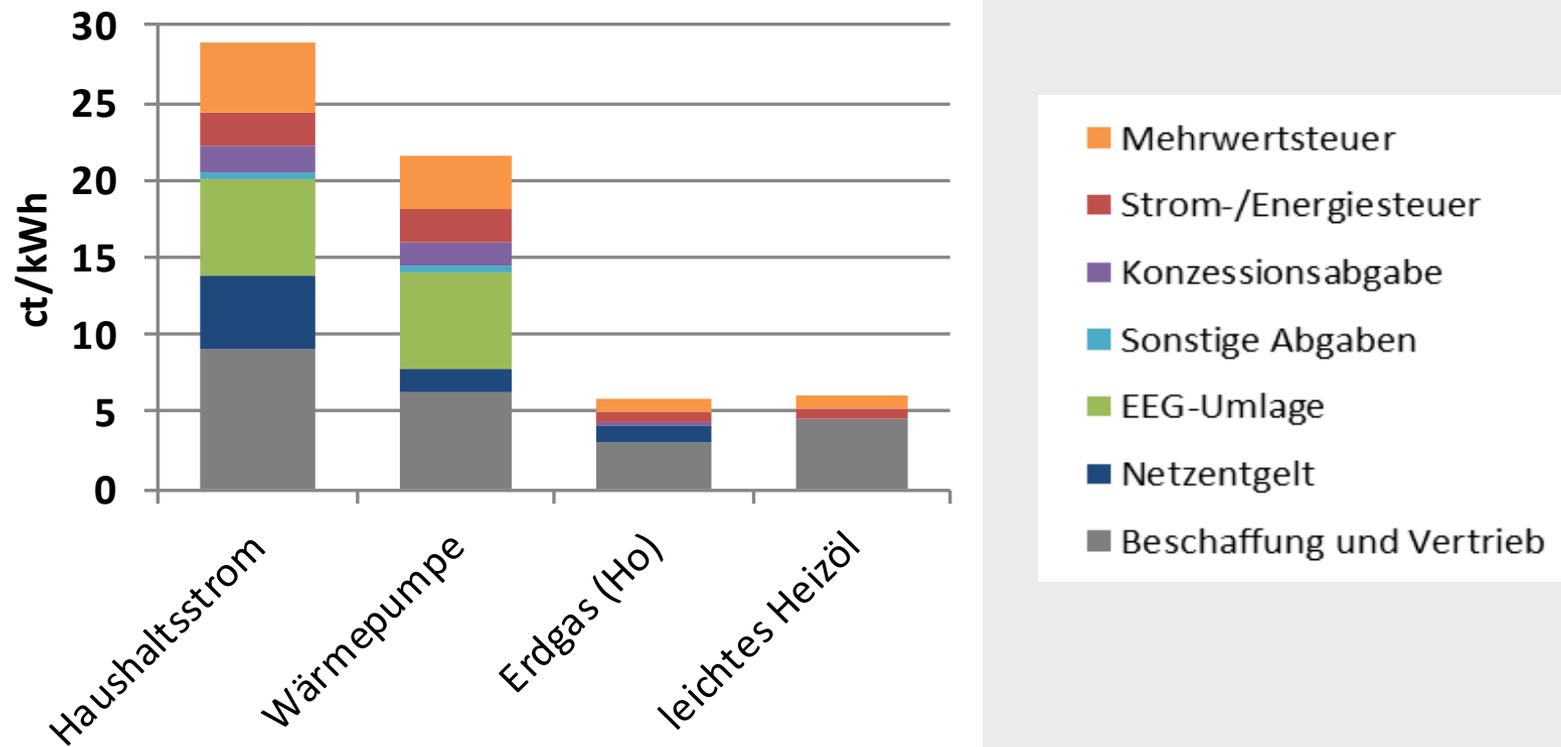
Actual situation

- Today 94% of the heat demand in the household sector in Germany is covered by fossil fuels
 - ➔ Substitution of fossil fuels in the heat supply sector is the most efficient measure für reducing greenhouse gas emissions



Actual situation

- In Germany the use of electric power in the heat supply sector suffers today from the high electricity tariffs (taxes and charges)



Technologies for electric heat generation and heat storage

Household, trade and commerce

- Resistive heating systems
 - Heating rod
 - Flow heater
 - Heating panels
 - Infrared radiation
- Electrode boiler (trade)
- Electric heat pumps
- Hybrid heating systems

Heat storage

- Sensitive heat storage
- Latent heat storage (phase change)
- Thermo-chemical heat storage

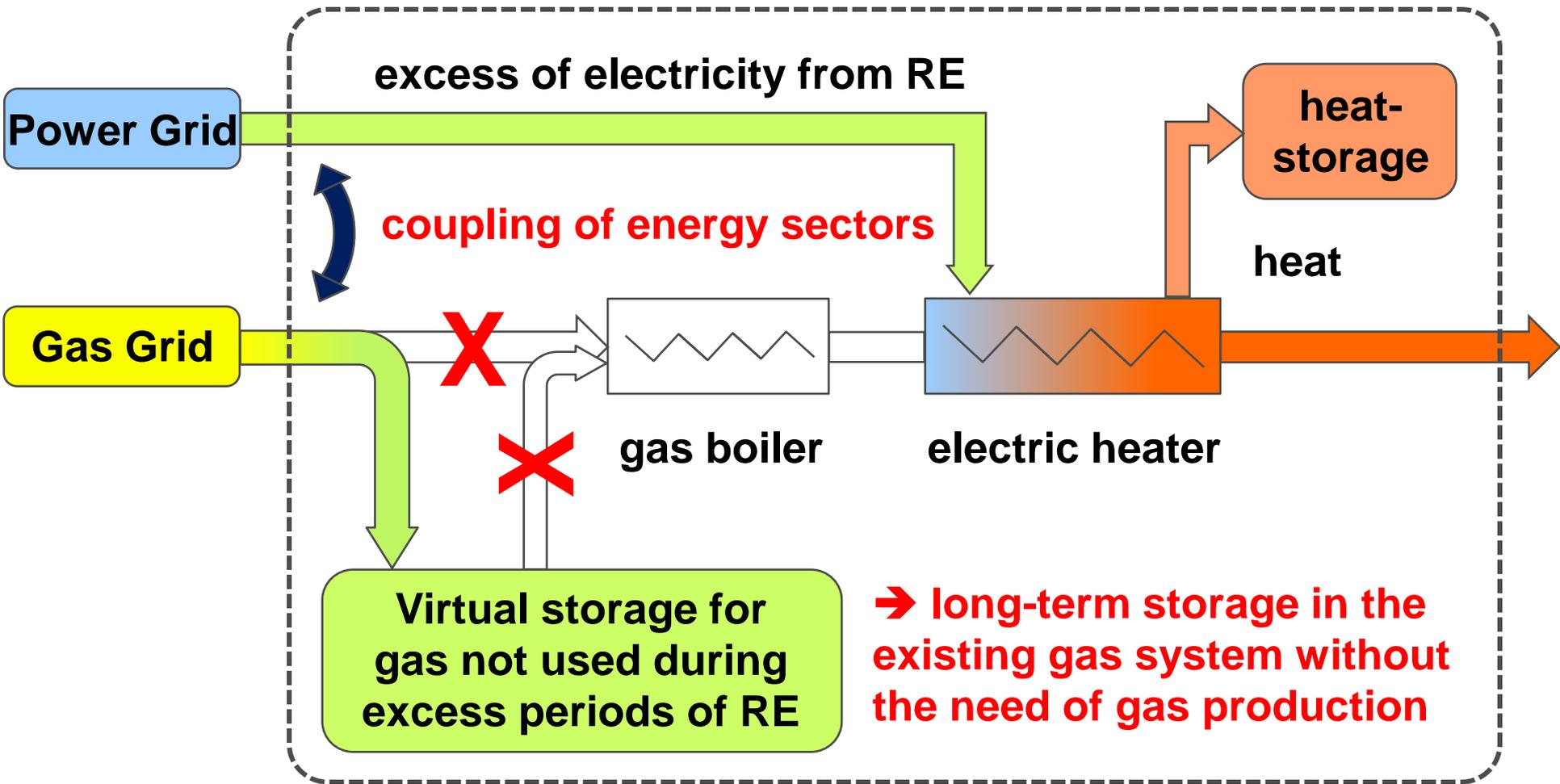
Industry and process-heat

- Processes
 - Conductive resistive heating
 - Inductive heating
 - High frequency heating
 - Magnetic DC heating
 - Electric infrared radiation
- Electrode boiler (combined with CHP)
- Large electric heat pumps

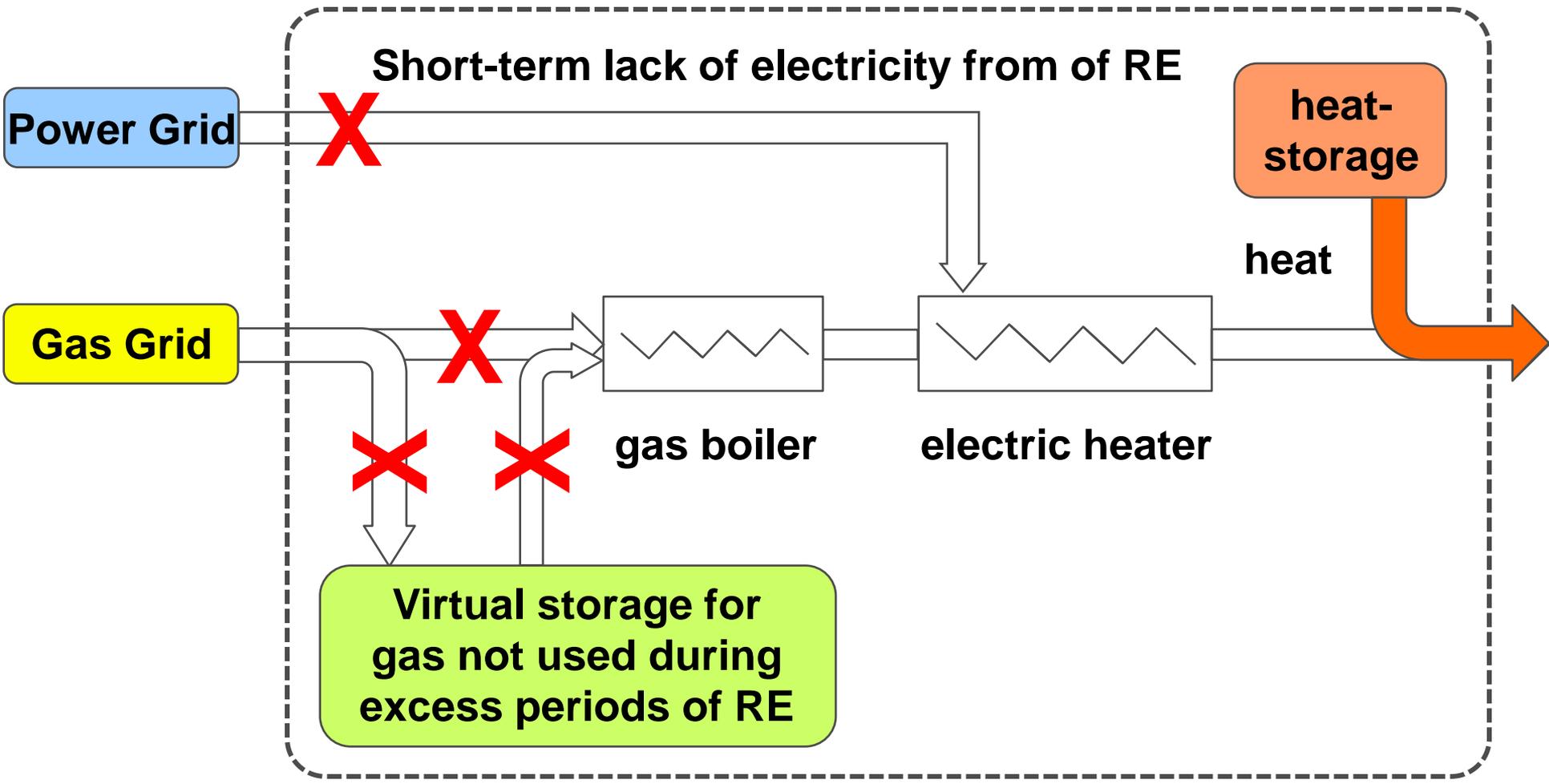
Distric heating

- Large electric heat pumps
- Hybrid heating systems
e.g. CHP combined with electrode boiler

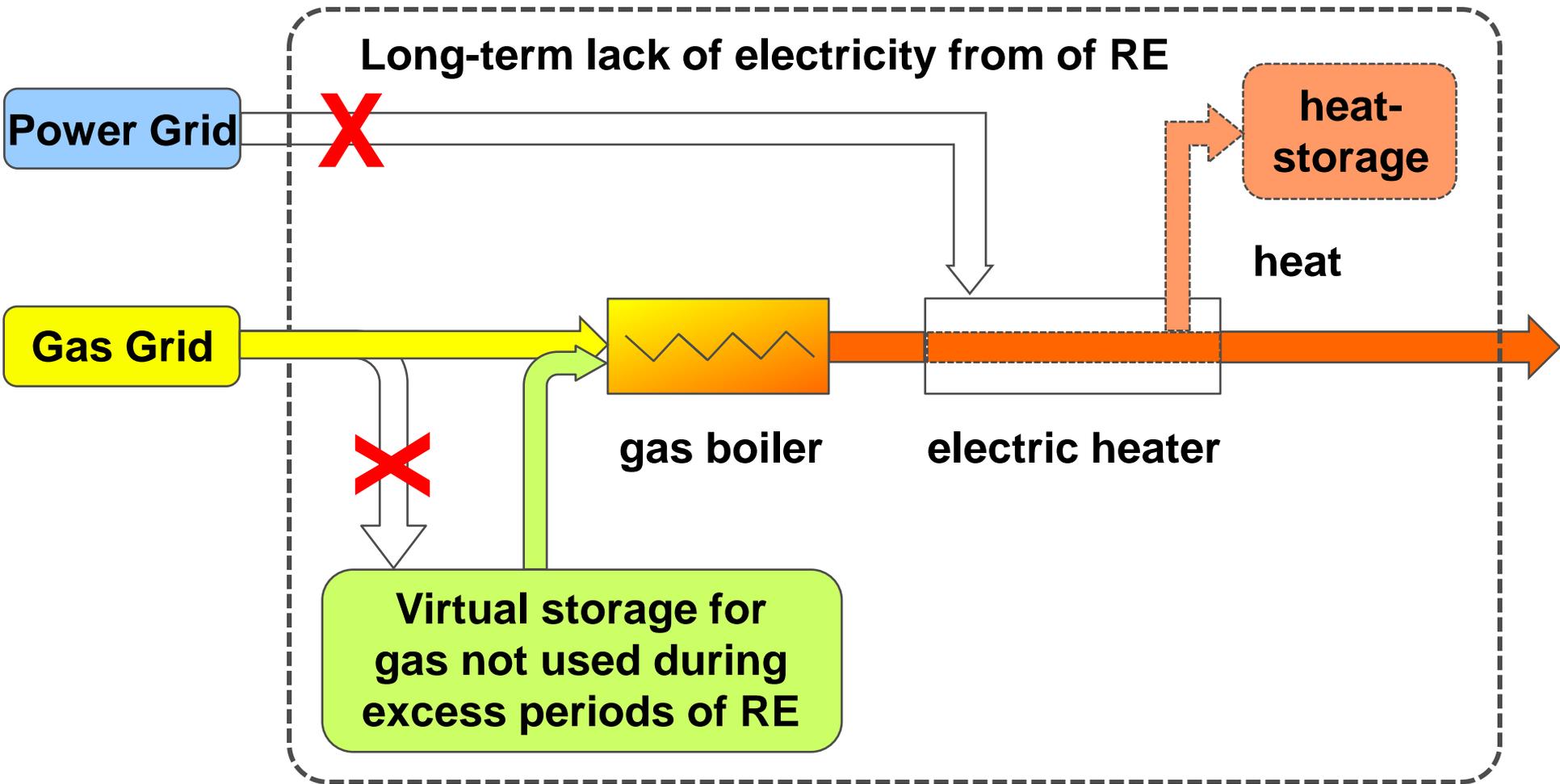
Hybrid systems (example shown for gas)



Hybrid systems (example shown for gas)



Hybrid systems (example shown for gas)



Power-to-Heat

Advantage:

- **technology is already available**
- **easily controllable (fast dynamics)**
- **very high efficiency**
- **emission free**
- **long lifetime**
- **low cost**

(e.g. flow heater: investment cost < 10 €/kW)

for comparison:

high pressure PEM electrolyzer:

today: 1200...1500 €/kW (3000 €/kW)

goal: 900 €/kW

methanation: ???

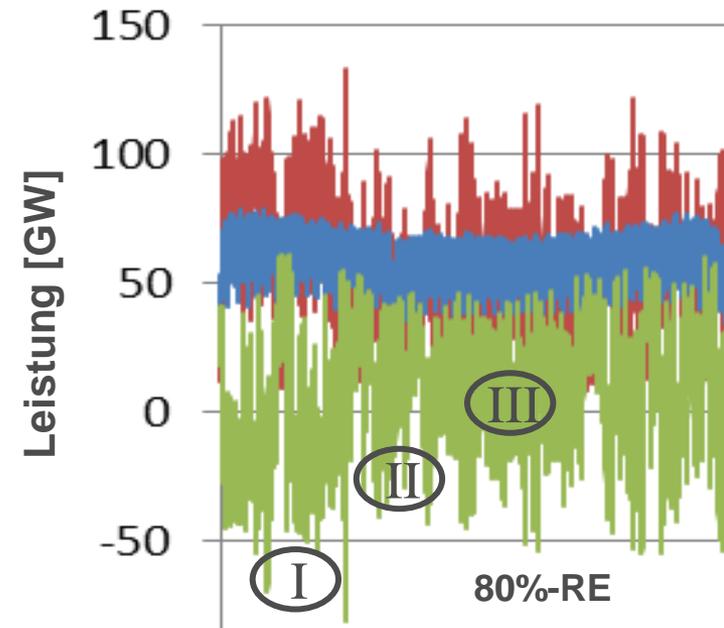
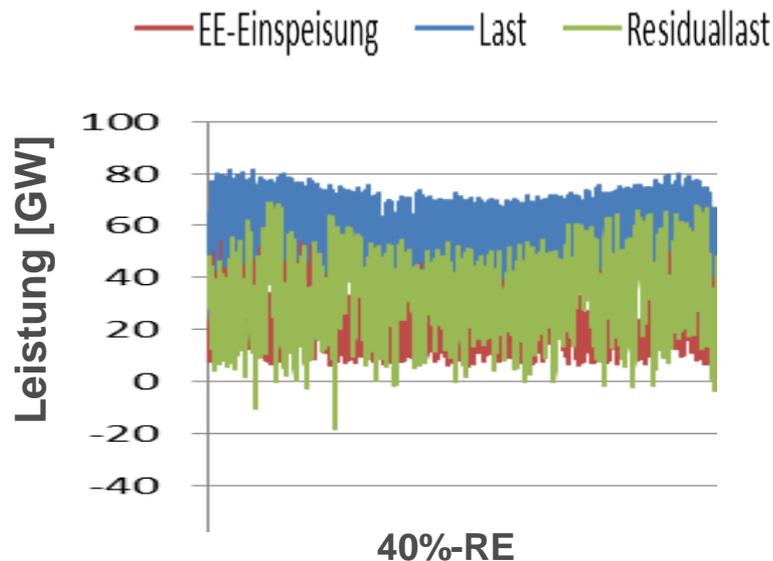
CO₂-source: ???

Characteristics of power generation with RE and its use in P2H-systems

→ also in the future **very high power peaks** which appear **only very seldom** **cannot be used in an economically efficient way** (I)

→ **resistive heaters** used for load management (DSM) show low investment costs **thus allowing an economic use of short-term excess of RE** (II)

→ **electric heat pumps are best suited to be used when long running times are possible** (III)



Provision of Grid Services and System Services with Power-to-Heat

- Already today the provision of **control power** with Power-to-Heat (electrode boilers) in combination with district heating systems (hybrid system) is an economic measure and will be increasingly used.
- The use of P2H is of special interest in the **industrial sector** as a high power demand is given **during the whole year**.
- The **heating of drinking water** in the **household sector** is also a considerable demand **throughout the whole year** (ca. 6 kWh_{th} per day for a 4 person household) and can be used for the provision of control power.
- A controlled operation of heat pumps can contribute to a local **reduction of the grid load**. (the highest grid load will occur during power injection from PV-systems)
- A controlled operation of heat pumps can also **support the voltage regulation** in low voltage grids.
- Power-to-Heat as a measure for Demand-Side-Management will **reduce the need for short-term electric energy storage systems**.

Conclusions

- ➔ The design of the future energy supply system needs an integral approach, taking into account all energy sectors (power, gas, heat, mobility ...).
- ➔ Most of Renewable Energies are made accessible directly via electric power (solar, wind, water).
- ➔ Also in RE-based supply systems, the efficiency of the applications remains a crucial issue. Heat pumps show best efficiency.
- ➔ Costly and lossy transformation of energy should be avoided.
- ➔ P2H shows the highest potential for the decarbonisation of the heat demand.
- ➔ Different reliable P2H-technologies are available.
- ➔ P2H will reduce the need for other short-term energy storage systems.
- ➔ Hybrid Systems offer also long-term storage options (virtual methane generation)
- ➔ It has been shown, that even the goal of 80% greenhouse gas reduction can be reached without the need for transforming power to gas.
- ➔ The tariff systems (at least in Germany) are not yet in favour for P2H in general but encourages self-consumption.

Thank you for your attention

VDE – Netzwerk Zukunft

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