German Perspective on Energy Storage

Febeg Energy Storage Seminar
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RWE
The energy to lead

RWE Research and Development
Dipl. Ing. Christian Metzger

Agenda

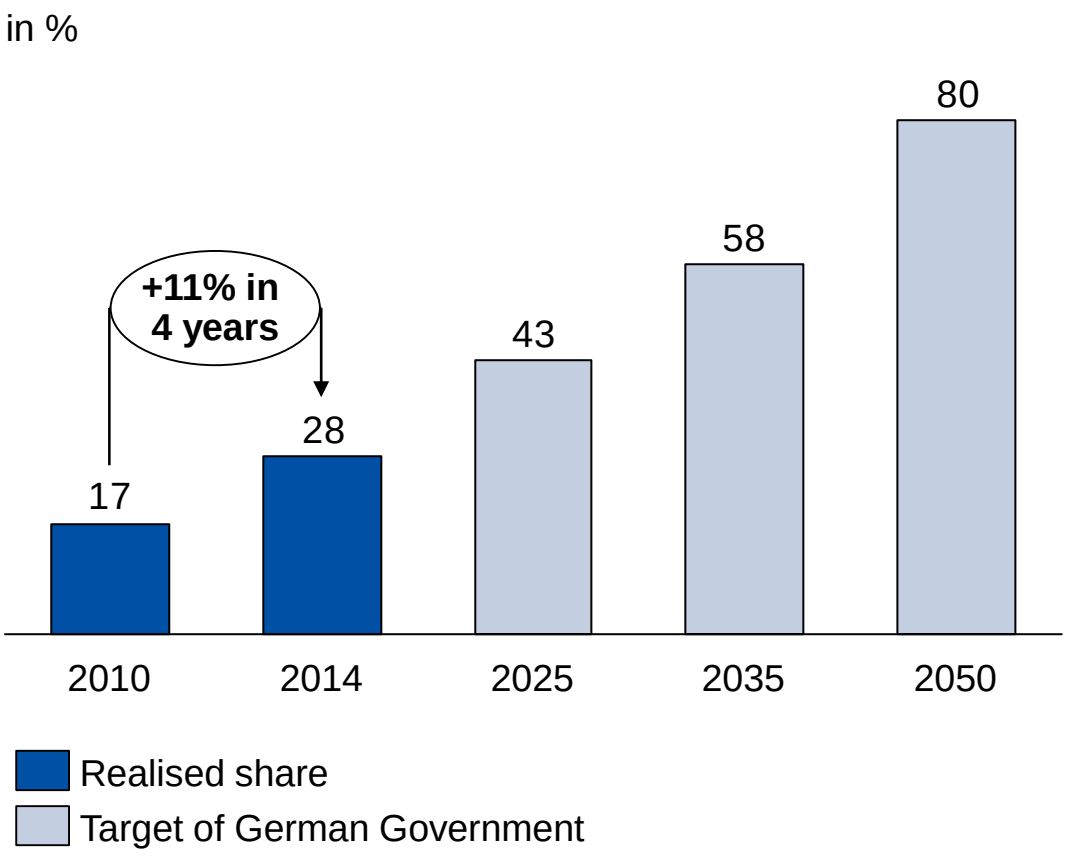
1 Energy Transition in Germany – Challenges and Solutions

2 Energy Storage – Options and RWE's Activities

3 Conclusion

Germany's renewable energy target anticipates 80% of fluctuating renewable energy generation in 2050

Renewable share at Germany's total electricity generation



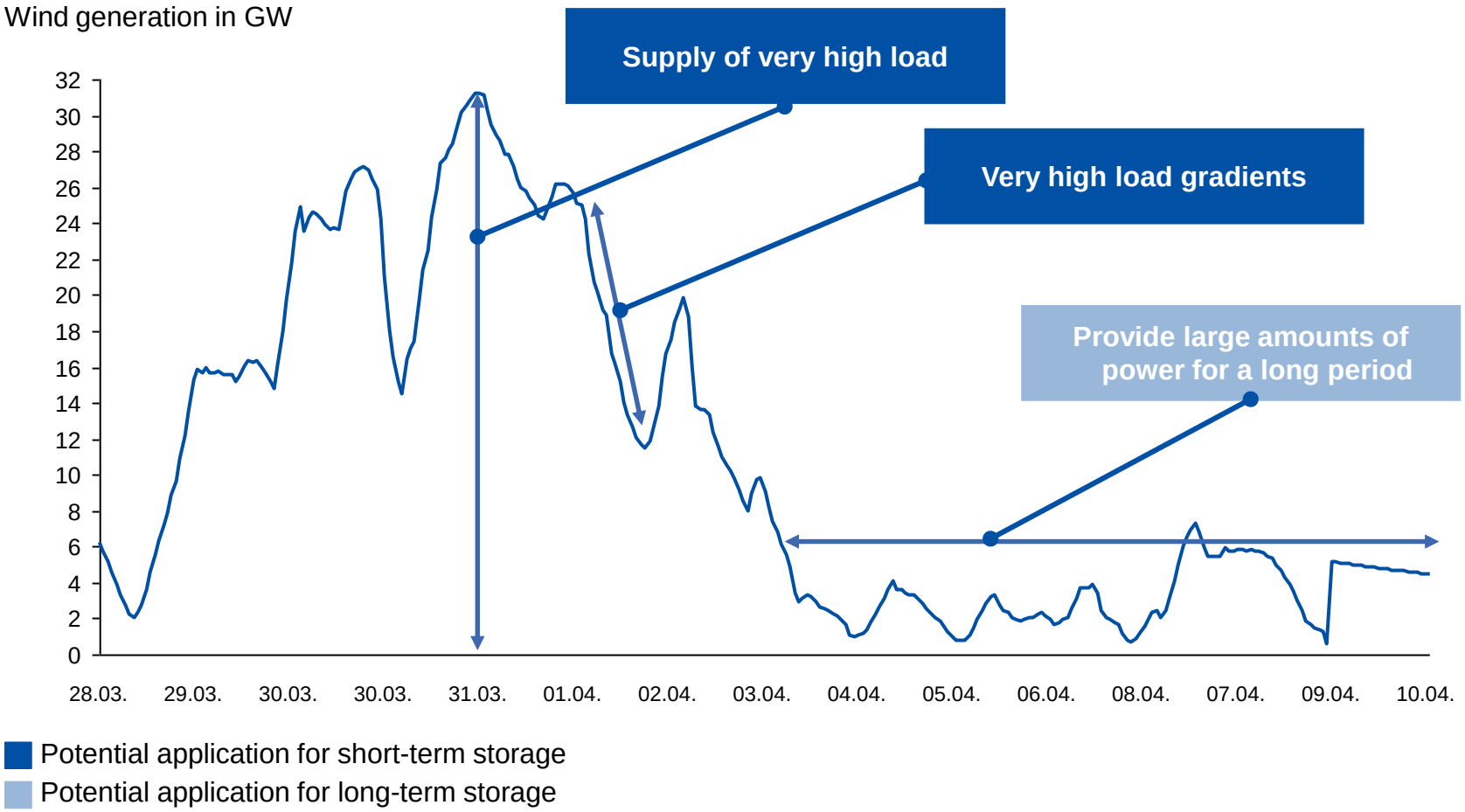
Description

- Additional renewable generation will depend on the **fluctuating technologies** of **photovoltaic (PV)** and **wind**
- **Installed power** of PV and wind is expected to double from **76 GW (2014**) to **149 GW in 2050**[1]
- For comparison: **Germany's total power demand** is approximately between **30 and 80 GW** (also in future)

[1] According to the German Transmission grid development plan 2015, Scenario „B"

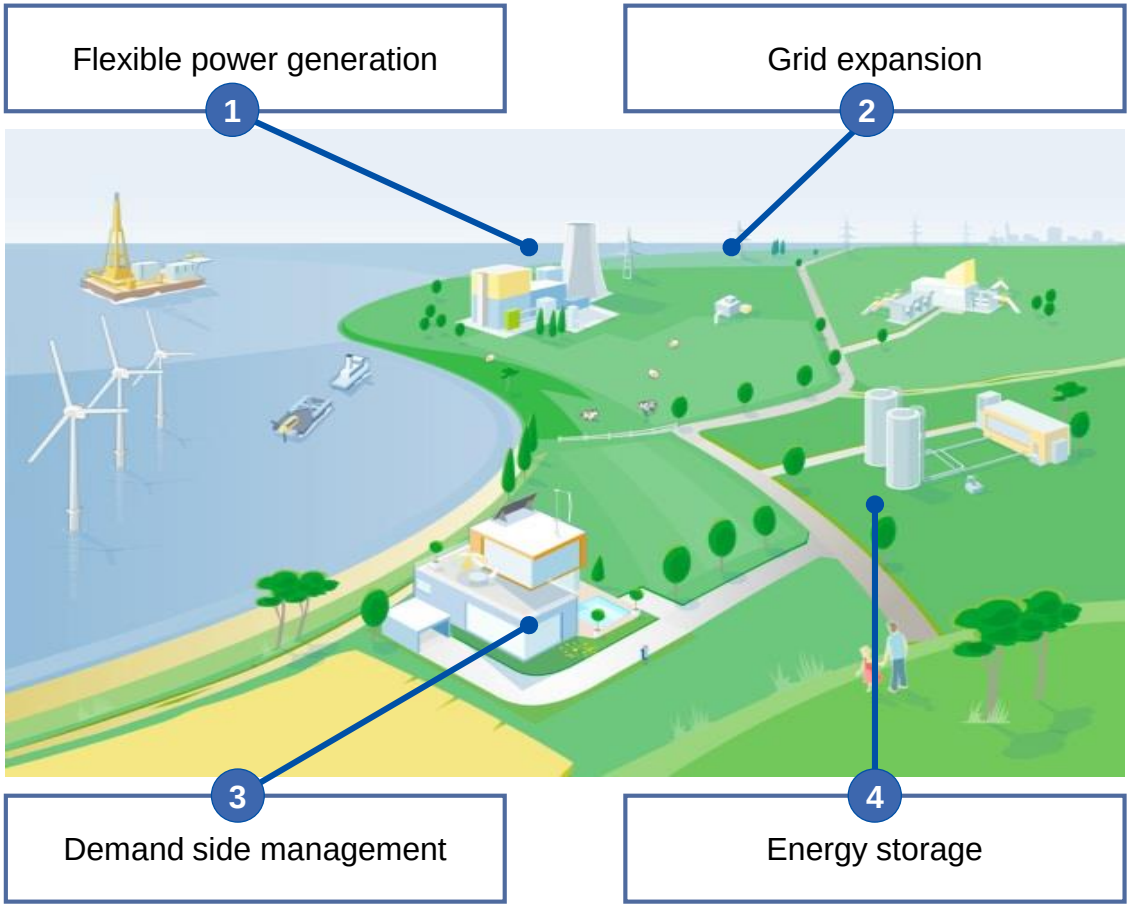
Integration of fluctuating power generation requires a high degree of flexibility in the energy system

German wind energy production at selected days in March and April 2015



Energy storage is just one of four ways to increase the flexibility of the system

Possible technical measures to increase flexibility



Applications for energy storage

> **"Energy transition needs no Energy Storage"**[1] Several recent studies agree**,** that **in the next 10 to 20 years** the **flexibility** required in the power system **can be provided by other, more cost-effective technologies** like **flexible power generation, grid expansion and demand side management**. New storage capacity will be only required when renewable energies reach very high shares

> At the same time **a market for decentral home storage in Germany** (ca. 20.000 installations at the end of 2015) is growing

> What is the way forward?

[1] Headline of German Newspaper "FAZ", September 2014

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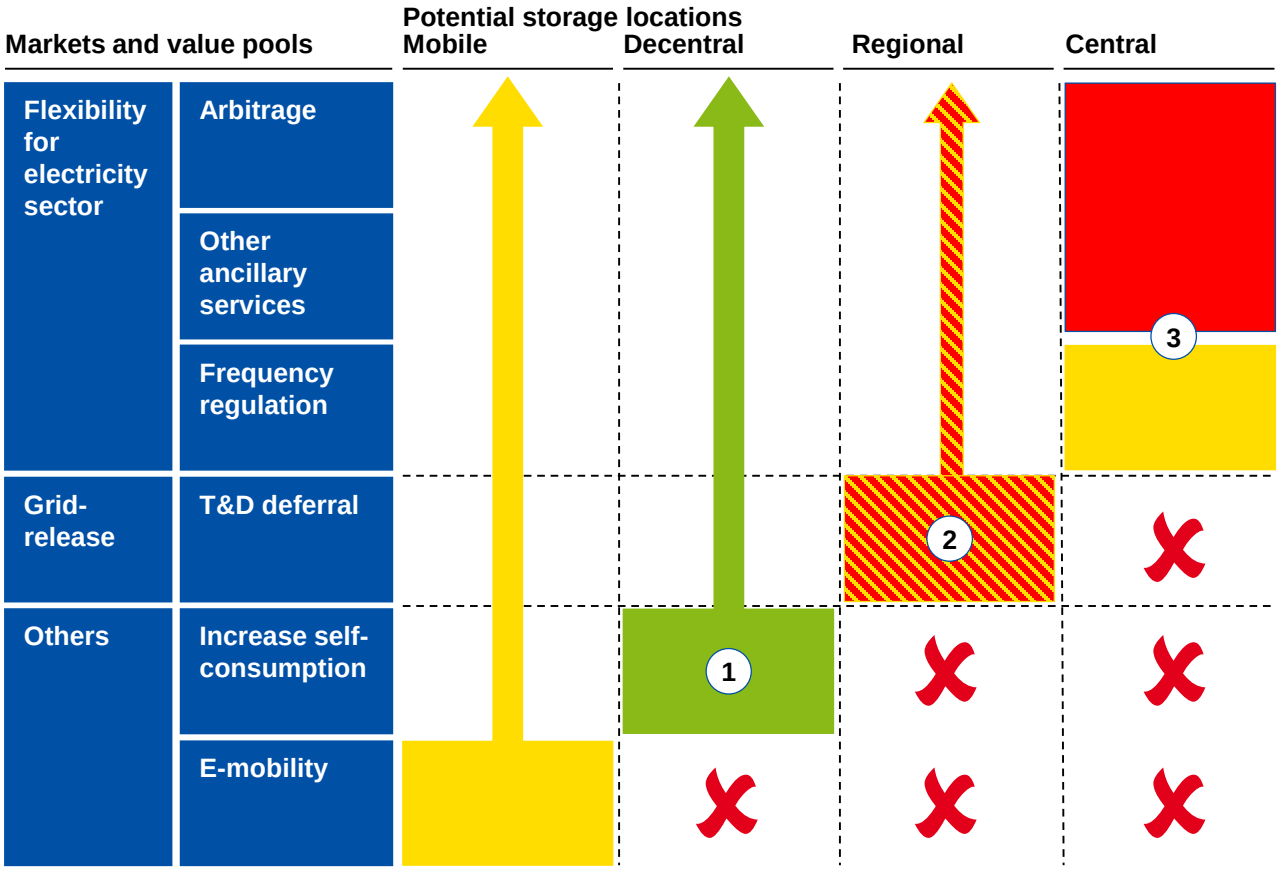
2 Energy Storage – Options and RWE's Activities

- 2.1 Decentral energy storage
- 2.2 Regional energy storage
- 2.3 Central energy storage

3 Conclusion

Decentral energy storage is driving the market growth



Conclusion

> **Ramp-up** of storage capacities will be driven by **decentral energy storage** systems

> This trend is **driven by individual profitability** based on increase self-consumption

> If **aggregated decentral energy storage can offer additional** flexibility and grid release **services at low marginal costs**

> **Decentral storage ramp-up** will **potentially reduce the demand for** regional and **central storage** capacity

Short/mid term profitability
Limited short/mid term profitability
No short/midterm profitability

Service can not be provided
Potential additional application for already financed storage

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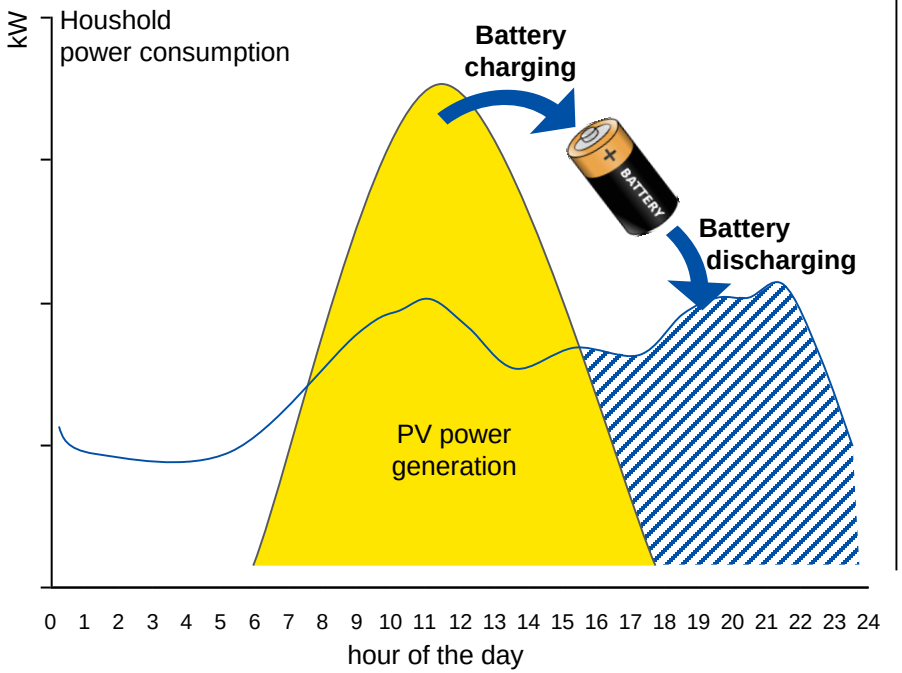
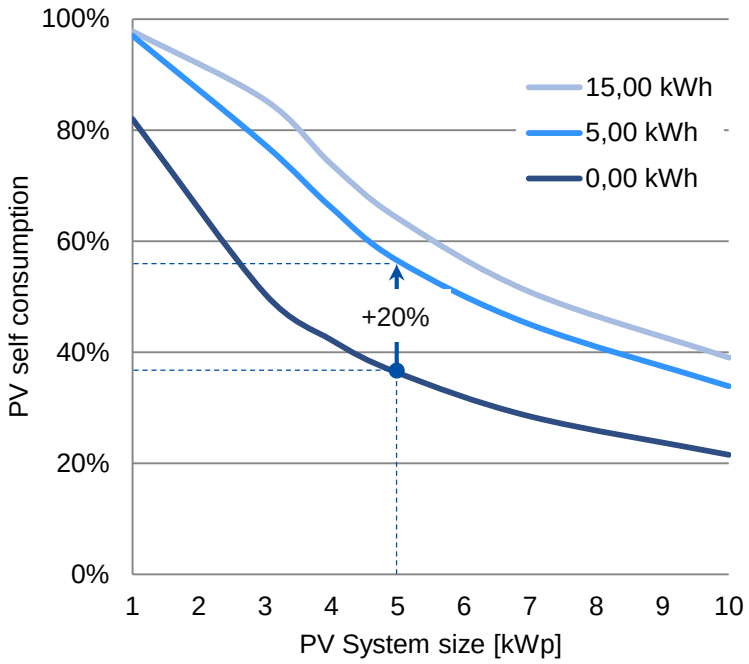
① Home storage increases PV self-consumption and is close to individual profitability

Local PV power generation and consumption can be decoupled time-wise



For a typical[1] B2C customer a battery will increase the self consumption by about 20 %



> The economics of batteries rely on the avoided power purchases
> **Business case depends on regulation** and avoided grid fees, taxes, …
> With decreasing battery prices home-storage will be profitable for the investor

[1] Family household, 4.500kWh annual consumption, 5 kWh Battery, 5 kWp PV

1 RWE participates in the decentral energy storage market with a broad product portfolio – Tesla shacked up the market

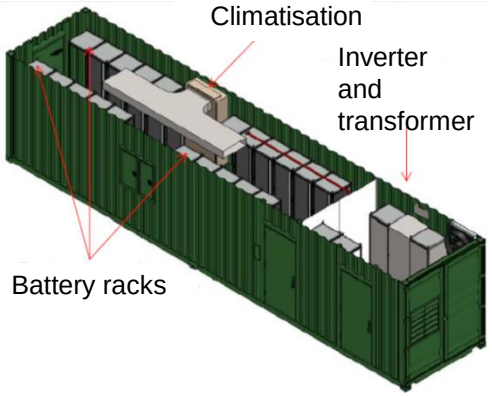
	Portfolio RWE HomePowerStorage			Tesla Powerwall	
Product	Storage Eco	Storage Vario	Storage Flex	10 kWh Backup power	7 kWh
					
Typ	Li-Ion	Li-Ion	Li-Ion	Li-Ion	Li-Ion
Capacity (kWh)	4,5 – 13,5	4,6 – 10,1	3,9 – 7,8	10,0	7,0
Life time (cycle)	5000 (20 years) @80% DoD	8000 (> 20 years) @90% DoD	10000 (> 20 years)	500 (< 8 years)	n.A.

② Local grid storage is not the best flexibility option – grid extension is generally more cost-effective

Grid type	Description	
Low voltage grid		> **Typical example**: increasing PV generation requires more flexibility in the system – low voltage **grid extension (600 m branch length) competes with the installation of a 100kW/4h battery storage** > **Grid extension** costs **around € 60k**, even with branch length as long as 600 m > **Battery storage** using a 100 kW/4h Lithium-Ion Battery will still cost **about € 90k** assuming a optimistic future specific price of 225 EUR/kWh > With more than 40 years **grids have at least twice the operational life time compared to storage**
Medium voltage grid		> **Medium voltage grid extension** cost per kW is **even cheaper** than in low voltage > Although distances are longer, the storage business cases in the regarded scenarios do not close > **However, in specific situations energy storage is competitive (e.g. Wettringen)**

② RWE installed a 1MWh-Lithium-Ion-Battery in the distribution grid for peak shaving

Battery storage near Wettringen



Motivation

> Close to Wettringen (100km north of Essen) the 400V-grid was utilized above design load due to strong PV feed-in
> Planned 110kV-grid extension will solve this overload issue in several years
> Temporary grid congestion can be eliminated cost-competitively with a battery due to it‘s reusability

Technical parameters

> 250 kW/1000 kWh
> 400 V
> Lithium-Ion-Battery-Cells
> Complete system in 40” container
> Autonomous control based on local grid signal
> Minimal expected lifetime: 15 years

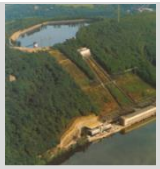
③ Only with a share of RES exceeding 50% significant storage increase on system level will be required

Increasing share of renewable generation

Activities

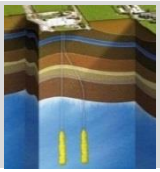
20 to 25% | 35 to 40% | 50 to 60% | 75% to 100%

New Pumped Hydro



> Keep future options open

Compressed Air



> Pursue R&D projects

Long-term storage

(e.g. Power-2-Gas)

> Pursue R&D projects

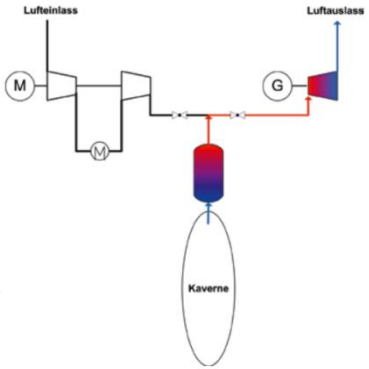
Today | 2020 | 2030 | 2050

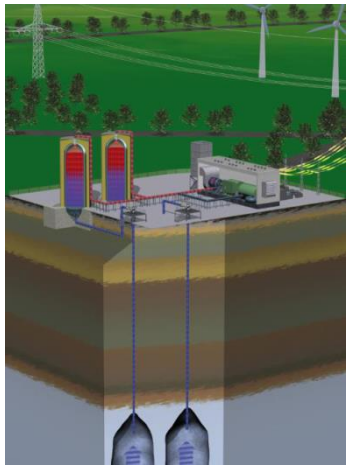
Relevance of new storage

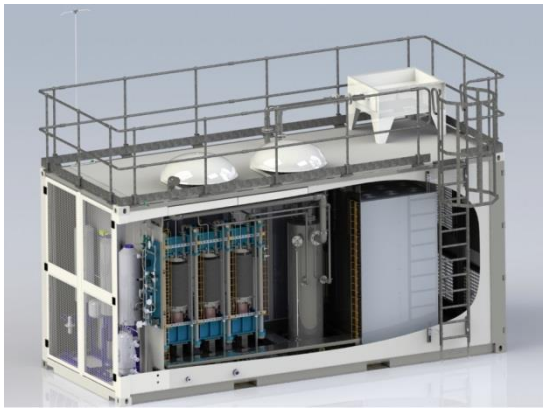
Build up of decentral storage capacity might reduce the need for central storage

③ RWE participates in research activities for central energy storage

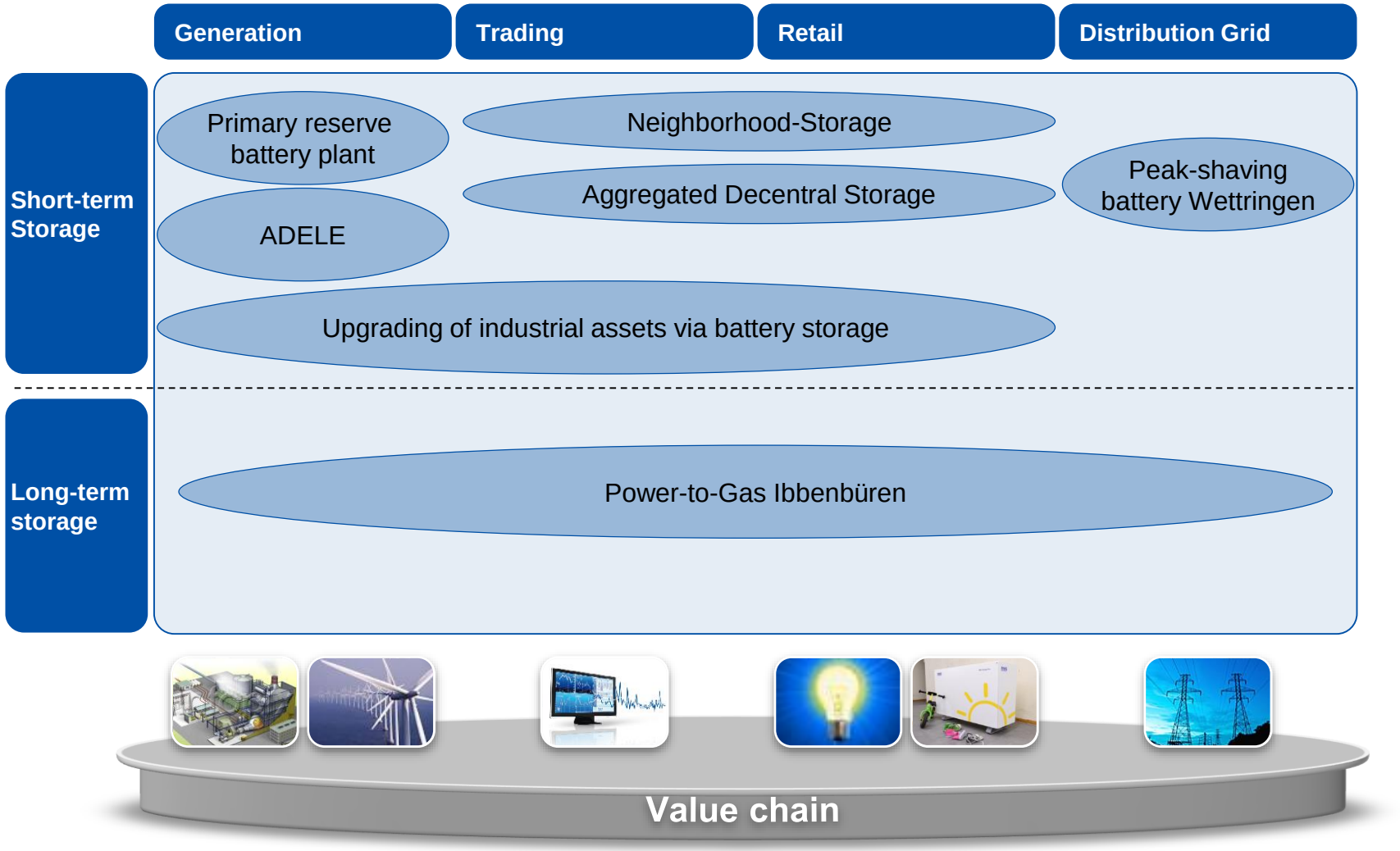
	Description
ADELE-ING **Adiabatic compressed air storage**	> **ADELE** has reached **advanced development stage** – Cost target of **1.300 EUR/kW** reached – on par with pumped hydro storage – Charge **200 MW**, discharge **260 MW**, capacity **1-2 GWh** (4-8 h), round trip efficiency 70% > Plans for demonstration plant were suspended due to insufficient profitability > Currently working on further improvement of system design to facilitate market entry. The explored options are – **Downscaling** of system (10-30 MW) to access more applications – **Hybrid-configuration** (semi-adiabatic systems using natural gas)
P2G **Demo plant in Ibbenbüren**	> Use of Power-to-Gas-technology in **intermittent operation mode** – operated exclusively with green electricity from a wind farm > Application of innovative PEM (Proton Exchange Membrane)-Technology > Standard operating point **150 kW** (el. consumption) > Production of approx. **30 m³N/h hydrogen at 14 bar(g)** – Feed-in into the regional gas grid of RWE Deutschland AG







Current R&D storage activities cover the complete energy value chain



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Conclusions

Energy storage is installed in Germany rather decentrally and can serve all markets when aggregated

The increasing presence of decentral energy storage will reduce the demand for regional and central energy storage

The regulatory frame – not the macroeconomic benefit – decides upon the future success of energy storage technologies