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Energy storage technology –

Economic use of energy storage

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Energy storage technologies - Introduction

- Generation and consumption are not congruent and differ increasingly with the energy transition from a centralized to a decentralized volatile (electricity) generation system. This leads to increased requirements for the energy system and poses a challenge for grid operation.
- Temporally temporal occurring surpluses in electricity generation should be utilized and if necessary converted into other energy forms for the holistic efficiency of the energy system.
- Energy storage serves to improve the integration of renewables in all sectors. Holistic decarbonization and higher electrification requires a mix of different energy storage and conversion technologies.
- Lower energy storage prices, increased energy and power density especially in electrochemical storage systems as Li-Ion enable new use cases on a smaller commercial scale in the energy system.

Energy storage technologlies - Technologies and classification (electric)

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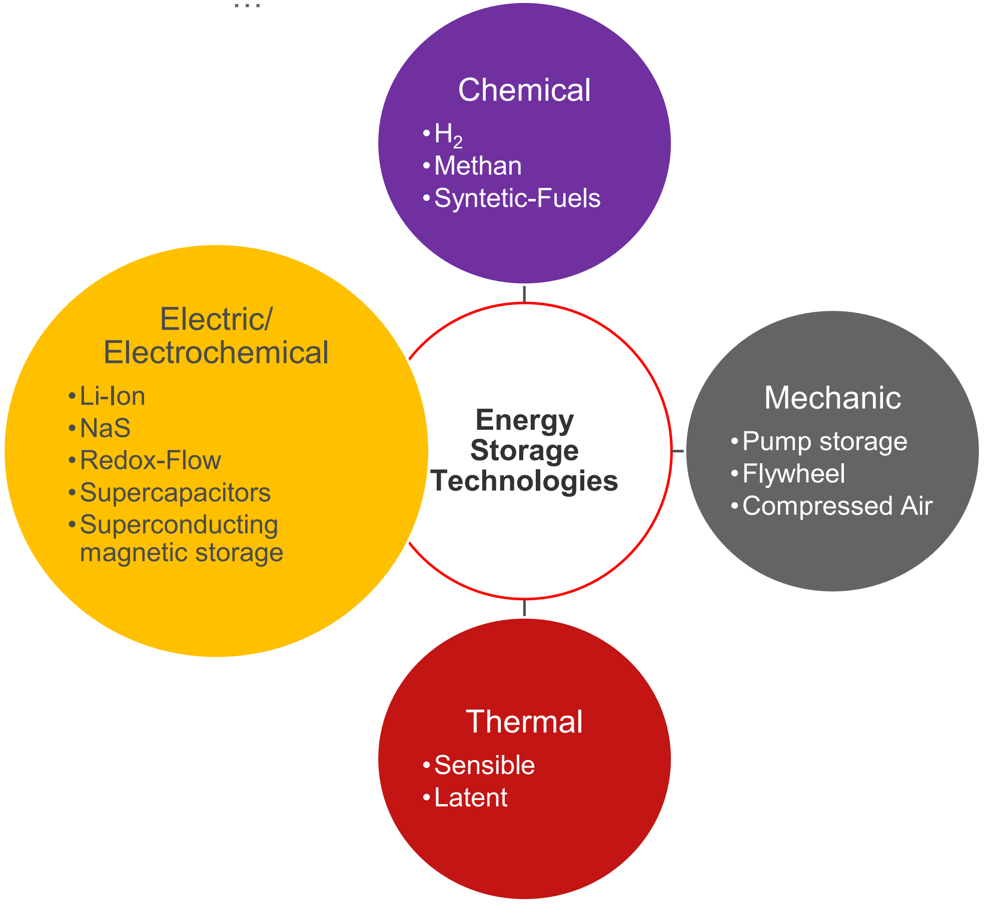
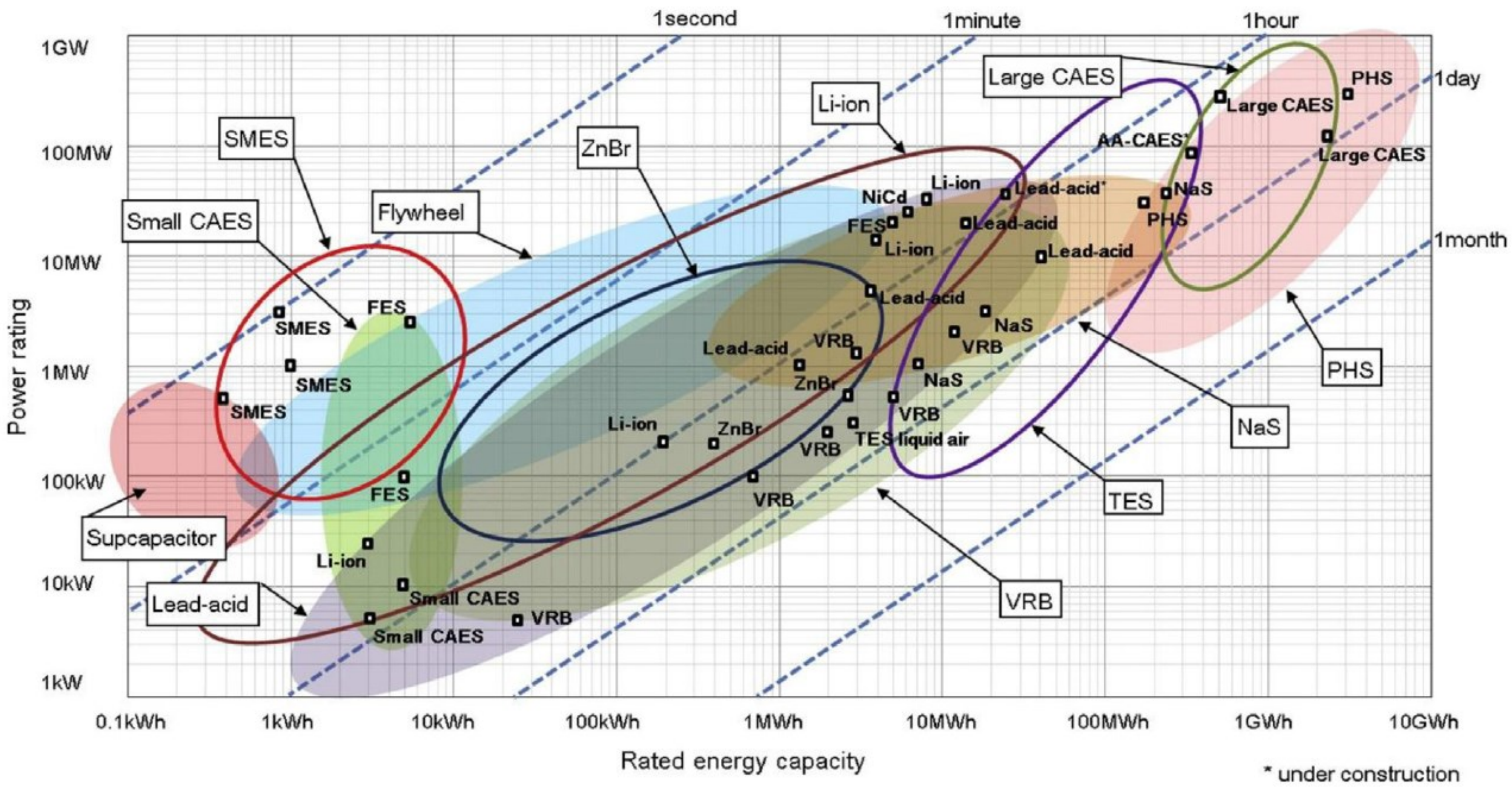
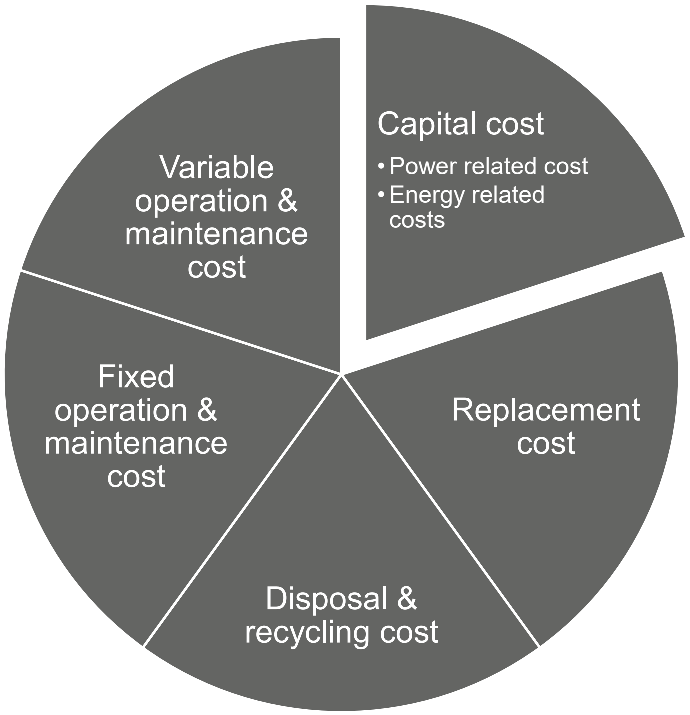




Source: sX. Luo, J. Wang, M. Dooner, J. Clarke, Overview of current development in electrical energy storage technologies and the application potential in power system operation, Appl. Energy 137 (2015) 511–536.

Energy storage technologlies - Valuation key parameters

- Each use case requires an individual consideration of the existing energy storage technologies and their individual technical key parameters:
  - Usable capacity and power
  - Specific energy and power density per volume or per weight
  - Full cycles and lifetime
  - Depth of discharge
  - Response time
  - Efficiency of the System
  - Capital and operating costs
- To compare possible technologies for a respective use case, a uniform evaluation parameter must be applied. The evaluation of the “levelized costs of storage” (LCOS) or “annualized life cycle cost of storage” (LCCOS) are commonly used for this purpose.
- The LCOS takes into account the different technical parameters and shows the derived costs per unit of energy stored while it considers all costs during the lifetime of a specific technology.
- General statements about economic viability are rarely possible and must always be examined in the context of the respective use case.
- Further technical development and cost decrease continuisly change the valuation



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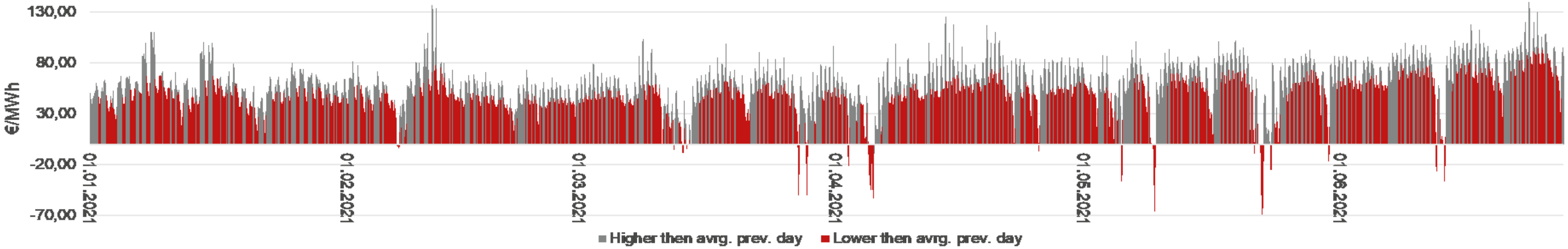
Energy storage technologlies – Flexibility as a chance

- The flexibility gained through energy storage can be used both for consumption and for the marketing of on-site generated power.
- Grid services alone are no longer sufficient for successful storage operation.
- Multiuse applications with grid services and optimization of on-site generation and the consumption are becoming increasingly important in a volatile energy system.
- The digital connection of decentralized storage systems and generation assets in virtual power plants or swarm concepts enables an optimization of revenue streams through Multi-Use application.
- Volatility now becomes a chance for flexible systems.

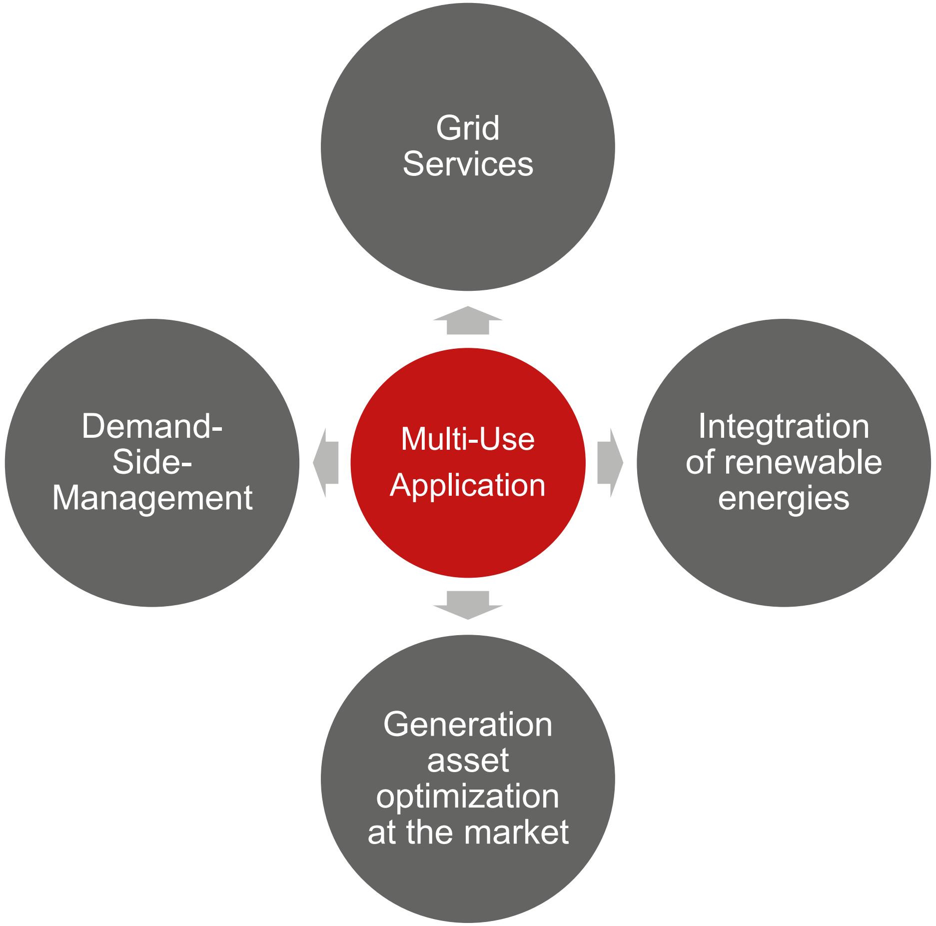
Prices for Frequency Containment Reserves (FCR) [€/MW/week]

Source: www.regelleistung-online.de

DayAhead Spot Price DE/LU



Energy storage technologies – From Single-Use to Multi-Use-Application



- **Optimizing grid related costs of energy consumption:** Current grid regulation enables the reduction of grid-related costs through grid-supportive consumption, known as peak-load shaving.
- **Increasing the consumption of renewable energy produced on site:** On site generated electricity consumption is more costeffective then grid consumpted electricity.
- **Market driven commercialization of flexibility:** Intelligent demand-driven control of power generation increases the value of the generation-unit and can enable higher revenues of energy surplusses.
- **Grid Services:** The aggregation of small scale energy storage systems in virtual power plants or swarm-concepts can provide grid services which they are usually not able to because of their scale.

Conclusion and Outlook

- Cost regression, especially for electrochemical energy storage, enables broader commercial use in different sectors.
- Finding the optimal energy storage solution from an economic point of view depends on many individual factors of the projects. Standardization of uniform evaluation methods is necessary.
- Energy storage taps revenue potential, saves costs or minimizes risks, which would not be possible without this flexibility.
- Smaller-scale networking of generators and consumers enables multi-use applications to the benefit of energy storage operators and the energy system as a whole.

THANK YOU

for your attention

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