# Business cases for flow batteries

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## Introduction

Flow batteries are a very interesting energy storage technology due to their very high cycle life (> 15000 cycles), low levelized costs of storage of 0.055 USD/kWh/cycle when produced at scale [1], scaling capacity costs and easy recyclability.

What are the most promising business models for redox flow batteries, today and in the coming years? Where do flow batteries outcompete other storage technologies and why?

Conversations with customers and domain experts revealed: the most important advantages of flow batteries from a business case perspective depend on the business case.

## Important advantages of flow battery for business cases

For behind-the-meter applications:

- Non-flammability (fire protection requirements, insurances)
- Cycle life/lifetime

For in-front-of-the-meter applications:

- Low footprint (kWh/m²)
- Levelized costs of storage LCOS
- Supply chain security

## Example 1: behind-the-meter application

Increasing solar own-consumption of an agricultural customer in Germany

Key parameters:

- Solar 2 MWp
- Average consumption: 120 kW
- Simulated redox flow battery configurations: 100 kW-300 kW /400 kWh-2400 kWh, RTE = 75%
- Cost parameter assumptions:
  - Fixed solar feed-in tariff of 0.05 €/kWh, electricity costs from the grid: 0.3 €/kWh
  - CAPEX: 500 €/kW plus 250 €/kWh
  - OPEX: 1% of CAPEX

Key takeaways:

- Fastest payback time with 5.4 years for a 100kW/800 kWh redox flow battery
- Additional earnings due to flexible grid fees not yet considered.
- Other storage technologies (e.g. LFP) are not an option due to flammability risks/installation close to a building

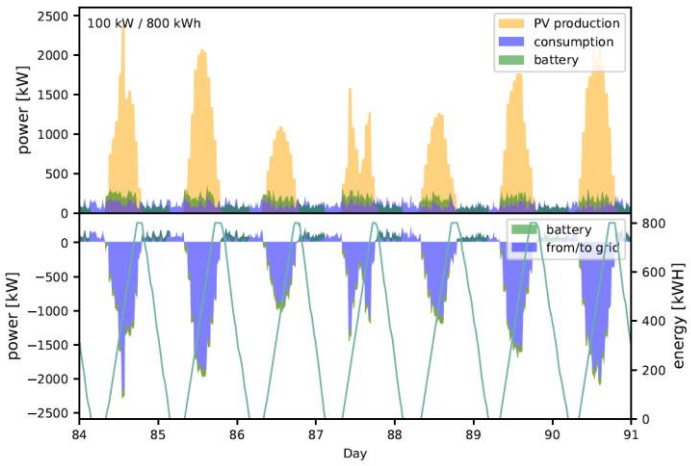



*Figure 1 Typical solar generation and consumption profile including a 100 kW/ 800 kWh battery*

## Example 2: in-front-of-the-meter application

Gas power plants vs. solar plus redox flow batteries

Key parameters:

- Levelized costs of energy (LCOE) and levelized costs of storage (LCOS) values from Lazard and DOE study [1, 2]
- In the future, gas power plants will be powered with hydrogen as well

Key takeaways:

- Batteries plus solar are competitive compared to gas-based power plants
- Redox flow batteries plus solar offer lower LCOE compared to lithium ion plus solar
- Most probably it is not an EITHER/OR-game but a combination of technologies: in many of the cases redox flow batteries plus solar are the more economic solution, but in times of longer lack of renewables (e.g. 2 weeks Dunkelflaute), gas power plants are the preferable solution for energy security. See also [3].

## Barriers for flow batteries vs. other batteries

- Higher CAPEX due to lack of economies of scale
- Commercial maturity

**What helps to strengthen and broaden the use cases for flow batteries?**

- Lowering CAPEX:
  - Electrolyte leasing
  - New, cheaper electrolytes
  - Stacks with better price/performance
  - Standardized components -> economies of scale
- Policies:
  - Recognition of value of storage for grid stability and renewable integration
  - Supportive conditions for growth of storage installation, e.g. fees, grid connection costs
  - Support for long-duration energy storage
  - Capacity markets

**Conclusion**

Different business cases for flow batteries are already viable. For broader market penetration, costs for flow batteries need to be reduced. Strong drivers are the reduction of electrolyte costs and the remaining hardware like stacks. VANEVO pursues to reduce stack and redox flow module costs via improved production processes and standardization, enabling potentials of economies of scale. Policies need to consider and incentivize broader installation of energy storage like flow batteries.

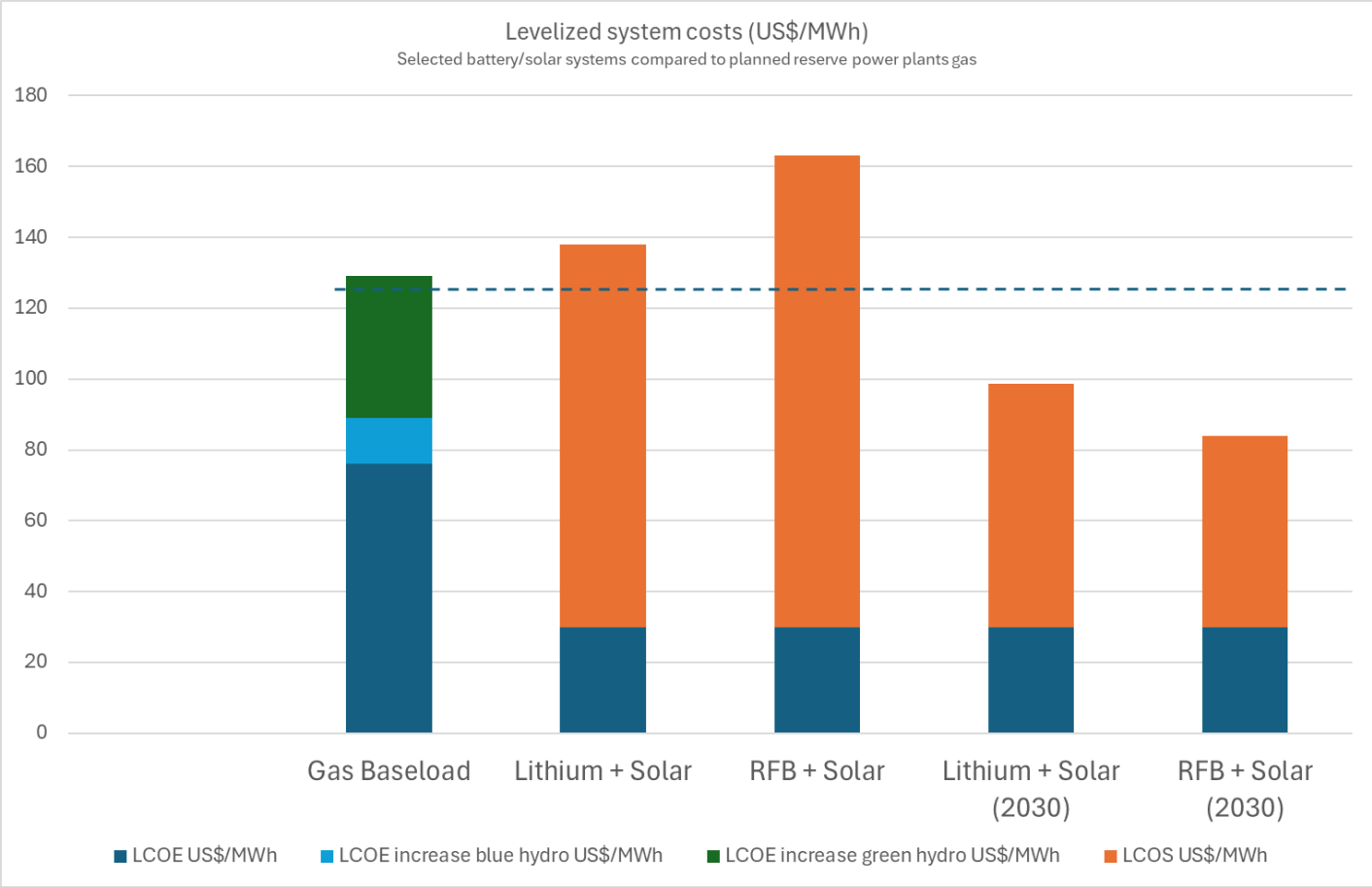



*Figure 2 Comparison of levelized costs of energy for gas power plants vs. solar plus different battery types*

**References**

[1] “Achieving the Promise of Low-Cost Long Duration Energy Storage”, Department of Energy (USA), 2024, https://www.energy.gov/sites/default/files/2024-08/Achieving%20the%20Promise%20of%20Low-Cost%20Long%20Duration%20Energy%20Storage_FINAL_08052024.pdf

[2] Lazard’s levelized cost of energy analysis v15 and Lazard’s levelized costs of storage analysis v4.0

[3] https://www.linkedin.com/posts/luca-pedretti-746ba218_across-markets-4-hour-batteries-now-have-activity-7309720308242866176-PYhk/?utm_source=share&utm_medium=member_desktop&rcm=ACoAADK-fWYBFSxqqiDJfE9jGoD9o44aQnwxu9Y