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LARGE SCALE BATTERIES FOR ENERGY PROJECTS: FLOW TECHNOLOGY

This series of articles highlights the commercial case for two different types of large scale battery. Large scale batteries widely differ in terms of their flexibility, life-time resilience, day-to-day reliability, initial purchase price (or CAPEX) and the ongoing cost of their maintenance & upgrades (OPEX). It is, obviously, crucial to identify the right battery design and manufacturer.

Flow technology (1974) is older than Lithium (1986), but is not portable and generally less well understood. As recent technology breakthroughs makes Flow an alternative to Lithium and Sodium Sulphur, a quick background explanation may be useful.

Flow Batteries:

Electricity is stored in electrolyte liquid in two storage tanks. The tanks feed (via pumps) into their own half-cell, each separated by an ion-exchange membrane or 'exchanger' (a delicate graphite film manufactured by Du Pont).

The same substance, vanadium is dissolved in sulphuric acid (solving the contamination problem which dogged other designs) is stored in both tanks but at different states of charge.

Vanadium ions are exchanged across the membrane as pumps are activated. Chemically-stored energy is 100% transferred into electrical energy (and 100% back from electrical energy to chemical energy when the battery is recharging).

Pros:

- High round-trip efficiency, but slightly below 'high-end' Lithium and Sulphur designs. Yet significantly more flexible, reliable and versatile out in the field. Flexibility to charge / discharge up or down to any level with no wear or tear issue.

- Capacity to reverse-flow i.e. charge-discharge-charge inside a 100th of a second's notice.

- This Flexibility makes them suitable for both Frequency Response and for Primary Control. Reserve/Storage i.e. one can use the same unit battery to fulfil both tasks and avoid overspend.

- This cycling/frequency-response flexibility makes Flow suited to successive peak-shifting and arbitrage. This can earn a second revenue for the owner and help to pay down CAPEX. A commission Agency Trader (e.g. big six generator on commission can optimise the battery and extract trading economies of scale for the battery investor).

- The storage capacity of a Flow battery is simply determined by size of the storage tanks.

- *Flow batteries have a higher CAPEX than Lithium or Sodium-Sulphur. However Flow batteries are more reliable and they require less maintenance. Also OPEX is low - circa 2.5% of CAPEX (less than Lithium or Sodium-Sulphur). For this reason, Flow batteries are generally the cheapest option when the full life-cycle of the system, including maintenance, repairs or part replacement are included in the calculation.*

Cons:

- Flow batteries are a less well known, less common and less understood technology. For this reason alone, they can be harder to win support from internal finance directors and external financers.

- Flow batteries are less portable than many solid-state batteries due to their low energy density.

- There are fewer Flow battery manufacturers and still many different variants of flow battery.

- They use corrosive acid as the electrolyte which requires a robust and expensive membrane (the exchanger) for use in every cell. This cost can mount up and it partially explains the high price of Flow batteries. Continuous RND costs is another significant overhead which the consumer ultimately pays for in terms of CAPEX.

- A Flow battery has a lower energy density than any Lithium Ion or Sodium Sulphur battery and so the actual space required to house this storage is significantly greater.

Lithium Ion v Flow Battery: Conclusion

A Flow design involves significantly less maintenance than a Lithium Ion or Sodium Sulphur.

The Vanadium variant battery (same electrolyte solution used in each tank (i.e. on both sides of the exchanger) has solved the 'cross contamination problem' with Flow technology.

OPEX is more quantifiable at the project outset than in a Lithium-ion battery. OPEX will be lower: ca. 2% of CAPEX vs. a significantly higher OPEX figure for Lithium Ion. e.g. replacement cells, annual maintenance and inspection of fire-prevention systems.

Consequently, the Flow battery is claimed to be the cheapest 'Lifetime Option' as well as the most robust and flexible alternative.

Recent trends in global Lithium Carbonate prices may conceivably lead to unaccounted for (all prices quoted are subject to change) increases in CAPEX cost or (perhaps more likely) increases in future OPEX costs.

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