Li-Ion Batteries for Distributed Energy Storage

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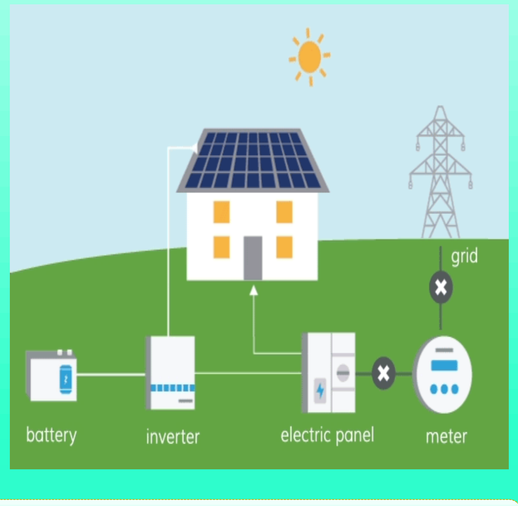
Introduction

Solar panels collect sunlight and transform it into electricity. The problem is, they can make that energy only when the sun is shining, so the ability to store solar energy for later use is essential. For homes with solar panels and off-grid or non-net metering locations, energy storage using lithium ion batteries like the Powerwall are becoming more prevalent. An important question is the cost and life of the pack.



Methodology

Estimate battery pack cost: Calculate present value of the Li-Ion battery pack based on the life of the pack.

Estimate battery pack life: Explore publicly available data on cycle life for Li-Ion batteries.

Cycle Life Data

Battery Data Set

Experimental data from Li-Ion battery cycling tests at different temperatures was obtained from NASA Ames available at https://ti.arc.nasa.gov/tech/dash/groups/pcoe/prognostic-data-repository/.

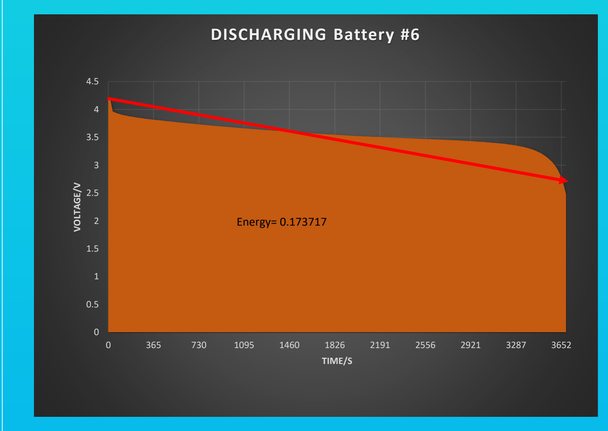


Figure 1: Battery #6 at 24°C

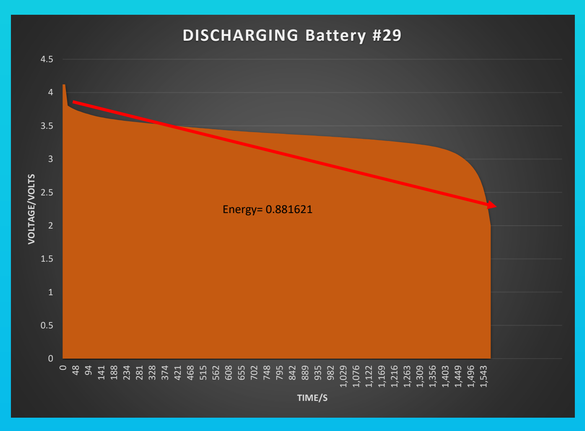


Figure 2: Battery #29 at 43°C

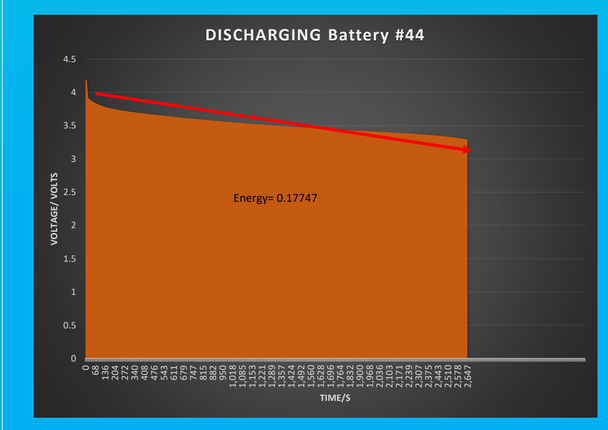


Figure 3: Battery #44 at 4°C

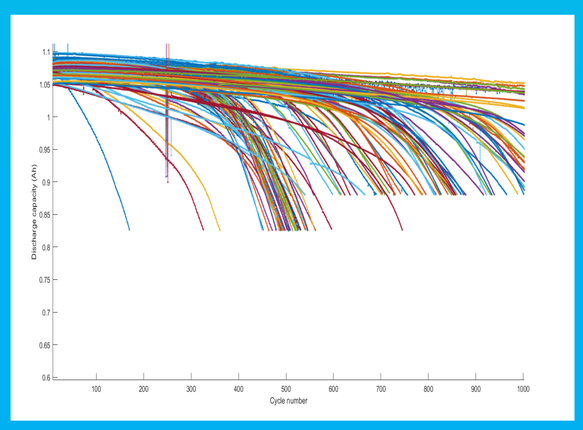


Figure 4: Discharge capacity versus cycle number

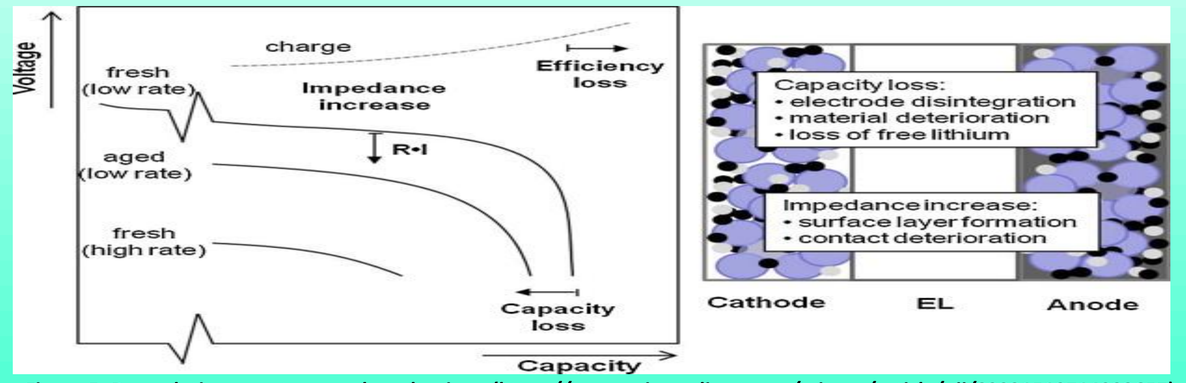


Figure 5: Degradation symptoms and mechanisms (https://www.sciencedirect.com/science/article/pii/S0921510714002657)

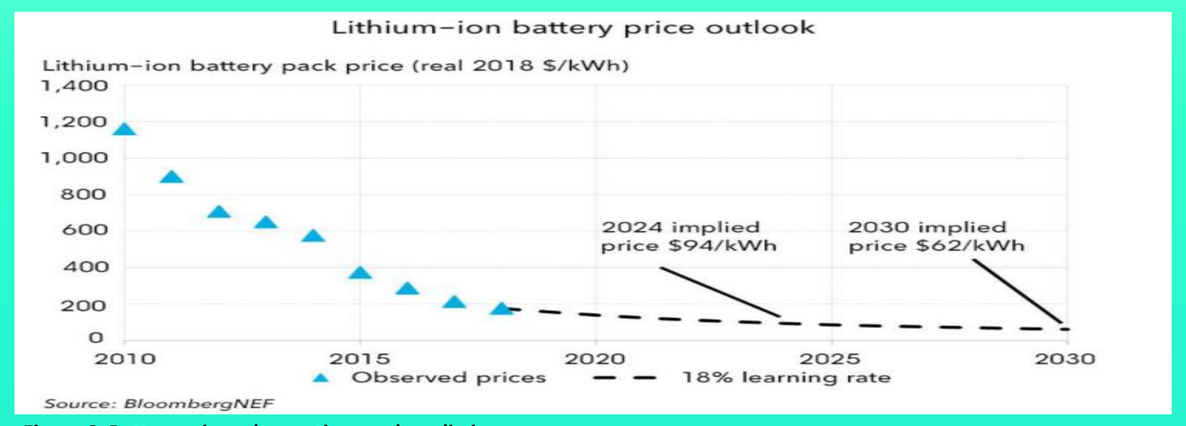


Figure 6: Battery prices observations and predictions

Cost versus Battery Life

For a 30-year Li-Ion battery pack installation, multiple battery packs will be needed because their lifespan is typically 8 – 10 years. Battery capacity typically reduces 1-3% per year so in 10 years the capacity could be 80% of the original value. The figure shows that longer life battery packs are lower cost.

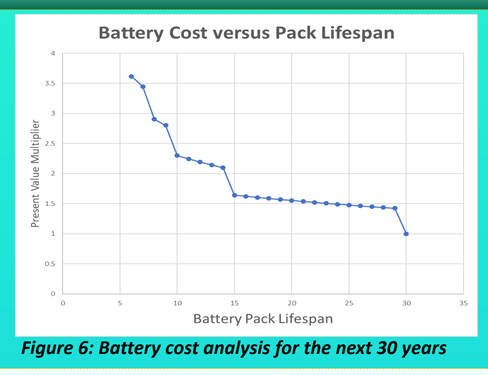


Figure 6: Battery cost analysis for the next 30 years

Conclusions

- Li-Ion batteries have high energy density, so they take up less room in a home installation and their cost is dropping rapidly due to the growing EV market.
- Battery degradation causes irreversible capacity loss and increase in cell impedance, tied with changes in kinetic and thermodynamic properties of involved materials. It is caused by cycling and calendar ageing.
- Extending the life of Li-Ion batteries is critical to reducing cost. Increasing the lifespan from 10 years to 30 years would cut the present value cost by more than a factor of two.

Future Work

- We want to figure out the capacity needed to be home economic for home energy storage. How battery initiatives can be implemented in society at a greater efficiency.
- Considering the carbon emissions and wasted energy without battery presence.

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