Laboratory testing of Lithium Titanate based cells for BESS applications

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HNEI is leading a team engaged in the research, development, deployment, and analysis of grid-scale battery energy storage systems (BESS). The program seeks to identify high value BESS applications at various system levels and develop control algorithms that maximize the benefit to the grid/customer and the lifetime of the BESS.

One of the task of this endeavor is to understand the degradation of the individual batteries to anticipate failures. Laboratory testing of advanced Li-ion battery cells is performed to support lifetime analysis of technologies targeted for large-scale grid energy storage applications.

Accelerated testing of lithium titanate battery technology identical to the one used in deployed BESS was performed and those results will be used to develop predictive performance models.

As real world data is collected from the grid batteries, the predictive models will be compared and assessed for accuracy and ability to predict performance.

This work presents preliminary results on the definition of the testing protocols and on the testing of the cells.

HNEI monitored LTO based BESS

<table>
<thead>
<tr>
<th>Type</th>
<th>Model</th>
<th>Capacity (kWh)</th>
<th>Voltage (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 LTO based BESS installed in Hawai’i</td>
<td>COASTAL1, Big Island, HI (grid: 30MW)</td>
<td>1MW/28kWh</td>
<td>2.4</td>
</tr>
<tr>
<td></td>
<td>COASTAL2, Oahu, HI (grid: 1LTO)</td>
<td>1MW/20kWh</td>
<td>3.3</td>
</tr>
<tr>
<td></td>
<td>COASTAL3, Oahu, HI (grid: 1LTO)</td>
<td>1MW/22kWh</td>
<td>3.2</td>
</tr>
</tbody>
</table>

Usage analysis and Experiment design

Battery usage is sporadic and current usage must be known. What parameters are really relevant?

Varying parameters:
- SOC range
- SOC ramp rate
- Temperature

We assumed that pulse duration and SOC ramp rate variations do not impact battery lifetime. They will be constant in this study.

Experimental design with pulse intensity, SOC sweep and temperature.

Testing implementation:
- Converge pulse duration and SOC ramp rate with varying current
- Not straight-forward need to define microcycles.

Cell selection

Altairnano provided 2 sizes of cells
- 50Ah and 11Ah cells. Are they comparable?
- Large ones in BESS but small ones easier to test

Cycle aging

Cycling experiment:
- 16 GRN1 cells cycling - In progress, 5 months in.
- 4 months of cycling, cells lost up to 7% of their capacity. Temperature increase is not responsible for the largest depredations followed by current increase and SOC sweep duration.
- The full test: 0.2C, 50% SOC, current around 50% SOC are causing more degradation than 25°C is surprising.

Conclusions & Perspectives

The preliminary results of the accelerated testing of BESS deployed LTO cells showcases that battery degradation is influenced by increases of temperature and current. More surprisingly, much SOC takes around 50% SOC seems to degrade the cell faster than others. It is not the case at higher temperature and state of charge.

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