Operations and Maintenance Considerations for PV+Storage

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Motivation

- Photovoltaic (PV) technology is a rapidly developing technology in response to supply-demand balancing needs.
- Although there is some understanding of costs associated with PV O&M, costs associated with emerging technologies such as PV plus storage lack details about the specific systems and/or activities that contribute to the cost values.

Study Objectives

- This study aims to:
  1. Identify specific factors and drivers contributing to utility-scale PV plus storage (UPVS) systems O&M costs,
  2. Understand how particular storage technologies were selected,
  3. Learn how O&M data is being collected and used by owners and operators,
  4. Catalog ongoing challenges and needs in this space from field.

Methods

- Obtain insights from industry experts
- Online questionnaire
- Semi-structured interviews
- Snowball sampling
- Word of mouth
- Advertising in industry publications

Questionnaire Demographics and Site Details

- Insights from 81 sites (14 partners) with co-located PV-Storage captured Geographic distribution spans 13 states
- Total PV system size: 51.1 MW
- Total Battery Storage size: 64.1 MWh
- Site age: Mean = 5.2 years, Range = 0-11 years
- Storage technologies: Li-ion (77%), Lead Acid (23%)
- Metering location: Back (69%), Front (19%)
- Percentage of storage technology's energy source coming from PV at the site: Mean = 51.6%

Study Findings

- Storage system's maintenance is primarily performed by system vendor or in-house
- 61% respondents have observed no change in O&M costs over time
- 50% respondents have a warranty period of at least 5 years
- 35.8% of sites have already filed a warranty

Selection and Purpose of Energy Storage

- Storage is most often cycled daily

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Storage Technology</th>
<th>Li-ion</th>
<th>Lead Acid</th>
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</thead>
<tbody>
<tr>
<td>Capital cost ($ per kWh)</td>
<td>487-594</td>
<td>500-667</td>
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<tr>
<td>Expected Lifetime (years)</td>
<td>13.6±1.3</td>
<td>15.4±3.6</td>
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<td>Degradation rate (%/year)</td>
<td>1.4±0.2</td>
<td>1.57±0.4</td>
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Challenges and Needs

- New processes needed to set up PV+storage contracts
- Missing PV-storage performance metrics
- Prior experience of individual technologies but no experience combining technologies
- Long-term vendor availability and reliability
- Data management and handling
- Expected versus actual storage lifetimes, field performance
- Storage technology obsolesce
- Locally available technicians and parts for servicing O&M needs
- Changing standards and codes affect equipment availability

Ongoing and Future Work

- Collect more data to update the database
- Participating site performance data
- Operations and maintenance logs
- Expand PV cost model to include battery storage and more public information
- Industry suggested opportunities
  - Validation of name plate battery lifetime
  - Predictive maintenance and alarm tools
  - Refinement of analysis tools and metrics