Customized Predictions of the Installed Cost of Behind-the-Meter Battery Energy Storage Systems

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Motivation

- Deployment of behind-the-meter (BTM) battery energy storage systems (BESS) is accelerating.
- Bottom-up, detailed engineering estimates of the cost of a particular system at a single site are outside the scope of many research applications.
- Recent scholarly literature assumes a linear equation relating the total cost of BTM BESS to its energy capacity and power capacity.

Research Question

What equation best fits the data for the fully installed cost of BTM BESS?

Methodology

16 candidate equations were estimated and compared on the Akaike Information Criterion:

\[ AIC = 2k - 2\ln(L) \]

\( k \) = number of parameters

\( L \) = maximum of the likelihood function

Parameter Estimates

<table>
<thead>
<tr>
<th>Scale Parameters</th>
<th>Sector-Year Fixed Effects (ω^2)</th>
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</thead>
<tbody>
<tr>
<td>Energy (β_1)</td>
<td>Power (β_2)</td>
</tr>
<tr>
<td>-0.132 (0.043)</td>
<td>0.959 (0.038)</td>
</tr>
<tr>
<td>Energy^2 (γ_1)</td>
<td>Power^2 (γ_2)</td>
</tr>
<tr>
<td>0.551 (0.021)</td>
<td>0.601 (0.025)</td>
</tr>
<tr>
<td>Energy x Power  (γ_3) -1.141 (0.045)</td>
<td></td>
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</tbody>
</table>

\[ \ln(C_i) = \alpha + \beta_1 \ln(E_i) + \beta_2 \ln(P_i) + \gamma_1 \ln(E_i)^2 + \gamma_2 \ln(P_i)^2 + \gamma_3 \ln(E_i) \ln(P_i) + \delta_1 AC_i + \delta_2 DC_i + \delta_3 \ln(w_d^e) + \varepsilon_i \]

Results

A translog equation best fits the SGIP data:

\[ \ln(C_i) = \alpha + \beta_1 \ln(E_i) + \beta_2 \ln(P_i) + \gamma_1 \ln(E_i)^2 + \gamma_2 \ln(P_i)^2 + \gamma_3 \ln(E_i) \ln(P_i) + \delta_1 AC_i + \delta_2 DC_i + \delta_3 \ln(w_d^e) + \varepsilon_i \]


Acknowledgment

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Data Sources

- publicly-available Administrative data from the Self-Generation Incentive Program (SGIP) for California utility customers
- Tracking The Sun (TTS) database from Lawrence Berkeley National Laboratory

Economies of Scale in BTM BESS

values assumed: year = 2021, discharge duration = 2.64 hours, AC coupling, electrician wages = statewide median for 2021