Capacity Credit for Energy-Limited Resources

*Use of ELCC in the PSCo ERP*

ESIG Fall Conference

October 7, 2021
What We Are Discussing

aka “The ELCC Study”

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A Primer: Firm Capacity

PSCo 2030 Preferred Plan

<table>
<thead>
<tr>
<th>Resource</th>
<th>TOTAL*</th>
<th>FIRM</th>
<th>Capacity Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fossil-Based Generation</td>
<td>5,257</td>
<td>5,257</td>
<td>100%</td>
</tr>
<tr>
<td>Hydroelectric</td>
<td>24</td>
<td>13</td>
<td>55%</td>
</tr>
<tr>
<td>Solar</td>
<td>4,652</td>
<td>1,264</td>
<td>27%</td>
</tr>
<tr>
<td>Wind</td>
<td>5,738</td>
<td>843</td>
<td>15%</td>
</tr>
<tr>
<td>Storage and DR</td>
<td>1,581</td>
<td>1,300</td>
<td>82%</td>
</tr>
<tr>
<td>Total</td>
<td>17,252</td>
<td>8,678</td>
<td></td>
</tr>
</tbody>
</table>

*summer net dependable capacity

Installed Capacity × Capacity Credit = Firm Capacity

This is an Important concept.
Capacity Credit

• The amount of the installed capacity that counts as firm capacity, often expressed as a percentage (firm/installed)
  – Could be a rule of thumb (4hrs = 100%)
  – Regulatory designation
  – Approximate Generation Method
  – Effective Load Carrying Capability (ELCC)
    • This is the gold standard

ELCC is a mathematical method for determining a reliability-based capacity credit
The Dataset

- **Effective Load Carrying Capacity...**
  - 2023 thermal generation capacity, scheduled outages, Hx EFORs
  - Hourly load and renewable generation for six annual periods (2014-2019) carefully grown to 2023 levels and beyond
  - Hourly DR and storage dispatch to maximize LOLP reduction.
  - Calculations are for *incremental* resources of a system flush with wind, solar, and dispatchable energy-limited resources (ie DR, ES)

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Like Effects Like

ELCC changes with increasing penetration of like resource

Diversity Matters

RE sited in the same location drives down ELCC faster than a geographically diverse portfolio.
Incremental Wind

Colorado

ERZ1
ERZ2
ERZ3

Existing Wind
Incremental Wind

Colorado

ERZ3 – Diverse! Unique! HIGH

ERZ1/2 – Already has a LOT of wind

More Wind = Declining ELCC
Incremental Solar

[Graph showing average ELCC against incremental solar (MW_AC)]
Incremental Solar

More Solar = Declining ELCC

WS/NFR – Diverse! Unique! HIGH

BTM (behind the meter) – Concentrated in Denver Metro area; technology disadvantage (fixed pane)

Geographic diversity wins in the end

SFR – Already has a LOT

More Solar = Declining ELCC
Incremental Storage
Incremental Storage

Already have over 1100MW of (~4hr) energy storage or like resources

More hours, higher ELCC

Incremental to existing 1100MW...

More Storage = Declining ELCC
Storage and Solar

Graph showing the relationship between incremental solar (MW) and average ELC (percentage) for different MW of 4-hour storage.
Storage and Solar

More Storage = Declining ELCC!

A LOT More Solar = Inc ELCC

DIVERSIFIED