Effective Load Carrying Capability (ELCC) Analysis for Wind and Solar Resources

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• PJM’s original objective was to calculate ELCC of wind resources to justify making a change to the current wind capacity credit calculation
  – The change was to use the median instead of the mean performance of wind units over peak summer hours
• After PJM presented the ELCC results, stakeholders showed interest in the overall ELCC methodology
Effective Load Carrying Capability (ELCC)

- Methodology to determine the contribution that an individual generator or a fleet of generators makes to overall system resource adequacy
- Specifically, ELCC is a measure of the additional load that the system can supply with the particular generator(s) of interest, without a change in reliability
- Consequently, the ELCC results are driven by the output of the generator(s) of interest during hours with potentially high reliability risk
• The ELCC analysis was performed using GE-MARS, a resource adequacy software tool.
• The Wind ELCC was calculated for the collection of wind resources projected for DY 2021/22.
  – 12,540 MW of nameplate capacity approximately
• Nine Wind ELCC values were calculated, one for each delivery year in the period 2009/10 – 2017/18
• The capacity model was from the 2017 Reserve Requirement Study
Wind ELCC Analysis – Input Load/Wind Shapes

• Each of the nine hourly load shapes was derived as follows:
  – Each of the 8,760 unrestricted hourly loads was divided by the peak unrestricted hourly load in the calendar year

• Each of the nine hourly wind shapes was derived as follows:
  – For each of the 8,760 hours, the total simultaneous wind output was calculated (only wind farms that were in-service for the entire duration of the delivery year were included)
  – The total simultaneous wind output for each hour was then divided by the total nameplate wind capacity in the delivery year
  – The per-unitized hourly values above were then multiplied by the projected nameplate wind capacity in 2021/22
Wind ELCC Analysis – Procedure

• Using each of the nine hourly load shapes (and without using the hourly wind shapes), iteratively modify the hourly peak load until the LOLE is 0.1 days/year
  – Each of these nine Base cases now meets the 1 day in 10 years criterion
• Add the corresponding wind hourly shape to each of the nine Base cases. The LOLE will now be less than 0.1 days/year.
• Increase the hourly peak load in each of the nine cases above until the LOLE is back at 0.1 days/year.
• The difference between this New hourly peak load and the hourly peak load from the Base case is the ELCC (in MW). The ELCC is commonly expressed as a percentage of the nameplate capacity.
Wind ELCC Analysis – Results

The mean ELCC is 11.3%; the median ELCC is 9.1%
The ELCC analysis was performed using GE-MARS, a resource adequacy software.

The Solar ELCC was calculated for the projected set of solar resources for delivery year 2021/22.  
- 1,710 MW of nameplate capacity approximately

Six Solar ELCC values were calculated, one for each delivery year in the period 2012/13 – 2017/18

The capacity model was from the 2017 Reserve Requirement Study
The mean ELCC is $48.5\%$; the median ELCC is $50.2\%$
• The above RTO-wide Wind/Solar ELCC values apply to the entire set of Wind/Solar resources
• The ELCC needs to be allocated to the individual wind and solar units based on individual unit performance
  – The allocation must be performed for Existing and New units
• How should the allocation be performed?
Allocation of ELCC – MISO’s methodology

• MISO only performs ELCC for Wind resources
• MISO allocates the ELCC as follows,
  – For Existing resources, the system-wide capacity credit is calculated as the ELCC (in %) times the total existing nameplate. This system-wide MW capacity credit is then allocated to individual units based on the average output of an individual wind unit during the top 8 daily peak hours in each year for which the unit was in-service
  – For New resources, the capacity credit corresponds to the system-wide ELCC (in %) times the nameplate of the new unit.
Allocation of ELCC – Existing Resources - Options

• For Existing resources, the system-wide MW capacity credit is calculated as the ELCC (in %) times the total existing nameplate capacity.
  – Identical to what MISO does, so far

• To allocate this system-wide MW capacity credit, PJM can prorate it based on:
  – **Option A**: the average output of an individual unit during the top X daily peak hours in each year for which the unit was in-service
  – **Option B**: the average output of an individual unit during the daily peak hours where the LOLE is non-zero in each year for which the unit was in-service
  – **Option C**: the average output of an individual unit during hours ending 3, 4, 5, 6 PM during the summer season in each year for which the unit was in-service
## Allocation of ELCC – Existing Resources - Options

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<thead>
<tr>
<th>Options</th>
<th>Pros</th>
<th>Cons</th>
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<tbody>
<tr>
<td>Option A</td>
<td>- More data points compared with Option B</td>
<td>- A few of the hours now included do not matter from an LOLE perspective</td>
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<tr>
<td>Option B</td>
<td>- More consistent with system-wide ELCC result, which is driven by hours with LOLE</td>
<td>- Limited amount of data, especially for units with shorter history</td>
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<tr>
<td>Option C</td>
<td>- Significantly more data points</td>
<td>- Most of the hours now included do not matter from an LOLE perspective</td>
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Existing Wind Resources - Option A (Top 8 Hours) - Results

ELCC = 11.3%
 Existing Wind Resources - Option B - Results

ELCC = 11.3%
Existing Solar Resources - Option A (Top 8 Hours) - Results

ELCC = 48.5%
Existing Solar Resources - Option B - Results

ELCC = 48.5%
Existing Solar Resources – Options A & B - Results

ELCC = 48.5%
• PJM has not calculated the potential allocation under Option C yet.
For New resources, the capacity credit can be calculated as

- **Option A**: the system-wide ELCC (in %) times the nameplate of the new unit (the MISO methodology)
- **Option B**: an estimated zonal ELCC (in %) times the nameplate of the new unit
- **Option C**: an estimated unit-type ELCC (in %) times the nameplate of the new unit
## Allocation of ELCC – New Resources - Options

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<td>Option A</td>
<td>- More consistent with system-wide ELCC result</td>
<td>- Less granularity</td>
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| Option B | - More granularity | - Limited amount of units in some zones  
- Less consistent with system-wide ELCC result |
| Option C | - More granularity | - Limited amount of units in some unit-type categories  
- Less consistent with system-wide ELCC result |
Next Steps

- PC – November: Seek feedback from stakeholders
- PC – December: Further discussion
- PC – January: First read of proposed manual changes