Manual 21
Rules and Procedures for Determination of Generating Capability Changes

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Operating Committee
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New CIR Section

- How CIRs are attained
  - ISA, WMPA or Integration
    - Results of a deliverability study
- How CIRs are retained/lost
  - Performing summer capability verification tests
  - Proving CIRs once every three years
  - Specific rules for units with aggregated CIRs
Appendix B, Wind and Solar Capacity Factors

- Wind and Solar capability should be based on the 50/50 expectation of production
  - Current Wind/Solar capability is based on the peak hour average (June 1 through August 31, Hours Ending 1500-1800 LPT)
  - It was thought that the peak hour average was a good approximation for the median
  - For the average solar unit, the above is true; however, for nearly two in seven hours there is no production from the average wind unit and this causes the mean and median to diverge
  - The peak hour median capacity factor is what should be used to estimate future performance

- For the analysis on the next two slides a load index was created
  - The load index is the unrestricted PJM RTO load (for each peak hour) divided by the PJM Weather Normalized Peak for that year
  - Wind/Solar mean and median capacity factors are plotted against the load index
Solar Capacity Factors
Summer Peak Hours (HE 1500-1800)
2015-2017

Load Index
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0

Capacity factor %
0 10 20 30 40 50 60 70

- Average Capacity Factor
- Median Capacity Factor
- Linear (Average Capacity Factor)
- Linear (Median Capacity Factor)
Wind Capacity Factors
Summer Peak Hours (HE 1500-1800)
2015-2017

Summer Peak Hours

<table>
<thead>
<tr>
<th>Unit Type</th>
<th>Average Capacity Factor</th>
<th>Median Capacity Factor</th>
<th>Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind</td>
<td>15.4</td>
<td>7.0</td>
<td>Summer 2008-2017</td>
</tr>
<tr>
<td>Solar</td>
<td>39.9</td>
<td>38.6</td>
<td>Summer 2008-2017</td>
</tr>
<tr>
<td>Wind</td>
<td>16.7</td>
<td>7.9</td>
<td>Summer 2015-2017</td>
</tr>
<tr>
<td>Solar</td>
<td>42.1</td>
<td>40.9</td>
<td>Summer 2015-2017</td>
</tr>
</tbody>
</table>
Appendix B, Wind and Solar Capacity Factors

• Wind
  – The peak hour average is about the 64th percentile production level
  – In other words, that production level is expected only 36% of the peak hours
  – Typically, wind production is zero in 2 of every 7 peak summer hours

• Solar
  – The peak hour average is nearly the 50th percentile production level

• Proposed change
  – Use the median capacity factor instead of the average capacity factor for both wind and solar resources starting Delivery Year 2022/2023
Intermittent and Capacity Storage Resources

- Intermittent and Capacity Storage Resources are defined in PJM Manual 18
  - Capacity Storage Resources
    - Pumped Storage Hydro
    - Conventional hydro with pooling/storage/dispach capability
    - Batteries
    - Flywheels
  - Intermittent Resources
    - Wind
    - Solar
    - Conventional hydro without pooling/storage/dispach capability
    - Landfill Gas Units

- These resource types have no must offer requirement in CP
- All but Wind/Solar have test requirements covered in Manual 21, Appendix A (Discrete Test)
- Wind/Solar have test requirements covered in Manual 21, Appendix B (Capacity Factors)
• ICAP is expected to be determined with respect to the RAA, Schedule 9.C
  • The rules and procedures shall recognize the difference in types of generating units and the relative ability of units to maintain output at stated capability over a specified period of time. Factors affecting such ability include, but are not limited to, fuel availability, stream flow for hydro units, reservoir storage for hydro and pumped storage units, mechanical limitations, and system operating policies.

• ICAP must also be determined using site conditions coincident with the past 15 years’ PJM summer/winter peaks
  – This is a proxy for future PJM peak conditions

• ICAP needs to be based on summer/winter conditions per Manual 21; not specifically the nameplate or prime mover rating if summer/winter conditions limit the plants output

• ICAP should be based on streamflow/head expected during the summer/winter peaks

• The new version of Manual 21 should require simultaneous testing of all Intermittent and Capacity Storage Resources at a plant to ensure that the plant can produce its total ICAP (Pumped Storage Units may need to be exempt from the simultaneous test).
• 90% of all PJM summer peaks in the last 40 years occurred in July and August
  – Does the June through August testing period remain sensible?
• If plants have common load that is spread across multiple units, would simultaneous testing be more indicative of a plants true capability?
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