Reserve Capability Calculation with Segmented Ramp Rates

Market Implementation Committee

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Joel Romero Luna

Monitoring Analytics

Reserve Capability Calculation

- **PJM calculates reserves using the units' ramp rates. The reserves are also limited by the units' Eco Max, Synchronized Reserve Max or Secondary Reserve Max.**
- **Equations:**
  - **SR MW Capability = max {0, min [min(EcoMax, Synch Max) – Initial Energy Output, RampRate*10 minutes]}**
  - **SecR MW Capability = max {0, min [min(EcoMax, SecR Max) – Initial Energy Output, RampRate* 30 minutes] – SR MW}**

Ramp Rates

- **Units can offer a single ramp rate or use a segmented ramp rate curve.**
- **For units using a single ramp rate, PJM uses such ramp rate.**
- **For units using a segmented ramp rate curve, PJM calculates a ramp rate equal to the units' 10 minute ramping capability (in MW) from the initial energy output by 10 minutes.**
  - **DA, the initial energy output is the output the hour before.**
  - **RT, the initial energy output is equal to the state estimator MW.**

Example

- **A unit with the ramp rate curve below, synch max of 600 MW and initial MW of 450 MW will have a calculated ramp rate of 5.5 MW per minute to be used in the reserve capability calculation.**

Output (MW)	Ramp Rate (MW/min)
500	10
550	1

Example

- **The 5.5 MW per minute is equal to 5 minutes at 10 MW per minute to go from 450 MW (initial MW) to the first segment of the ramp rate curve (500 MW). Next, 5 more minutes (to complete 10 minutes) at 1 MW. The ramp rate is equal to:**

$$\text{Average Ramp Rate} = \frac{[(5\ \text{min} \times 10\ \text{MW/min}) + (5\ \text{min} \times 1\ \text{MW/min})]}{(5\ \text{min} + 5\ \text{min})} = \frac{55\ \text{MW}}{10\ \text{min}} = 5.5\ \text{MW/min}$$

Example

- **The 5.5 MW/min ramp rate is used in the synchronized reserve (SR) MW capability calculation. This unit SR MW will be limited by 5.5 MW/min times 10 minutes, or 55 MW. The unit can provide 100 MW of SR reserves when operating between 300 MW and 400 MW. Beyond 400 MW, the unit's SR capability is reduced because the ramp rate goes down to 1 MW/minute after 500 MW.**

Example

- **Because this calculation is done before the optimization and before the calculation of the dispatch signal, the result could be under or overstating the actual capability. In the example above, if the dispatch signal is 400 MW, the unit can provide 100 MW of SR. If the dispatch signal is 500 MW, the unit can provide 10 MW of SR.**
- **The calculation results in the correct capability when the dispatch signal is equal to the initial MW or when the units are not crossing a discontinuity on the ramp rate curve.**

MMU Recommendation

- **The Market Monitor had previously recommended that Market Participants use segmented ramp rates and not synchronized reserve max to reflect discontinuities in offer curves. That recommendation was based on an incorrect assumption that reserve capability is calculated from the dispatch signal.**

MMU Recommendation

- **For example, a CC can use a slow ramp rate when it reaches the duct burner MW level on its offer curve to reflect the amount of time it takes to bring the duct burners on.**
- **The idea behind the use of slow ramp rates is to ensure that SCED does not dispatch the unit up to a level the unit cannot achieve in 5-10 minutes.**
- **Another benefit, if done correctly, is that the unit will not be assigned reserves it cannot provide in 10 minutes.**

MMU Recommendation

- **The assumption that reserve capability is calculated from the dispatch signal was not correct.**
- **Ideally, reserves are calculated as the MW a unit can provide in 10 minutes from the dispatch signal.**
- **When the ramping capability changes due to segmented ramp rates, that assumption is incorrect.**

MMU Recommendation

- **The Market Monitor still believes units should use segmented ramp rates to reflect discontinuities but it no longer believes that segmented ramp rates can replace the use of synchronized reserve max given the reserve capability calculation.**
- **The MMU recommends that PJM:**
  - **Document in Manual 11 how the ramp rate used in the SR and SecR MW capability is calculated.**
  - **Communicate to all units with discontinuities that they should request use of synchronized reserve max to reflect such discontinuities in the reserve MW capability calculation.**

Communication

- **Requests should be sent to PJM/MA at reserves@pjm.com**
- **Market Sellers should include supporting documentation in the requests. For example, operating level at which additional equipment needs to be deployed in order to reach higher outputs.**

Ideal Calculation

- **The ideal calculation of the ramping capability of the units should be a function of the energy signal. Equations:**
  - **SR MW Capability = max {0, min [min(EcoMax, Synch Max) – Energy Signal , 10 Minutes Ramping Capability from Energy Signal]}**
  - **SecR MW Capability = max {0, min [min(EcoMax, SecR Max) – Energy Signal, 30 Minutes Ramping Capability from Energy Signal] – SR MW}**
- **This is not possible without changes to the market engine. This will also affect the performance of the engine.**

MMU Recommendation

- **The ultimate and practical solution for this problem is to treat discontinuities as additional commitment instructions. This requires improved unit modeling.**
- **For example, units will provide the time required to deploy additional equipment and/or operating modes along with minimum run times and minimum down times.**

MMU Recommendation

- **SCED would then provide commitment recommendations when the additional MW should be deployed.**
- **MW that can be deployed in 10 minutes would qualify as synchronized reserves.**
- **MW that can be deployed in 30 minutes would qualify as secondary reserves.**
- **There would be no need for synchronized reserve max or secondary reserve max parameters.**
- **Reserves and energy would be consistent.**

Monitoring Analytics, LLC
2621 Van Buren Avenue
Suite 160
Eagleville, PA
19403
(610) 271-8050

MA@monitoringanalytics.com
www.MonitoringAnalytics.com