Needs For and Alternatives To

APPENDIX 7.4

Capacity Value of Wind Resources

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Capacity Value of Wind Resources

In analyzing wind resources, it is important to distinguish the difference between the average capacity factor of a wind resource, and the capacity value (also called the capacity credit) of a wind resource on the planning horizon. The average capacity factor for a wind resource is equal to the actual wind generation for the period divided by the wind generator capacity times the number of hours in the period. For example, if a 100 MW (megawatt) wind farm produced 341,640 MWh (megawatt-hours) per year, the capacity factor can be calculated as 39% (341,640/ (100 MW x 8,760 hours per year)).

The capacity value of a wind resource is that portion of a wind generator's capacity that can be counted on to meeting the peak regional load. As wind is an intermittent resource, a wind generator is unlikely to be at full output during peak system load conditions. In fact, wind generation output within the Midcontinent Independent System Operator (MISO) market footprint is negatively correlated with the MISO load, as noted by MISO's Independent Market Monitor:

> "Wind output is strongly negatively correlated with load, which means that wind is often the lowest during peak periods when it is needed most. This presents challenges for developing an appropriate capacity credit for wind resources[1]."

Given the intermittent nature of the wind resource, the determination of the capacity value of wind is inherently complex, as noted by NERC in its 2009 Special Report[2]:

> "The calculation of the capacity contribution of conventional generating units to reserve margins is somewhat straightforward, based on the unit performance rating, forced outage rate, and annual unforced maintenance cycle. However, the capacity contribution of variable generation is not intuitive due to its inherent characteristics of variability and uncertainty."

[1] Potomac Economics, 2012 STATE OF THE MARKET REPORT FOR THE MISO ELECTRICITY MARKETS ANALYTICAL APPENDIX, June 2013, Page A26.

[2] North American Electric Reliability Corporation, Special Report: Accommodating High Levels of Variable Generation, April 2009, page 38.

MISO annually determines a wind resource capacity credit for wind generation located within the MISO market footprint. Note that the MISO market is a summer peaking region and the capacity value of wind to the MISO market is derived from the capacity contribution of the wind generation during the summer peak load hours. MISO's most recent analysis[3] was issued on December 1, 2012 and concluded:

> "The system-wide wind resource capacity credit for Planning Year 2013 is 13.3 percent. This was the fourth year of applying a process based on determining the Effective Load Carrying Capability (ELCC) from analyzing wind performance over historical years since 2005.
>
> As of June 30, 2012 there was 11,774 MW of registered wind capacity on the MISO system. After analyzing 2005 through August 2012 wind performance, this means that 11,774 x 13.3 percent = 1,567 MW potentially qualify as unforced capacity megawatts under Module E-1 of MISO's tariff. To the extent that the 1,567 MW of unforced wind capacity is deliverable at the individual wind Commercial Pricing Nodes (CPnodes), the unforced capacity megawatts may be converted to Zonal Resource Credits (ZRC) to meet Resource Adequacy obligations."

MISO's determination of the proportion of planning capacity for wind generation based on 13.3% of the wind farm capacity was disputed by Potomac Economics, MISO's Independent Market Monitor[4], who stated:

> "Wind resources receive capacity credits toward satisfying Module E requirements that are only a fraction of their installed capacity. This is because their output is variable and intermittent, and their full capability cannot be relied upon during peak load times. Credits averaged 14.9 percent for Planning Year (PY) 2012–13 and 13.3 percent for PY 2013–14. These credits reflect the average performance of wind resources during prior years' peak load hours.

[3] MISO 2013 Wind Capacity Credit Report dated December 1, 2012.

[4] Potomac Economics, 2012 STATE OF THE MARKET REPORT FOR THE MISO ELECTRICITY MARKETS, June 2013, page 15.

> We [MISO's Independent Market Monitor] believe that these UCAP credits substantially exceed the true capacity value of the wind resources. As much as possible, wind UCAP credit should be estimated in a manner that produces a comparable level of expected availability to other types of generating resources.
>
> However, this is not the case under MISO's methodology, which produces wind credits that will likely not be achieved in most peak load hours. Because its methodology is based on the mean wind output, one unusually windy peak day can cause this measure and the resulting capacity credits to be overstated. Using the median output level by unit in peak load hours would lower the average PY 2013–14 capacity credit to 11.5 percent. Even using the median, however, overstates the credit because one should expect the wind output to be less than this level in half of the peak load hours. Therefore, this report shows the effects of assuming the lowest quartile of output during peak hours on the unit-by-unit basis. This methodology would produce an average capacity credit for the wind resources of 2.7 percent for PY 2013–14. We recommend that MISO consider this as an alternative for granting UCAP credits for wind resources in future."

For Manitoba Hydro, the analysis of capacity value of wind must consider the winter season as Manitoba Hydro has a winter peaking load. Manitoba Hydro has examined the performance of the existing wind generation fleet in Manitoba during the peak load hour of each month during the period from June 2007 to May 2013. In examining the data it was found that the minimum wind generation, during the peak load hour each month, was zero or near zero each least once each month.

A further consideration for wind turbine operation in Manitoba is low temperature operation. At the present time, commercially available utility scale wind turbines are shut down at -30°C to avoid mechanical failures as a result of low temperature operation. As Manitoba Hydro is winter peaking, the very extreme cold temperatures that cause low temperature wind turbine shut downs also tend to cause peak load conditions.

In consideration of the performance to date of wind generation during the peak monthly load conditions, and the operating requirement to shut down wind generators at -30°C, when the Manitoba load tends to be peaking, Manitoba Hydro has determined that the capacity value of wind generation within Manitoba to meeting the winter peak load is zero.