Impact of Curtailment on Wind Economics

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The increase in utility scale wind development across North America has and continues to change the energy supply mix in many jurisdictions. Driven primarily by state-level renewable portfolio standard (RPS) requirements and clean air regulation, state and provincial supply mixes once dominated by coal, hydro nuclear and natural gas are now becoming more diverse. Intermittent generation sources – once a small component of total capacity – are becoming substantial. And, as a result, system operators have had to periodically curtail these intermittent generators in order to maintain system balance and reliability.
A 2010 study conducted for the National Renewable Energy Laboratory (NREL) revealed that 2009 wind generation curtailment varied significantly by jurisdiction — ranging from as low as 1 percent in the Midwest Transmission System Operator's (MISO) control area to as high as 16 percent and 10 percent in Texas and Alberta, Canada respectively. These higher levels of curtailment can have a significant impact on a wind generator's economics. The table below provides an overview of the impacts of different levels of curtailment on both revenue and the Debt Service Coverage Ratio (DSCR), a key metric used by lenders to determine a project's ability to meet debt obligations.[1]

% of generation curtailed	0%	1%	5%	10%
Reduction in revenue	0%	1%	5%	10%
DSCR	1.45	1.43	1.36	1.28
Reduction in DSCR	—	1%	6%	12%

Impact of curtailment o0n DSCR for wind.

At 1 percent curtailment, revenues and DSCR remain at a level that would be comfortable to most lenders. However, at 5 percent curtailment and higher, revenues and DSCR deteriorate, putting projects at risk of not meeting their debt obligations or reducing the amount of debt the project's cash flows can support.

Will Curtailment Continue to be an Issue?

Curtailment can occur for any number of reasons including local congestion, global oversupply, and operational issues. Each type of curtailment occurs with differing frequency depending on the regional and local system's generation and electrical characteristics.

Local Congestion

Local congestion occurs when there is more generation, wind or otherwise, than there is available transmission or distribution capacity to move the power to load centres. Nowhere has this been better demonstrated than in West Texas where there are excellent wind resources and limited transmission capacity. In 2009 there were about 8,000 MW of installed capacity but only 4,500 MW of available transmission, according to the same 2010 NREL study. As a result, monthly wind curtailment averaged between 24 to 28 percent in the February to April 2009 timeframe. Due to the shorter development times associated with building wind farms as compared to transmission lines, local congestion can have an ongoing impact on wind projects economics. Although transmission development *should* eventually catch up with intermittent generation development (wind or other) and relieve the majority of curtailment, system planners typically design transmission upgrades to incorporate an allowable amount of congestion. For example, the Ontario Power Authority used a 5 percent planned congestion level when it assessed transmission expansions in a study it conducted under Ontario's Feed-in Tariff program.

Global Oversupply

During the economic downturn of 2008/2009, a number of jurisdictions across North America had more generating capacity than needed. During this time of low energy demand, several jurisdictions experienced periods of global oversupply – when the amount of generation on the system exceeded local demand – which, in some cases, created negative price environments. Concern over negative prices appears to be part of the reason Bonneville Power Administration (BPA) curtailed wind generators during periods of high hydro generation and low energy demand in 2011. Jurisdictions with an inflexible baseload resource (such as nuclear and large hydro in Ontario, or large hydro in BPA) are inherently more susceptible to periods of global oversupply. The incremental impacts of intermittent generation on systems with these characteristics can cause undesirable outcomes such as curtailment, negative price environments or temporary shutdown and restart of nuclear units.

While global oversupply conditions are anticipated to subside as energy demand recovers in the coming years, these conditions can have a significant impact on new and existing generators if they are not contractually protected against this type of curtailment.

Operational Curtailment

Operational curtailment includes curtailment related to ensuring sufficient supply is available to meet variations in demand and intermittent generation. As electricity demand increases and decreases throughout the day, so must generation. A system operator's ability to ramp up and down generation in order to meet changing demand is critical to ensuring that supply and demand are always in balance. The highest rate of increase in demand often occurs in the morning. Although some

areas rely on storage hydro to increase output during these times, typically coal and/or natural gas generation provide this ramping capability. In anticipation of this period of ramping, coal and natural gas generators may need to be started early to ensure sufficient ramping capability to meet the changing load. In order to accommodate this generation, other intermittent generation, such as wind, may have to be curtailed.

As coal plants are retired in favour of natural gas combined cycle generation in order to meet new Environmental Protection Agency (EPA) regulations, operational forms of curtailment are likely to increase due to the reduced flexibility of natural gas combined cycle generation relative to that of coal. While the change-out from coal to gas has significant environmental benefits, from an operability perspective, coal-fired generation provides a distinct advantage in that it can operate at a lower minimum load ratio to its rated capacity. A typical coal plant can turn down to about 20 percent of its rated capacity, as compared to 40 percent for natural gas combined cycle units. For a 500-MW generator, the result is 100 MW of additional generation. Therefore, if natural gas combined cycle plants are being used instead of coal plants to ramp up supply to meet morning peak demand, there will be more supply on the system resulting in possible curtailment of wind in order to maintain system balance.

Ongoing development of intermittent resources (due to existing RPS rules, as well the substitution of coal-fired power for natural gas) means increasing the likelihood of curtailment. Assessing the project-specific risks associated with a new or existing project requires understanding its exposure to all types of curtailment. Unless contract provisions protect generators from all types of curtailment, developers, investors and lenders need to understand the project-specific interconnection, market rules, local generation and transmission system characteristics in order to forecast exposure to curtailment over a project’s life.

Curtailment will continue to have an impact on renewable project returns. Even curtailment of 5 percent of potential output, which has occurred in several jurisdictions in North America in the last few years, can reduce the DSCR such that incremental equity payments are required from investors. Projects operating in deregulated markets with insufficient transmission, significant amounts of wind, and/or inflexible baseload resources are likely to have the highest levels of exposure. However, even in regulated markets, site and zonal-specific details will play a significant role in estimating curtailment’s total impact.

[1] Calculations assume a 35% capacity factor, total revenue of $85/MWh, a debt/equity ratio of 75/25, a cost of debt of 6% and a O&M of $40/kW-year.

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www.renewableenergyworld.com [1]

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