

Examples of Wind Curtailment

Kevin Porter and Sari Fink
Exeter Associates, Inc.

Energy Foundation Meeting on Wind Integration
Beijing, China
June 2010

Outline

- Introduction
- Examples of Wind Curtailment
 - Generator interconnection
 - Contractual
 - Bid-based curtailment
 - Daily operating limits
 - By type of wind technology
 - Amount of available reserves
- Compensation
- Curtailment Data
- Conclusions

Introduction

- Wind power development has increased dramatically over the last decade, while transmission investment in many regions has failed to keep pace.
- Additionally, wind facility construction times are much shorter than for transmission.
- Wind may blow stronger at night when loads are low.
- This has resulted in situations where wind energy production can at times exceed the electricity system's ability to operate reliably.
- Curtailment of wind energy has increased as a result.
- This presentation summarizes different approaches.

Condition of Generator Interconnection

- Wind generators connecting to the grid are required (like all generators) to execute interconnection agreements.
- These interconnection agreements can include clauses whereby wind facilities agree to curtail generation, on request from the grid operator, if transmission constraints or system conditions require it.

Examples: E.On Netz and BPA

E.On Netz in Germany required wind generators to accept 'wind power management' for interconnecting in certain areas until transmission upgrades were completed.

Bonneville Power Administration in Western U.S. includes curtailment procedures in large generation interconnection agreements for wind facilities.

Contractual

- Some individual utilities include wind curtailment conditions in power purchase agreements.
- Under these agreements, wind facilities often provide a set amount of wind generation curtailment for a specified amount of time each year at no cost or reduced cost to the purchasing utility.

Example: Xcel Energy

Xcel Energy has contractual agreements with wind plants in Minnesota and Colorado to provide set amounts of curtailment.

The Logan Wind plant in Colorado has a contract to provide up to 14 GWh of annual curtailment at no cost, as of 2008.

Wind plants in Minnesota curtailed on a rotational basis and are made whole by Xcel for the curtailed energy.

Market Bid-Based

- Some regions with wholesale energy markets are integrating wind energy into their economic dispatch.
- Wind generators bid price curves into wholesale markets indicating at what prices and amounts they are willing to generate.
- Due to tax credits/incentives wind plants may want to produce at negative prices.

Example: New York ISO

In 2009 the NYISO implemented new market rules for wind energy. Wind plants can bid price curves, up to 11 price-quantity pairs into the real-time energy market for each operating hour. NYISO altered its economic dispatch software to accept negative prices. Wind generators must participate in the NYISO's wind forecast and be able to accept electronic basepoint dispatch signals.

Daily Operating Limits

- Some grid operators have imposed daily operating limits on wind farms.
- This is generally done on an area-specific basis when there is a concentration of wind plants developed in a single transmission constrained region.
- Wind plants must match their output to the daily limit.

Example: ERCOT

Wind facilities developed rapidly in the less-populated wind-rich areas of West Texas.

Because of a lack of adequate transmission, the Electric Reliability Council of Texas (ERCOT) instituted daily operating limits on wind plants in the McCamey area. ERCOT used day-ahead load projections to calculate and assign operating limits to the wind plants for the next day. ERCOT stopped using daily operating limits in 2009.

Differentiated by Technology

- Wind technology has evolved quickly over the last decade.
- Newer wind plants have more advanced control capabilities.
- Some grid operators have taken advantage of the advanced control capabilities for faster response to system events.

Example: ERCOT

In west Texas, ERCOT also created two categories of wind plants – rapid response (RRWF) and slow response (SRWF).

During congested times RRWF's could reduce production within 15 min and SRWFs would be able to respond within 30 minutes.

In the following hour, pro-rata shares would be adjusted to allow RRWFs to recoup the extra lost production.

Availability of Reserves

- Some grid operators have tied wind curtailment to the availability of generation reserves.
- When generation reserve use reaches a set level, wind is asked to curtail production to the lower of their scheduled amount or actual operating amount.
- This reduces the need to acquire additional reserve generation.

Example: BPA

The Bonneville Power Administration (BPA) manages and sells hydro power from federal dams in the Pacific Northwest. BPA also has integrated over 2,700 MW of wind and says it is running low on reserves. To manage reserves, BPA requires wind generators to reduce schedules to the lower of their scheduled amount or actual generation, once 90% of these balancing reserves have been utilized .

Compensation

- Compensation for lost energy production varies by jurisdiction both within the U.S. and outside the U.S.
- Compensation can also be differentiated by the reasons for the curtailment.
- Situations where wind plants may not be compensated include:
 - Curtailments may be covered by contract or by agreement.
 - Curtailments are due to a system emergency or reliability event where all generation may be curtailed.
 - Transmission constraint was caused or aggravated by the curtailed wind plant.
 - Curtailment is the outcome of a market-based economic dispatch process (i.e., by virtue of market bids, wind curtailment was the most economic option to curtail).

Compensation (cont.)

- When provided, compensation amounts can be determined in various ways. Examples include:
 - ERCOT paid out-of-merit energy payments for curtailments in real-time.
 - Southern California Edison provides make whole payments for energy.
 - Xcel Energy provides make whole payments for both fixed and variable wind plant costs in Minnesota and make whole payments, including the Production Tax Credit, for curtailments in Colorado that are above the contracted amounts.
 - Germany provided payments equal to lost revenues.
 - In Ireland, curtailed wind plants are paid in the energy markets as if they generated at full available output.
 - In Spain, compensation for real-time curtailments is a percentage of the wholesale price of electricity, currently set at 15%.

Curtailment Data

- Curtailment data can be difficult to acquire as there are seldom requirements in place for reporting it.
- The table below gives some data for various jurisdictions.

Entity	Curtailment Data
BPA	As of March 30, 2010, total cumulative capacity of wind that has been limited is 2900 MW.
ERCOT	In 2009, curtailed on average around 500 to 2,000 MW daily, max amount approximately 3,900 MW. ERCOT curtailed about 16% of wind generation in 2009.
Midwest ISO	In 2009, around 1,100 incidences of wind curtailment totaling about 200,000 MWh, representing about 1% of total wind generation.
SCE	About 15 MW for 3-4 hours every two days from a single wind plant in Tehachapi (contractual arrangement).
Xcel	In 2009, 42,359 MWh of wind generation in Minnesota and 18,991 MWh of wind generation in Colorado were curtailed.
Alberta ESO	Curtailed wind for about 838 hours in 2009.
Germany	Between 2004 and 2006, approximately 74,000 MWh of wind energy was curtailed.
Ireland	In 2008, approximately 100 MWh of wind energy was curtailed.
Spain	In 2009, approximately 54,000 MWh of wind curtailed, or about 0.15% of total wind production. Expected to increase dramatically to as much as 6.8%.

Conclusions

- Amount of wind curtailment is likely to rise in the United States and elsewhere, at least until transmission issues are resolved.
- If curtailments are necessary the following principles should be incorporated into curtailment initiatives:
 - Grid operators should ensure that all actions that can be taken have been taken prior to curtailing any generation, such as ensuring all non-wind generation is running at minimum, imports have been reduced or eliminated, and export opportunities have been exhausted.
 - If curtailments are necessary, wind should be treated comparably with all generation. Wind should not be curtailed just because it is easy to do so.
 - To the extent that markets allow/exist, wind generators (along with all generators) should have the option/ability to bid in prices at which they are willing to be curtailed.
 - Issue of whether generators (including wind) should be paid if curtailed (and how much) needs to be addressed.
 - Other measures to reduce curtailment include large balancing areas, dynamic scheduling and dynamic ratings of transmission lines.

Report

- Full report is at <http://www.nrel.gov/docs/fy10osti/46716.pdf>.

Contact Information

Kevin Porter

Exeter Associates, Inc.

10480 Little Patuxent Parkway, Suite 300

Columbia, MD 21044

410-992-7500

410-992-3445 fax

kporter@exeterassociates.com