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# Recommendation on Issues Related to the Curtailment of In-State Electric Generation Plants

## I. Introduction

Section E.233(a)(2) of Act 50 requires that the Vermont Department of Public Service "submit to the House and Senate Committees on Natural Resources and Energy . . . a recommendation on issues related to the curtailment of in-state electric generation plants." This report summarizes the primary reasons that generation projects in Vermont are curtailed, notes the impacts of curtailment, and provides recommendations on strategies to address curtailment of generation resources. In addition, we note the availability of a memorandum prepared by ISO-NE[1] that provides a summary of wind power and curtailment in New England, attached to this report.

## II. ISO-NE Interconnection Process

In order to interconnect generation units with a nameplate capacity of approximately 5 MW or greater in New England, the generator must follow the interconnection process required by ISO-NE.[2] ISO-NE in turn must comply with requirements of the Federal Energy Regulatory Commission (FERC) and the National Electric Reliability Corporation. The interconnection process is required to ensure that the introduction of new generation into the transmission system does not adversely impact system stability (which involves controlling voltage and the frequency of alternating current) and reliability (which ensures that the transmission system will function as designed). Since it is difficult to store generation on a large scale, the amount of energy used and produced must be balanced; further, once electricity is generated, it will flow across the system depending on the configuration and status of the transmission lines. The interconnection process requires an analysis of the system conditions and how a proposed generation unit will impact both the typical operating conditions and reasonably anticipated changes to the system.

The interconnection process requires that the developer pay for studies that examine the potential impacts of the project on the electric grid. The proposed location and size of the unit will determine the complexity of the studies necessary – for example, a unit with a small nameplate capacity located in an area with a robust transmission system would likely have fewer interconnection issues. A developer must conduct a system impact study, which is a detailed analysis of the proposed generator's impact on the stability of the transmission grid and which identifies the upgrades needed to mitigate

[1] ISO-NE is the Independent System Operator (ISO) or Regional Transmission Organization (RTO) for the New England region. Each part of the country has an RTO or somewhat similar entity that is responsible for reliably dispatching generation and managing transmission planning, and where applicable, wholesale electric markets.
[2] Generation units with a nameplate capacity of less than 5 MW are typically reviewed under Public Service Board Rule 5.500 – *Interconnection Procedures for Proposed Electric Generation Resources.*

any impacts the generator may have on the system. The interconnection studies require certain information, such as the nameplate capacity of the project, the capacity of the transmission line, the amount of load in the area, and what could happen to the system if the generator is operating and certain contingencies occur – such as one or more transmission line outages. ISO uses the same planning criteria regarding the interconnection of generators as it does for the construction of a new transmission line.

In addition to the system impact study, generators may also conduct additional studies during the process, with each study containing incrementally more detailed information regarding system conditions and identification of necessary upgrades. The end result of the interconnection process is an interconnection agreement, which documents the transmission upgrades to be paid by the developer, the schedule for completion of the upgrades, and the operational requirements which the generator must follow. Having an interconnection agreement does not guarantee that the generator may produce energy whenever it is able; rather, it ensures that the generator is not adversely impacting the stability of the grid. The generator must still participate in the electricity market and ISO-NE may curtail the unit when necessary in order to protect system stability.

In 2003 FERC required all public utilities that own transmission to implement new standards for interconnecting generators, implemented by ISO-NE as a minimum interconnection standard. The minimum interconnection standard is designed, in part, to acknowledge that there is a competitive market for wholesale electricity in New England, and examines the potential system impacts of the generation unit with the assumption that units in the same geographic area will compete economically in the competitive wholesale electricity market and therefore may not be dispatched at the same time. Since the output of other generators in the area is a significant factor in determining the impact a particular generator will have on system stability, the minimum interconnection standard results in an incomplete picture of the amount of energy that a particular unit can safely introduce into the system. Utilizing the minimum interconnection standard can significantly reduce the costs of the necessary interconnection studies; however, because it assumes that generators will be competing against each other in the market, it increases the likelihood that generators will be curtailed due to transmission constraints.

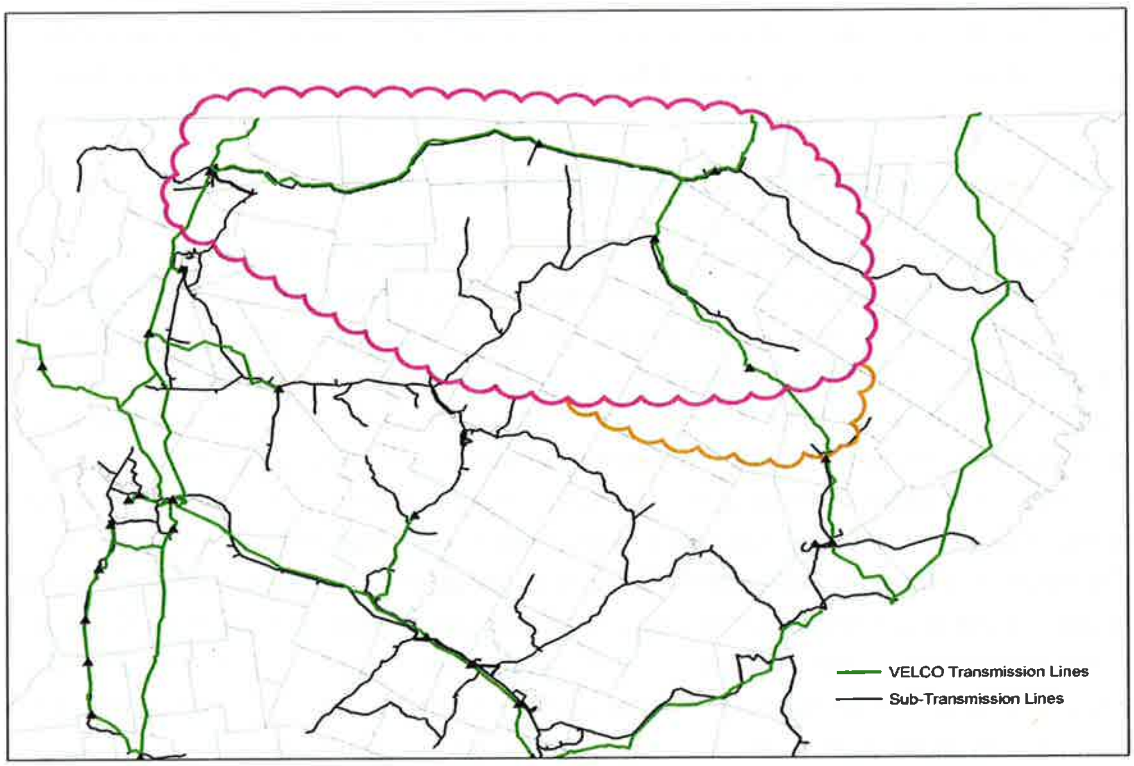
Operating conditions can be placed on any type of generation unit and curtailment can generally occur for a variety of other reasons. Aside from curtailments required by ISO-NE, wind power curtailment, for example, can result from measures to protect wildlife or for safety-related reasons related to icing conditions. Additionally, curtailment of generators is not unique to Vermont but occurs in several New England states, most prominently in northwestern Maine, and also other regions around the country.

## III. Causes of Curtailment in Vermont

### a. Transmission Congestion

In Vermont, there has been some focus recently on curtailment specifically as it applies to new wind generation projects. Most of the on-shore areas in New England with very good wind resources tend to be remote and the transmission lines in the vicinity were originally designed to serve small amounts of load in the area, not to transport large amounts of generation out of the area. As increasing amounts of generation is interconnected with the transmission system, upgrades are necessary to ensure that the generation does not overload transmission lines or otherwise impact system stability. Necessary upgrades can include devices that help control the amount of voltage and reactive power in the system, such as a capacitor banks, static compensators, and synchronous condensers, or can be as significant as a complete rebuild of a transmission line to increase the capacity of the line. In areas with a significant amount of load, the generation output is absorbed near the generation source; accordingly the energy is not carried long distances and there is less need for upgrades to the transmission system.

In the constrained area in northern Vermont, identified in the figure below, there is approximately 120 MW of load served by the transmission system, while the output of generators in the area is approximately 420 MW.[3]




*From: Dunn, Interconnecting Wind Generation in Northern Vermont at 5, Presented at the Vermont System Planning Committee, 6/6/13.*

[3] Kowalski, Wind Development in Constrained Areas at 23, presented at the NEPOOL Planning Advisory Committee, 3/21/13.

With significant amounts of excess generation, the electricity must travel relatively long distances on transmission lines not originally designed to carry significant amounts of generation.[4] The recently constructed Kingdom Community Wind project, with a nameplate capacity of 63 MW, is the second-largest generation source within the constrained area, after the Highgate converter station, which delivers 220 MW of energy from HydroQuebec into Vermont.

The system impact study for Kingdom Community Wind identified concerns that the operation of the project could cause voltage levels below the reliability threshold in the transmission system during certain sets of contingencies, including during times of light load. In order to maintain reliability, Kingdom Community Wind was required to install a dynamic reactive power device, which can rapidly correct for voltage deficiencies in the event of a contingency. The system impact study allowed the interconnection and operation of Kingdom Community Wind prior to completion of this device, a synchronous condenser, subject to operational constraints determined to be necessary by ISO-NE to ensure system reliability.[5] The project has been curtailed by ISO-NE for a significant number of hours, and is expected to continue to face operational constraints until the synchronous condenser is completed in the fall of 2013. The completion of the synchronous condenser will solve many of the operating constraints; however, depending on system conditions, it is still possible that the Kingdom Community Wind project will be curtailed. During the spring of 2013, Green Mountain Power Corporation, Vermont Electric Power Company, Inc. (VELCO), and ISO-NE entered into an operating agreement that allows ISO-NE to have greater information regarding the sub-transmission system in the area so that it can limit the number of hours that the Kingdom Community Wind project is curtailed.

### b. Addressing Curtailment Caused by Transmission Congestion

In areas of transmission congestion, additional transmission infrastructure is likely to be needed to interconnect additional generation without adversely impacting system reliability. This could include reactive devices such as the synchronous condenser or additional transmission lines. Also, the addition of load in a constrained area might also alleviate the transmission congestion. In cases where the transmission constraint is caused by an imbalance in the timing of load and generation, storage may also play a role. In northern Vermont, it is likely that additional transmission lines will be required if additional generation is added to the area, as the installation of the synchronous condenser will address the operational issues of the Kingdom Community Wind project, but is not designed to address any additional generation in the area. Also, reactive devices are designed to address issues such as voltage regulation and reactive power and do not address the capacity of a transmission line to carry energy without overloading the line. Operating and communication protocols can be developed that provide information to ISO-NE so that ISO-NE is aware of the operation of the sub-transmissions system, which is an important piece of information in determining the need to curtail a generation unit.

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[4] 50 miles of 115 kV line is roughly equivalent to 450 miles of 345 kV line. Kowalski, Wind Development in Constrained Areas at 4, presented at the NEPOOL Planning Advisory Committee, 3/21/13.

[5] *See*, PSB Docket 7987, Order of 3/28/13 at 8; *Order Accepting Unexecuted Large Generator Interconnection Agreement*, 140 FERC ¶ 61,175.

When conducting a system impact study, ISO-NE is required by national planning standards to test the impact of the generator on the system in the event that a contingency, such as a line outage, occurs while the unit is feeding energy onto the system. In selecting the contingencies with which to test the system to ensure that a project can be reliably interconnected ISO-NE does not take into account the probability of the contingencies occurring. Instead, it examines contingencies that are likely to result in a significant impact. Such conservative planning is consistent with FERC and NERC requirements, however, it results in more curtailments and increased costs related to system upgrades. New England states are addressing whether it is appropriate to include the probability of a contingency in the planning process. If the states conclude that it is appropriate to modify this requirement it may necessitate pursuing policy changes at FERC and NERC in addition to changes at ISO-NE.

Recent commercially available storage technologies allow wind projects to "smooth" out power production during the day, thereby addressing some of the concerns regarding interconnecting wind projects. Storage technology would likely be most useful in situations where there are moderate difficulties in interconnecting wind generation (i.e., storage technology, by itself, would not be sufficient to address the transmission congestion issue in northern Vermont, and likely would not be necessary if wind was connected to a strong transmission system and/or proximate to load). Storage becomes increasingly more viable the smaller the scale of the project.

ISO-NE is undertaking improvements to its elective transmission expansion process that would allow for more efficient planning with respect to the system upgrades necessary to interconnect a group of generators in one area. ISO-NE will be initiating this process in mid-July of 2013.

**c. Minimum Generation Emergencies**

Load and generation need to be balanced to ensure system stability. If there is more generation on the New England system than is needed to provide power (which typically occurs during early morning hours and only occurs a few hours per month) then ISO-NE curtails generators to keep the system in balance.

In determining which generators to curtail, ISO-NE looks at both reliability and cost issues. Generators that do not participate in the day-ahead market are curtailed before generators that have a financially binding commitment in the day-ahead market (ratepayers will pay the cost of a unit committed in the day-ahead market even if it is not called on to run). Resources such as wind generators and run-of-the-river hydroelectric facilities typically do not participate in the day-ahead market due to uncertainty regarding weather conditions (if a generator bids in and cannot deliver, penalties are incurred) and are therefore more likely to be curtailed.

**d. Addressing curtailment due to minimum generation emergencies**

Resources dependent on wind and rainfall need sufficient information regarding expected next-day production in order to effectively participate in the day-ahead market. To the extent that generators participate in the day-ahead market, it is unlikely these generators would be curtailed during minimum generation emergencies.

There are two factors that are likely to occur in the relatively near term that will improve the ability of intermittent resources to effectively participate in the day-ahead market. First, ISO-NE is developing a system to improve centralized wind forecasting that should provide wind generators with sufficient information regarding expected next-day production to allow wind generators to effectively participate in the day-ahead market. It is expected that this system will be operational in the fall of 2013.

The second factor is the commercial availability of storage technology. For the past few years, storage has been increasingly cited as a potential "game changer" for intermittent resources, and there are signs that storage is close to being a wide-spread, commercially viable solution. For example, General Electric has developed a storage unit specifically designed to be used in conjunction with wind turbines. At present it appears that the General Electric storage technology is intended to "smooth" out power production over the course of the day, rather than store significant amounts of generation for long periods of time. The increase in availability (and decrease in cost) of commercially available long-term storage will allow generators to be dispatched by ISO-NE and participate fully in the day-ahead market.

## IV. Impacts of Curtailment

### a. Less emissions reductions

To the extent that a renewable resource such as wind or run-of-river hydroelectric is operating, the generation from such units reduces the need to generate electricity utilizing another source of fuel. The amount of emissions displaced depends on the type of generation that would otherwise be called upon to run (also called the marginal unit) and the amount of reserve and regulation generation required at the time. In New England, natural-gas-fired units tend to be on the margin the majority of the time, therefore, when an intermittent renewable generator is running, it typically results in emissions reductions from natural-gas-fired generation.

In order to ensure system reliability, ISO-NE maintains reserve units. These reserve units are classified into three different categories: ten-minute spinning reserves (units that are operating and synchronized to the grid and can increase output within 10 minutes); ten-minute non-spinning reserves (an off-line resource that can be electrically synchronized to the grid and provide output within ten minutes; and thirty-minute operating reserves (units that can be off-line and synchronized to the grid and provide output within thirty minutes, or are currently producing power and can increase output within thirty minutes). Regulation is the capability of generating units to increase or decrease their generation output every four seconds in response to signals from ISO-NE. Regulation is necessary to balance supply levels with the second-to-second variation in demand. As the amount of intermittent generation increases on the system, there will need to be an increase in the amount of reserves and regulation.

At the current level of intermittent resources in New England, the amount of emissions reduced per MWh of electricity produced from wind plants is approximately 1:1; that is, for each MWh of wind power generated, a MWh's worth of a marginal unit's generation is reduced or avoided. As the amount of intermittent generation increases, the need for greater reserves and regulation units will reduce the amount of emissions reductions per MWh of wind production. It is important to note that this reduction is not linear and is also influenced by the type of resources that provide regulation and reserves – for example, storage and demand response could provide these services without the need for additional fossil-fuel-fired generators. Regardless, even if wind provided 40% of the electricity on the grid, and required an increased use of spinning reserves and regulation units such as gas-fired generators to balance the intermittent production, wind would still provide an emissions reduction benefit relative to relying on fossil-fuel-fired generation.[6]

### b. Loss of energy, renewable energy certificates, and production tax credit revenues

Curtailment will directly reduce the revenues of the curtailed generator, creating a disincentive for developers. To the extent that the impact is on merchant generators, ratepayers are insulated from the economic impacts. To the extent that the wind project curtailed is a utility-owned project, ratepayers will not see the full economic benefits that are associated with the creation of renewable energy certificates and the capture of the production tax credit.

## V. Department Recommendations Regarding Curtailment of In-State Generation

The Department recommends that any certificate of public good under 30 V.S.A. § 248 issued by the Public Service Board for a generation project interconnected at the transmission level contain a condition prohibiting construction prior to a sufficient demonstration that it will be able to operate the project with minimal expected curtailments. Given the flexibility in the interconnection study process, it is difficult to identify a specific study that would provide this demonstration; however, the Department could work with ISO-NE to determine a mechanism for establishing, with a reasonable level of confidence, that the project can be operated at nameplate capacity without experiencing curtailments. At a minimum, the Applicant, Department, and Board should understand the implications of meeting the minimum interconnection standards versus other interconnection or system upgrades relative to incurring or relieving operational constraints.

Such a requirement would be separate and distinct from Section 248(b)(3), requiring that the project will not adversely affect system stability and reliability. A project could have no adverse impact on system stability and reliability by being required to curtail operations. However, reducing the number of hours that a renewable project is curtailed has environmental benefits. Even though the Public Service Board must make a positive finding that a project does not have an undue adverse impact on natural resources, every generation project will have some impact on natural resources; the operation of the wind project and resulting environmental benefit mitigates these impacts. To the extent that a wind project is constructed but not operating, the environmental benefits of the project are not being maximized.

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[6] Valentino, et. al, System-Wide Emissions Implications of Increased Wind Power Penetration, Environmental Science & Technology 2012, 46, 4200-4206.

In addition, the Department recommends that it continue to work with regional stakeholders and ISO-NE to review ISO-NE's planning processes to ensure that the requirements and assumptions ensure the protection of a reliable transmission system without imposing overly conservative requirements that impair the ability of generators to interconnect and that increase costs to ratepayers. This work would also include ISO-NE initiatives to improve its planning process generally, such as the elective transmission expansion process.

The Department recommends that Vermont policymakers examine how to strategically deploy energy storage technology where appropriate, to help address the intermittent nature of resources such as wind, solar, and run-of-river hydroelectric plants. A complementary solution is the creation of better predictive modeling for local weather forecasting, such as the "Deep Thunder" effort by IBM. Providing some measure of predictability regarding when these resources provide energy to the transmission system would allow these resources to more effectively participate in the competitive wholesale electricity markets, which would reduce the possibility of curtailment.

Finally, the Department recommends that ISO-NE work with stakeholders to develop a policy related to curtailment. A 2009 study commissioned by ISO-NE included the following recommendation:

> As wind generation penetrations grow, selective use of curtailment can be appropriate and economically justified under some operating conditions. ISO-NE should use the results of the current integration studies, along with periodic studies of a similar nature going forward, to develop a basis for its curtailment policy.
> The study results need to establish the probability, frequency, duration, and value of curtailment as a mitigation measure for operational problems. Absent such quantification, it is very difficult to justify curtailment as a general mitigation strategy because of the uncertainty it can pose to wind project developers and financing.[7]

While the Department recognizes that curtailment can be necessary to ensure reliability, as the 2009 study notes, curtailment creates uncertainty for project developers. Such a policy could include recommended interconnection studies that developers should undertake to address the probability that specific units might be curtailed and a rough approximation of the number of hours that curtailment could occur.

## VI. Conclusion

Curtailment of generation resources is a complex issue that involves national and regional planning requirements as well as the operation of the competitive wholesale electricity market. Addressing the issue will require involvement of stakeholders at the regional level and is likely to occur over the longer term.

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[7] Technical Requirements for Wind Generation interconnection and Integration, November 3, 2009, at 19.

ISO new england

memo

To: New England Stakeholders

From: Eric Wilkinson, External Affairs

Date: June 28, 2013

Subject: Summary of Wind Power and Curtailment in New England

*Introduction*

Wind power is a growing source of energy in New England and this growth is being driven, in part, by state policies that support the development of renewable sources of energy. Wind plants supply electricity to the transmission or distribution system (depending on how they are interconnected) when there is adequate wind to power these facilities. When they operate, wind resources generally displace other sources of energy that are dispatched by ISO New England in the region's wholesale electricity market. However, there are times when the ISO, local transmission service providers, or wind plant operators themselves must reduce or "curtail" the amount of power that these resources provide to the system.

Curtailments generally arise when the maximum potential output of a resource would exceed the capacity of the existing transmission system. Resources that are most-often subject to curtailment produce electricity based on the availability of their primary source of energy (e.g., wind). This output may not correlate well with system needs or commitments. Grid operators currently have limited ability to dispatch wind resources, except to dispatch them down, or curtail them. Grid operators utilize curtailments to prevent transmission facilities from being overloaded by issuing instructions that limit the output of resources to a level that can be reliably accommodated by the system.[1] This summary looks at the underlying factors that result in curtailments and highlights some potential enhancements to minimize curtailments in the future.

*Wind Background*

At the start of 2013, there were about 700[2] megawatts (MW) of nameplate wind capacity installed in the six New England states,[3] up from approximately 2 MW in 2005.[4] In 2012, wind provided

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[1] See: http://www.iso-ne.com/regulatory/ferc/filings/2012/sep/er12-2690-000_9-26-2012_wind_dispatch_rules.pdf

[2] See: http://www.iso-ne.com/committees/comm_wkgrps/prtcpnts_comm/pac/mtrls/2013/may222013/a4_wind_energy_update_052213.pdf

[3] The total capacity of New England's generation fleet is currently about 37,000 MW.

[4] See http://www.iso-ne.com/trans/sys_studies/rsp_docs/rpts/2005/102005_RSP05_App_Final.pdf

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about 1% (1,172 GWh)[5] of the energy produced in New England. More wind resources are on the interconnection horizon. As of April 1, 2013, 28 wind projects were in the ISO's generator interconnection study queue totaling about 2,053 MW, or nearly half of the nameplate capacity in the queue. In New England, most of the commercially operating wind resources are located in Maine, New Hampshire and Vermont. They tend to be located in rural areas, far from concentrations of customers, and notably, in areas with the least robust transmission facilities. The transmission resources in these parts of New England were built to serve the native load, but not designed to accommodate the addition of generation sources or the movement of large amounts of power.

*Causes of Curtailments*
Wind resources have low operating costs and, therefore, it is almost always economic[6] for the region to have them operate to the maximum extent that wind conditions allow. This is true except when that maximum output level would jeopardize reliable operation of the system. Resources are less susceptible to curtailment if they interconnect in areas with particularly strong transmission infrastructure (generally closer to the load), or elect to install upgrades to the grid.

When the output from any resource, including wind, jeopardizes reliability, curtailment may be necessary. The ISO, at times, needs to curtail wind resources to ensure that the bulk power system and/or sections of the system are not overloaded, and service to customers is maintained. Several factors can contribute to the need to curtail wind resources. These include: transmission constraints; interconnection choices; and the technologies associated with wind generators.

- *Transmission Constraints*

Transmission constraints are physical limitations on the amount of power that can flow across the transmission system. Transmission constraints, both at the regional and local levels are the most significant cause of curtailments. Regional constraints occur in broader areas of the system and may act to constrain the operation of larger groups of generators. Local transmission constraints occur in smaller areas of the system and may constrain individual or small groups of generators. Local constraints may be located behind other constraints, particularly regional constraints.

- *Interconnection Choices*

Many wind resources choose to connect to the weaker parts of the New England bulk power system that were not originally designed to integrate large amounts of additional power supply. These sites often have the best potential for wind power, but are usually found on portions of the transmission system with long stretches of 115 kV lines, or on lower voltage transmission facilities. The addition of wind farms in these areas can result in transmission constraints.

Pursuant to Federal Energy Regulatory Commission (FERC) orders,[7] wind resources generally are not required to provide the same basic voltage support capability that is required of other types of resources, unless studies determine that this capability is needed. Often, wind resources interconnect with a bare minimum of voltage support capability, thus providing no additional

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[5] See http://www.iso-ne.com/committees/comm_wkgrps/prtcpnts_comm/pac/mtrls/2013/apr242013/a3_new_england_rsp13_load_and_capacity_resource_overview.pdf

[6] Interconnecting as an energy resource allows wind plants to compete for transmission access based on their offer prices into the energy market.

[7] See FERC Orders 661 http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=10594521 and 661A http://www.ferc.gov/EventCalendar/Files/20051212171744-RM05-4-001.pdf.

strength or improved reliability margins to the transmission system. Moreover, as wind resources tend to develop fairly close to one another, the first-in-service plants tend to exhaust any existing thermal, voltage and stability margins, resulting in the need for more significant upgrades or curtailments for subsequent generators.

Under FERC policy, wind generators connect to the system using a minimum interconnection standard. However, this standard does not ensure that the resource will be able to put its full output onto the grid. Generators that do not fund additional elective upgrades to enhance their access to the transmission system, or connect to a relatively weak area of the system, are at a higher risk of being curtailed.

- *Wind Generator Technology*

Although the ISO has seen some improvements in recent years, historically wind generators have not provided significant system voltage or stability support to the grid compared to other types of energy resources. Also, the voltage control and reactive power capability of wind generators is mostly consumed within the wind farm, thus providing little transmission system support. Some of the electronic controls for wind generators do not function properly in less robust parts of the transmission system.[8] This, in combination with the factors described above, can result in wind plants being extremely sensitive to the normal variations in system operating conditions and more likely subject to curtailments than other types of resources.

*Markets*

ISO New England operates real-time and day-ahead energy markets. The main purpose of the day-ahead market (DAM) is to serve as a hedge against potentially volatile real-time prices. Market participants can purchase and sell energy at financially binding day-ahead prices. The DAM also serves as the starting point for initial unit commitment for the next operating day. This point is particularly important for wind resources. Because wind resources are often unsure of their ability to produce specific amounts of power the next operating day, they tend to "self-schedule" and not participate in the DAM. In contrast, other types of traditional generators can be scheduled and committed to run by the ISO. Traditional resources typically participate in the DAM and have binding offers to sell energy and can also be dispatched by the ISO in real-time. Therefore, there may be times when, despite a wind resource's availability to produce power, it is not called on by the ISO because other resources that are already committed through the DAM will be sufficient to meet demand.

*How Much Curtailment Occurs on the Grid?*

The ISO does not collect specific data related to the amount of time that any particular resource is curtailed. Moreover, if ordered by a local transmission service provider, or self-curtailed by the wind plant operator, the ISO may not know that the resource is being curtailed. However, the ISO has begun a process to collect indicators of curtailments related to wind generators. This data collection effort is part of the ISO's enhanced wind power forecasting project. When this project is fully operational, the ISO expects to have a better understanding of the magnitude of curtailments.

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[8] See ISO presentation: Wind Development in Constrained Areas, March 21, 2013 available at: http://www.iso-ne.com/committees/comm_wkgrps/prtcpnts_comm/pac/ceii/mtrls/2013/mar212013/a5_wind_development_in_constrained_areas_new.pdf

*Potential Enhancements*
The following types of activities could help reduce the amount of curtailments of wind power.

- *Planning*

Improvements to the elective transmission expansion[9] process may help reduce curtailments by allowing more efficient identification of marginal interconnections and transmission constraints. A more efficient elective expansion process would better complement the existing generator interconnection process. Also, the interconnection study process could potentially be enhanced by the development of a more thorough study regimen that would analyze a wider range of operating conditions than current practices. The possibility and nature of potential changes to interconnection studies is currently under consideration at the ISO.

- *Operations*

**Wind Power Forecast Integration Project**: The ISO is currently undertaking an initiative that will incorporate wind forecasting and wind resources into ISO processes, scheduling, and dispatch services. The project will acquire external wind power forecasting services, create operator situational awareness displays, partially integrate wind into the real-time dispatch and maintain historical wind data for future use of the forecast service, auditing, and other analysis. The project is scheduled for implementation in the second half of 2013.[10]

**Increased Efficiency & Automation**: When system operators need to communicate dispatch instructions or other information related to the operation of a wind resource, it is done by placing a telephone call to the resource. This is in contrast to the fully automated system that ISO employs with dispatchable resources like natural gas plants.

After the wind power forecast integration project becomes operational, all wind resources will be required to provide real-time telemetry indicating current output and additional meteorological data. This information will support the ISO's short-term wind power forecast system and will greatly improve the system operators' situational awareness during changing weather conditions. The equipment necessary to provide this telemetry will also provide a critical link in the technical capability for wind resources to receive dispatch instructions electronically.

The ISO is also developing enhancements to the dispatch algorithm that will determine and communicate to each wind resource an output limit approximately every five minutes (which will be defined in the ISO Tariff as a "Do Not Exceed Dispatch Point"). A wind resource will be able to operate at any output level between 0 MW and its output limit. The "Do Not Exceed Dispatch Point" is analogous to the dispatch instruction sent to fully dispatchable resources except that it provides additional flexibility to account for variability in weather conditions. When design details are complete, the ISO plans to continue working with stakeholders to incorporate the dispatch enhancements for wind resources into the market rules. Barring unforeseen difficulties, implementation is anticipated in the first half of 2015.[11]

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[9] An Elective Transmission Upgrade is an upgrade to the New England transmission system voluntarily funded by one or more participants that have agreed to pay all the costs of the upgrade. See: http://www.iso-ne.com/trans/rsp/2012/rsp_final_110212.docx
[10] See: http://www.iso-ne.com/committees/comm_wkgrps/prtcpnts_comm/prtcpnts/mtrls/2013/feb12013/2013_work_plan_update.pdf
[11] See: http://www.iso-ne.com/regulatory/ferc/filings/2012/sep/er12-2690-000_9-26-2012_wind_dispatch_rules.pdf