Integration of Wind into System Dispatch

A New York ISO White Paper

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The purpose of this paper is to review work done to date, identify the current challenges of integrating large amounts of wind generation into the New York transmission system, and propose changes to the market rules that will improve the reliable dispatch of wind resources in New York State.

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1. Introduction

Wind power is growing as a generation resource in New York State. The number of wind plants operating in the state has increased significantly over the past two years. Wind-powered projects also comprise a dominant portion of the proposed new generation projects in the New York Independent System Operator's (NYISO) interconnection queue.

Wind capacity in New York is projected to grow to more than 1,200 MW by the summer of 2009. The projects currently under review in the interconnection queue indicate the potential for another 6,500 MW of wind capacity to be developed by 2011. Due to the location of these resources and their intermittent nature, this presents a new challenge for grid and market operations in New York. Many of the proposed wind plants are seeking to interconnect in concentrated clusters located in the northern and western regions of the state. These regions are supported by an existing transmission network that will not be capable of delivering all the potential wind output to the load centers in the southeastern regions of the state.

The expected level of wind penetration as well as the concentration or clustering of the wind plants in areas of the grid not built to accommodate that level of generation may require that wind output be re-dispatched when system security and reliability is threatened. Dispatching other resources around wind plant output may not alone be adequate to efficiently manage the expected levels of wind generation in New York. Long-term solutions may include the need for additional transmission to move wind power, energy storage devices to absorb excess power in off-peak hours, and new operational rules to protect system security.

To enhance the integration of existing wind plants and prepare for the influx of additional wind generation, the NYISO has taken the following steps:

- Funded and participated in the 2005 study, The Effects of Integrating Wind Power on Transmission System Planning, Reliability and Operations, sponsored by the New York State Energy Research and Development Authority (NYSERDA)
- Expanded the eligibility of intermittent resources for special market rules from 500 MW to 3,300 MW to accommodate increased penetration levels of wind plants on the system
- Initiated a centralized wind forecasting system integrating wind generation into the NYISO day-ahead and real-time market software systems in order to better predict the output of wind projects in the NYISO's system dispatch.

The NYISO can best optimize wind plant output by evaluating each plant's economic preferences within the NYISO's real-time Security Constrained Economic Dispatch (SCED) process, as it does other generating resources. If the wind plant's economic offers are not known, the NYISO or local system operators must take less efficient, out-of-market actions to protect the reliability of the system. Therefore, the NYISO proposes to extend its market-based SCED systems to optimize the scheduling of wind plants.

This is the next step in the NYISO's market evolution for wind resource management. The integration of increased levels of wind will be facilitated by using the NYISO's market software to evaluate the economic offers submitted by all generation resources, including wind plants, to determine the most cost effective way to address reliability issues. The offers submitted by each wind plant will be evaluated along with all other resources in the NYISO's real-time SCED process, ensuring better utilization of wind plant output while maintaining a secure, reliable system.

Integration of wind plants into SCED will provide several benefits, including:

- Evaluating the operation of wind plants on a five-minute basis to minimize the period and amount of generation curtailments
- Eliminating the need for manual intervention by system operators to address system reliability issues in areas with high penetration levels of wind
- Enhancing the reliability of the transmission grid
- Minimizing periods of extreme negative Locational Based Marginal Price (LBMP) in the Real Time Markets.

This paper proposes an innovative approach to manage wind plant output, when system reliability requires it, through the evaluation of economic offers submitted by the wind plants. Incorporating these improvements into wind power dispatch is necessary in order to maintain reliable operations of the bulk electricity grid and support the integration of more renewable resources.

2. NYISO Wind Integration

The NYISO has been a leader in the integration of wind plants since the adoption of the Renewable Portfolio Standard (RPS) by the New York Public Service Commission (NYSPSC) in 2004.[1] Working in collaboration with state and federal regulators, market participants and the environmental community, the NYISO has actively endeavored to resolve technical and administrative issues in order for wind plants to fully participate in the NYISO markets.

The NYISO's markets, in combination with the RPS program incentives and the federal production tax credits, have facilitated significant growth in the installed base of wind generation. In fact, wind plants are the dominant renewable resource seeking interconnection service. The 72 wind plants in the NYISO interconnection queue make up over 30% of the total nameplate capacity and over 55% of all the generation projects listed in the queue. Figure 2-1 shows the current fuel mix of projects in the interconnection queue.

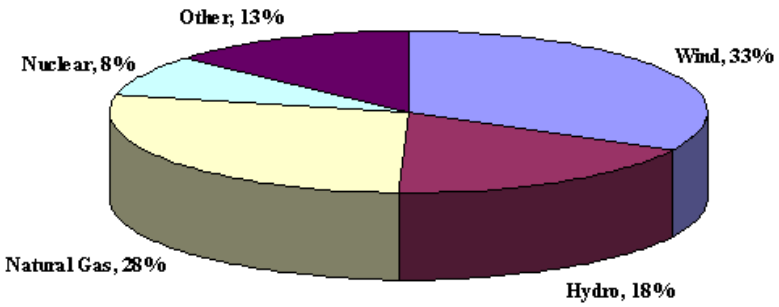

Figure 2-1: Proposed Generation Capacity - NYISO Interconnection Queue (8/28/2008)

The regions of North America served by the organized markets administered by independent system operators (ISOs) and regional transmission organizations (RTOs), hosted 79% of installed wind generation in 2007, well above the 44% share of wind energy potential in those regions and their 53% share of total North American electricity demand.[2]

According to an October 2007 study[3] published by the ISO/RTO Council, the features of wholesale electricity markets that foster development of renewable resources include the following:

- Large, organized markets open to all those interested in investing and building new power plants

[1] The RPS is a statewide initiative that requires the development of renewable energy resources for the bulk power system. State funding of new renewable resources to meet the RPS requirement has come in large part from NYSERDA.
[2] Michael Skelly. February 27, 2007. Comments, Federal Energy Regulatory Commission (FERC) Docket No. AD07-7-000.
[3] *Increasing Renewable Resources: How ISOs and RTOs Are Helping Meet This Public Policy Objective*, ISO/RTO Council, October 16, 2007.

- Price transparency that allows developers to know the value of their power and makes investment decisions easier
- Dispatch systems that reduce the cost of integrating wind into the power system by taking advantage of wind diversity and the ramping capability of conventional generators
- Coordination of regional transmission planning that makes it possible to build the transmission needed to bring renewable energy to market.

The study also noted that the open governance process of ISOs and RTOs, which includes extensive stakeholder input in establishing market rules, can promptly address the needs of new technologies.

Wind Integration in New York State

In New York State, the majority of the wind plants that have been sited or are being proposed for development are located in regions distant from New York's major load centers in the downstate region. In some cases, multiple wind plants are seeking to interconnect to the same transmission system facilities or in concentrated clusters on portions of the grid where the existing transmission system cannot transmit such large amount of generation. Further, the intermittency of wind plant generation creates additional challenges for system operation.

It is now widely understood that these impacts could require physical transmission system reinforcements and special bulk power system planning and operating practices as penetration levels of wind generation increase. Operational experience with these potential impacts on the transmission systems was limited in the United States when the NYISO co-funded a study entitled, *The Effects of Integrating Wind Power on Transmission System Planning, Reliability, and Operations* (2005 Wind Study) with NYSERDA. The 2005 Wind Study was conducted by GE Energy in two phases. This study has since been a model for several additional studies conducted throughout North America. Phase 1 of the 2005 Wind Study provided a preliminary assessment of the impact of large-scale wind generation on the reliability of the New York State bulk transmission system. It included an analysis to determine the maximum capability of a selected distribution of wind generation sites that could be accommodated by the existing transmission system infrastructure. This analysis, which focused solely on the thermal transmission limits, determined that the existing New York Control Area (NYCA) transmission system could accommodate approximately 5,700 MW of wind plant output, assuming the redispatch of other generating resources, before thermal limits would be exceeded.

Phase 2 of the study expanded upon Phase 1 to provide a detailed technical evaluation of the impact of 3,300 MW of large-scale wind penetration statewide (10% of the NYISO peak load in 2004). The Phase 2 Final Report, which was issued on March 4, 2005, indicated that approximately 3,300 MW of wind generation could be reliably integrated into New York's system if recommended interconnection requirements and operational

practices were implemented. The recommendations included the following mix of proven and emerging wind turbine technologies:

- Voltage regulation at the Point-of-Interconnection (POI)
- Low-voltage ride-through
- Power curtailment capability
- Ability to set power ramp rates
- Governor functions
- Reserve functions
- Zero-power voltage regulation.

Centralized forecasting of wind power production across the state was identified as an essential tool for system operators to minimize the impacts of the variable, intermittent wind generation. The study also identified the need to establish a unit commitment process and ramping requirements to better integrate wind in light load and peak load conditions.

The 2005 Wind Study concluded that the transmission system could reliably accommodate 3,300 MW of wind generation based on an assumed distribution throughout the NYISO without exceeding the thermal ratings of transmission facilities. The Study, however, assumed that large-scale wind generation would be more evenly distributed among all the regions of New York State. To date, the development of wind generation has predominantly occurred in the western and northern regions of the state.

Special Market Rules for Wind

Since the wholesale markets opened in New York, the NYISO has had special market rules that recognize the unique characteristics of wind plants and other renewable resources. These special market rules exempt wind and run-of-river hydro units from financial penalties for deviations from expected schedules. In December 2006, the NYISO filed tariff revisions with the Federal Energy Regulatory Commission (FERC) to extend its special market rules, doubling the amount of energy that qualified for special payment provisions and penalty exemptions up to 1,000 MW of installed intermittent resources.

The 706 MW of wind generation in operation as of September 1, 2008 utilizes the NYISO's special market rules. The NYISO expects wind capacity in New York to grow to more than 1,200 MW by the summer of 2009. While not all of the proposed wind plants[4] in the NYISO's interconnection queue can be expected to be built, it is reasonable to expect to have penetration levels at or exceeding 3,300 MW by 2011. To accommodate more wind, the NYISO filed revised tariff language on April 18, 2008 with FERC that

[4] See NYISO's August 28, 2008 interconnection queue at http://www.nyiso.com/public/services/planning.

further increased the amount of intermittent generation eligible for the special payment provisions and penalty exemptions to 3,300 MW of intermittent renewable resources.[5]

Centralized Wind Forecasting System

In June 2008, the NYISO implemented a centralized wind forecasting system to forecast the amount of energy expected to be produced by each wind plant for use in the NYISO's day-ahead and real-time SCED systems. Wind plants are also required to collect data on wind speed and direction and transmit that data to the NYISO's forecast vendor as well as make payments to maintain the forecasting system. The NYISO uses the wind data to create wind power output forecasts and includes those into its day-ahead and real-time SCED processes.

Accurate wind power forecasts in the day-ahead unit commitment process minimize the potential to over- or under-commit other generation resources to meet forecast load when wind generation, which is not required to offer into the day-ahead market, shows up in the real-time. After the day-ahead commitment, updated wind forecasts, which are provided in 15 minute intervals, are evaluated in the NYISO Real-Time Commitment and Dispatch (RTC/RTD) SCED processes. The wind forecast allows the NYISO to produce more efficient commitment decisions in real-time and allows more efficient transaction scheduling with neighboring control areas.

Interconnection Process and Operating Procedures

Proposed generation projects are required to comply with the applicable NYISO interconnection procedures.[6] The interconnection study process identifies any adverse reliability impacts of the proposed project and identifies facilities required in order for the project to interconnect in a manner consistent with applicable reliability standards. The interconnection study process assesses the reliability of the system while providing the project access to the transmission system; however, it does not assure delivery service across the network.[7]

Wind plants, like all other generators, may be subject to re-dispatch if interconnected to constrained portions of the transmission system. While a conventional generator typically indicates its willingness to be re-dispatched through its economic offers so that the NYISO can optimize the use of limited transmission via SCED, wind plant operators currently have no such requirement. NYISO and local transmission operators today rely on manual intervention to re-dispatch wind plants when it is necessary to address a reliability issue. This may lead to sub-optimal reductions of wind plant output during periods of transmission limitations.

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[5] See April 18, 2008 Filing Letter to Honorable Kimberly D. Bose, Secretary, FERC from Michael E. Haddad, Counsel for the NYISO (hereafter, "2008 Filing Letter").

[6] As established in the NYISO Open Access Transmission Tariff (OATT) and Attachments S, X and Z of the OATT.

[7] The NYISO is currently in the process of implementing a second level of interconnection service (Capacity Resource Interconnection Service or CRIS) that incorporates a deliverability standard for new interconnection proposals that want to supply capacity in the NYISO's Installed Capacity markets.

3. Current Steps for Additional Wind Integration

Since the completion of the 2005 Wind Study, the NYISO has compiled over two years of operating experience with large-scale wind plants. NYISO staff has completed and approved System Reliability Impact Studies (SRIS) for over 3,470 MW of wind plants with over 1,200 MW of additional projects currently undergoing the SRIS review.[8] This experience has confirmed that the variability of wind plant output combined with the proposed locations of these wind plant interconnections presents reliability issues that can be best addressed by incorporating each wind plant's economic offers into SCED.

Given the expected number of wind plants in the near future, it is important that the NYISO move forward to implement wind plant dispatch into its SCED system in 2009. This next step in wind resource management will allow the NYISO to optimize the amount of wind energy delivered when the system is constrained.

NYISO Experience to Date

The NYISO has experienced two primary operational issues in the dispatch and control of wind plants. We have seen that during periods of negative pricing wind plant operators have an incentive to instantaneously cut output, instead of producing power at a financial loss. Similarly, a plant that is at or near its full capacity can drastically and unexpectedly reduce output as a result of changes in local weather conditions. Both have an impact on market outcomes, and potentially on reliability. The NYISO has observed circumstances where redispatching wind plant output through SCED would have resulted in more efficient market outcomes with respect to reliability.

There have been cases in which wind plant operators have shown that they would prefer not to generate during times of negative pricing, which can occur when the transmission system is constrained. In at least one case, a wind plant ramped down from near full output to zero in a little over two minutes. A more efficient wind plant operation would have resulted if SCED was employed to re-dispatch the wind plant output to the point of just relieving the constraint. This would have allowed the plant to continue to generate at a reduced level that would be consistent with its economic offer.

NYISO operators have also observed the highly variable wind plant output that can occur from local weather conditions. This variability recently occurred on June 10, 2008 as strong storms rolled through New York. Severe thunderstorms resulted in high wind speed cutout events for some large-scale wind plants. The storms caused the wind plants to ramp down nearly their full output in an eight minute period and took over 30 minutes to return to the pre-cutout power level. Figure 3-1 shows an aggregate of minute-by-minute wind data in upstate New York on that day.

[8] The NYISO interconnection queue indicates the status of interconnection studies. This is available on the NYISO website at http://www.nyiso.com/public/webdocs/services/planning

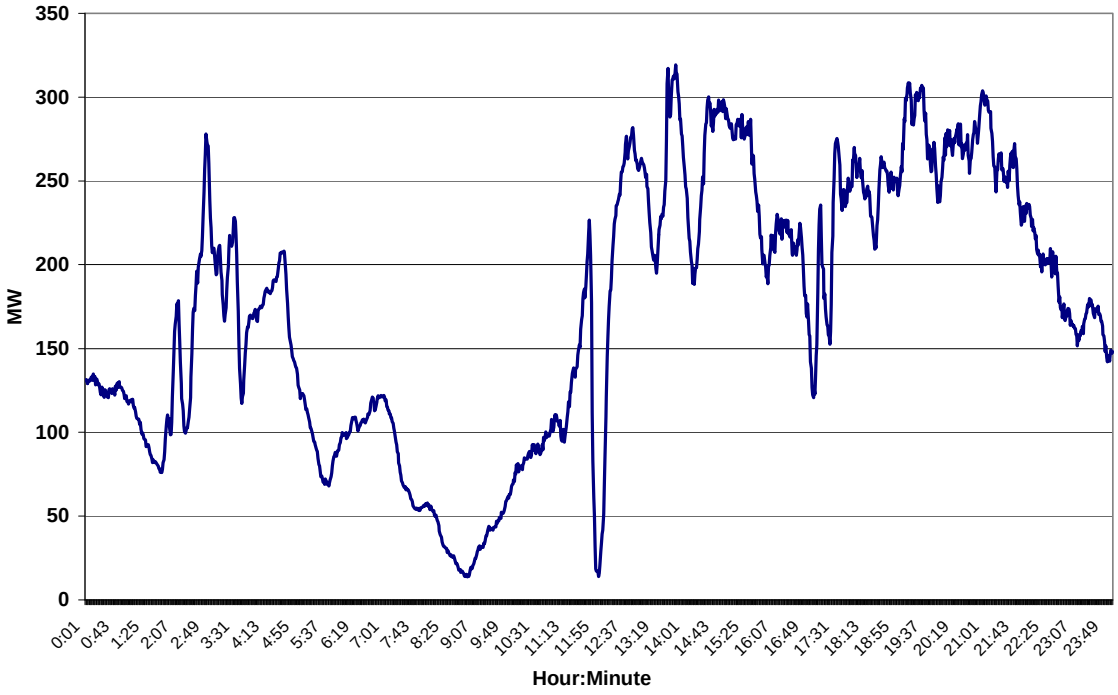

Figure 3-1: Aggregate Wind Output - Northern Zones (June 10, 2008)

The large swings in wind plant output created operational challenges in balancing the power grid as other resources needed to be quickly ramped up and back down again in response to the high wind speed cutout event. The larger the share of wind generation in a power system, the more pronounced the effect of such events on the system.

2008 Wind Study

The NYISO must balance efforts to enhance wind generation in New York with the fundamental need to maintain reliability.[9] The NYISO staff has begun a new wind study to update the 2005 Wind Study to evaluate penetration levels of wind greater than 3,300 MW. Total wind plants in the NYISO interconnection queue now exceed 7,700 MW. Figure 3-2 shows the current distribution of the existing and the proposed wind generation resources to be interconnected through 2011.

[9] In its April 18, 2008 Filing Letter to FERC, the NYISO indicated that: "The intermittency of wind resources can introduce operational difficulties, notwithstanding the presence of a centralized wind forecast, particularly in those localities where New York's transmission system experiences frequent congestion. The NYISO, therefore, intends to evaluate the implications of increasing amounts of wind resources interconnected to the New York State Transmission System. Over the next year, the NYISO will reexamine whether there are statewide or locational limitations that would be needed in order to support the NYISO's ability to fully integrate wind resources while maintaining reliability."

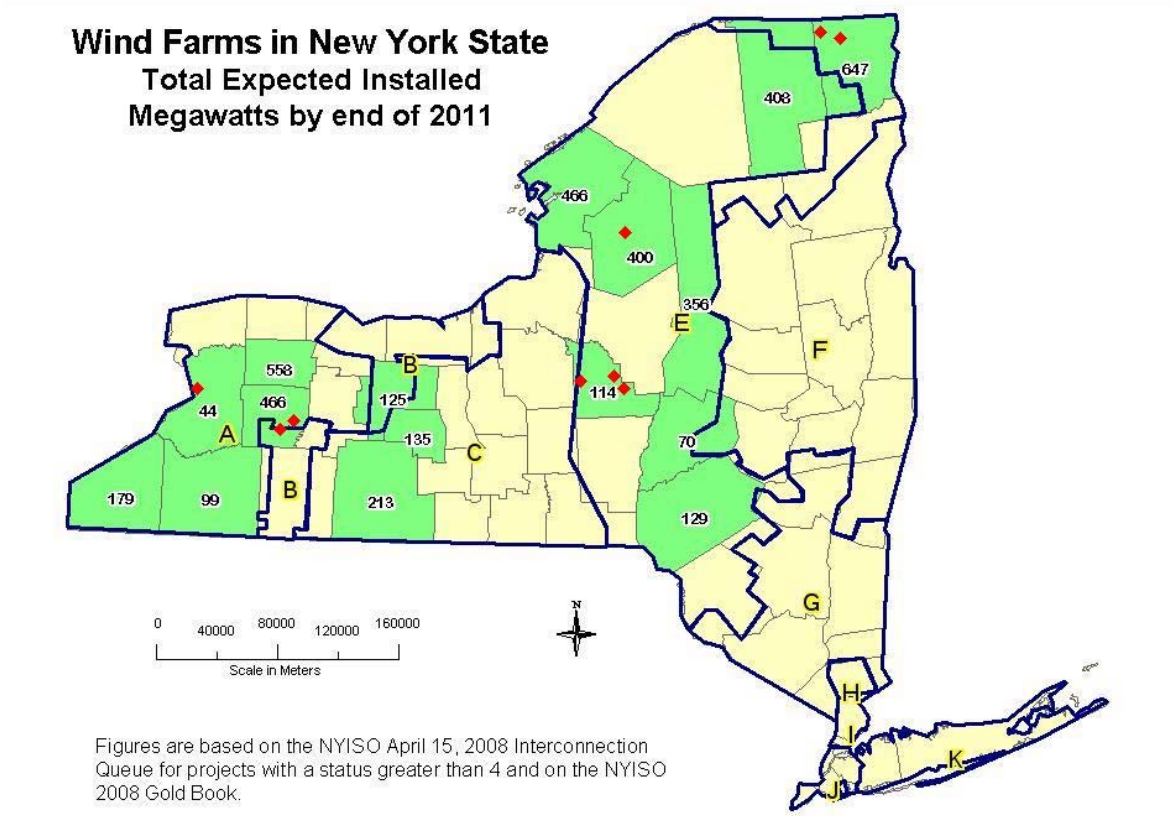

Figure 3-2: Distribution of Wind Interconnection Forecast

Preliminary results indicate that a new wind plant's interconnection point will play a major role in determining the amount of generation that can be integrated before transmission limitations are encountered. Several wind plants have proposed interconnection points concentrated in the north and west regions in the state. Existing transmission limits and anticipated levels of wind generation are expected to require re-dispatch of wind plants concentrated in these areas.

NERC Reliability Requirements

The North American Electric Reliability Corporation (NERC) develops and enforces electric reliability standards in the United States. In December 2007, in anticipation of the growth of wind and other variable generation, NERC's Planning and Operating Committees created the Integration of Variable Generation Task Force (IVGTF). NERC charged the IVGTF to report on the philosophical and technical considerations for integrating variable resources and to provide specific recommendations for practices and requirements, including reliability standards that cover the planning, operations planning, and real-time operating timeframes.

The goals of the IVGTF report are to:

- Raise industry awareness and the understanding of characteristics of wind/variable generation
- Raise industry awareness and the understanding of the challenges associated with large scale integration of wind/variable generation
- Investigate impacts on traditional approaches used by system planners and operators to plan, design and operate the power system
- Review NERC Standards, FERC rules and business practices to identify possible gaps and future requirements to ensure bulk power system reliability in light of large scale integration of wind/variable resources.[10]

The IVGTF's Preliminary Conclusions and Actions were presented to the NERC Planning and Operating Committees at their September meeting. One recommendation made by the IVGTF is that Balancing Authorities must work with the wind plant operators to ensure procedures, protocols and communication facilities are in place so dispatch commands can be communicated to the wind plant operators on an as-needed basis to maintain reliability.

The NYISO's proposed market rules are consistent with the IVGTF efforts.

[10] Transmission & Distribution World. "Integration of Variable Generation," Mark Lauby, NERC. April 1, 2008,

4. Wind Dispatch Proposal

As the system operator, the NYISO is responsible for system security and reliability planning. The NYISO maintains minute-by-minute system security by dispatching resources to meet the electrical load using a least-cost, bid-based optimization algorithm that recognizes transmission constraints. The automated, Security Constrained Economic Dispatch is the cornerstone of NYISO's reliable, market-based, grid operations. SCED is generally defined as "the operation of generation facilities to produce energy at the lowest cost to reliably serve consumers, recognizing the operational limits of generation and transmission facilities."[11]

The NYISO's operational experience with wind generation, its preliminary assessment from the 2008 Wind Study, NERC initiatives, and other nationwide developments combine to support NYISO efforts to meet the challenge of integrating higher levels of wind generation. The NYISO's proposal aims to better integrate wind generation into the NYISO SCED system so that wind plants can operate using economic dispatch signals as the NYISO maintains reliability of the transmission system.

The wind dispatch proposal allows each wind plant to provide the NYISO with real time energy bids in price-quantity pairs to indicate the price levels (LBMP) at which it would prefer to operate. The NYISO's SCED would evaluate these offers as it does all other supply offers.

Wind Plants will receive dispatch signals from the NYISO and the following will be required:

- During normal (unconstrained) operating periods, wind plants will continue to operate as today and be paid for all output pursuant to the NYISO's special market rules and penalty exemptions.
- During periods of reliability constraints, wind plants will be provided a re-dispatch signal if they are economically identified to relieve a constraint.
  - Wind plants will be required to follow this dispatch instruction until the reliability issue is resolved.
  - Wind plants will be paid for all output at or below the re-dispatch signal.

The NYISO anticipates that these proposed rules would be implemented in 2009.

Requirements for Wind Integration

The proposed wind plant dispatch rules will require all applicable wind plants to submit economic offers into the NYISO's real-time market. Real-time offers are due 75 minutes before each operating hour. The offers can be for up to 11 price-quantity pairs,

[11] Congress defined economic dispatch generally in section 1234 of the Energy Policy Act of 2005. FERC adopted this definition as their definition of SCED while recognizing that there are differences among the control areas in the way SCED is performed. *Order Convening Joint Boards Pursuant to Section 223 of the Federal Powers Act*, (Docket No. AD05-13-000) 112 FERC ¶61,353, issued September 30, 2005.

and may change hourly. Since wind resources cannot offer to increase output, the offers would indicate prices below which the resource would no longer want to generate. The supply offers and load forecast are run through the NYISO real-time SCED to determine schedules for generators every five minutes. During over-generation periods, real-time LBMPs may become negative in some locations, resulting in generators paying to remain connected to the transmission system. By providing re-dispatch signals during reliability events, it may be possible to avoid negative pricing – allowing generation to operate more efficiently.

Benefits of Better Wind Integration into Dispatch

During periods of transmission congestion, the cost of moving power across the system is reflected in the congestion component of the LBMP. This congestion charge is the cost of dispatching more expensive generation on the unconstrained side of a constraint, plus the cost of decrementing generation on the constrained side. The NYISO relies on SCED to manage limited transmission capacity. When more generation is trying to use the transmission system than can be accommodated, SCED will produce generator schedules and LBMPs that reflect the marginal resources' re-dispatch cost. Without implementing a mandatory wind plant dispatch program, the NYISO would be forced to continue using the manual curtailment process. Manual schedule adjustments are less efficient because they tend to be less frequent, which could result in larger reductions in wind generator output than necessary along with underutilized transmission. Better integrating wind resources into the NYISO's SCED will increase the overall output of wind generation as well as the utilization of the transmission system.

It is important to recognize that similar issues relating to wind plant integration are being faced by other control areas in North America as well as in Europe where wind generation has reached significant penetration levels. Texas, which is one of the few states ahead of New York in wind penetration, has surpassed 5,400 MW of wind generation capacity and is already grappling with these issues. When Texas first reached transmission limitation for its wind plants, the system operator took out-of-market actions to re-dispatch and paid all wind resources lost revenues. This approach was abandoned, however, after only six months as lost revenue payments quickly exceeded agreed-upon limits. Similar to NYISO's wind dispatch proposal, Texas is now adding a wind forecasting system and is also planning to integrate wind plants into their system dispatch to allow wind resources to indicate its willingness to redispatch rather than rely on out-of-market actions.

5. Longer-term Wind Integration Solutions

Greater integration of wind resources into the NYISO's economic dispatch will allow for increased wind penetration into New York. Just meeting New York State's 25% renewable energy mandate may require as much as 4,000 MW of wind capacity to be built in New York.[12] Further, wind plants are being developed in New York in order to sell energy as part of the renewable energy programs in place in neighboring states. It is therefore possible that New York's wind plant capacity may exceed 4,000 MW. With wind plants continuing to locate in the northern and western portions of the state it will become difficult to meet state RPS targets without additional transmission infrastructure to balance and move the wind energy southeast to the larger load centers. In the long-term, increasing the amount of wind that can be reliably integrated into the bulk power system and delivered to the load may require new operating procedures, market rules, new storage technologies, as well as transmission reinforcements.

Enhanced Centralized Wind Forecasting

The NYISO is concerned with high-speed wind events such as the one depicted in Figure III-1 due to the reliability implications resulting from the intermittent characteristics of wind turbines during such events. The geographic concentration of wind plants under development in the north and west regions of the state may impact the NYISO's ability to meet NERC's Balancing Authority reliability rules due to these high-speed wind events. As a result, the NYISO is evaluating potential steps to enhance its Centralized Wind Forecasting System in order to effectively predict the occurrence of such events and minimize the resulting impacts on the system.

Impact on Reserves and Regulation Requirements

A significant increase in intermittent resources in New York may increase the need for regulation and reserves services to maintain system reliability. For example, a recent wind study by the California Independent System Operator (CAISO) concluded that increased wind generation will increase the requirement for regulation, due to near-term wind forecast uncertainty.[13] The requirement for regulation in the past has been mainly a function of the variability of electrical load. Wind plants may create a significant demand for increased regulation and reserves, thus making it imperative to look for new sources and new technologies for these services.

The NYISO is currently evaluating changes to its market rules and scheduling tools to better accommodate energy storage technologies, such as flywheels or batteries, into the regulation markets. These types of devices have limited energy storage, but they have a fast dynamic response rate that allows them to quickly switch from absorbing to injecting real power into the transmission system, and thereby provide frequency regulation and short-duration Area Control Error (ACE) regulation.

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[12] This is based on Combined Targets of 12.3 million MWh, with an assumed a 30% capacity factor for wind resources, and 25% non-wind new RPS resources. Source for Combined Targets: *New York State Renewable Portfolio Standard Performance Report, August 2007*. NYSERDA

[13] *Integration of Renewable Resources*, California ISO, November 2007.

In some control areas, such as Denmark, where wind plants have become such a large part of the generation mix that their peak capacity exceeds off-peak load, it has become necessary to consider allowing wind resources to provide regulation services. The Danish grid code now has provisions that require wind resources to provide frequency control through "Delta Control" that limits a wind plant's output so it may provide both balancing up and down service.[14] Reliance on thermal generating units to meet increased regulation requirements could actually increase emissions of CO_2, NO_X and other pollutants, thereby defeating one of the main benefits of wind generation.[15] Therefore, it will be important to allow new technologies to provide regulation and reserves.

Energy Storage Opportunities

Figure 5-1 depicts New York's average hourly wind vs. load profile in June 2008. The typical diurnal pattern for wind generation peaks late at night and is lowest during the day. The price of energy typically follows the load pattern, with costs lowest at night and highest during the day. The ability to take advantage of the spread between on- and off-peak prices creates value for additional energy storage in New York.

Figure 5-1: Average Hourly Wind vs. Load Profile in New York, June 2008

Pumped hydro and battery storage resources have been a part of electric power systems for many years. Pumped hydro, however, is limited by land and topology, and batteries are relatively expensive and have limited amounts of storage. Given these

[14] *European Operational Experience with Wind Integration*, Energynautics, June 20, 2008.
[15] "The Character of Wind Power Variability and its Effects on Fill-in Power" Jay Apt and Warren Katzenstein, Carnegie Mellon University, June 25, 2008.

limitations there may be an opportunity for new storage technologies, such as compressed air, plug-in hybrid vehicles, and others to be integrated into the bulk power system and into load management systems.

Transmission Expansion Trends to Accommodate RPS Targets

Some states that have enacted ambitious renewable portfolio standards are now implementing transmission expansion programs in order to ensure that the renewable energy, which is often sited in remote areas, is deliverable to the existing load. States like California and Texas have put in place such programs.

The California Energy Commission (CEC) has established a Renewable Energy Transmission Initiative (RETI) in order to identify the necessary transmission projects required to facilitate the state's renewable energy goals. RETI relies on the identification of Competitive Renewable Energy Zones (CREZ), which are zones that can develop large amounts of energy from renewable resources in a cost effective and environmentally benign manner. Once these zones are identified by the California Public Utilities Commission (CPUC) and the CEC, the process requires the development of detailed transmission plans. This process is integrated into CAISO's planning process. It relies on a collaborative process to build consensus support for the development of renewable energy resources in the CREZ and the related transmission expansion. On April 19, 2007, FERC approved CAISO's Location Constrained Resource Interconnection Process (LCRIP), which is a mechanism for financing transmission facilities to interconnect the renewable resources. The process requires that proposed transmission facilities go through the CAISO transmission planning process and are turned over to CAISO control once in operation. There must be a demonstrated interest exceeding 60% of the capacity of the proposed transmission lines, and at least 25% of the capacity must be subscribed by new interconnections before the load serving entities would be required to build the transmission facilities. Costs of the facilities are rolled into the CAISO's transmission access charge, which is subject to pro rata payments of the going forward costs from subsequent generator interconnections.

Texas has also implemented a transmission expansion program that relies on CREZs. The legislature in Texas directed the Public Utility Commission of Texas (PUCT) to collaborate with the Electric Reliability Council of Texas (ERCOT) and the Southwest Power Pool to designate CREZs and develop transmission plans for areas with significant renewable generation potential and developer commitment. In July 2007, the PUCT designated five CREZs within west Texas and the panhandle. ERCOT submitted optimized transmission plans to the PUCT for developing between 12,000 MW and 24,000 MW of wind resources. ERCOT submitted four scenarios, each addressing three major criteria: 1) system reliability, 2) adequate transfer capability, and 3) benefit-cost ratios. On July 28, 2008, the PUCT elected to approve ERCOT's second scenario that will construct transmission facilities to ultimately interconnect over 18,450 MW of wind power at a costs of $4.93 billion. Similar initiatives in other control areas are also underway. For example, the Midwest Independent System Operator (MISO) is currently coordinating efforts to evaluate the transmission needed to support integration of 20% wind generation within Minnesota, Wisconsin, Illinois and Iowa.

While no transmission policy initiatives are currently underway in New York State, in 2009, the NYSPSC will evaluate the implementation and administration of the RPS program to date. Also, the Governor has established a State Energy Planning Board, which will issue a draft State Energy Plan on or before March 31, 2009. Among other topics, the plan will include an assessment of the existing electric generation, transmission and distribution systems.

6. Conclusion

Because of New York State's incentive programs and the NYISO's open access and market rules, New York has become a leader in wind integration. Significant progress has been made to integrate greater levels of wind plants onto the New York transmission system. The NYISO, however, is continuously striving to increase efficiency and support environmental sustainability through markets. Improved integration of wind resources into the NYISO markets, as proposed in this paper, is expected to be implemented in 2009.