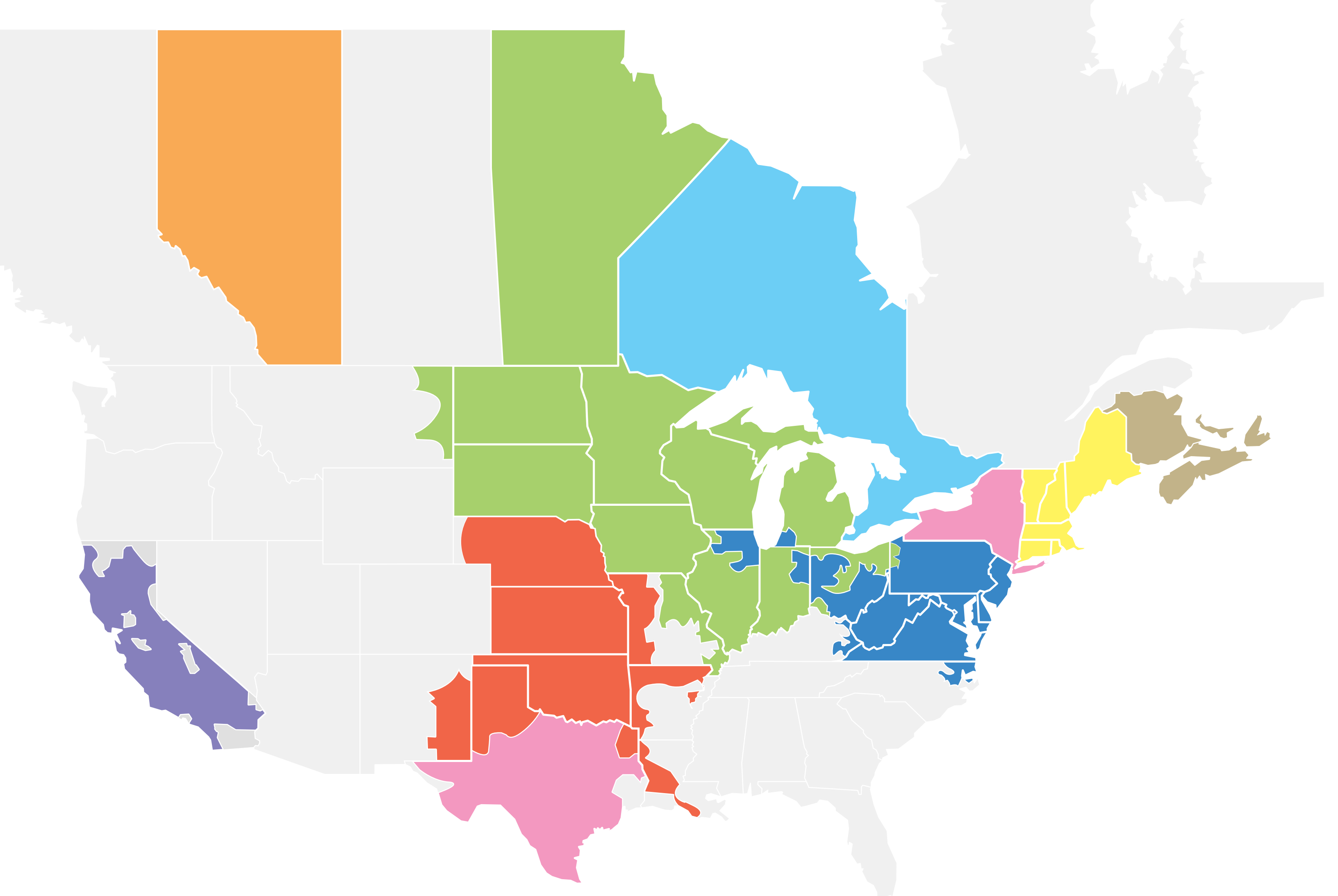

2009 State of the Markets Report

IRC
ISO/RTO Council

The Alberta Electric System Operator (AESO), California Independent System Operator (CAISO), Electric Reliability Council of Texas (ERCOT), Ontario's Independent Electricity System Operator (IESO), ISO New England, Inc. (ISO-NE), Midwest Independent Transmission System Operator, Inc. (Midwest ISO), New York Independent System Operator (NYISO), New Brunswick System Operator (NBSO), PJM Interconnection, L.L.C. (PJM), Southwest Power Pool, Inc. (SPP), and Scott Harvey and Susan Pope of LECG assisted in the preparation of this report.

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Executive Summary

The formation of Independent System Operators and Regional Transmission Organizations (ISOs/RTOs) began in the mid-1990s to support the introduction of competition in wholesale power markets. At present, two-thirds of the population of the United States and more than one-half of the Canadian population are served by transmission systems and organized wholesale electricity markets run by ISOs or RTOs. These ISOs/RTOs ensure that the wholesale power markets in their regions operate efficiently, treat all market participants fairly, provide all transmission customers with open access to use of the regional electric transmission system, and support the reliability of the bulk power system. Currently, 10 ISOs/RTOs operate in the United States and Canada. The ISO/RTO Council (IRC) is an industry organization consisting of representatives of the North American ISOs/RTOs. The IRC works collaboratively to develop effective processes, tools, and standard methods for improving competitive electricity markets across North America.

One of the most important responsibilities of ISOs/RTOs is to maintain reliable bulk power system operations in real-time. They provide critical reliability services including outage coordination, generation scheduling, voltage management, ancillary services provision, and load forecasting. ISOs/RTOs enhance reliability through their large geographic scope – by dispatching generation over a broad region they reduce the number of decision makers managing the grid, which simplifies coordination and improves reliability. ISOs/RTOs also use sophisticated computer models to analyze the real-time state of electrical flows on the grid and identify potential reliability problems, as well as to meet consumer load at least-cost, using software that works on a wider scale and with a higher level of technical sophistication than that used by smaller control areas.

Most ISOs/RTOs coordinate competitive wholesale spot markets in which energy providers submit supply offers and purchasers submit demand bids. A market clearing price balances supply and demand, selecting least-cost supplies until demand is met. ISO/RTO wholesale markets further enhance reliability by informing all market participants of real-time grid conditions through the public posting of electricity and ancillary service prices and other key system information. High prices signal to loads and off-line generators able to respond in a timely manner where more low-cost generation or load reduction are needed and valued.

A variety of analyses have concluded that the implementation of competitive power markets based on centrally-coordinated economic dispatch has reduced the cost of electric power within the regions served, relative to the level of costs that would otherwise have been incurred. The consumer benefits of centrally-coordinated wholesale markets are reflected in declines in fuel-adjusted wholesale electric prices in ISO/RTO regions. These declines in power prices within ISOs/RTOs, relative to the levels that would otherwise have prevailed, reflect a number of factors, including: the cost reductions made possible through security-constrained economic dispatch; incentives for improved generator availability; optimizing reserves over larger areas; investments in new more efficient generating units; and retirement of uneconomic facilities.

Demand response is an increasingly important part of the overall resource mix used to meet electric power demand reliably, serving to both reduce costs and enhance reliability.

In real-time, demand response reduces peak demand, enabling system operators both to reliably meet load and avoid dispatching relatively high-cost, or energy-limited, resources. Traditional vertically integrated and transmission-dependent utilities have long employed interruptible load to reduce capacity needs and enhance reliability. ISO/RTO dispatch, settlement, and demand response rules accommodate these utility programs. In addition, ISOs/RTOs are able to encourage the development of efficient demand response capability in a number of ways that have not been feasible within the programs of individual utilities. As a result, 31,695 megawatts (MW) of demand response are presently available in North American ISO/RTO markets, up from 17,146 MW at the end of 2006, and representing 6.6 percent of 2008 peak electricity demand within the combined ISO/RTO regions. With the capacity of an "average" power plant at 500 MW, ISO/RTO demand response resources provide the equivalent of more than 63 power plants.

ISOs/RTOs accommodate and facilitate the development of renewable resources. ISOs/RTOs provide fertile ground for "green power" such as wind generation, by providing one-stop shopping for interconnection to the grid, access to an energy spot market, reliance on financial mechanisms such as financial transmission rights and day-ahead market schedules to define transmission system entitlements, and coordination of dispatch over a broad region with many dispatchable resources. Wholesale electricity markets coordinated by ISOs/RTOs support the development of renewable resources by providing a flexible and competitive marketplace for the output of the renewable resource, ensuring the resource owner is not limited to selling its power only to the local control area operator.

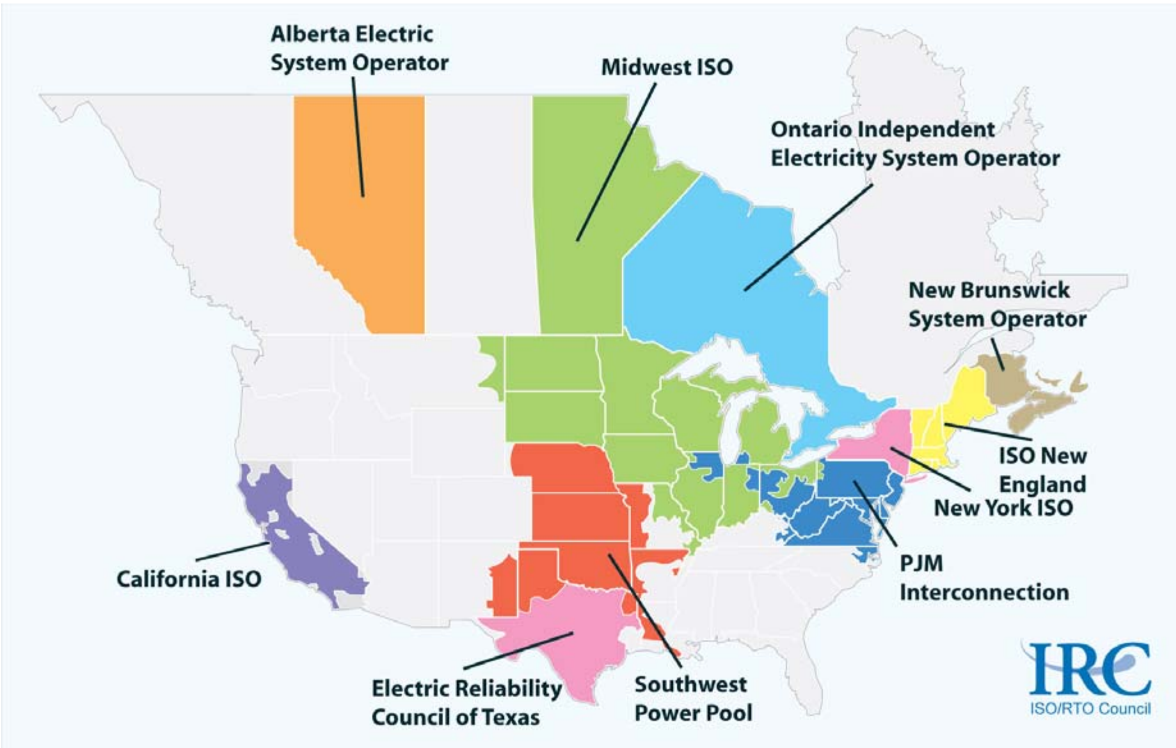
These advantages provided by ISOs/RTOs have stimulated a continuing increase in wind generation within the ISO/RTO footprints. Overall, wind generating capacity located within the 10 ISOs/RTOs has increased four-fold since 2004, and total wind generation output approached an average of 5,000 MW-hours per hour during 2008 (4,750). Moreover, close to 80 percent of total U.S. wind generating capacity is now located within the footprint of the ISOs/RTOs in the United States.

ISOs/RTOs coordinate transmission-planning processes to evaluate proposed transmission improvements. Importantly, the wider geographic scope of ISO/RTO markets, compared with most transmission owner operated control areas, supports the development of large-scale transmission projects that serve loads over broad regions, and are supported by the dispatch of generation over a broad region. Large-scale transmission projects spanning the service territories of multiple transmission system owners have been completed or initiated in Midwest ISO, PJM, ISO-NE, and ERCOT in the last several years.

I. Introduction

The formation of Independent System Operators and Regional Transmission Organizations (ISOs/RTOs) began in the mid-1990s to support the introduction of competition in wholesale power markets. At present, two-thirds of the population of the United States and more than one-half of the Canadian population are served by transmission systems and organized wholesale electricity markets run by ISOs or RTOs.[1] These ISOs/RTOs ensure that the wholesale power markets in their regions operate efficiently, treat all market participants fairly, provide all transmission customers with open access the regional electric transmission system, and support the reliability of the bulk power system. Currently, ten ISOs/RTOs operate in the United States and Canada.[2] Figure 1 portrays the footprint of the North American ISOs/RTOs.

Figure 1



ISO/RTO Map

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1 An organized wholesale electricity market is a region in which a central operator, such as an Independent System Operator (ISO) or Regional Transmission Organization (RTO) coordinates the dispatch of generation and demand response resources within the region to meet the region's electricity demand. Wholesale electricity can be bought and sold based on prices determined by the cost of meeting electric load in that ISO/RTO coordinated dispatch.

2 As of 2009, the North American ISOs/RTOs include the Alberta Electric System Operator California Independent System Operator, Electric Reliability Council of Texas, Ontario's Independent Electricity System Operator, ISO New England, Midwest Independent Transmission System Operator, New York Independent System Operator, New Brunswick System Operator, PJM Interconnection, and Southwest Power Pool.

The ISO/RTO Council (IRC) is an industry organization consisting of representatives of North American ISOs/RTOs. The IRC works collaboratively to develop effective processes, tools, and standard methods for improving competitive electricity markets across North America. The IRC's goal is to balance reliability considerations with market practices, resulting in efficient, robust markets that provide competitive and reliable service to electricity users.

Over the last decade, ISOs/RTOs have established real-time dispatch to meet regional electric demand (or, in some cases, have expanded existing real-time dispatch processes), established competitive wholesale electricity markets supported by this real-time dispatch, and developed effective regional transmission planning processes to support the reliable operation of the bulk power grid, all carried out on a non-discriminatory basis and in a cost-effective manner.

The purpose of this report is to summarize the state of these regional markets as of early 2009, and to discuss some of the more significant areas of progress in the continuing development of these markets, focusing on the following five topics: [3]

- Reliability of the bulk power system;
- Competition in wholesale power markets;
- Integration of demand response;
- Interconnection and transmission of power generated by renewable resources; and
- Regional planning for development of electric system infrastructure.

Many of the benefits from organized wholesale electricity markets derive from two key features of ISO/RTO operation:

- Security-constrained economic dispatch in which all wholesale market participants can participate; and
- An associated spot market in which these entities can buy and sell power, typically at locational marginal prices.

Security-constrained economic dispatch and open access to the spot market can provide substantial benefits for all consumers, whether the participating entities are traditional vertically integrated investor-owned utilities, municipal utilities, transmission-dependent utilities with limited generation, load-serving entities that own little or no generation, or independent power producers.

For example, within an ISO/RTO coordinated spot market, a vertically integrated utility has the choice of meeting its customers' load with its own generation, at incremental cost, or of buying power from the ISO/RTO coordinated spot market whenever the spot price is lower than the incremental cost of its own generation. Similarly, ISO/RTO coordinated spot markets can benefit load-serving entities that lack generation of their own by enabling them to meet their customers' electric load either by purchasing power in forward markets or by buying power in the spot market to meet imbalances. Moreover, even when load-serving entities purchase power through forward contracts, the ISO/RTO markets can reduce the costs of such contracts by

[3] This report is based on information as of the end of 2008 or early 2009. More recent information can be obtained at the individual web sites of the ISO/RTOs: aeso.ca, caiso.com, ercot.com, ieso.ca, iso-ne.com, midwestiso.org, nbso.ca, nyiso.com, pjm.com, spp.org, and the IRC website iso-rto.org.

lowering the energy delivery costs and risks for suppliers. This best-of-both-worlds feature of ISO/RTO coordinated spot markets plays an important role in reducing consumer power costs.

ISO/RTO coordinated security-constrained economic dispatch benefits consumers by ensuring that the least-cost generation is used to meet power demand over broad regions and over each five or 10 minute dispatch interval. While individual utilities typically conduct an economic dispatch of utility owned generation within their footprint to meet the demand of their customers, ISO/RTO coordinated dispatch spans the transmission systems of multiple utilities and also accommodates the dispatch of non-utility generation, as well as the scheduling of transactions with neighboring control areas. The greater scope of the ISO/RTO dispatch provides increased potential to reduce power costs. Because ISOs/RTOs are able to dispatch the generation within their footprint on a short-term basis, they are able to fully utilize valuable transmission capacity, dispatching generation during each five or 10 minute dispatch interval, rather than scheduling generation hourly based on contract path limits that leave substantial amounts of transfer capability unused.

These two features of ISOs/RTOs – coordinated security-constrained economic dispatch and the associated spot markets – is a central theme in the discussion of the following diverse topics, ranging from their impact on the cost of meeting consumer load, the ability to support demand response, the ability to integrate wind and other renewable resources, and the ability to coordinate operations with adjacent system operators.

II. ISOs/RTOs Support and Improve the Reliability of the Bulk Power System

One of the most important responsibilities of ISOs/RTOs is to maintain reliable bulk power system operations in real time. They provide critical reliability services including outage coordination, generation scheduling, voltage management, ancillary services provision, load forecasting, and more. In the face of extended heat waves in 2006, every ISO/RTO met its peak load without incident by scheduling and coordinating the use of the available supply and demand-side resources, while day-ahead and real-time prices provided incentives for market participants to deliver electricity at the times and places needed. Further, ISOs/RTOs have taken the lead in improving grid reliability by initiating innovation in grid management technology and procedures, including data visualization for system operators, faster contingency analysis and data interpretation, and cyber-security protection measures.

All of North America’s ISOs/RTOs are members of the North American Electric Reliability Corporation (NERC), participate in their respective regional reliability councils, and meet or exceed the reliability standards set by NERC and the regional councils in operating their bulk power systems.

Operational Control over a Broad Region

ISOs/RTOs improve reliability in part through their large scope – by dispatching generation over a broad region, they reduce the number of decision makers managing the grid, which simplifies coordination and improves reliability. In the event of a system emergency, the ISO/RTO is the central authority within its footprint, determining which actions transmission and generation owners should take to protect the grid. The wide scale of ISO/RTO operations also allows them to see a broader picture of grid conditions than a small, stand-alone balancing authority. Their "big picture" view and use of advanced tools make them better able to detect developing problems on the grid. Their coordination of real-time dispatch provides them with the flexibility and capability to respond effectively to the situations they detect.

ISOs/RTOs possess the size, scope, scale, tools, information, and authority to be effective grid managers as electrical topologies have become increasingly complex. They have responded to the challenge of maintaining and improving grid reliability during a period of increased grid usage, lower capacity margins, and higher inter-control area flows.

The ability to monitor and evaluate the transmission grid across wide regions is crucial for grid optimization and power flow management. The reliability of the interconnected grid can be affected by conditions at distant locations, and electrical events that threaten reliability can occur with little or no warning. If a small control area observes only localized conditions, it may not identify all of the factors that could affect operating conditions and contingencies within its footprint, and as a result may take actions that fail to adequately address regional reliability problems or emergency conditions.

The scope of ISO/RTO contributions to reliability has grown beyond their individual boundaries through the development of coordination agreements and market-based congestion management processes with their neighbors, including data exchange, transaction and market scheduling, communications protocols, and more. ISOs/RTOs have developed tools to exchange data with adjacent regions, and use the data in their computer systems to monitor transmission grid reliability. This ensures their analysis of conditions affecting the areas inside their footprint is accurate. For example, the data exchanged by PJM and Midwest ISO ranges from long-range planning data to coordinate planning models, to shorter-term operational planning data to coordinate available transfer capability calculations, to two-second EMS data used by system operators in minute-to-minute security-constrained economic dispatch of the two systems.

The coordination mechanisms implemented by ISOs/RTOs give operators real-time access to system conditions data information for neighboring areas on a minute-by-minute and second-by-second basis. For example, the real-time data exchanged by PJM and Midwest ISO and the accompanying dispatch protocols and compensation rules allow the system operators to jointly manage transmission constraints in either system that are affected by power flows and generation dispatch within both footprints. PJM and Midwest ISO each conduct security-constrained economic dispatch for their region, producing energy prices that reflect the impact of transmission constraints within their footprint and in neighboring areas, thereby supporting reliable operations and reducing costs.[4] Midwest ISO and SPP have a similar joint operating agreement covering congestion management. This dispatch coordination permits consistent pricing for constraints that are near the ISO/RTO borders, and provides incentives for market participants to act in ways that support reliable operations. This type of coordination is not possible for regions in which centrally-coordinated economic dispatch and competitive wholesale electricity markets do not exist.

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[4] For example, joint dispatch coordination between PJM and Midwest ISO for the Wylie Ridge flowgate has provided PJM operators with more reliable real-time transmission constraint control capability and has saved as much as $4 million in transmission congestion control costs in a one-month period.

Additional examples of how ISOs/RTOs have worked to expand their understanding of grid conditions within and beyond their footprints include:

- In 2008, the AESO developed long-term adequacy rules to provide early warning of potential operating problems. The rules describe how the AESO monitors and reports on the long-term adequacy of Alberta's electricity market, and the steps the AESO may take to address any concerns that it identifies.

- As part of its reliability role, every ISO/RTO performs outage coordination, looking several months ahead at transmission and generation owner forecasts of maintenance and other planned outages for generation and transmission facilities. This ensures that the combination of outages does not violate local or regional reliability criteria, while accommodating the maintenance needs of grid equipment. While individual transmission owners also attempt to minimize the reliability and economic impact of outages, they are only able to coordinate transmission and generation outages on their transmission system, while ISOs/RTOs are able to coordinate outages across all of the transmission systems within their footprint. ISOs/RTOs minimize the effect of outages on reliability and the cost of serving load by adjusting outage schedules to eliminate undesirable combinations of transmission and or generation outages.

- PJM, Midwest ISO, and the Tennessee Valley Authority have established a Joint Reliability Coordination Agreement for data exchange and coordinated control of transmission facilities that the combined systems affect, and to reduce reliance on the NERC Transmission Loading Relief procedure. Under the Joint Reliability Coordinating Agreement, these regions also coordinate available transfer capability calculations for transmission reservations to make sure that transmission service is not oversold, and undertake regional transmission expansion planning.

- The Northeast Power Coordinating Council has a Regional Reserve Sharing program that includes ISO-NE, IESO, NBSO, and NYISO, which allows for reductions in the amount of reserves each ISO must provide each day. In addition, both the ISOs/RTOs belonging to the Northeast Power Coordinating Council and PJM participate in a Shared Activation of Reserve program that allows for the sharing of reserves during contingency events to enable more rapid recovery.

The success of the ISOs/RTOs in developing and implementing coordinating/sharing agreements to manage and improve reliability stems in part from the consolidation of authority into a limited number of entities, each carrying out similar functions for a large geographical region. It would be difficult to develop comparable reliability agreements among a large number of small balancing authorities because of the multiple separate negotiations that would be required, the generally limited level of resources available to the smaller entities, and the difficulty of coordinating actions among a large number of entities in real-time.

The independent status of ISOs/RTOs also facilitates development of coordination and information sharing agreements. The ISO/RTO can act as an objective facilitator, and market participants can allow the ISO/RTO to perform this coordination role without concern that the ISO/RTO will use the coordination process to favor its own assets or customers, or that it will misuse confidential information.

Advanced Technologies Improve Reliability

ISOs/RTOs carry out many complex information technology-intensive tasks to manage the highly interdependent and complex transmission grids whose reliability they maintain. ISOs/RTOs use sophisticated computer models to analyze the real-time state of electrical flows on the grid and identify potential reliability problems, as well as to meet consumer load at least-cost. They use software that works on a wider scale and with a higher level of technical sophistication than that used by smaller control areas. [5]

The large footprints of the ISOs/RTOs, as well as the sizeable amounts of generation capacity they manage, enable them to spread the costs of sophisticated software tools over a significant number of users and transactions. Technological tools, such as the system control and data acquisition systems used to acquire grid condition data or the state estimators and contingency analysis models used to monitor and project the grid's condition, are expensive and require a significant amount of support and maintenance, costs that would generally not be economic to incur to serve an individual transmission owner's load.

ISOs/RTOs work with software providers to identify performance enhancements and needed operating features to improve reliability over a wide-area region. Highlights of these technology advances:

- *Large-Scale State Estimator:* To address the need for wide-area transmission system visibility and the wide regional scale of ISO/RTO control of the transmission system, ISOs/RTOs have expanded their operators' real-time visibility beyond the ISO/RTO immediate footprint, reaching various distances into neighboring regions.

- *Real-time Voltage Analysis:* Regional power transfers may have significant impact on voltage performance during contingency events. PJM has developed on-line voltage analysis software that monitors the voltage characteristics of power transfers by re-calculating regional system voltage characteristic curves every 10 minutes based on current system operating characteristics. The automated calculation provides power system operators with real-time information on reactive power transfer limitations, which are directly introduced into the unit dispatch system to ensure the deployment of generation resources to meet demand is within reliability limits.

- *Visualization Technology*: ISOs/RTOs have aggressively pursued advances in visualization technology to enable operators to manage large transmission systems, particularly during periods of rapidly changing grid conditions. Displays supporting real-time grid operation need to show relevant information without overwhelming the operators with more information than can be assimilated. For example, ISO-NE is using advanced visualization technologies in the control room to convey complex power

[5] In 2004, the Federal Energy Regulatory Commission (FERC) examined the minimum requirements and best practices for reliability software and hardware. For all measures studied, NERC reliability audit program results confirm that only RTOs, ISOs, and a few very large utilities have invested in development and installation of the sophisticated, complex software tools identified as best practices needed for reliable grid operations. (Frank Macedo study, presented at FERC Reliability Software Technical Conference, July 14, 2004.)

system data in an intuitive and timely manner to improve situational awareness in the control room. With the new technology, operators are better equipped to make the necessary decisions to ensure reliable system operations.[6] Similarly, PJM is using new projection technology to facilitate the display of information to operators. PJM is also working with software vendors to create a spatially dynamic visualization and decision-support tool to enable better real-time decision-making and protect grid reliability.

- Transmission Transfer Limit Calculator: ISO-NE has developed a Transmission Transfer Limit (TTC) Calculator that provides a highly efficient, parallel computing technology for automated and robust calculation of second contingency interface limits. This has led to improvements in system reliability through accurate and consistent results that minimize error and take into consideration multiple scenarios simultaneously.

Extensive Operator Training

Reliable grid operations require staffs of highly trained, expert operators who can quickly evaluate current grid conditions and possible threats to grid reliability, and make lightning-quick decisions about actions necessary to protect reliability of the power system. This is not possible without significant investments in recruiting and training a large corps of highly skilled operators and support staff. ISOs/RTOs invest significant time and resources to train operators and operations support personnel in all aspects of system operations and emergency condition management, including effective communications between control rooms and operators.

Highly qualified and trained personnel are critical for reliable operations because of the complexity of the interconnected ISO/RTO transmission grids, and the potentially dire consequences of operational errors. Large ISOs/RTOs use operational simulators to create near-real operational conditions so operators can practice without the negative consequences of errors. Operators are videotaped and then are debriefed, reviewing their actions to understand errors and reinforce critical learning.

NERC audits have confirmed the excellence of ISO/RTO training. Operators attend NERC-approved continuing education programs and NERC tracks each operator's training hours. Examples include:

- Following the 2003 blackout, NERC increased its requirements for operator training to include at least 32 hours per year of training and drills in system emergency response,

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[6] Major features of visualization in the ISO-NE's control room include:
1) Retrieving Energy Management System (EMS) and market data from redundant PI systems every a few seconds with seamless failover
2) Real-time dynamic view of all 345 kV, 230 kV and major 115 kV lines flows with animation and color changing when line is overloaded or outaged
3) Real-time dynamic view of all units outputs and unit control modes
4) Contingency visualization
5) Voltage contour and LMP contour
6) Three dimensional unit megawatt and megavar reserve monitoring
7) Wide-area view of other control areas (PJM, NY, IESO, NB, Hydro-Quebec, etc.), including loads, interchanges, frequency and ACE

including realistic simulations, for each staff person with responsibility for real-time operation or reliability monitoring of the bulk electric system. PJM provides this training for its operators and those of its member companies. PJM has one complete team of operators on a training shift each week, such that every sixth week the operators are scheduled for a training week. The NYISO continues to provide training programs similar in form and content to those provided by PJM. On average, NYISO operators receive more than 100 hours of NERC-approved training per year, exceeding the three-year NERC operator certification requirements by more than 50 percent**.**

- The AESO participated in a NERC/Western Electricity Coordinating Council (WECC) readiness evaluation in June 2008. In their published report the NERC audit team cited the AESO as a model operating organization in terms of experienced and knowledgeable operators, leadership and management support ensuring operational input to plans and systems, and company culture and learning environment. The NERC report cited 11 positive observations and six suggestions for improvement.[7] Half of the recommendations for improvement have been addressed, with the remainder expected to be in place by 2010.

- In the fall of 2008, an Northeast Power Coordinating Council (NPCC) compliance audit found NBSO to be fully compliant with all of the applicable reliability standards with regard to operator training. Similarly, in December of 2007, an NPCC compliance audit found the NYISO to be fully compliant with all of the applicable reliability standards with regard to operator training. The NPCC also found the IESO to be fully compliant with 38 key electricity reliability standards and 168 reliability requirements imposed by NERC in a summer 2008 audit.

- In 2009 the NYISO's simulation facilities were expanded to allow all New York operators to participate interactively and simultaneously in restoration simulation. Customized tabular displays and one-lines were developed to realistically mimic the company-specific information. In 2008, NYISO took the lead in coordinating a region-wide restoration exercise, building on the scheduled exercises of Midwest ISO and IESO. The NYISO simulator was used in conjunction with WebEx to coordinate steps and provide a wide-area view of the exercise.

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[7] The final report is available on the NERC website: http://www.nerc.com/docs/rap/audits/AESO_Evaluation_Report.pdf

ISO/RTO Coordinated Markets Support and Enhance Reliability

Most ISOs/RTOs operate wholesale markets for energy and ancillary services, such as reserves, frequency and voltage regulation, and voltage support.[8] ISO/RTO wholesale markets enhance reliability by informing all market participants of real-time grid conditions through the public posting of electricity and ancillary service prices and other key system information on their websites. Higher prices signal to loads and off-line generators able to respond in a timely manner that generation supply has tightened. High prices provide specific signals as to where more low-cost generation or load reduction are needed and valued, while low prices indicate the reverse.

Real-time Wholesale Markets Strengthen Grid Reliability

The economic incentives of individual participants in competitive wholesale markets administered by ISOs/RTOs improve system reliability. While a centrally managed system requires a single operator to direct activity on the grid, competitive markets also utilize transparent prices to communicate information about grid conditions simultaneously to hundreds of market participants, providing them with the information and incentive to take actions that support the transmission system. In markets based on locational marginal pricing (LMP), each market participant can tell when and where congestion or supply shortages arise. LMP pricing makes every market participant a partner in assuring system reliability, because when they submit economic bids and offers to the ISO/RTO market and respond to prices and dispatch instructions in real-time, they are acting in a way that supports and enhances system reliability.

ISOs/RTOs have learned through experience that a competitive price for power, derived through the bids and offers of willing buyers and sellers, will enhance reliability when prices determined in the market reflect the physical state of the power grid. ISOs/RTOs determine market prices through a regional bid-based dispatch constrained by the demands of the network, and then communicate the results to all market participants. From a reliability perspective, the crucial aspect of the real-time wholesale prices is that they result from the security-constrained economic dispatch, which is based on a real-time assessment of grid capabilities. Experience has shown that market prices work best to support reliability when prices are locational, because locational prices that are consistent with dispatch instructions provide market participants with financial incentives to take actions that maintain the physical balance between supply and demand for power at each grid location.

Locational prices resulting from the security-constrained dispatch conducted by the ISOs/RTOs provide continuous information to the market about where stress is appearing in the system, providing an incentive for participants to redirect resources where they are most needed. For example, if a transmission line is congested, the price on the delivery side will be relatively high, signaling the need for more generation or less demand on that side. Any available generation on the delivery side of the constraint will see the price rising and will have an incentive to respond to alleviate the reliability problem because the prices and desired reliability response are

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[8] Ancillary services support reliability because they help system operators react quickly and effectively to changing conditions on the grid, such as the loss of a generation unit or a transmission line.

consistent. When coupled with time-based retail pricing, the wholesale price also can incent customers to reduce demand in response to rising prices before a tight supply situation develops into a critical reliability problem. If costly transmission constraints persist over time, market prices give market participants an incentive to undertake investments such as energy conservation, transmission upgrades, or construction of new generation to resolve the problem. Since price signals are transparent, all parties in the market have the same information and opportunity to respond in ways that will relieve the transmission constraint.

Security-Constrained Unit Commitment and Reliability

In addition to operating real-time regional wholesale markets based on security-constrained economic dispatch, many ISOs/RTOs enhance transmission grid reliability by scheduling generation day-ahead using a regional unit commitment process. This forward-looking scheduling process provides advance notification to generation owners of when they need to start units to meet load on the next day. The NYISO began operating a security-constrained day-ahead market when it began operations in 1999, PJM in 2000, ISO-NE in 2003, Midwest ISO in 2005, and IESO in 2006. Most recently, the CAISO implemented a security-constrained day-ahead market in 2009.

These unit commitment engines coordinate generator operating schedules with forecast load, transmission outage schedules, and regional power flow projections to provide assurance to system operators that adequate generation capability will be available to meet ongoing grid operational reliability requirements. The broad scope of ISOs/RTOs means that unit commitment systems provide a regional perspective on upcoming grid operations and advance notice of potential regional operational issues.

III. Benefits of Competition in ISO/RTO Coordinated Wholesale Power Markets

Most ISOs/RTOs coordinate competitive wholesale spot markets in which market participants are paid market clearing prices for their incremental output and pay market clearing prices for power they purchase. A variety of analyses have concluded that the implementation of competitive power markets based on centrally-coordinated economic dispatch has reduced the cost of electric power within the region, relative to costs that would otherwise have been incurred.[9] As has been widely pointed out,[10] assertions that the implementation of centrally-coordinated economic dispatch has not led to substantial cost savings are typically based on comparisons that do not control for changes in fuel costs or for differences in resource mix (such as cost differences between regions able to meet their load largely with coal or hydro generation and regions dependent on gas-fired generation to meet much of their demand).[11]

Moreover, many of these comparisons are between states that have or have not implemented retail competition, rather than comparisons between regions with wholesale market competition supported by centrally-coordinated economic dispatch of an independent system operator versus regions with fragmented control areas and no open access wholesale spot market. The benefits of ISO/RTO coordinated wholesale power markets are not limited to regions that have implemented some form of retail competition, and may in fact be substantial even in regions that have implemented little or no retail competition.

While a transparent competitive wholesale market is necessary to support retail competition, ratepayers served by vertically integrated utilities with a traditional obligation to serve also benefit from implementation of ISO/RTO coordinated wholesale markets in regions that have not

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[9] See for example, Bates White, "An Empirical Assessment of the Benefits of Competition in Wholesale and Retail Electric Markets," May 2006; Mark L. Fagan, "Measuring and Explaining Electricity Price Changes in Restructured States," 2006; Global Energy Decisions, "Putting Competitive Power Markets to the Test – The benefits of Competition in America's Electric Grid: Cost Savings and Operating Efficiencies," July 2005; Intelometry, "Texas Retail Competition, Impact on Residential Prices 1995-2008, December 1, 2008; Edward Krapels and Paul Fleming, "Impacts of the PJM RTO Expansion," November 2005; New York State Department of Public Service, "Staff Report on the State of Competitive Energy Markets: Progress to Date and Future Opportunities:" March 2, 2006; Scott Harvey, Bruce McConihe, and Susan Pope, "Analysis of the Impact of Coordinated Electricity Markets on Consumer Electricity Charges," June 18, 2007; SPP Market Monitoring Unit and Boston Pacific, "Estimation of Net Trade Benefits from EIS Market," April 22, 2008; Polestar Communications & Strategic Analysis, "A Review of Electricity Industry Restructuring in New England," September 2006; Susan F, Tierney, "ERCOT Texas's Competitive Power Experience: A View From the Outside Looking In," October 2008.

[10] See for example, Frank Huntowski, Neil Fisher and Aaron Patterson, " Embrace Electric Competition or it's Déjà vu All Over Again," October 2008; Brattle Group, "Why are Electricity Prices Increasing, An Industry Wide Perspective, " June 2006; Analysis Group, "Electricity and Underlying Fuel Prices – A Survey of Non-Restructured States," April 2006; Sue Tierney, "Decoding Developments in Today's Electric Industry – Ten Points in the Prism," October 2007; J. P. Pfeifenberger, G.N. Basheda and A.C.Schumacher, "Restructuring Revisited," Public Utilities Fortnightly, June 2007.

[11] See, for example, Marilyn Showalter, "Price Trends For Industrial Electricity, Deregulated vs Regulated States," November 6, 2007 (no attempt to control for differences in resource mix, some low price coordinated wholesale market states counted as regulated (e.g. Pennsylvania, West Virginia), high priced non-coordinated wholesale market states counted as deregulated (e.g. Montana); Arthur Wright, "Electric Rates in Connecticut" Buyer's Remorse On 'Deregulation'" The Connecticut Economy, Summer 2008 (no attempt to control for differences in resource mix).

implemented retail competition. Most of the states within the SPP footprint have not implemented retail competition, for example, but cost benefit studies have shown significant benefits from implementation of the SPP wholesale market.[12]

Consumer benefits of centrally-coordinated wholesale markets are reflected in declines in fuel-adjusted wholesale electric prices in ISO/RTO regions. A number of factors affect the supply and demand for electricity and its wholesale cost, including weather, economic conditions, fuel cost, transmission constraints, and participation in demand response programs. Electricity prices can be expressed in a number of ways, including average time weighted nominal prices, load weighted average nominal prices, or load weighted fuel price adjusted average prices. Because electricity prices are strongly impacted by fuel prices, which vary over time, adjusting prices for fuel price changes helps identify price trends that are not driven by changes in fuel prices.

Table 2 shows the change in average annual load weighted wholesale electricity energy spot prices in ISOs/RTOs with no adjustment for fuel cost changes. These prices do not reflect the prices actually paid by utilities and other load-serving entities to purchase power, as the purchase prices may be set by longer-term contracts. These are the spot prices that would be paid for power not covered by such contracts or supplied by the load-serving entities' own generation. Also, these prices do not reflect all costs incurred to meet electric load, as load-serving entities may need to pay additional amounts for ancillary services and capacity market charges, or may need to recover the cost of the generation they own and use to meet all or a portion of their load.

Table 2
Change in Average Annual Load Weighted Wholesale Energy Spot Prices 2005-2008
($/megawatt-hour) (a)

Region	2005	2006	2007	2008	2005-2008 Price Change (%)
AESO ($Cdn)	$49.30	$83.74	$69.55	$92.39	n.a.
CAISO	$57.83	$47.55	$47.61	$52.27	-9.6%
ERCOT	$70.28	$54.10	$55.71	$70.52	.33%
IESO ($Cdn)	$72.14	$48.75	$50.51	$51.67	-28.4%
ISO-NE	$79.96	$62.74	$69.57	$83.91	4.9%
MIDWEST ISO	$52.98	$43.32	$46.37	$51.17	-3.4%
NYISO	$90.80	$73.10	$76.57	$90.09	-.8%
PJM	$64.54	$54.31	$64.52	$71.75	11.1%
SPP (b)	n.a.	n.a.	$51.78	$57.42	n.a.

(a) No central organized wholesale market exists within NBSO, therefore spot prices are not available for this region. NBSO operates a balancing market.
(b) The SPP spot market began operation in 2007.

[12] SPP market monitoring unit and Boston Pacific, "Estimation of Net Trade Benefits from EIS Market," April 22, 2008.

Table 3 portrays prices for the same years, adjusted for changes in fuel costs, showing that fuel cost adjusted prices have been declining.[13]

Table 3
Change in Average Annual Load Weighted
Fuel-Adjusted Wholesale Spot Energy Prices 2005-2008
($/megawatt-hour) (a)

Region	2005	2006	2007	2008	2005-2008 Price Change (%)
AESO ($Cdn) (e)	$50.96	$86.57	$71.32	$75.17	n.a.
CAISO (f)	n.a.	$44.37	$43.26	$40.26	n.a.
IESO ($Cdn) (d)	$50.15	$46.69	$43.61	$35.83	-28.6%
ISO-NE (b)	$45.00	$43.00	$45.00	$42.00	-6.7%
MIDWEST ISO (g)	$37.29	$37.74	$42.57	$34.15	-8.43%
NYISO (h)	$50.07	$54.83	$49.74	$49.07	-2.0%
PJM (c)	$19.57	$18.34	$18.74	$18.17	-7.2%

(a) No central organized wholesale market exists within NBSO, therefore spot prices are not available for this region. SPP's balancing market did not begin operation until 2007 and fuel cost adjusted prices are not available. Fuel cost adjusted spot prices are also not available for ERCOT.
(b) (2000 base year) The ISO-NE internal market monitoring unit has calculated a fuel-adjusted electricity price by using the year 2000 as a base year for fuel prices, and adjusting the supply offer of the marginal unit for each five-minute interval in the current year by the price of the unit's fuel in 2000. This approach shows the impact of fuel prices on electricity prices, but does not account for the second order impact that changes in relative fuel prices, load growth, and resource mix since the year 2000 have had on system dispatch and marginal prices.
(c) 1998/99 base year
(d) 2003 base year. The fuel-adjusted Hourly Ontario Energy Price (HOEP) uses a Fuel Price Index that is a weighted average of fuel prices (uranium, natural gas, and coal). Weights are derived using actual production shares (actual energy output divided by total energy output) of nuclear, gas and coal generation units.
(e) AESO reports a market heat rate equal to the hourly pool price divided by the daily AECO-C natural gas price ($/GJ). The fuel cost adjusted price is the annual market heat rate multiplied by a constant natural gas price of $6/GJ.
(f) The fuel cost adjusted price is calculated using the July 2004 gas price ($5.70/mmbtu).
(g) The fuel cost adjusted price is calculated based on 2004 fuel prices.
(h) 2000 base year. Average load-weighted energy price per MWh paid by load-serving entities, adjusted by average annual price of natural gas for Transco Z6 (NY).

The same pattern of declining fuel adjusted prices shown over 2005-2008 also prevailed prior to 2005 in the ISOs/RTOs that were operating. For example, the average fuel cost adjusted wholesale price of electricity in New York fell 10 percent from 2000 to 2008. If capacity costs are included, the total fuel adjusted cost of wholesale power fell 18 percent in New York during this period.

Similarly, between April 1, 1998-March 31, 1999, PJM operated under a cost-based LMP energy market. In this year, the PJM load-weighted fuel-adjusted LMP was $24.4 per

[13] These data are useful for comparing spot prices within a given RTO over time, but not for comparisons across ISO/RTOs. Because the various ISO/RTOs began operations at different points in time, they have different base years for the fuel adjustments, making the figures non-comparable across ISO/RTOs.

megawatt-hour (MWh). In contrast, the load-weighted fuel-adjusted LMPs were $18.72 per MWh in 2007/2008 and $18.17 per MWh in 2008/2009. Comparison to a cost-based market employing prices from a time period in which many restructuring policy decisions were made shows the efficiency gains facilitated by regional economic dispatch and wholesale competition.

In CAISO, total wholesale costs normalized to a fixed gas price fell from 2006 to 2007; these data include forward costs, ancillary services costs, and the real-time and reliability costs of serving load.

In Ontario, the fuel-adjusted and load-weighted wholesale electricity price (HOEP) declined by an average of 7 percent between 2003-2008. Although the nominal HOEP rose slightly from 2007-2008, the fuel-adjusted HOEP declined significantly from about $46 per MWh, to just under $35 per MWh.

Unlike the average annual price of electric energy in New England, which rose 20 percent between 2007 and 2008, the fuel-cost adjusted price in 2008, $41 per MWh, was 8 percent lower than the similar fuel cost adjusted price in 2007.

These declines in power prices within ISOs/RTOs, relative to the levels that would otherwise have prevailed, reflect a number of factors including: the cost reductions made possible through security-constrained economic dispatch, incentives for improved generator availability, investments in new more efficient generating units, and retirement of uneconomic facilities. The actions of individual market participants, acting under the decentralized incentives of wholesale market pricing, have resulted in higher power-plant availability, lower outage rates, the development of demand response programs, and new plant construction when and where needed, all of which have contributed to lower power prices.

The decline in fuel-adjusted wholesale electricity prices has occurred despite increases in demand within the ISOs/RTOs. Although peak loads vary from year to year with weather conditions and are occasionally affected by changes in ISO/RTO footprints, peak demand levels within organized market regions have trended upwards over time. Cool summers in recent years have masked increases in peak load growth. Table 4 shows peak hourly loads in ISOs/RTOs from 2005- 2008.[14] Despite experiencing significant load growth, ISOs/RTOs have maintained high levels of grid reliability, and have met peak loads without incident.

14 Peak loads reported in Table 4 are not weather-normalized. Although actual peak loads are what challenge grid performance and reliability, analysts sometimes use weather-normalized peak loads for long-term comparisons because the weather-normalization better reflects underlying population and economic growth rates in a region. The change in Midwest ISO peak load between 2006 and subsequent years reflects in part the effect of changes in the Midwest ISO footprint.

Table 4
ISO and RTO Peak Loads 2005-2008 (b)
Megawatts

Region	2005	2006	2007	2008
AESO(a)	9,236	9,661	9,701	9,806
CAISO	45,562	50,270	48,615	46,896
ERCOT	60,259	62,294	62,196	62,197
IESO	26,160	27,005	25,737	24,195
ISO-NE	26,885	28,130	26,145	26,111
MIDWEST ISO	112,078	116,030	104,292	98,595
NBSO (a)	3,154	2,807	3,187	3,078
NYISO	32,075	33,939	32,169	32,432
PJM	133,763	144,644	139,428	130,100
SPP	40,187	42,284	42,594	42,891
Total	489,228	517,064	494,064	476,302

(a) The Alberta and New Brunswick systems peak in winter because of high electric heating and lighting load (and minimal air-conditioning load in summer). Other ISOs/RTOs systems are summer-peaking.

(b) Peak loads are not normalized for weather nor adjusted for changes in footprints.

Efficient Regional Dispatch Results in Use of Lowest Cost Generation

Open, non-discriminatory access to a competitive wholesale market based on security-constrained economic dispatch serves to reduce power costs in several ways. First, it directly reduces the cost for load-serving entities to serve their consumers in real-time by enabling them to buy power at the real-time spot price whenever that price is lower than their alternative source of supply. Second, it reduces forward power procurement costs by reducing cost for sellers to cover their forward contracts, allowing them to purchase power in the spot market at real-time spot prices whenever it is cheaper to cover their contract in the spot market than by operating their own generation.

The implementation of real-time security-constrained economic dispatch across previously separately dispatched control areas in ERCOT, Midwest ISO, SPP, and CAISO has directly reduced the cost of meeting consumer load by ensuring that least-cost generation is used to meet load in real-time.[15] While predecessors to several other ISOs/RTOs (such as NYISO, PJM, ISO-NE, and IESO) carried out security-constrained economic dispatch, participation in this

[15] The benefits of economic dispatch are widely recognized, for example:
"The Value of Economic Dispatch: A Report to Congress Pursuant to Section 1234 of the Energy Policy Act of 2005", United States Department of Energy, November 7, 2005; and "Study and Recommendations Regarding Security Constrained Economic Dispatch (SCED) in the Northeast by the Joint Board on Economic Dispatch for Northeast Region", FERC Docket AD05-13-000, May 24, 2006

economic dispatch was often not open to all generation located within the footprint. The inefficiency of non-market pricing systems also limited participation in economic dispatch. The introduction of open access in these regions has reduced costs by allowing additional generators to participate in economic dispatch. Improved pricing, particularly the introduction of locational pricing and financial transmission rights in most regions, has also reduced costs by eliminating incentives for the inefficient scheduling of generation. The PJM footprint has expanded dramatically since the RTO's formation, providing greatly increased opportunities for cost savings from security-constrained economic dispatch across a broad region. For regions in which no ISO/RTO has been established to centrally-coordinate use of the transmission system through economic dispatch, a source of unnecessary power cost for consumers is the inefficient scheduling and use of available transmission and generation.

In these non-ISO/RTO regions, contract path scheduling processes routinely produce outcomes in which the transmission system appears to be fully utilized in the contract path scheduling process, yet real-time power flows are typically far below the actual electrical limits.[16] This situation arises because the contract path limit is set artificially low to compensate for the security coordinator's inability to control transmission grid flows in real-time through security-constrained economic dispatch. The situation persists in real-time because of the lack of economic dispatch, which means the transmission capacity cannot be fully utilized in real-time. In non-ISO/RTO regions, end-use consumers and regulators lack visibility into how much the underutilization of the transmission system raises consumer rates. There is no public data on the relationship between actual real-time flows and transmission grid limits outside the ISO/RTO footprints.

Another benefit of the expanded scope of the dispatch coordinated by ISOs/RTOs relative to individual transmission owners is increased competition, due to the much larger number of independent entities participating in ISO/RTO economic dispatch. Competition is supported by explicit processes to review market outcomes on an ongoing basis. All ISOs/RTOs have internal and external market monitoring units that assess competitive conditions, an institution that is completely lacking outside the ISO/RTO footprints.

In a competitive market, prices will rise when demand rises or when production costs rise (such as fuel prices). Conversely, prices will fall if demand falls or if fuel prices fall. These outcomes are seen in ISO/RTO wholesale electricity markets, which is consistent with evidence that these markets are competitive and that price changes are the result of market fundamentals such as changes in fuel prices and changing levels of demand.

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16 The issue is not the relationship between path "schedules" and the "scheduling limit" but the relationship between the actual pre- or post-contingency flows on the monitored element of the underlying transmission constraint, compared to the pre- or post-contingency limit for that monitored element.

Improvements in Generator Availability

Declining fuel cost adjusted prices reflect the impact of competition among generators, accompanied and supported by the economic dispatch and bid based spot markets administered by ISOs/RTOs. This has provided incentives for existing generators to upgrade equipment and improve maintenance to improve their heat rates and capacity factors. Competitive wholesale power markets have provided incentives for generation owners to take actions to achieve higher power plant availability and lower forced outage rates, particularly during peak demand periods. This has reduced the cost of producing electricity and the need to construct new generating capacity. For example:

- In New York, average plant availability increased from 87.4 percent during 1992-1999 (prior to formation of the NYISO) to 94.4 percent from 2001-2007. This improvement is equivalent to adding 2,400 MW of generation to the system, which is approximately the capacity of four to five "average" power plants.

- Forced outages rates in Ontario declined continuously from 2003-2006. Forced outage rates in 2007 and 2008 increased slightly relative to 2006, but remained well below the level prior to 2006.

- PJM's equivalent forced outage rate fell from 7.5-8 percent in 1994-1996 to 6-7 percent in recent years, while the overall equivalent availability factor has risen from 81-83 percent in 1994-1996 to around 87 percent in recent subsequent years.

Construction of More Efficient Generation

Competition has fostered construction of efficient new power plants (under the auspices of ISO/RTO generation interconnection queue management) with lower heat rates and lower operations and maintenance costs than older existing units. Older units that were too costly and inefficient have been "mothballed" or retired, leaving a more efficient fleet with a lower net and marginal heat rate so that consumer demand is served by lower-cost, more fuel-efficient generators. For example, the average system heat rate in New York improved by 21 percent from NYISO's start-up in 1999 to 2008. Operation of these more fuel-efficient generation resources has not only put downward pressure on power prices, it has also helped to reduce CO^2 and other emissions.

Price and market transparency, new market incentives, and transmission infrastructure improvements achieved through regional system planning have facilitated significant new investments in generation, as well as the retirement of older power plants. Table 5 shows the total amount of installed generation in North America's ISOs/RTOs in 2008 and the amount of new generation added between 2003-2008. Also shown is the percentage of installed generation from resources coming on line between 2003-2008.

Table 5
Total Generation and Generation Capacity Added 2001-2008
(Summer Ratings in Megawatts)

Region	2008 Installed Generation Capacity	New Generation Capacity 2001-2008	Percentage of 2008 Generation from New Capacity
AESO	12,159	3,251	26.7%
CAISO	55,098	15,194	27.6%
ERCOT	80,141	26,681	33.4%
MIDWEST ISO (a)	127,204	10,254	8.1%
IESO	33,121	4654	14.1%
NBSO	4,271	462	10.8%
ISO-NE	31,088	8622	27.7%
NYISO	40,187	7,314	18.2%
PJM	164,895	15,504	9.4%

(a) MIidwest ISO data covers 2003-2008

- In February 2006, a Public Utility Commission of Texas staff report found that competitive forces resulted in the replacement of older power plants with new, more efficient plants, making a major contribution to the reduction of electric industry emissions and the progress toward meeting national air quality standards in a number of Texas cities. Wholesale competition provided an efficient mechanism for meeting goals for renewable energy and energy efficiency, which have contributed to reduced emissions.

- Since 2000, competitive markets coordinated by NYISO have provided incentives for the construction of 4,500 MW of new merchant generation investment in New York. Of the nearly 7,314 MW of new generation built by private investors and public power authorities in New York since 2000, over 80 percent has been located in the downstate region and half has been located in constrained load pockets.

- In 2008, 491 MW of new capacity was added to the Alberta system. As in other ISOs/RTOs, the Alberta interconnection queue is extensive, containing thousands of MW of proposed capacity additions from wind and other non CO^2 emitting sources

- In New England, the first Forward Capacity Auction took place in December 2007 to procure capacity for the June 2010-May 2011 commitment year. Approximately 1,814 MW of capacity from new resources secured capacity obligations in the auction. Of this amount, about 1,188 MW came from new demand resources. The Forward Capacity Auction worked as designed to attract significant investment in new resources while maintaining needed existing resources in New England.

- In 2007-2008, 643 MW of new generation was added in California, and 3,141 additional MW are projected for 2009. Between 2001 and 2008, roughly 15,000 MW of new generation was added to the CAISO system and over 5,500 MW of generation was retired.

- ERCOT's generation mix has undergone dramatic changes since the restructuring of the electricity industry in Texas. Approximately 26,000 MW of efficient combined cycle gas generation has been added to the ERCOT system and many old, inefficient gas-steam units have been retired. In 2008 alone, 3,730 MW of new wind generation and 5, 225 MW of other new generation came on line in ERCOT.

Market Participation and Increased Price Transparency

Another measure of the efficiency and competitiveness of ISO/RTO wholesale markets has been the large increase in the number of firms participating in these markets. For example:

- The number of participants in NYISO's markets increased from 144 in 2001 to over 400 in 2008.

- The number of participants in the ERCOT market has increased steadily, reaching 251 in 2008.

- The number of market participants in Ontario has gradually risen every year since 2002; there are now over 285 market participants.

- CAISO currently has over 100 market participants. This number has been gradually increasing over the past several years.

Competition in organized ISO/RTO markets has been accompanied by an increase in the transparency of information available to market participants regarding prices and transmission system conditions. Increased price transparency is important in harnessing market forces to supply energy when it is valuable, and to site generation and transmission where it is needed. Day-ahead and real-time prices reveal resource scarcity and transmission congestion across time and space, enabling the competitive market process to respond efficiently to short- and long-term energy needs.

IV. Integration of Demand Response into ISO/RTO Markets

Demand response is a potentially important part of the overall resource mix used to reliably meet electric power demand, reducing costs and enhancing reliability. In real-time, demand response reduces peak demand, enabling system operators to reliably meet load and avoid dispatching very high-cost or energy-limited resources. By providing an alternative to the dispatch of high-cost generation, demand response can constrain the exercise of supplier market power. In the long run, the ability of consumers to respond to high prices by reducing consumption allows society to avoid building new generation resources that rarely operate and whose true costs exceed their value to consumers. Because consumers can respond to high prices in a much shorter time frame than new generation capacity can be built, developing additional demand response alternatives provides flexibility in planning to meet future power demand. The need to build capacity to meet load forecasts that may be too high is reduced, yet reliability is not sacrificed if load forecasts turn out to be correct.

Benefits of ISO/RTO Operation for Demand Response.

Traditional vertically integrated and transmission-dependent utilities have long employed interruptible load to reduce capacity needs and enhance reliability. ISO/RTO dispatch, settlement, and demand response rules accommodate these utility programs and enable consumers to participate in capacity, ancillary service, and electric energy markets in a number of additional ways, including:

- Direct participation in energy or ancillary service markets administered by the ISO/RTO, competing directly with generation resources when they are dispatched to balance supply and demand within the ISO/RTO;
- Reducing consumption in response to high real-time electricity prices; and
- Participation in capacity markets administered by the ISO/RTO through the resource's ability to reduce power consumption when needed to maintain transmission system reliability.

ISOs/RTOs encourage the development of efficient demand response capability in a number of ways that have not been feasible within the programs of individual utilities.

ISOs/RTOs (depending on state and provincial regulatory policies) allow demand response providers to supply demand response independent of transmission owners, eliminating potential bias towards construction of generation or transmission for inclusion in the transmission owner's rate base. By coordinating real-time spot markets based on security-constrained economic dispatch and locational pricing, ISOs/RTOs provide transparent market prices for a variety of demand response products (capacity, ancillary services, and energy), making it easier for demand response providers to more accurately evaluate the prospective value of new demand response resources, and enabling regulators to better measure the value provided by demand response resources and approve appropriate levels of compensation.

- In many ISOs/RTOs, LMP provides a localized price measure of the value of demand response, which can be important within ISOs/RTOs that encompass a wide footprint over which reliability conditions can differ dramatically as a result of transmission constraints.

- In ISO/RTO markets relying in part on capacity markets to provide generator going-forward costs, demand response can participate in these markets and displace generation on a competitive basis. This allows much more transparent competition between generation and demand response than is possible within a vertically integrated utility's planning process, and provides larger benefits to society it is possible to avoid building generation that is rarely needed.

- ISO/RTO markets' broad scopes, standardized rules, communication procedures, and meter data submission protocols allow demand response providers to operate across a broad region at lower-cost than would be possible operating within balkanized programs of individual electric distribution companies. The IRC has been working with the North American Energy Standards Board (NAESB) to develop measurement and verification standards for demand response.

- The IRC Markets Committee mapped current ISO/RTO demand response program characteristics to NAESB standards. This analysis is available in the form of a matrix posted on iso-rto.org, and has been used to highlight regional variations in technical requirements. The matrix also provides additional information on the demand response programs of individual ISOs/RTOs. [17]

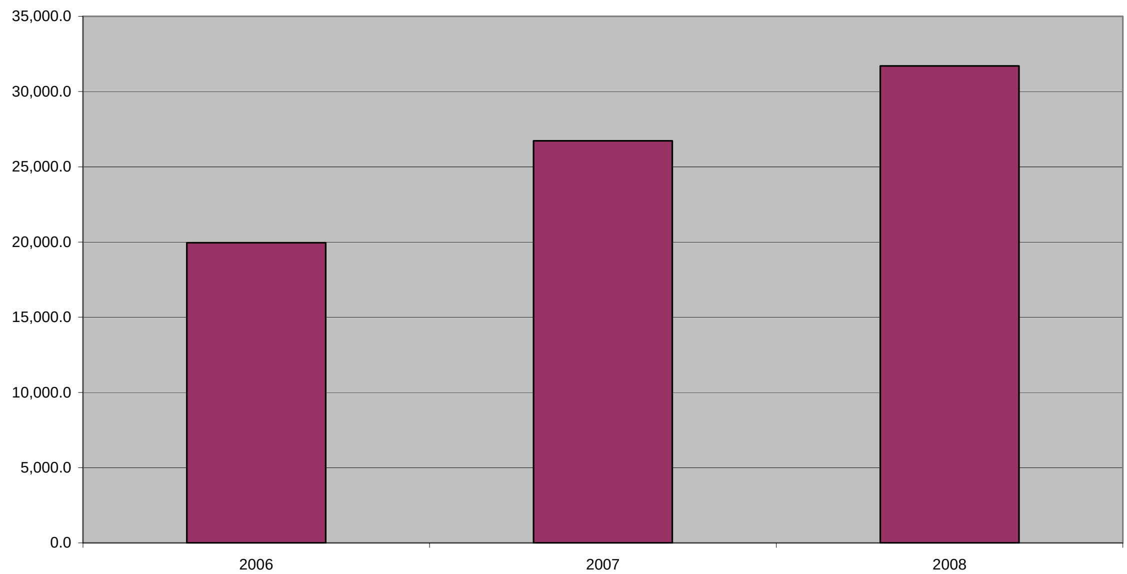
Demand response in U.S. ISOs/RTOs continues to be developed consistent with retail rate design of relevant state regulators. ISO/RTO markets provide a flexible enabling framework for the continued evolution of demand response in concert with the policy decisions of state regulators and their retail rate designs.

[17] see http://www.isorto.org/atf/cf/%7B5B4E85C6-7EAC-40A0-8DC3-003829518EBD%7D/IRC%20DR%20M&V%20Standards%20Implementation%20Comparison%20(2009-04-28).xls

Growth of Demand Response in ISO and RTO Markets

31,695 MW of demand response are presently available in North American ISO/RTO markets, up from 17,146 MW at the end of 2006, and representing 6.6 percent of 2008 peak electricity demand within the combined regions.

Figure 6
ISO/RTO Demand Response Capability*
2006-2008



*Data on California ISO demand response is not available for 2006. Figure 6 assumes no change in California ISO demand response between 2006 and 2007.

These 31,695 MW of demand response fall into four broad categories: capacity, ancillary services, energy price, and energy voluntary. Table 7 (appended) shows demand response capacity in each ISO/RTO by category and as a percentage of system peak load. [18]

Demand response capacity resources commit for a term of a year or longer to reduce load when directed by the ISO/RTO. Because they can be counted on to perform during high load conditions, they reduce the amount of generating capacity needed to meet consumer load. Much of the increase in demand response capacity resources since 2006 is a result of the implementation of more effective capacity markets in New England and PJM, which have resulted in a near tripling in available demand response capacity resources within those regions. There have also been declines in demand response in some regions, such as New Brunswick, reflecting the loss of the industrial load that provided the demand response.

[18] Figures in Table 7 have been adjusted to avoid double counting demand response capacity that may qualify under more than one program. The capacity figures shown are the registered capacity values. The actual response to a particular activation may differ from these values.

The role of demand response in providing capacity in PJM and ISO-NE will continue to increase in coming years due to the procurement of demand response capacity resources in forward auctions. For example, 2,554 MW of demand response capacity was purchased in the ISO-NE forward capacity auction covering the 2010- 2011 capacity year, and 2,936 MW of demand response capacity was purchased in the ISO-NE forward capacity auction covering the 2011 to 2012 capacity year.

Demand response ancillary service resources typically provide non-spinning reserves, and accounted for more than 4,000 MW of capacity at the end of 2008, up slightly from the end of 2006. The bulk of these resources have historically been located in Ontario and Texas. In 2008, NYISO introduced a program that allows demand response resources to supply ancillary services on the same basis as generation resources. CAISO’s Market Redesign and Technology Upgrade (MRTU) platform, which began operation on April 1, 2009, similarly allows participating loads to provide non-spinning reserves.

ISO/RTO coordinated reserve markets stimulated the development of demand-side provision of ancillary services by providing a level playing field for these demand response resources to displace generation if the demand-side resource can supply the required ancillary service at a lower cost.

Demand response energy price resources are resources that commit to reduce consumption based on price on a short-term basis. These resources accounted for another 4,400 MW of capacity at the end of 2008, up from around 2,000 MW at the end of 2007. Beginning in early 2009, Midwest ISO has administered regulation and reserve markets in which demand resources, if qualified, can participate on an equal basis with generation. Currently, almost 50 MW of demand resources are providing regulation service.

Several ISOs/RTOs operate demand response programs in which resources are compensated for reducing consumption during emergency conditions, but are not obligated to do so. These energy voluntary programs accounted for another 2,790 MW of demand response at the end of 2008, up from 631 MW at the end of 2006.

Each ISO/RTO is identifying additional reforms that would eliminate remaining barriers to the entry of cost-effective demand response resources, pursuant to FERC Order 719.

V. Integration of Renewable Resources

ISOs/RTOs accommodate and facilitate the development of renewable resources, including hydro, wind, solar, geothermal, and biomass. [19] Hydro generation has long provided an important portion of generation supply in Ontario, California, New Brunswick, New England, and New York. In recent years, many states within ISO/RTO regions have established renewable portfolio standards that stimulate investment in renewables. Several ISOs/RTOs have experienced rapid development of intermittent renewable resources such as wind generation.[20] Even more accelerated development may take place under forthcoming federal and state/provincial legislative requirements. ISOs/RTOs are facilitating the integration of renewable resources through advances in system operations and needed changes to market rules and grid planning methods.

Key benefits that ISOs/RTOs provide for the integration of renewable resources, such as wind generation, are one-stop shopping for interconnection to the system, access to a spot market for energy, reliance on financial mechanisms such as financial transmission rights and day-ahead market schedules to define transmission system entitlements, and coordination of dispatch over a broad region with many dispatchable resources. Access to the spot market for energy coordinated by the ISO/RTO supports the development of renewable resources by providing a flexible and competitive market for the output of the renewable resource, ensuring that the resource owner is not limited to selling its power to the local control area operator. [21]

ISO/RTO utilization of financial transmission rights and day-ahead schedules to define transmission system entitlements helps ISO/RTO markets accommodate the introduction of intermittent resources by avoiding the "use it or lose it" incentives associated with transmission access based on physical transmission rights. These "use it or lose it" incentives can prevent intermittent resources from displacing other resources, even when the other resources are higher cost.

The open access dispatch coordinated by ISOs/RTOs provides a mechanism for accommodating intermittent resources such as wind on the transmission system, avoiding the need for such resources to pay for firm transmission service that the intermittent resource would only be able to utilize sporadically. While there are important engineering issues to be resolved in reliably accommodating significant quantities of intermittent resources on the transmission grid, the ISO/RTO competitive market and security-constrained economic dispatch model avoids creating artificial barriers that reflect arbitrary rules rather than real reliability issues limiting the integration of renewables.

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19 See also ISO/RTO Council (IRC), "Increasing Renewable Resources: How ISOs and RTOs Are Helping Meet This Public Policy Objective," October 16, 2007, available at iso-rto.org.

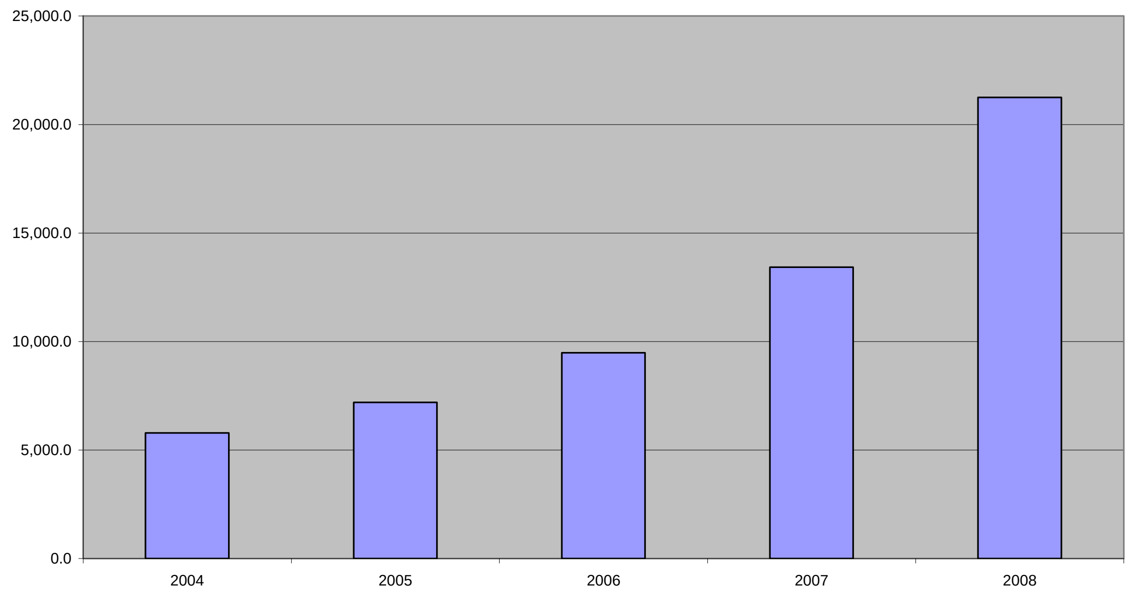
20 An intermittent generation resource has an output that varies with factors outside control of the plant operator (due to the variability of wind, solar radiation, waves or tides), and may experience substantial uncertainty about its output, due to difficulties in weather prediction.

21 See February 26, 2007 letter of American Wind Energy Association to FERC chairman Kelliher, and the American Wind Energy Association statement on Competitive Wholesale Electricity Markets and Renewable Energy, January 9, 2008, at http://www.awea.org/newsroom/releases/index.html

Importantly, the dispatch of generation over a large balancing authority area, such as those of most ISOs/RTOs, provides a greater ability to accommodate the output variations of intermittent resources (because there is a larger pool of other resources, such as generation, demand response, and storage, that can be incremented or decremented to balance variations in the output of intermittent resources).

The advantages ISOs/RTOs provide in accommodating wind and other intermittent generation resources (along with state renewable portfolio standards) have stimulated a continuing increase in wind generation within the ISO/RTO footprints, as summarized in Figure 8.

Figure 8
ISO-RTO Wind Generating Capacity*
2004-2008



*Data on MISO footprint wind generating capacity is not available for year end 2004. Figure 8 assumes no change in MISO wind generating capacity between 2004 and 2005.

Because wind generation output depends on weather conditions, it will not be economic to develop at every location. However, Table 9 (appended) shows the widespread and increasing development of wind generation resources across the 10 members of the IRC.[22] Overall, wind generating capacity located in ISOs/RTOs has increased fourfold since 2004, and total wind generation output approached an average of 5,000 MW per hour during 2008 (4,750). Almost 80 percent of total U.S. wind generating capacity is now located within the footprint of U.S. ISOs/RTOs, based on Energy Information Administration data for total wind generation capacity.

Another way in which ISOs/RTOs are stimulating reliable and efficient integration of renewable resources is by supporting the development of improved wind forecasting mechanisms within

[22] The wind generation and total generation capacities in Table 9 are capacity figures that do not include any adjustments for outages or other factors affecting availability.

their footprints. Several ISOs/RTOs, including AESO, CAISO, ERCOT, NYISO, and PJM now have centralized wind forecasting systems with state-of-the-art modeling. These systems better predict the output of wind resources and incorporate those projections into operation of their day-ahead and real-time unit commitment and dispatch systems. ISOs/RTOs are establishing advanced operational tools, including visualization of wind conditions, to improve system operators' situational awareness. This allows for more efficient commitment and dispatch of conventional resources around wind availability to ensure a sufficient balance of resources. Several ISOs/RTOs, in conjunction with national labs, are evaluating the impacts of rapid large wind output changes (such as what takes place during storms) and investigating the ability to manage significant regional wind plant output changes.

As renewable resources become a more substantial component of power systems, they need to become more dispatchable – to allow system operators more control over their output, as with conventional generators. Historically, wind generation has not bid into ISO/RTO spot markets, but has simply operated in response to wind conditions. At times, wind output has been manually curtailed in the event of congestion or overgeneration[23] (both of which typically require wind to reduce output). ISOs/RTOs are implementing additional price-based dispatch control over wind to allow for efficient management of the power system. Dispatch-directed output reductions based on the economics of a wind generator's offer will enhance market efficiency by avoiding the need for the ISO/RTO to estimate the size and duration of manual wind output reductions necessary to preserve reliability and by including, in the real-time price, the impact of the economically-driven wind output reduction

For example, to further enhance NYISO's ability to reliably and efficiently operate the New York transmission system and to accommodate increased levels of wind-powered resources, the organization is integrating wind generation into its security-constrained economic dispatch system. This will allow NYISO to direct wind resources to reduce their output when necessary and economically appropriate. Similarly, PJM has implemented an advance wind forecasting tool that provides forecasts for 25 wind farms totaling 2,265 MW of generating capacity. PJM updated its unit dispatch system algorithms to recognize the unique nature of wind, and modified its market systems to account for negative offer prices to better accommodate the needs of wind resources. CAISO implemented new wind forecast methods that improve unit commitment and dispatch efficiency and allow operators to better respond to the variability of intermittent generation. ERCOT also initiated use of a new wind generation forecast system (AWS Truewind) during 2008.

ISOs/RTOs have identified a range of operational requirements for the power system to support increased levels of renewable resource integration, notably an increased need for other resources to ramp upwards and downwards. These operational requirements will be provided by generation, demand response and storage, and potentially by increased controllability of intermittent resources. Most ISOs/RTOs are developing market rules to facilitate entry of demand response and storage into ancillary service markets. In particular, several ISOs/RTOs have concluded that high levels of wind integration will create greater demand for regulation service needed for second-by-second balancing.

23 Overgeneration means there is excess supply on the system relative to load and a lack of other generation resources whose output can be reduced to restore balance between generation and load.

For example, in 2009 NYISO is establishing a regulation-only product available to storage technologies, such as batteries and flywheels, which offer very rapid response characteristics for short duration needs. Similarly, based on experience it has gained with a storage technology test pilot (1 MW battery storage device), PJM is investigating enhancements to its regulation market rules to recognize the dependable, quick-response characteristics of storage technologies. Adding resources utilizing these storage technologies to the regulation market will increase competition in that market and assist ISOs/RTOs in meeting the potential for increased system regulation requirements that may result from higher levels of renewable resource integration.

VI. Regional Planning for Development of Electric System Infrastructure

ISOs/RTOs coordinate transmission planning processes to evaluate proposed transmission improvements. The expanded geographic scope of ISO/RTO markets, compared to most transmission owner-operated balancing authorities, supports the development of large-scale transmission projects that serve loads across broad areas and are supported by the dispatch of generation over a large region. Large-scale transmission projects spanning the service territories of multiple transmission system owners have been completed or initiated in Midwest ISO, PJM, ISO-NE, and ERCOT in the last several years.

In 2008, several key projects were completed to strengthen Alberta's transmission system. Two new 500 kV transformers were installed, a third line was upgraded to 500 kV, and two transmission lines were converted from 240 kV to 500 kV. Construction was also completed on 10 kilometers of 240 kV underground transmission in the City of Edmonton.

AESO is currently working on four important transmission system reinforcement projects. These projects will create a stronger transmission system between the two largest population centers in Alberta, address the power needs of industry based on oil sands production, upgrade the system around Calgary where there has been significant load growth, and increase the ability to connect the southern Alberta system to new wind farms. The first phase of the southern transmission reinforcement will connect as much as 1,200 MW of new wind power to the region.

NYISO has expanded its planning processes by adding both a local transmission planning component and a regional economic planning component to its all-source Comprehensive Reliability Planning Process (CRPP). NYISO conducts three planning steps sequentially within its biennial Comprehensive System Planning Process:

- Local transmission planning
- Regional reliability planning
- Regional economic planning

Each NYISO transmission owner develops its Local Transmission Plan, as would transmission owners in other regions. Additionally, NYISO coordinates an evaluation of broader regional needs to identify reliability needs not met by the Local Transmission Plans and evaluates proposals for "economic projects" meeting regional needs.

In 2004, ISO-NE, NYISO, and PJM entered into the Northeastern ISO/RTO Coordination of Planning Protocol, with the cooperation of IESO and other Canadian members of the NPCC. This provides the framework for enhanced inter-regional planning for the Northeast. The process includes an open and transparent stakeholder forum and posting of all study materials on the "Inter-ISO" website.[24] The most recent Northeastern Coordinated System Plan was completed in March 2009.[25]

24 See http://www.interiso.com/default.cfm

25 see http://www.nyiso.com/public/webdocs/services/planning/ipsac/NCSP03-27-09.pdf

Table 7
Demand Response Capacity

	Alberta	CAISO	ERCOT	IESO	ISO-NE	MIDWEST ISO	NBSO	NYISO	PJM	SPP	TOTAL
Capacity Demand Response											
2006	0		0	318	538.9	5,752	150	1,216.2	1,678	1201	10,854.1
2007	0	1,762.5	0	243	1,595.7	8,226	90	1,338.5	2,145	1201	16,601.7
2008	0	2,069	310	627	1,942.9	8,246	60	1,743.8	4,498	1201	20,387.7
Demand Side Ancillary Services											
2006	231		1,963	974	0	400		0			3,598
2007	201	Confid	2,005	906	0	400		0	116		3,628
2008	171	Confid	2,136	948	0	400		0	410		4,065
Energy Price Demand Response											
2006	360		0	88	142.4	15.9		385.9	1,100.65		2,092.85
2007	300	1,043	0	88	98	15.9		319.4	2498		4,362.3
2008	300	1,113	0	0	86.1	15.9		331.4	2,294.7		4,451.1
Energy Voluntary Demand Response											
2006	0		0	65	0	0		566.05			631.05
2007	0		0	266	0	200		456.68	0	1206	922.68
2008	0		0	429	0	720		364.4	0	1278	1513.4
Total Demand Response											
2006	591	0	1,963	1445	681.3	6,167.9	150	2,168.15	2,778.65	1201	17,146
2007	501	2,805.5	2,005	1,503	1,693.7	8,841.9	90	2,114.58	4,759	2,407	26,720.68
2008	471	3,182	2,446	2,004	2,029	9,381.9	60	2,439.6	7,202.7	2,479	31,695.2
System Peak											
2006	9,661	50,270	62,339	27,005	28,130	116,030	2,807	33,393	144,644	42,284	516,563
2007	9,701	48,615	62,188	25,737	26,145	104,292	3,187	32,169	139,428	42,594	494,056
2008	9,806	46,897	62,197	24,195	26,111	98,595	3,078	32,432	130,100	42,891	476,302
Demand Response as % Peak Load											
2006	0.061174	0	0.031489	0.053509	0.02422	0.053158	0.053438	0.064928	0.01921	0.028403	0.033192
2007	0.051644	0.057709	0.032241	0.058398	0.064781	0.08478	.02842	0.065733	0.034132	0.05651	0.054084
2008	0.048032	0.067851	0.039327	0.082827	0.077707	0.095156	.019493	0.075222	0.055363	0.057798	0.066544

Table 9
Wind Generation

	Alberta	CAISO	ERCOT	IESO	ISO-NE	MIDWEST ISO	NBSO	NYISO	PJM	SPP	ISO/RTO Total
Wind Nameplate Capacity (megawatts)											
2004	251	2,560	1,385	0	1	Confidential	0	48	244.9	428	4,917.9
2005	255	2,670	1,854	0	1	871	0	246	306.9	996	7,199.9
2006	362	2,820	2,875	396	5	1,032	0	390	356.9	1,246	9,482.9
2007	497.5	2,820	4,785	475	5	1,462	0	423.7	1,327.9	1,627	13,423.1
2008	497.5	2,820	8,005	704	31	3,008	96	1,063.7	2,113.8	2,915	21,254
Wind Generation (hourly average in megawatts)											
2007	163.4018	599.4187	996.9103	116.4384	1.940639	434.0909		99.3976	153.6301	521.1285	3,086.357
2008	175.6261	544.0856	1734.731	134.3352		946.9651		142.4449	377.2086	697.6093	4,753.006