Progress of Organized Wholesale Electricity Markets in North America

A Summary of 2006 Market Data from 10 ISOs & RTOs

ISO/RTO Council

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Introduction

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), meets the electricity demand in that region using a coordinated dispatch of all generators, and wholesale electricity is bought and sold at prices based on that dispatch. Two-thirds of the United States and more than 50% of Canadian populations are supplied wholesale electricity through markets run by ISOs or RTOs.

ISOs and RTOs began forming in the mid-1990s when competition for wholesale power was first introduced. These organizations ensure that emerging wholesale electricity markets are efficient and fair for all market participants; that bulk power systems are operated reliably; and that new, non-utility competitors have open access to the transmission grid. Currently, 10 ISOs and RTOs operate in the United States and Canada.[1] Figure 1 shows the footprint of the North American ISOs and RTOs.

Over the past decade, ISOs and RTOs have established highly competitive wholesale electricity markets, developed effective regional planning processes to ensure a reliable bulk power grid and have improved operating efficiencies—all in a cost-effective manner.

The purpose of this report is to summarize 2006 data on wholesale electricity market operations and the progress that has been made in the restructured electric industry. This report is not intended to be an exhaustive analysis of ISO and RTO markets. Moreover, since market information is continuously changing, this report is based on information as of 2006. Updated information can be obtained at the individual Web sites of the ISOs and RTOs.[2]

A review of the 2006 data from these ISOs and RTOs shows that organized wholesale electricity markets in North America are maturing and delivering substantial benefits:[3]

- Demand is growing, but wholesale electricity prices are falling.
- Markets and additional transmission infrastructure encouraged by ISO and RTO-led regional planning are stimulating investment in generation, encouraging use of demand resources, and reducing congestion costs.
- The bulk power systems in organized market regions are operating reliably.

[1] As of 2007, the North American ISOs and RTOs include the Alberta Electric System Operator (AESO), California Independent System Operator Corporation (CAISO), Electric Reliability Council of Texas (ERCOT), Ontario's Independent Electricity System Operator of (IESO), ISO New England, Inc. (ISO-NE), Midwest Independent Transmission System Operator, Inc. (MISO), New York Independent System Operator (NYISO), New Brunswick System Operator (NBSO), PJM Interconnection, L.L.C. (PJM), and Southwest Power Pool (SPP).

[2] Individual ISO and RTO Web site addresses include: AESO: www.aeso.ca; CAISO: www.caiso.com; ERCOT: www.ercot.com; IESO: www.ieso.ca; ISO-NE: www.iso-ne.com; MISO: www.midwestiso.org; NBSO: www.nbso.ca; NYISO: www.nyiso.com; PJM: www.pjm.com; SPP: www.spp.org.

[3] Unless otherwise noted, all data and conclusions contained in this publication are based on 2006 market data published in 2007 that were extracted from the annual, publicly available market reports, planning reports, market monitor reports or state-of-the-market reports produced by market monitors or by other market agencies for each wholesale electricity market.

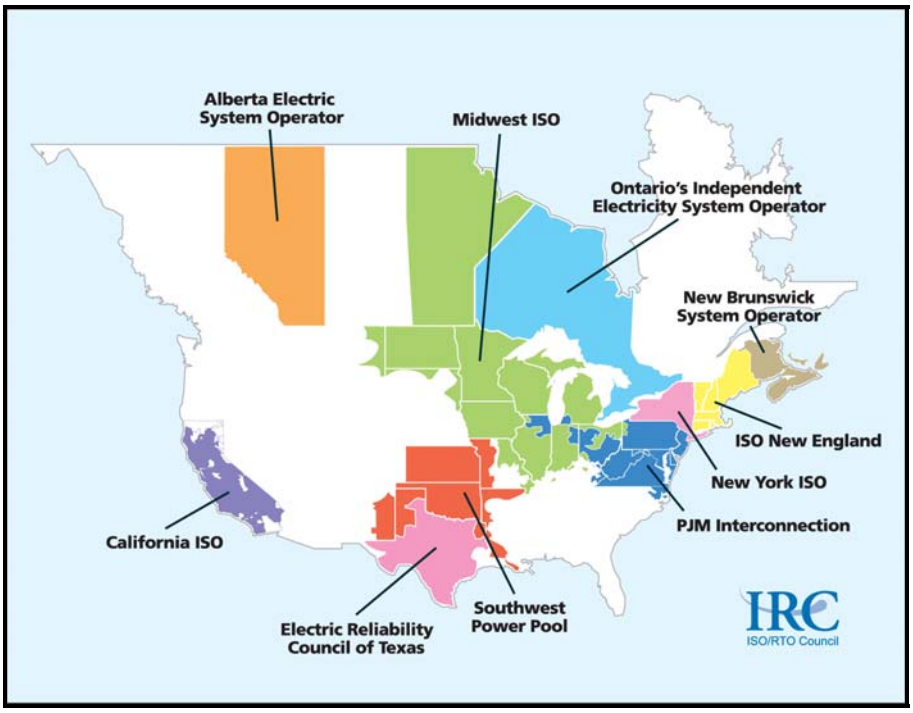

Figure 1: Footprint of the North American ISOs and RTOs.

Source: http:// www.iso-rto.org

Demand Is Growing; Prices Reflect Supply and Demand Conditions

Demand Growth

Peak demand levels within organized market regions have grown consistently, reaching record levels in 2006. Table 1 shows peak hourly loads in the organized markets in 2005 and 2006 and the percentage change from 2005 to 2006. Despite experiencing this significant load growth, the ISOs and RTOs have maintained high levels of grid reliability, and have met peak loads without incident.

Table 1
Peak Hourly Loads in Organized Markets (Megawatts)[a]

Region	2005	2006	% Change
AESO	9,236	9,661	4.6%
CAISO	45,431	50,270	10.7%
ERCOT	60,274	62,339	3.4%
IESO	26,160	27,005	3.2%
ISO-NE	26,885	28,130	4.6 %
MISO	112,078	116,030	3.5%
NBSO[b]	3,154	2,807	-11.0%
NYISO	32,075	33,939	5.8%
PJM	133,763	144,644	8.1 %
SPP	40,187	42,284	5.2%

(a) These are actual loads that are not weather-normalized. Although actual peak loads are what challenge grid performance and reliability, analysts use weather-normalized peak loads for long-term comparisons because the weather-normalization betters reflects underlying population and economic growth rates in a region.

(b) The New Brunswick system peaks in winter because of high electric heating load (and minimal air-conditioning load in summer).

Prices Reflect Supply and Demand Conditions

A number of factors affect the supply and demand for electricity and its wholesale cost. These factors include weather, the economy, the cost of fuel used to produce electricity, transmission constraints, consumer response to retail rates, and participation in demand-response programs.

A number of these factors, especially lower fuel prices, have driven down wholesale electricity prices in most organized wholesale electricity markets. In 2006, nominal wholesale electricity prices fell in almost all the organized wholesale markets, as shown in Table 2.

Table 2
Change in Average Annual Load-Weighted
Wholesale Electricity Prices ($/megawatt-hour)[a], [b], [c]

Region	2005	2006	Price Change (%)
AESO ($Can)	$70.36	$80.79	14.8%
CAISO	$57.83	$47.55	(17.8%)
ERCOT	$77.22	$55.23	(28.5%)
IESO ($Can)	$72.14	$48.75	(32.4%)
ISO-NE	$79.96	$62.74	(21.5%)
MISO	$34.91	$29.98	(14.1%)
NYISO	$88.81	$71.32	(19.7%)
PJM	$63.46	$53.35	(15.9%)

(a) Electricity prices can be expressed in a number of ways, including nominal average compared with time-specific, weighted by load levels, and fuel-adjusted (because electricity prices are strongly driven by fuel prices, which vary widely over time). These prices are nominal averages without fuel-price normalization, but they have been weighted to reflect the number of megawatt hours (MWh) consumed at different price levels over the course of the year.

(b) No central organized wholesale market exists within SPP or NBSO, thus these figures are not available for these regions. However, SPP and NBSO operate balancing markets.

(c) In Alberta, wholesale prices increased in 2006 due to a decrease in the reserve margin, from 40% to 20%, resulting from the retirement of generation in the 2004–2006 timeframe. The numbers for Alberta are not load weighted.

Markets and Additional Transmission Infrastructure Are Stimulating Investment in Generation, Encouraging Use of Demand Resources, and Reducing Congestion Costs

Organized Markets Reflect Meaningful Competition and Produce Crucial Price Signals

Within the organized wholesale electricity markets, all resources—both supply- and demand-side—compete to secure the right to meet electricity needs. The interaction of supply and demand determines the market-clearing price for every hour. This competitive process has motivated improvements in generation operating efficiencies and investment in new, more-efficient generation facilities—this means that more demand is served by lower-cost, more fuel-efficient generators. In addition, infrastructure improvements in the ISO and RTO regions, as discussed in a subsequent section, have improved access to additional, lower-cost resources.

Organized wholesale electricity markets are also providing important price signals to market participants. The competitive market process provides accurate price signals that reflect the value of electricity across time and place, revealing both resource scarcity and transmission congestion. These price signals are provided via day-ahead and real-time prices and are reflected in numerous forward contracts and indices. Day-ahead and real-time price signals also indicate the operating status of the regional bulk power system and the value of incremental generation or load reductions, which provide resource owners and load-serving entities with information that enables them to operate in a mutually beneficial fashion. Forward price indices based on these markets provide important information to facilitate longer-term contracts.

New capacity market mechanisms are being implemented in several of the organized wholesale electricity markets. These mechanisms—including PJM's Reliability Pricing Model (RPM) and ISO-NE's Forward Capacity Market (FCM)—are also providing price signals that can result in the development of additional supply and demand resources. PJM's first RPM auction cleared 311 megawatts (MW) of new or upgraded generation capacity and 127 MW of demand-response offers for delivery in the June 2007 through May 2008 period. The RPM auction procures capacity needed after participants already have arranged self-supply and contracted for resources. In early 2007, ISO-NE received over 400 applications for the initial February 2008 auction for capacity to be delivered in June 2010. These applications encompassed over 17,000 MW, including 2,200 MW of demand-side resources.

Regional System Planning Processes Are Producing Much-Needed Transmission Upgrades

The ISOs and RTOs conduct extensive system planning and interconnection studies to assess reliability and market efficiency needs, as well as to accommodate new transmission, generation, and demand resources. Over the past several years, these planning efforts have expanded greatly in scope and complexity, covering longer time horizons and more types of projects.

These planning processes are open and inclusive and include participation by state government officials, market participants, and other interested entities. The planning processes use a wide variety of publicly available information. Significant accomplishments have been made as follows:

- PJM's Regional Transmission Planning program uses a 15-year planning horizon. Its plan incorporates both reliability and economic transmission projects. Since the RTO began system planning in 2000, its board has authorized construction of over $7 billion of new transmission investment.
- MISO's Midwest Transmission Expansion Planning process has brought nearly $1 billion of new transmission on-line, with nearly 2,400 miles of upgraded lines. MISO's builders have committed over $2.1 billion of new transmission investment that is expected to lower congestion costs by
  $2 billion/year across its 15-state, 2-province footprint.
- In New England, transmission planning began in 1997; between 2002 and 2006, transmission projects totaling $833 million were placed in service. Projects valued at $336 million will come on-line by the end of 2007, including new lines to support Boston and Southwest Connecticut; other parts of these areas' needed upgrades are under way. ISO-NE's 10-year Regional System Plan is tracking the development of transmission projects that have a total cost of approximately $4.4 billion.
- CAISO began transmission planning in 1998. By the end of 2006, the CAISO board had approved over $8.2 billion in new transmission project investments, representing over 400 different transmission projects; a third of those are scheduled to come on-line in 2007. That transmission helped enable the interconnection of more than 16,000 MW of new capacity and the retirement of 5,500 MW of older and more polluting power plants. Recently, CAISO secured approval from the Federal Energy Regulatory Commission (FERC) for an innovative new funding mechanism to ease and accelerate the allocation of costs to interconnect thousands of megawatts of new renewable energy projects in remote areas.
- ERCOT has built, rebuilt, or re-conductored over 5,200 circuit miles of transmission since 1999 at a total capital cost of $3.5 billion.
- AESO has $1.5 billion in transmission reinforcements underway and the potential for $3.5 billion in upgrades by 2016.

Significant New Generation Resources Are Being Added in ISO and RTO Regions

Price and market transparency, new market incentives, and the transmission infrastructure improvements achieved through regional system planning have facilitated significant new investments in the organized wholesale electricity markets. Table 3 shows the total amount of installed generation in North America's organized markets in 2006 and the amount of new generation added between 2001 and 2006. Also shown is the percent of installed generation from resources coming on-line between 2001 and 2006.

Table 3
Total Generation and New Generation Added in 2001–2006 (Summer Ratings in MW)

Region	2006 Installed Generation	New Generation 2001–2006	% of 2006 Generation from New Sources
AESO[(a)]	11,501	3,056	26.6%
CAISO	54,500	15,986	29.3%
ERCOT	80,141	21,883	27.3%
MISO	137,016	25,114	18.3%
IESO	31,214	2,624	8.4%
ISO-NE	30,825	8,304	26.9%
NBSO	4,302	102	2.4%
NYISO	40,536	4,754	11.7%
PJM	162,143	19,465	12.0%
SPP	45,950	10,883	23.7%

(a) Winter ratings are indicated for Alberta because that region is a winter-peaking system.

Organized Markets Are Encouraging Demand Response

Demand response is an essential element of competitive wholesale electricity markets. By giving loads access to information on time-based electricity costs and the opportunity to respond to them, or to become aware of and responsive to grid conditions, demand response turns customers into partners with the bulk power system operator and suppliers. Demand response acts as a resource to address near-term and real-time reliability problems, enhances long-term system adequacy, mitigates peak prices and price volatility, limits supplier market power, and, in the future, will act as a valuable balancing resource for intermittent renewable resources such as wind power.

As the FERC has recognized, demand response has flourished within ISO- and RTO-operated organized markets. Over 23,000 MW of demand response are available within the footprints of the ISOs and RTOs. Highlights of this participation include the following.

- As of September 2007, more than 1,200 MW of demand response are being used in New England as a resource to protect power system reliability. Demand-response programs interrupted a high of 625 MW on the 2006 peak load day (August 2). Throughout the year, demand-response programs caused an average price decrease of $1.74/megawatt hour (MWh) in those hours with load interruptions.

- NYISO has over 1,800 MW of demand response and almost 400 MW of customers registered to offer their load reductions into the wholesale market on a day-ahead basis. Demand-response resources represent 5.4% of NYISO's 2007 forecast summer peak load. NYISO recently implemented a targeted demand-response program to secure load reductions in New York City and is working to qualify demand-response resources for ancillary services provision.
- PJM had 6,703 MW of total demand-response resources in the summer of 2006, which was equivalent to 4.6% of peak demand. Over the course of a week-long August 2006 heat wave, the use of demand response produced price reductions equivalent to $650 million in payments for electricity use. Customers' voluntary load curtailments caused wholesale price reductions that exceeded $300/MWh during the peak hours. On the day that PJM reached a new all-time peak load, the cost of electricity would have been $230 million higher without demand response.
- MISO has approximately 20 MW of dispatchable demand-response capability, and as much as 2,971 MW of price-responsive demand has bid into the spot market. To date, approximately 8,000 MW of demand response have qualified as capacity resources within MISO.
- Ontario's IESO reports 676 MW of dispatchable demand response from large industrial customers and at least another 200 MW of price-responsive demand. In one market event in 2006, Ontario's Market Monitor found that four customers' 25 MW load reduction prevented the market price from rising by as much as $9/MWh and reduced the need to schedule expensive generation.
- An extreme heat wave in the summer of 2006 in the Western region, equivalent to a 1-in-50-year event, demonstrated the value of demand-response programs in California. A total of 2,700 MW from emergency demand-response programs and voluntary conservation helped balance supply to load, while 1,200 MW were used as reserves to meet any additional contingencies that may have occurred on the system. In addition, California is investing in advanced metering technology so that 5% of all load (approximately 2,500 MW) will provide price-response demand reductions within the next few years.
- ERCOT's Responsive Reserves Market continues to attract participation from the region's nearly 2,000 MW of "Loads Acting as a Resource" (LaaRs), making ERCOT the leading ISO for demand-response resources providing ancillary services. LaaRs, which consistently meet 50% of ERCOT's standing 2,300 MW Responsive Reserves requirement, are predominantly industrial loads deployed through verbal dispatch with a 10-minute curtailment requirement. They are also equipped with under-frequency relays to help enable rapid recovery from sudden grid-frequency events.
- The AESO has over 200 MW of load that responds to the energy market pool price and approximately another 380 MW are counted on for ancillary services.

Organized Markets are Reducing Transmission Congestion Costs

Infrastructure improvements and lower electricity prices have significantly reduced transmission congestion costs in the wholesale electricity markets. Congestion occurs when limited transmission facilities prevent the delivery to local loads of low-cost electricity produced in more distant parts of the region as a whole; congestion costs are thus designed to reflect the cost differentials caused by transmission constraints and the prevailing costs of electricity on each side of the bottleneck. Congestion costs fell in 2006 in every organized market:

- In the CAISO, the costs for managing reliability on the grid in 2006 have fallen by 57% since 2004 due to the completion of several major new transmission lines that reduced power grid bottlenecks.
- In ERCOT, congestion costs have fallen steadily since 2001 due to steady increases in new transmission construction and careful reliability management. Inter-zonal congestion costs

decreased from $79 million in 2005 to $52 million in 2006, while intra-zonal (local) congestion costs have decreased from $400 million in 2003 to under $180 million in 2005.

- In MISO, total congestion costs in day-ahead and real-time markets equaled $550 million in 2006, down significantly from the $800 million in congestion costs that occurred in the last nine months of 2005.
- In PJM, total congestion costs fell by 23% to $489 million from 2005 to 2006, and over 98% of these congestion costs were hedged (i.e., the receiving customers secured financial products that protected them from paying the actual costs of congestion).
- In ISO-NE, total congestion costs fell 33% from $266 million in 2005 to $180 million in 2006 due to transmission improvements and overall lower energy prices. In New England (as in several other regions), congestion costs may be hedged through Financial Transmission Rights.
- In Ontario, congestion costs dropped dramatically from 2005 to 2006. Ontario's wholesale market has a single uniform market price (i.e. no locational prices) and hence there is no direct measure of congestion costs. However, congestion management settlement charges, which are predominantly used to recover congestion costs, dropped by over $100 million. This was mainly due to lower energy prices.

Bulk Power Systems in Organized Market Regions Are Operating Reliably

One of the most important responsibilities of ISOs and RTOs as control area operators is to maintain secure bulk power system operations in real time. In the face of extended heat waves in 2006, every ISO and RTO met its peak load without incident by scheduling and coordinating the available supply- and demand-side resources and having day-ahead and real-time prices provide the incentives to these resources to deliver in the times and places needed.

ISOs and RTOs use a suite of reliability tools to assure real-time grid security. One such tool is five-minute dispatch, which provides responsive and accurate control of power flows across the transmission system. Another reliability tool is to coordinate the availability of generation the day before it is needed. In many regions, this occurs through competitive day-ahead markets, where much of the generation dispatched to meet load is scheduled through a market-based selection process. This coordinated scheduling saves money by reducing the quantity of generation that is needed while committing the most economic generation available, and using sophisticated scheduling algorithms for this purpose.

Contingency reserve sharing also improves regional reliability while lowering costs by pooling and measuring the resources available to meet operational margins across multiple control areas. PJM began contingency reserve sharing in 2005. MISO began reserve sharing in January 2007, aggregating operational reserves across 35 balancing areas so the available resources can serve more areas and customers cost-effectively. The Northeast Power Coordinating Council (NPCC) has a Regional Reserve Sharing and a Shared Activation of Reserves program that includes ISO-NE, the IESO, NBSO, and NYISO, which reduces the amount of reserves each ISO must provide each day. AESO and PJM also have reserve sharing arrangements. Making more reserves available to grid operators in these ways allows operators to react to energy emergencies more quickly and efficiently. The AESO creates a generation schedule based on day-ahead market submissions and has reserve-sharing arrangement with the Northwest Power Pool.

The continuing decline of "Transmission Load Relief" incidents within PJM and other markets further demonstrates these reliability improvements. As PJM uses locational marginal prices to guide

generators' operational decisions, it finds fewer incidents of overloaded transmission lines and can more frequently use economic redispatch to cure potential overloads.

Conclusion

The organized markets operated by North America's ISOs and RTOs are maturing and delivering benefits and value to consumers. Since these markets began operation, they have provided incentives that have led to the more efficient operation of electric generators and the bulk power transmission system. These efficiencies have enhanced power system reliability and put downward pressure on wholesale electricity prices, despite a rise in demand.

Facilitated by comprehensive system planning efforts by the ISOs and RTOs, the regions served by these organized wholesale markets are attracting new transmission and generation investment. This new investment is lowering congestion and electric energy costs, in part due to increasing market opportunities for demand-response resources to provide valuable services on terms that are often equivalent to those for generation.

While the ISOs and RTOs have made significant progress since their inception, many challenges remain. Most importantly, solutions must be developed to meet the growing demand for electricity in an environmentally sound and secure manner. The markets run by ISOs and RTOs provide the best avenue for meeting rising demand and environmental objectives in a timely, cost-effective way. By harnessing the energy and innovation inherent in market forces, ISO and RTO markets can induce the investment needed to meet growing demand at efficient prices. ISOs and RTOs have well-established stakeholder processes that facilitate the exchange of ideas to further innovation and progress. ISO and RTOs, as well as their stakeholders, are poised to play a valuable role in meeting future electric energy needs and environmental policy objectives.

About the ISO/RTO Council

Founded in 2003, the ISO/RTO Council (IRC) is an industry organization comprised of 10 Independent System Operators and Regional Transmission Organizations in North America, responsible for delivering two-thirds of the electricity consumed in the United States and just over 40% in Canada.

In addition to coordinating electric generation and transmission across a wide geographic area, ISOs and RTOs provide non-discriminatory transmission access, facilitate competition among wholesale electricity suppliers, and conduct regional planning to ensure a reliable grid for the future.

The IRC works collaboratively to develop effective processes, tools, and methods for improving competitive electricity markets across North America. The IRC's goal is to balance reliability considerations with market practices, and have resulted in efficient, robust markets that provide competitive and reliable service to electricity users.