

# **A Review of Market Monitoring Activities at U.S. Independent System Operators**

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## Table of Contents

ABSTRACT .....	3
I. INTRODUCTION .....	5
II. ISO MARKETS AND THE APPROACH TO MARKET MONITORING.....	9
<i>The Markets</i> .....	9
<i>Market Monitoring Units: Organization and Size</i> .....	10
PJM .....	10
NYISO .....	11
ISO-NE .....	12
CAISO.....	13
<i>Data and Metrics</i> .....	14
<i>Reporting</i> .....	19
III. CORRECTIVE ACTIONS TO ENCOURAGE COMPLIANCE AND MITIGATE MARKET PROBLEMS .....	21
<i>Impact of Market Monitoring: Case Studies</i> .....	24
Example 1: PJM Interface Pricing .....	24
Example 2: PJM Capacity Market .....	25
Example 3: Reliability-Must-Run Units and Local Market Power .....	26
Example 4: CAISO Market Surveillance Committee Views on a Damage Control Bid Cap .....	27
Example 5: Informal Mitigation .....	28
IV. DISCUSSION .....	29
(1) What approach(es) should Market Monitoring Units use to achieve their objectives?.....	29
(2) What are major actions or strategies that can be used to ensure the “independence” of market monitoring functions? .....	29
(3) How should resource needs and funding be established for market monitors? .	30
(4) What are the potential roles and value of External Market Monitors (Advisors) .....	30
(5) How have ISO market monitors related to state regulatory agencies? .....	31
(6) How have ISO MMUs addressed issues associated with access to confidential wholesale market data by state regulatory agencies? .....	31
<i>Summary: Lessons Learned</i> .....	34
ACKNOWLEDGMENTS .....	35
APPENDIX A. METRICS AND STATISTICS FOR LONG-TERM ANALYSIS .....	39

## **Abstract**

Policymakers have increasingly recognized the structural impediments to effective competition in electricity markets, which has resulted in a renewed emphasis on the need for careful market design and market monitoring in wholesale and retail electricity markets. In this study, we review the market monitoring activities of four Independent System Operators in the United States, focusing on such topics as the organization of an independent market monitoring unit (MMU), the role and value of external market monitors, performance metrics and indices to aid in market analysis, issues associated with access to confidential market data, and market mitigation and investigation authority. There is consensus across the four ISOs that market monitoring must be organizationally independent from market participants and that ISOs should have authority to apply some degree of corrective actions on the market, though scope and implementation differ across the ISOs. Likewise, current practices regarding access to confidential market data by state energy regulators varies somewhat by ISO. Drawing on our interviews and research, we present five examples that illustrate the impact and potential contribution of ISO market monitoring activities to enhance functioning of wholesale electricity markets. We also discuss several key policy and implementation issues that Western state policymakers and regulators should consider as market monitoring activities evolve in the West.



## I. Introduction

Over the past two decades, the creation of competitive wholesale electricity markets has been a major thrust of federal energy policy. This movement has been spurred by federal legislation and regulatory initiatives undertaken by the Federal Energy Regulatory Commission (FERC).<sup>1</sup> Wholesale electricity transactions are under FERC jurisdiction and FERC is mandated to ensure that rates meet a just and reasonable standard under the Federal Power Act of 1935. In meeting this statutory responsibility, FERC has broad discretion and has relied on both traditional cost-based approaches and market-based rate authority.<sup>2</sup> Prior to the crisis in the California electricity market, competition policies at FERC had primarily focused on the creation of competitive market structures that could be relied upon to produce just and reasonable rates. However, in Order 2000, FERC also acknowledged that market monitoring was a core function of newly forming regional transmission organizations (FERC 1999).<sup>3</sup> In approving the establishment of ISOs in the Eastern U.S., FERC approved market power mitigation protocols that gave the ISOs limited power to review and regulate generator offer prices under certain conditions, such as situations in which there are local transmission network constraints.

In the aftermath of the California crisis, both federal and state policymakers have increasingly recognized the structural impediments to effective competition in electricity markets (FERC 2002). Electricity markets are relatively new and the markets are not fully competitive for several reasons. First, the existence of transmission-constrained load pockets allows generators to exercise market power during certain time periods, even if generation ownership is not concentrated in the market overall. Second, the lack of significant price-responsive demand is a fundamental limitation in today's electricity markets, due to retail rate structures that mask wholesale price signals and myriad technical and institutional barriers faced by customers. Third, because the markets for electricity are comprised of multiple markets (day-ahead and real-time energy markets, a market for energy reserves (reliability), transmission congestion hedging instruments, and generation capacity), rules and monitoring are needed to ensure that gaming across these various markets do not compromise fair competition. This recognition has resulted in an increased emphasis on the need for careful market design and market monitoring in wholesale (and retail) electricity markets, including reliance upon various market power mitigation

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<sup>1</sup> See Energy Policy Act of 1992, FERC Order 888 (which opened wholesale power sales to competition) and FERC Order 2000 (which encouraged transmission owners to voluntarily join regional transmission organizations).

<sup>2</sup> Under a cost-based approach, accepted standards for just and reasonable prices are those that recover production costs, including a fair return on the capital invested by the firm. In reviewing applicants for market-based rate authority, FERC has utilized hub-and-spoke market power screen, the Supply Margin Assessment (SMA), and ISO market power mitigation rules as justification for granting this authority (see Bushnell 2003 and Stoft 2001 for critiques of the hub-and-spoke approach).

<sup>3</sup> The functions of an RTO included: (1) transmission service and tariff, (2) congestion management, (3) parallel path flow, (4) ancillary services, (5) transmission availability information, (6) market monitoring, (7) transmission planning and expansion, and (8) interregional coordination.

measures that attempt to limit seller market power by influencing and restraining their behavior (Bushnell 2003; Wolak 2003).<sup>4</sup>

As part of ongoing discussions on the future structure and organization of electricity markets in the Western U.S., market participants that are active in forming RTOs have established a discussion forum (the Seams Steering Group – Western Interconnection, or SSG-WI) to facilitate the creation of a seamless Western market and propose approaches that resolve differences in RTO procedures and practices. The SSG-WI has created a Market Monitoring Working Group that is developing a proposal for a West-wide Market Monitoring Entity that would monitor transactions among the California ISO and the other two proposed RTOs in the Western Interconnection; RTO West and WestConnect RTO) (SSG-WI Market Monitoring Work Group 2003). The Western Interstate Energy Board’s Committee on Regional Electric Power Cooperation (CREPC) is interested in improving the efficiency of the Western electric power system and has been participating actively in these discussions on market monitoring in the West.<sup>5</sup> As part of this effort, CREPC requested that Lawrence Berkeley National Laboratory (LBNL) review and summarize market monitoring activities and experience in other regions and identify key issues of interest to state policymakers.

In conducting this study, LBNL adopted the following approach. We focused on four ISOs: the California Independent System Operator (CAISO), ISO-New England (ISO-NE), the New York ISO (NYISO), and PJM LLC. (PJM). Each of these ISOs has operational experience and derives its authority from FERC.<sup>6</sup> These ISOs have approved Market Monitoring Plans and have established market monitoring units (MMU) that perform various activities designed to assess and improve competition in wholesale electricity markets. Activities of MMU include: gathering data, monitoring and ensuring compliance with market rules and procedures, evaluating and reporting on market performance, proposing changes to rules to improve market operation and performance, and applying mitigating measures and sanctions when applicable and authorized. We highlight a number of topics and issues that are important to the establishment of an effective market monitoring process and organization, including:

- The structure of an **independent** market monitoring unit;
- Data access and confidentiality;
- Performance metrics and indices to aid in market analysis;
- Mitigation and investigation authority;
- The role of external market monitors; and

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<sup>4</sup> As an alternative to automatic mitigation procedures (AMP) in which ISOs may revise hourly offer bid prices, Wolak proposes that FERC should develop explicit guidelines on the extent to which electricity prices over a 12 month horizon can exceed some competitive benchmark level which would trigger automatic intervention if this standard is violated (see Appendix A).

<sup>5</sup> CREPC consists of the public utility commissions, energy agencies, and facility siting agencies in the Western states and Canadian provinces that are in the Western electricity grid.

<sup>6</sup> ERCOT is not included in our study because it is regulated only by the state of Texas, i.e., it is not FERC-jurisdictional. The Midwest ISO is not included because it isn’t scheduled to operate electricity markets before November 2004. In additionally, the Midwest ISO tariff was withdrawn from FERC for consideration in October 2003.

- Market analysis and influence on market design.

In this study, our primary objectives are: (1) to synthesize information on market monitoring experience in wholesale electricity markets, (2) describe the organizational structure, staffing requirements, activities, impacts, and suggestions from those actively involved in market monitoring, and (3) highlight key issues of concern to state policymakers. LBNL reviewed the trade press and academic literature, the ISOs' market monitoring plans, annual reports filed by market monitors, ISO tariffs and operation agreements, market rules, and various papers and presentations. Interviews were conducted with market monitoring staff at each of the ISOs, FERC's Office of Markets Investigation and Operations (OMOI), technical consultants, and regulatory agency staff in several states.

The remainder of this report is organized as follows. In Section II, we briefly review the ISO-managed markets, present information on the management and organizational structure of ISO market monitoring units, and highlight data and indices that are used to monitor the markets. In Section III we discuss ISO investigation and mitigation authority, and provide examples of market monitoring actions. In Section IV, we highlight and discuss key policy, technical, and/or implementation issues.





## II. ISO Markets and the Approach to Market Monitoring

In this section, we review the ISO-managed markets and the approach, responsibilities, and organization of the market monitoring units within ISOs. ISO-operated electricity markets are still relatively new and market rules at each ISO continue to evolve. To stay abreast of these changes, readers should refer to the respective ISO websites.<sup>7</sup>

### The Markets

In Table 1, we compare the specific types of markets operated by four ISOs: PJM, New York Independent System Operator (NYISO), ISO-New England (ISO-NE), and the California ISO (CAISO). Electricity market design at these four ISOs share many common elements, including real-time balancing markets (spot markets, or imbalance markets), markets for regulation resources, spinning reserves markets<sup>8</sup>, and financial tools for hedging against congestion rent, which we will refer to as Financial Transmission Rights (FTRs) in this paper.<sup>9</sup> Spinning reserves represent extra capacity available on-line for use in the case of contingencies. PJM, the NYISO, and ISO-NE all operate day-ahead energy markets; the CAISO is planning a day-ahead market as part of its market redesign. Bilateral contracts and day-ahead markets are used to procure most of the forecasted necessary energy for the following day, with the remaining energy being purchased in the real-time market. The real-time markets allow offer-based economic dispatch every five minutes (or every ten minutes in California). On a second-by-second basis discrepancies between actual load and actual generation are made up by generators providing regulation, which are controlled directly and automatically by the ISOs. Congestion revenues and the allocation of FTRs are typically calculated based on conditions in the day-ahead analysis.<sup>10</sup>

**Table 1.** ISO Markets (as of October 2003)

	<b>PJM</b>	<b>NYISO</b>	<b>ISO-NE</b>	<b>CAISO</b>
Day-Ahead Energy Market	Yes	Yes	Yes	No
Real-Time Energy Market	Yes	Yes	Yes	Yes
Capacity	Yes	Yes	Yes	No
Regulation	Yes	Yes	Yes	Yes
Spinning Reserves <sup>11</sup>	Yes	Yes	Yes (as 10- or 30-minute reserves)	Yes
Non-Spinning Reserves	No	Yes	Yes (as 10- or 30-minute reserves)	Yes
FTRs	Yes	Yes	Yes	Yes

<sup>7</sup> CAISO [www.caiso.com](http://www.caiso.com); ISO-NE [www.iso-ne.com](http://www.iso-ne.com); NYISO [www.nyiso.com](http://www.nyiso.com); PJM [www.pjm.com](http://www.pjm.com).

<sup>8</sup> New England plans to begin operating a forward reserve market in January 2004.

<sup>9</sup> These hedging instruments all work in the same basic way, but are called Transmission Congestion Contracts in New York, Firm Transmission Rights (previous name) or Congestion Revenue Rights (MD02 name) in California, and Financial Transmission Rights (FTRs) in New England and PJM. For simplicity, we refer to all these tools using the term FTR.

<sup>10</sup> Since the CAISO doesn't have a day-ahead market, congestion costs are calculated by a procedure involving the valuation of transmission path usage by scheduling coordinators. The most valued schedules are chosen first and the value of the last chosen schedule sets the congestion price, if the path becomes congested.

<sup>11</sup> In New England, reserves are defined as 10-minute reserve and 30-minute reserve. 10-minute reserves are both spinning and non-spinning reserves able to be synchronized with the grid in 10 minutes. 30-minute reserves are both spinning and non-spinning reserves able to be synchronized with the grid in 30 minutes.

The greatest variability among the four ISOs is in reserve markets. New England is planning to start bi-annual forward reserve auctions in January 2004, in which 10-minute and 30-minute forward reserve offers will be solved simultaneously and produce separate clearing prices for each product. The other ISOs run day-ahead and hour-ahead reserve markets which are co-optimized with the energy market. New York operates markets for 10-minute spinning, 10-minute non-synchronized and 30-minute spinning and non-synchronized reserves. PJM operates markets for regulation and spinning reserves. The California ISO currently operates day-ahead and hour-ahead markets for regulation and operating reserve services, however, with the implementation of its Market Design 2002 (MD02), California will operate an integrated reserves market, including spinning and non-spinning resources, and regulation.

Market Monitoring Units: Organization and Size

Market monitoring units focus primarily on the operation of electricity markets administered by ISOs, although they are also concerned with outside factors that may impact their markets. For example, fuel markets (and fuel prices) have a direct impact on expectations for electricity market prices; thus, fuel prices are often considered in monitoring and market analysis processes. MMUs perform similar functions, including the monitoring of compliance with rules, screening for and investigation of anti-competitive behavior, evaluation of market performance, and compilation of information and preparation of reports. Staffing levels vary somewhat by ISO. As shown in Table 2, MMU staffing levels range from 11-14 full-time employees (FTE) at three ISOs (ISO-NE, PJM, and CAISO), while NYISO has about 30 FTEs. Not surprisingly, the MMU staffing levels and budgets have increased significantly since their original formation. These increased staffing and budget levels appear to be a response to problems in the various ISO bid-based markets as well as increased recognition of the need for ongoing market monitoring and mitigation (Synapse Energy Economics 2001). The structure and organization of the MMU also differs somewhat by ISO.

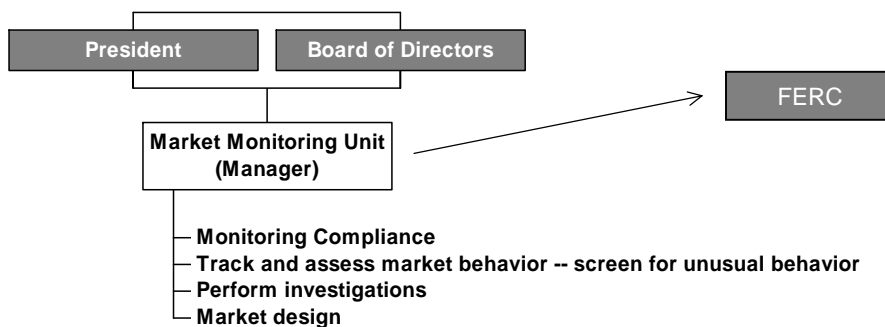
**Table 2.** Market Monitoring Staff

	<b>PJM</b>	<b>NYISO</b>	<b>ISO-NE</b>	<b>CAISO</b>
Full Time Employees	12	31.5	11	14

**PJM**

The PJM MMU includes a manager and eleven staff. Collectively, they perform the tasks of monitoring compliance with the PJM operating agreement, screen for instances of market power and unusual behavior, perform investigations, track and assess market behavior, and seek solutions to improve market design. They are a single group with a division of labor roughly divided by the different markets. The MMU is administratively under the President (see Figure 1), and the MMU manager has authority to independently contact the President, the PJM Board, and FERC (see PJM Market Monitoring Plan 2002). The MMU does not have sanctioning or mitigation authority (except to impose cost-based offer caps on must run units), but rather reports its findings to the appropriate entities (e.g., PJM Board and management, state and federal regulators). PJM does not retain a

designated external market advisor. They employ consultants to advise them on market issues as specific needs arise.



**Figure 1.** PJM Market Monitoring Unit Organizational Chart

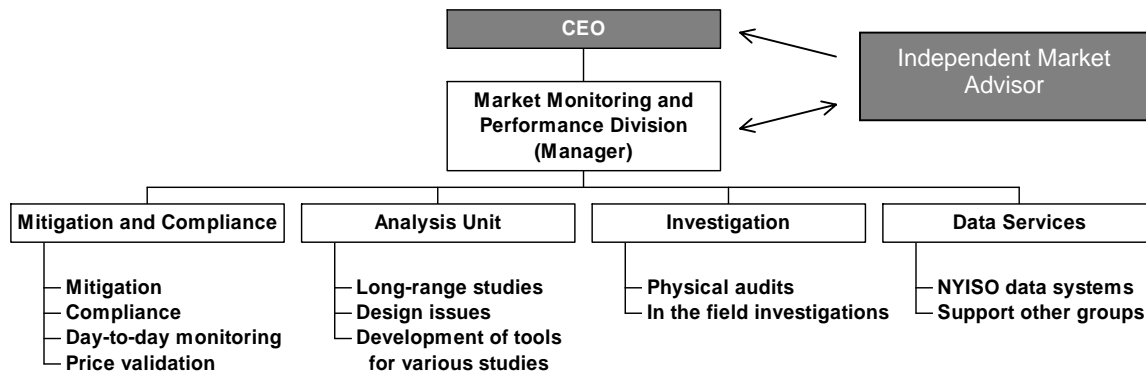
In November 2003, the PJM Board of Managers conducted a comprehensive review of market monitoring and MMU operations at PJM during the past four years, and largely affirmed the appropriateness of the current organizational structure (PJM 2003a).<sup>12</sup> NYISO

The organizational structure of the NYISO Market Monitoring and Performance Division is shown in Figure 2. The manager has 2.5 staff: an economist, analyst, and a half-time administrative assistant. The remaining 28 staff is divided into four units: Mitigation and Compliance, Analysis, Investigation, and Data Services.

The NYISO has explicit market mitigation authority. The Mitigation and Compliance unit performs day-to-day monitoring, checking for compliance and mitigating behavior as necessary and authorized, including administering the Automated Mitigation Procedure (AMP).<sup>13</sup> The Analysis unit focuses on long-range issues, including analysis of market performance and design issues. The Investigation unit performs investigations, including physical audits of facilities, which are kept confidential, and formal investigations into irregular or potentially non-competitive behavior. The Data Services unit supports the data needs of the other groups.

<sup>12</sup> The PJM Board concluded that: (1) the MMU should continue to be maintained within PJM rather than re-established as a separate external organization; (2) the MMU should continue actively to investigate and assess market participant conduct, but should not prosecute market rule violations or sanction conduct; (3) the MMU should have a significant role in formulation of PJM market rules to ensure, at the outset, that the rules best prevent the creation or exercise of market power; (4) there should be an annual “audit-like” plan that describes the scope of the particular areas that the Board believes require special attention by the MMU in any particular year.

<sup>13</sup> See Section III for discussion of AMP.



**Figure 2.** NYISO Market Monitoring and Performance Division Organization Chart

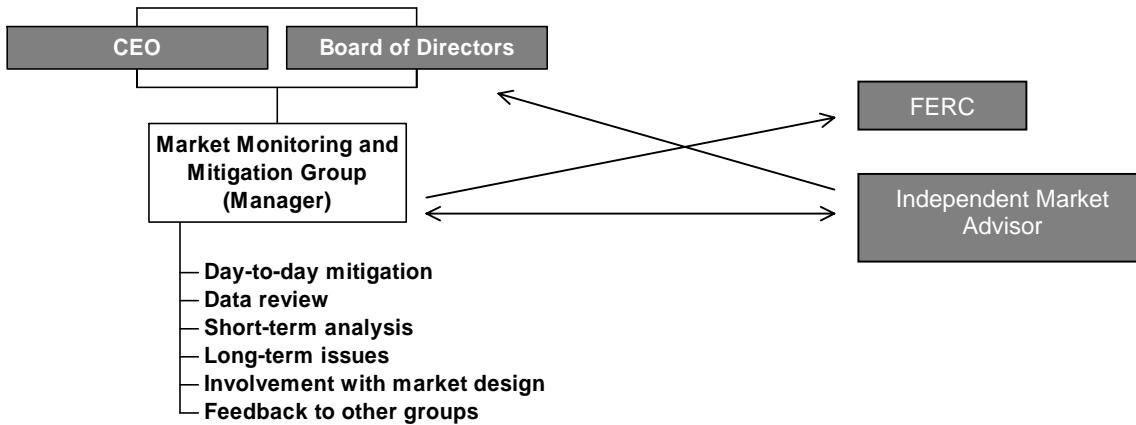
Under the NYISO Market Monitoring Plan, the MMU reports to the CEO of the NYISO, who is in turn responsible to the ISO board for monitoring activities (see NYISO Market Monitoring Plan 2001). The MMU also works closely with a board-appointed independent Market Advisor who takes an active role in market monitoring activities. The Market Advisor aids in setting market monitoring and mitigation procedures, provides an independent assessment of the ISO and the MMU itself, and prepares the yearly market report. The independent Market Advisor reports directly to the ISO board.

### ISO-NE

The ISO-NE Market Monitoring and Mitigation (MMM) group is comprised of a manager and 10 full time staff, as shown in Figure 3. About half of this team works on day-to-day mitigation, including data review and other short-term analysis, while the remaining staff is responsible for taking a broader view of long-term market issues, collaborating with the market design group, and offering feedback to other groups within the ISO. The MMM group suggests changes to market rules, evaluates proposed market rules, and proposes new monitoring procedures. The manager of the MMM group reports to the CEO and has authority to independently contact the ISO board and FERC directly, if needed (see ISO-NE 2002). Occasionally, the MMM group also hires expert consultants to perform special analyses.<sup>14</sup>

Similar to NYISO, ISO-NE uses an Independent Market Advisor who assesses ISO markets and conducts independent studies as needed, often times at the request of the ISO-NE board. The Market Advisor tends to interact informally with the Market Monitoring and Mitigation group and reports directly to the ISO board.

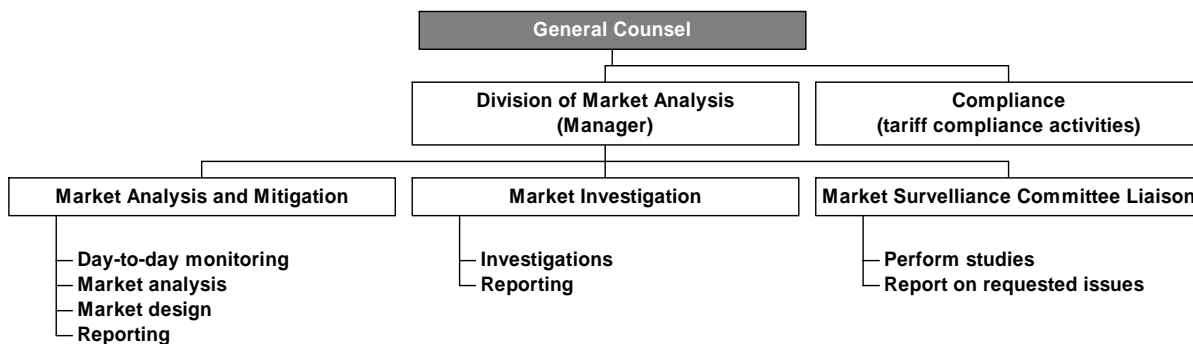
<sup>14</sup> See ISO-NE 2002 Annual Market Report (ISO-NE 2003) which discusses a market modeling tool developed by the Market Monitoring and Mitigation Department based on a special study of market competitiveness conducted by researchers at the University of California.



**Figure 3.** ISO-NE Market Monitoring and Mitigation Group Organization Chart

### CAISO

The responsibilities of the CAISO’s Division of Market Analysis, shown in Figure 4, include day-to-day monitoring to identify instances of anticompetitive behavior, analysis of data to evaluate market performance, investigations into potential instances of market manipulation or market power abuse, and involvement with market redesign activities.



**Figure 4.** CAISO Market Analysis Group Organization Chart

Unlike other ISOs, tariff compliance activities are conducted by a separate Compliance Division, which is not part of the Division of Market Analysis. Both Compliance and Market Analysis are administratively under the Legal Counsel. Within Market Analysis there are three groups: Market Monitoring, Market Analysis and Mitigation, and Market Investigations. The Market Monitoring Division conducts the day-to-day monitoring, analysis and reporting. When this group uncovers unusual bids or potentially non-competitive behavior, they turn over information to the Market Investigations group, who is responsible for investigating and reporting on the source of the unusual activity. Market Analysis and Mitigation primarily work on the design of market power mitigation measures and other market design issues related to market performance.

The CAISO also has an independent advisory body, called the Market Surveillance Committee, which presently is composed of four experts from academia who perform studies and prepare reports on relevant market issues as requested by CAISO or others (e.g., FERC).

### Data and Metrics

MMUs analyze large volumes of data and attempt to create useful information using various metrics, indices and summary reports. The data immediately available to MMU include all publicly available information, data collected and generated by the ISO in the course of their operations, and information provided by ISO operators and other sources.<sup>15</sup> MMUs also need access to proprietary data; the authority to request and obtain such data is written into their FERC-approved tariffs. Examples of proprietary data include generator costs data to justify bidding behavior and copies of plant operation logs during physical inspections of forced outages. Market participants typically provide proprietary data under confidentiality requirements. See NEPOOL Information Policy, Section 2 as an example of how ISOs discuss and treat confidential information.<sup>16</sup>

Day-to-day analysis ensures compliance with market rules and identifies noncompetitive conditions that may allow excessive market power. MMUs screen and look for anomalies in market prices, quantities, bidding behavior, and congestion. They also examine correlations between activities in the different markets and identify pivotal market participants with a residual supplier index or similar metric (regardless of whether they try to exploit that position). When anomalies are noted in operation and market indices, detailed studies are performed. Longer-term analysis or investigations into specific market problems may lead to policies to improve these markets.<sup>17</sup> In these situations, a MMU may not know *a priori* the data that will be needed in order to conduct an effective investigation. Appendix A includes a summary of market indicators and performance metrics that may be useful for long-term analysis and monitoring of electricity markets.

The process of day-to-day monitoring typically begins with a review of the previous day's activities through summary reports of market and system operation. These reports highlight operational characteristics including the location and amount of congestion, location of plant outages, and deviation from scheduled operation. MMU members then share the tasks of in-depth analysis. For example, hourly energy clearing prices from the day-ahead and real-time markets may be plotted together for easy comparison in the daily summary report. A single team member may then examine prices in specific markets (e.g., energy, capacity, FTR) in more detail (e.g., who set the prices, how often they set the price on the previous day, week, month, and if there is any correlation with other conditions).

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<sup>15</sup> MMUs report that ISO systems operators may alert the MMU of behavior and conditions that they find unusual, and that they occasionally receive calls from other market participants.

<sup>16</sup> Available at [www.iso-ne.com/FERC/filings/Other\\_NEPOOL/NIP\\_FERCstaff\\_3-5-01.pdf](http://www.iso-ne.com/FERC/filings/Other_NEPOOL/NIP_FERCstaff_3-5-01.pdf)

<sup>17</sup> Since the formation of ISOs, MMUs have uncovered a number of instances in which market participants have attempted to manipulate "coupled" markets. Units known to be necessary for reliability and who have special contracts for their energy have been known to have outages – to the benefit of other units with the same owner who received high price market rates. Offers have been made in the day-ahead market to create the appearance of congestion for inflating day-ahead prices or increasing the value of FTRs.

Table 3 includes a selected list of data and indices that MMU may use as part of their day-to-day monitoring activities. We group the data and indices in categories related to grid status, market status, competition, and market power.

**Table 3.** Short-term Market Analysis: Metric and Indices

<b>Metrics</b>	<b>Indices</b>
<b>Grid Statistics</b>	Load
	Available capacity
	Congestion and binding constraints
	Deviations from scheduled dispatch
	Resource outages
	Must-Run unit operation
<b>Market Status</b>	Prices
	Market volume
	Congestion costs
	Supply curves
<b>Competition</b>	Marginal units
	Concentration measures
	Price-cost markup
<b>Market Power</b>	Residual supplier index
	The frequency a participant sets the clearing price
	Correlations between prices and offers in different markets
	Correlations between prices and bidding to operating conditions (outages, congestion, load)

The grid status data are examined for unusual conditions, such as high (or low) loading, capacity differing from historical values, significant or unusual congestion patterns, outages, and deviations from scheduled dispatches. Any peculiarities may affect the market and appear in the market data and indices, and may possibly be correlated with bidding behavior. These status metrics are largely self-explanatory:

Load, expressed in power (MW) or energy over some period of time, is known for bus location, zone, and for the entire system.

Available capacity is the total supply available to meet present load and to supply power (MW) if called upon in an emergency. Available capacity has locational attributes and can be stated for the whole system, or within specified zones.

Congestion occurs when some network constraint is met. These are typically capacity limits on transmission lines but also include minimum and maximum voltage limits at locations. In monitoring, flows along key transmission paths are tracked and plotted against capacity constraints.

Deviations from scheduled operations refer to real-time generators outputs and outages, transmission power flows and outages.

Reliability Must-Run (RMR) units are units that are designated by an ISO as necessary to maintain reliability for certain expected system conditions (often high loads). Typically, the ISO has special operations agreements to compensate these

generators. Heavy reliance upon RMR units may indicate local reliability issues and skew the market to be less competitive.

Prices refer to the clearing prices of the various markets. High prices usually reflect scarcity of a resource, but may also indicate market power.

Market volume indicates how much energy is being traded in the market and can be compared to energy scheduled through bi-lateral contracts or temporally different markets (real-time versus day-ahead).

Congestion costs help quantify the economic severity of transmission congestion. It is calculated as the product of power flow and the congestion price across a congested interface.<sup>18</sup> When locational marginal pricing is used, the congestion price is equal to the price difference across the interface, accounting for losses. Congestion costs are considered on a system-wide basis, and for each interface.<sup>19</sup>

Supply curves are constructed from supplier offers. In analysis they are useful by unit, company, and system-wide aggregate.

Marginal units are those that set the market clearing price(s). In a uniform price auction this unit receives payment at its offer price. A unit is marginal in the sense that at the market price, the unit would be used before generating units with higher offer bids to supply the next unit of increased demand. For monitoring purposes it is useful to track who sets the market price. If a single unit (or company) consistently sets the market price, then they may possess some locational or other advantage in the market that may warrant further study.

Indices of market competitiveness and market power tend to be more difficult to evaluate and are typically used as initial screens.

Concentration measures summarize supplier concentration in a simple scalar metric. The most commonly used is the Herfindahl-Hirschman Index (HHI), which is defined as the sum of squares of market share (where market shares are in percent). Thus, a market with two equal suppliers has an HHI of 5000 ((50)\*(50) + (50)\*(50)). A market with ten equal suppliers has an HHI = 1000. The following interpretations are recommended by FERC:

HHI > 1800 highly concentrated  
1000 < HHI < 1800 moderately concentrated  
HHI < 1000 unconcentrated

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<sup>18</sup> The term “congestion costs” is also used in planning studies to refer to the difference between system costs with transmission congestion and a hypothetical system with no congestion. The monitored real-time system congestion costs need to be handled in the ISO settlement policy.

<sup>19</sup> The value of congestion costs is also important in the ISO settlement process. The collected congestion revenues are disbursed to FTR holders.



Concentration ratios can be calculated at various levels of detail and disaggregation: for every hour, system-wide, within transmission defined markets, for zones, by total capacity, actual dispatch, and different regions in the aggregate supply curve.

Thus, a system-wide index by total capacity may not reveal significant market concentration. However zonal concentration ratios may show significant supplier concentration for a range of system loadings. See Bushnell (2003) for a discussion of the limitations of concentration measures as indicators of market power in electricity.<sup>20</sup>

The residual supplier index (RSI) is also a scalar index and is related to the number of pivotal suppliers available to meet demand. The lower the number, the fewer suppliers are available to supply the last MW of demand. The RSI is calculated as

$$RSI = \frac{(\text{Total Supply} - \text{Largest Seller's Supply})}{(\text{Total Demand})}$$

If the total demand exceeds the total supply without the largest seller, the RSI will be less than 1. Heuristically, if the RSI is less than 1.1 there is concern for collusion between suppliers. Empirical analysis suggests a strong correlation between the RSI and the price-cost markup (Sheffrin 2002).

Price-cost markup is essentially a Lerner Index in which an estimate of marginal cost represents the competitive price. A low markup implies a competitive market.

The competitive indices listed above can sometimes be used for market power screenings. The largest suppliers associated with a large HHI and/or low RSI deserve further consideration for market power potential. To study market power between markets, additional comparisons are necessary to correlate prices to system conditions and bidding behavior.

Tables 4 and 5 illustrate the types of metrics and indices used by CAISO and PJM respectively.

**Table 4.** Examples of CAISO data and indices <sup>21</sup>

<b>Data</b>	<b>Indices</b>
<b>Market Clearing Prices</b>	Percentage of time a participant sets or nearly sets the clearing price
	Correlations between clearing prices in various markets (ancillary service and imbalance markets, for example)
<b>Bidding Strategies</b>	Comparison of bidding strategies in markets

<sup>20</sup> Concentration measures infer a relationship between a firm's size and its ability to influence market prices (e.g., if firms raised offer prices or withheld output, what would be the impact on market prices). These measures are more useful in industries where customers are responsive to changes in market prices, or the product is inexpensive to store and where production can be expanded easily; such conditions don't apply in electricity markets (Bushnell 2002).

<sup>21</sup> See <http://www.caiso.com/docs/2002/05/29/200205290932133456.pdf>

	Comparison of bidding strategies for like-type generation (same technology and age)
	Comparison of bidding strategies under different conditions (congestion, must run)
	Comparison of bidding strategies to market share
	Correlation of bidding strategies to expected outages
<b>Concentration Measures</b>	Difference between clearing price and estimated competitive price
	Residual Supply Index (to identify pivotal suppliers)
	Supply Responsiveness – derivative of supply to price
	Traditional measures of concentration (e.g., HHI), applied to zones, different markets, and different conditions
	Additional measures of concentration as available
<b>Other</b>	Generation and transmission outages relative to historical averages
	Unexpected congestion
	Comparisons of clear prices and fuel prices

**Table 5. PJM Data and Indices** <sup>22</sup>

<b>Data</b>	<b>Indices</b>
<b>Summary Statistics</b>	Prices and Loads: averages, maximum, correlations.
	Congestion: maximum and total costs, binding constraints.
	Market volume: MWs bid, scheduled, bilaterals, imports, and exports
	Comparisons to geographically adjacent markets
<b>Locational Prices and Loads</b>	Bus LMPs
	Aggregate bus LMPs
	Bus LMPs less average price
	Loads and generation by bus
	Distribution of LMPs and loads/generation
	Price/Load/Generation min/max/average comparisons by day/week/month
	Zonal prices
<b>Congestion by hour/day/week/month/year by bus/zone</b>	Total congestion costs
	Peak congestion costs
	Percent of time with congestion
	Frequency of constraint
	Frequency of must-run price cap implementation.
	Frequency of constraints without must-run price cap implementation
<b>Offers and Dispatch</b>	Unit offer/supply curves
	Company aggregate offer/supply curves
	Aggregate PJM supply curves
	Comparison to historical supply curves
	Identification of units that set price
	Frequency of individual units setting price
	Deviations from requested dispatch.
	Ramp rates buy unit, company, time period
	Comparison of ramp rates
	Conditions on offers; start costs, min run times
<b>Available Capacity</b>	Total capacity resources
	Total available capacity
	Outage status by unit
	Frequency of outage by type, unit, time period
	Comparisons of outages across units
	Company summary outage frequency
	Comparisons of outages across companies
Frequency of unit outages by time period, by demand condition, by system/bus price	
<b>Market Structure</b>	Concentration ratios by hour
	Incremental concentration ratios by hour
	Concentration ratios by transmission defined markets

<sup>22</sup> See <http://www.pjm.com/markets/market-monitor/proposed-initial-market-indices.html>

	Concentration ratios by zone
	Concentration ratios by interface
<b>Price-Cost Ratios</b>	Unit specific price-cost margins
	Company price-cost margins
	Company supply curves by time period.
<b>Capacity Markets</b>	Company demand curves by time period.
	Market prices.
	Capacity position by company
<b>Other</b>	Current average cost of spinning reserves from synchronous condensers

### Reporting

ISO MMUs also have reporting responsibilities. They must file yearly public reports with FERC that evaluate the state of the market. These reports use more aggregate metrics to discuss market efficiency over the longer term than the indices used for day-to-day market analysis. These metrics include:

- Average energy costs, which provide a measure of direct economic impact on consumers;
- A price-cost ratio to quantify market efficiency;
- Total congestion costs and hours of congestion operation as a measure of transmission support; and
- A return index to determine the incentives for generation expansion.



### III. Corrective Actions to Encourage Compliance and Mitigate Market Problems

In this section, we discuss some of the tools and methods used by market monitoring units to encourage market participants to comply with ISO market rules and/or minimize the impact of various types of market flaws and problems, and the MMU authority to investigate, mitigate, or seek FERC action. We also provide several mini-case studies, which are based on our interviews and illustrate the potential and actual impacts of market monitoring on market performance and competitiveness.

Typically, MMUs have certain limited tools that can be invoked in order to address individual instances of conduct that are not consistent with ISO rules. The toolbox of corrective actions at the disposal of the MMU can be viewed as a series of steps that move from informal to formal interactions with individual market participants. In some cases, corrective actions lead to requests for changes in ISO market rules and ultimately formal regulatory processes. The approach used by PJM's MMU illustrates this hierarchy:

- Discussion of the issue/potential problem with relevant market participant(s), which may lead to informal resolution of the issue;
- MMU issues demand letter to market participant(s) requesting a change in behavior;
- MMU recommends modifications to ISO rules, standards, procedures or practices to PJM Committees or to PJM Board, and, if necessary, prepare regulatory filing to address market problem and seek remedial action
- Evaluate and consider additional enforcement mechanisms (Bowring 2003).

Market performance monitoring and mitigation policies adopted by ISOs have been among the more controversial corrective-type actions used by ISOs (see Farr and Felder 2002; Ruff 2002).<sup>23</sup> These policies typically include the following features: (1) ISO market monitoring entities focus on potential or actual abuses of market power or anti-competitive behavior by market participants (mainly generators), (2) supply offers are subject to a bid cap (e.g., \$1,000/MWh in Northeast markets, \$250/MWh in the CAISO), and (3) supplier resource bids can be mitigated in markets and/or zones where market power is a problem in order to limit the market effects of conduct that would significantly distort competitive outcomes.

This third policy is often referred to as Automated Mitigation Procedures (AMP). With AMP, ISOs screen the offer prices from individual generators and alter bids if an offer price exceeds some bound around a "reference" price level (Bushnell 2003). The underlying rationale for AMP is that these procedures enable ISOs to apply corrective actions quickly. Recall that the ISOs' authority to enforce market rules and apply sanctions derives directly from FERC. Unless specifically approved in an ISO's tariff, sanctions for noncompetitive behavior can only be applied by FERC. The longer it takes to accomplish

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<sup>23</sup> Critics of market performance monitoring and mitigation policies, who often represent generators, argue that these policies as implemented often don't reflect scarcity pricing, disincent long-term resource development, and require extensive regulatory intervention. They suggest that the appropriate standard is the comparison between "imperfect competition and imperfect regulation", rather than judging market performance to the competitive market ideal (Farr and Felder 2002).

corrective action, the more difficult it is to apply retroactive corrective measures to the entire market. If market participants believe that FERC regulatory processes are lengthy and cumbersome and that retroactivity is limited, then efficient operation of a market becomes more problematic, particularly for markets in which a uniform market price set by noncompetitive behavior may affect all participants.

The increased reliance by ISOs upon more active pricing regulations under the rubric of market power is partly a response to the California crisis of 2000, but also reflects a broader re-thinking and shift by electricity regulators on how much to rely on policies that focus on fostering competitive market structures versus application of regulations to specific market outcomes (Bushnell 2003). Thus, there is increasing sentiment to enable ISOs to apply corrective actions quickly. To illustrate this phenomenon, ISO-NE states that the purpose of these procedures is “to mitigate the market effects of any conduct that would substantially distort competitive outcomes in the NEPOOL Market, while avoiding unnecessary interference with competitive price signals and normal market operations.” The modifiers “substantially” and “unnecessary” are important in the context of how AMP is implemented; AMP allows the ISO to monitor and adjust participant offers for very obvious instances of market power.

AMP are typically applied in a multi-step process. First there is a *conduct test* that compares offers received from participants to certain reference price thresholds. Reference prices are set for each participant, usually as a specified rolling average of their accepted offer prices from previous hours (Bushnell 2003). Second, if bids fail the conduct test, i.e. bids are greater than the reference price, an *impact test* checks to see if the high bids exert a material impact on market prices (Wolak 2003). Third, if bids trigger both the conduct and impact tests, the ISO MMU will mitigate those bids that failed the conduct test. In this scheme, mitigation takes the form of replacing the offending offer with the reference offer.

Table 6 compares the established energy market mitigation procedures for the four ISOs covered in this report. There are several points to note about these market mitigation procedures. First, AMP procedures used by ISO-NE and NYISO are not “automatic” in all cases; mitigation is only applied after further review in Long Island and upstate New York’s real-time markets. Second, the reference prices and resulting conduct and impact thresholds are for system-wide levels, and are themselves important screens for day-to-day monitoring by MMU. Note that several ISOs (e.g. NYISO and ISO-NE) also have market mitigation procedures with more restrictive requirements for pre-defined constrained areas (e.g. New York City). Third, the mitigation procedure used by PJM is fundamentally different than the other ISOs. In PJM, if a unit is chosen for dispatch out of merit order for reliability reasons due to transmission congestion, then there is a price cap placed on the offer. PJM doesn’t use separate conduct and impact tests; for comparison purposes, we place the price cap in the conduct row, and the dispatch out of merit order in the impact row. Based on an initial comparison among the market mitigation procedures, it appears that PJM’s market mitigation method has the tightest conditions, because it is triggered whenever a generating unit needed for reliability is dispatched out of merit order. Fourth,

the effective detection of market power and mitigation requires valid and timely estimates of Reference Prices; this is a crucial input to effective monitoring and mitigation.<sup>24</sup>

The basic task in determining Reference Prices typically involves estimating short-run marginal costs of production for a generator, which involves a number of thorny technical issues and judgment (Reeder 2002). NYPSC staff that have been monitoring the NYISO market recommend that FERC provide some guidance on generic methods that should be used by ISO MMUs to estimate Reference Prices and that ISO/RTO be required to publish aggregate information on Reference Prices by type of generators (e.g., baseload, peakers) so that consumers and consumer groups have useful data to deal with information asymmetry issues (Reeder 2002).<sup>25</sup>

**Table 6.** Comparison of ISO Mitigation Measures for Energy Offers<sup>26</sup>

	<b>CAISO</b>	<b>ISO-NE</b>	<b>NYISO</b>	<b>PJM</b>
<b>Markets</b>	Real-time market	Day-ahead and real-time markets	Day-Ahead	
<b>Conduct levels</b>	Offer price exceeds \$100 or 200% over reference price.	Energy Offer Price – an increase of \$100 or 300%, whichever is lower, above the Reference Level.	Energy Offer Price – an increase of \$100 or 300%, whichever is lower, above the Reference Level.	Offer exceeding unit must run price cap.
<b>Impact Levels</b>	50\$ or 200 % increase	An energy price increase of \$100 or 300%, whichever is lower, above the Reference Price level	100\$ or 200 % increase	Out of merit order dispatch for reliability due to transmission congestion.
<b>Reference Prices in preferred order of use.</b>	Presently determined by independent entity.  In new market design, it will be the mean of the lower 25% of LMPs over the past 90 days – adjusted for fuel cost. (Separate values for off- and on-peak supply.)	90 day average (lower of mean and median), during competitive periods, adjusted for fuel prices.  If not enough information is available, the mean of the lower 25% of LMPs for past 90 days, adjusted for fuel cost.  Or, a cost-based estimate.	90 day average (lower of mean and median), during competitive periods, adjusted for fuel prices.  If not enough information is available, the mean of the lower 25% of LBMPs for past 90 days, adjusted for fuel cost.  Or, a cost-based estimate.	Weighted average LMP for a specified period for which the resource was dispatched in merit order.  Or, incremental costs plus ten percent.
<b>Mitigation</b>	Reference-level offer	Reference-level offers	Reference-level offers	Offer price cap

<sup>24</sup> FERC NOPR on SMD refers to the concept of “Competitive Reference Bids” which is an estimate of a reasonable bid; a bid that an entity facing full competition would submit.

<sup>25</sup> In developing methods to estimate Reference Prices, issues to consider include: (1) the time period for historical data to use (e.g., one year, several years), (2) how to measure fuel prices, and (3) whether there should be additional compensation for the high-end operation of a unit to reflect extreme stress when operated in that range (NYPSC 2002)

<sup>26</sup> See CAISO 2003a, NYISO 2001, and PJM 2003a.

It is also important to assess the actual performance and impact of AMP at various ISOs. In terms of intent, AMP are designed to deter generators from exercising local market power, so over time, we wouldn't necessarily expect to see many instances when they were invoked. Since its implementation at the CAISO in October 2002, the conduct and impact levels have never been simultaneously exceeded. In their 2002 Annual Report, the NYISO reports that AMP was not used in that year. In terms of their deterrence value, the CAISO notes in its 2002 Annual Report that it is too early to tell if the mitigation procedures will be effective because thus far market conditions have been so favorable to exclude the appearance of market power that would require mitigation.<sup>27</sup>

### Impact of Market Monitoring: Case Studies

In this section, we present several examples that illustrate the impact and potential contribution of market monitoring. These case studies are drawn from our interviews with ISO MMUs and were chosen to illustrate the range of responses and interactions that arise from activities by market monitors. These include quick action by an ISO MMU to correct manipulative behavior, slower corrections through rule changes, ISO MMU investigations that led to hearings and action by FERC, and the role of external market monitors.

#### *Example 1: PJM Interface Pricing*

In summer 2002, PJM noticed large discrepancies between scheduled and actual flows along their Southern and Western interfaces. Power scheduled for the Southern interface was being delivered at the Western interface. Further investigation indicated that this scheduling was purposeful and was exploiting loop flows to take advantage of different prices at the two interfaces. Loop flows occur when actual system power flows are different from scheduled flow and are due to the physical characteristics of the network. This case study illustrates the exploitation of loop flows and interface pricing.<sup>28</sup>

PJM determines energy prices based on actual power flows in the network. Up until July 19, 2001, payments for flow into/out of PJM were based on scheduled flows, rather than actual flows, creating an important difference in how the *price* of energy and the *payments* for energy were calculated. This created an incentive for suppliers who generate power in ECAR and MAIN to schedule a delivery to PJM through the Southern PJM/VAP interface (where prices tended to be higher) even if the suppliers planned to deliver through the lower priced (or even negatively priced) PJM/AEP interface. The wide difference between scheduled and actual flows had adverse effects on the transmission system. The scheduled and actual power flows diverged, sometimes exceeding 3,000 MW, and the true flows served to increase congestion and further separate prices.

This incentive existed for energy traders as well as energy suppliers. In one instance a participant bought power from PJM at the PJM/AEP interface for delivery to AEP. Then the participant scheduled to sell power to PJM from AEP though the PJM/VAP interface.

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<sup>27</sup> See CAISO 2003b.

<sup>28</sup> PJM 2003.



This scheduled loop of power resulted in no change in actual power flows, but the participant was paid the difference in prices between the interface buses.

On July 19, 2002, PJM addressed this situation through the following action. At 2:00 PM, PJM notified the market that, effective 3:00 PM, all transactions with a source or sink located in MAIN or ECAR would be priced at the PJM/AEP interface, regardless of the scheduled flow. This brought the payment of power deliveries in line with the pricing. PJM had the authority to take this action under their Operating Agreement (Schedule 1, 3.3.1(d)), which stipulates that external deliveries should be modeled “based on appropriate flow analysis.” Prior to this date, the ISO assumed scheduled flows to be appropriate. When the scheduled and actual flows diverged, PJM decided that the new rule would be better because it more closely tracked actual flows.

In this example, the ISO identified a problem and was able to take quick action. Because the market rule was written to allow some discretion on how the ISO modeled energy flows, the ISO was able to choose a more accurate model than accepting the schedules. The actual market rule did not need to be changed. In this case, that was advantageous because the rule adjustment would have required FERC approval and could have led to a lengthy regulatory process. More market participants may have become aware of the flaw/problem, potentially leading to increased abuse.

#### *Example 2: PJM Capacity Market*

In the first quarter of 2001 a single participant was able to exercise unilateral market power in PJM’s Capacity Credit Market.<sup>29</sup> According to the original rules of the PJM capacity market, all Load Serving Entities (LSE) are required to ensure that enough capacity is available to supply their demand plus a reserve margin. This can be accomplished through self-generation, contracts with other suppliers within and outside of PJM, and capacity credits through the market. There are daily, monthly, and multi-monthly capacity credit markets. When a LSE is deficient in their capacity credits, they are penalized \$177.30/MW-day, effectively establishing an upper bound on their willingness to pay. The collected capacity deficiency revenues were disbursed to those resources with outstanding offers in the market (i.e., offers that weren’t accepted).

During the fourth quarter of 2000 less than \$1,000 was collected from LSE for capacity deficiencies. Between January 1, 2001 and February 24, 2001, over \$11.7 million in capacity deficiency penalties were collected from deficient loads and given almost in entirety to a single firm. The clearing price for the daily capacity credit market was nearly constant at the capacity deficiency rate (CDR) of \$177.30/MW-day until nearly April.

The capacity requirement for the LSE for an upcoming year starts on the first day of that year. In 2001, the requirement increased by about 4 percent from the previous year. At this new level, it turned out that a single firm had unilateral market power. That is, to meet the entire daily capacity needs, some of its capacity was required. This was not true of any other firm. This firm offered their capacity into the market at a price exceeding the CDR.

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<sup>29</sup> See PJM 2001.

It was thus rational for an LSE to run short in capacity credits and pay the CDR penalty. According to the existing rules, the capacity deficiency revenues were then disbursed to this firm who offered its capacity into the market, whether or not the capacity was accepted. In April 2001, the available capacity in PJM increased to the point that this firm was no longer able to exercise unilateral market power (and thus the daily price decreased from its high of \$177.30).

Several things happened in response to this use of market power. Since there was no rule explicitly prohibiting the bidding strategy of this firm, a new rule was ultimately put into place. In contrast to the previous example in which the manipulation was subtle but the fix quick, the abuse in this case was obvious but the fix was complex. PJM proposed a new rule change that changed the manner in which capacity deficiency revenues were disbursed; the rule change required approval by various PJM committees and FERC.<sup>30</sup>

Under the new rule, revenues would be divided among suppliers who offer capacity into the market that is not cleared by the market, and those LSEs who have secured their required capacity. This provides a clear incentive to keep offers below the CDR. By sharing the capacity deficiency revenues with LSEs, suppliers will necessarily receive less than what they would have received had they offered into the capacity credit market at or below the CDR.

This example demonstrated the need for a rule change to eliminate future occurrences of clear market abuse. The MMU was involved in this process, as were state regulators in the region. The Pennsylvania Public Utilities Commission requested a special report on this issue, which was prepared by PJM.

### *Example 3: Reliability-Must-Run Units and Local Market Power*

Designated reliability-must-run (RMR) units are generators with special agreements to supply energy for a negotiated price when they are required to operate out-of-merit order for purposes of maintaining reliability. Between April 25 and May 11, 2000, unit outages at plants located in Huntington Beach and Alamitos, California, made it necessary to call upon other units, owned and operated by the same firms, though these called units were not subject to special RMR contracts (CAISO 2002). During these events, these plants were compensated at or near \$750/MWh. In tracking out-of-sequence payments, CAISO decided to investigate these outages and conducted physical site visits and reviewed taped telephone conversations between operators, employees, and the ISO. There were two issues: first, the timing and length of the outage, and second, a failure to maintain units to agreed-upon standards. Ultimately, CAISO presented the results of its investigation to FERC.

On March 14, 2001, FERC issued a Show Cause Order to Williams Energy Marketing & Trading Company and AES Southland Inc. to explain why they should not have to make refunds and should keep their present market-based sales authority. On April 30, 2001,

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<sup>30</sup> The PJM Reliability Committee approved the proposed new rule on February 28, 2001. PJM then submitted the rule to FERC on March 7, 2001 and FERC approved it on June 1, 2001.

FERC issued an order that approved a settlement in which Williams and AES refunded \$8M to CAISO and imposed additional conditions on their market-based sales authority (i.e., it was rescinded for one year in cases of forced outages of RMR units at the Huntington and Alamitos plants). Williams and AES did not admit to any wrongdoing and FERC made no finding on the issues involved.

This case study illustrates the ability and authority of the ISO to conduct investigations, which ultimately may lead to actions and/or decisions by FERC. While the process was lengthy, the settlement process and FERC's decision sends a signal that may deter similar conduct by other firms. However, FERC declined requests to impose additional penalties on the involved firms, noting that they did not issue findings of wrongdoing under the settlement, and had limited authority to impose penalties and remedies that are available under anti-trust law.

*Example 4: CAISO Market Surveillance Committee Views on a Damage Control Bid Cap*

The CAISO MSC is as an external market monitor and provides opinions on market issues to CAISO, FERC, state agencies and the public. Their reports have been well-regarded and have influenced the CAISO new market design. In this example we summarize a case in which the MSC generally agreed with a CAISO proposal for measures to mitigate market power, but disagreed with some details of the plan, illustrating both the role and potential impact of an independent external market monitor.

In April 2002, the CAISO MSC offered four recommendations on proposed market mitigation measures: (1) a damage control bid cap (DCBC) of \$250/MWh, (2) adoption of an automated mitigation procedure to mitigate local market power, (3) use of a 12 month competitive index to monitor performance over a longer time period, and (4) a means to monitor available capacity to help gauge LSE ability to meet loads (Wolak 2002). The DCBC and AMP are necessary short-term market power mitigation measures. Failure of the 12 month rolling average index would show serious flaws in market performance.

On April 25, 2002, the CAISO Board of Governors set the proposed DCBC to \$108/MWh. The MSC responded with a supplementary opinion on May 16, 2002, which suggested that the proposed DCBC approved by the CAISO Board of Governors was too low.<sup>31</sup> The MSC argued that a DCBC of 250\$/MWh was more likely to encourage participation in the market and reduce reliance on out-of-market (OOM) purchases.

In their July 17, 2001 ruling, FERC adopted the CAISO proposed DCBC, but with a change from the requested \$108/MWh to the MSC recommended level of \$250/MWh and cited the MSC opinion as part of the rationale for their decision.

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<sup>31</sup> The MSC argued that capacity purchase policies that rely on out-of-market (OOM) purchases when capacity is tight would give suppliers an incentive to withhold capacity and that suppliers could obtain more than \$108/MWh by supplying energy through OOM sales. Moreover, prices exceeding \$108/MWh are likely to occur at peak times during the year and the public is willing to pay for those times; OOM purchases will be necessary.

*Example 5: Informal Mitigation*

In our discussions with ISO market monitors, several monitors noted their belief that their most significant contribution was their deterrent value, although these impacts were difficult and not possible to quantify. They provided anecdotal evidence that suggested that in the wake of scandals and other bad press received by energy companies (e.g., Enron), many companies want to avoid situations in which they receive negative press coverage. MMU staff at several ISOs related instances where questionable behavior was quickly halted by simply phoning the party involved, which they attributed in part to the effectiveness of the “shame factor” in the current business environment.

## IV. Discussion

In this section, we highlight and discuss several key policy and implementation questions and issues for the West related to market monitoring, drawing upon our review of and assessment of lessons learned from market monitoring activities at ISOs.

*(1) What approach(es) should Market Monitoring Units use to achieve their objectives?*

The “toolbox” available to a MMU includes various strategies that range from informal discussion of issues and potential problems with market participants to formal letters requesting changes in behavior, and ultimately could lead to proposals to RTO committees and/or Board of Directions and FERC for new rules or modifications to existing market rules and/or procedures (see Section 3 for additional discussion). One theme from our interviews is the deterrence value of market monitoring in improving the compliance and performance of wholesale markets, which though difficult to quantify in terms of market impact, is quite real.

*(2) What are major actions or strategies that can be used to ensure the “independence” of market monitoring functions?*

There is broad agreement among policymakers that market monitoring should be independent from market participants. A MMU that has a relationship with market participants creates a perceived or actual conflict of interest in a competitive market. As a practical matter, independence from market participants’ interests can be facilitated by such actions as ensuring that market monitors have no financial relationship with representatives or organizations that are active participants in the regional electricity market, limiting the ability of market participants to modify an approved Market Monitoring Plan, by ensuring adequate staffing resources, and through hiring processes that limit the influence of market participants.

It is also important that a MMU be independent from ISO market and grid operations to the extent feasible. For example, because MMUs monitor bids and dispatches, they should not dispatch generation and transmission resources. Independence from a RTO can be facilitated by such actions as (1) having market monitoring managers report directly to the RTO Board of Directors, CEO/President, and FERC, (2) providing the MMU with authority to file reports with FERC without approval by a RTO, (3) through direct interactions with external market monitors or advisors, and (4) by mechanisms that ensure adequate budget and/or staffing. In addition, requirements that RTO file a Market Monitoring Plan which is subject to FERC approval limits the ability of a RTO to arbitrarily impose changes to an approved Monitoring Plan, particularly changes that affect staffing. For example, in approving PJM’s Market Monitoring Plan, FERC accepted, “the President of PJM will provide appropriate staffing for the MMU and is obligated to ensure that the MMU has adequate resources, information and cooperation from PJM to effectively do its job.”

*(3) How should resource needs and funding be established for market monitors?*

There is an obvious tension between the need to ensure adequate resources to monitor electricity markets effectively and the reality that funding is often limited and that mechanisms need to be developed to support this activity which benefits consumers and market participants in a region. Because of the primacy of ensuring independence, it is important that RTO members not have veto power over the budgets of market monitoring units. That being said, it may be appropriate to determine a rough estimate of initial funding and staffing levels by using benchmarking approaches (e.g., comparison to other ISO MMUs), or through preparation of a bottoms-up budget prepared by a MMU which is reviewed by a RTO Board of Directors and/or FERC (see Section 2 for a discussion of staffing levels at other ISOs).<sup>32</sup> The structure for market monitoring activities under discussion in the West has some distinctive features compared to other regions (i.e., a West-wide Market Monitoring Entity and individual market monitoring units for each Western RTO), so this will affect the ability to directly transfer funding/staffing guidelines and/or organizational models from other regions.

*(4) What are the potential roles and value of External Market Monitors (Advisors)*

Three of the four ISOs in our study utilize both internal and external market monitors. Specifically, NYISO and ISO-NE have a designated market advisor, and the CAISO has a committee of advisors (MSC). FERC's Order No. 2000 permits the market monitor to be either internal or external to the RTO organization, and this issue has been extensively discussed and debated among market participants in the four ISOs. Those favoring externalizing the market monitoring function maintain that doing so facilitates greater MMU independence. However, having an internal MMU unit with ISO/RTO employees offers a number of advantages, including increased opportunities for informal and near-real time interactions with ISO staff involved in system operations. This close proximity to scheduling and dispatch operators can help a MMU quickly identify abnormal market behavior (PJM 2003a; Synapse Energy Economics 2001).

External market advisors provide an independent assessment of ISO markets and can provide useful an additional check and balance for an ISO/RTO. They tend to focus on longer-term issues related to market design, provide opinions on suggested market rules and/or designs, and may recommend modifications to ISO markets. The external market advisors have access to ISO market monitoring data and can conduct independent studies and investigations; their advice and reports have had an impact on the market design and rules for various ISO markets. Typically, external market monitors do not spend much time or effort on daily compliance monitoring or day-to-day market operations. On a daily basis, the process of transforming data to information is a task that is well suited for internal market monitors, in part because they have direct access to data and operations personnel.

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<sup>32</sup> At PJM, the MMU proposes a budget to the PJM President who in coordination with the Competitive Markets Committee of the PJM Board reviews and approves the budget. The MMU has the right to appeal to this Committee and ultimately the full PJM Board if it does not agree with the decisions relating to the budget (PJM 2003a).

In the context of discussions on market monitoring in the West and the proposed division of labor between a West-wide Market Monitoring Entity and the individual RTO market monitoring units, the role and functions performed by external market advisors at other ISOs -- in particular their focus on longer-term market design and performance issues -- are fairly similar to the functions envisioned to be performed by the West-wide Market Monitoring Entity.<sup>33</sup>

*(5) How have ISO market monitors related to state regulatory agencies?*

Our sample of ISOs provides examples of two generic interaction models for MMUs: (1) ISOs (PJM and ISO-NE) that include multiple state jurisdictions, and (2) ISOs (NY, CA) that are contiguous with one state. Several themes emerged from our interviews with MMUs and state regulatory agency staff. First, informal and formal interactions between MMUs and state regulatory agency staff have increased over the last 3-4 years. Moreover, some MMUs indicated that they were looking at options to formalize periodic and regular interactions with state regulatory agencies. Second, not surprisingly, ISOs in only one state jurisdiction report that they have regular, ongoing discussions with state regulatory agency staff; ISO MMUs that encompass multiple states report that their interactions with state regulatory agency staff have tended to be more ad hoc. Third, we are beginning to see more examples of explicit ISO MMU/state agency cooperation. For example, the NYISO MMU is working with the NYPSC on a study of gas markets and the effect on electricity markets. At FERC's direction, PJM and state commissions are sharing proposals addressing state access to confidential market data. CAISO's MMU is working with CPUC's Generation Maintenance Program, which, among other activities, examines physical withholding behavior by generators in California.

*(6) How have ISO MMUs addressed issues associated with access to confidential wholesale market data by state regulatory agencies?*

Access to ISO/RTO wholesale market data by authorized state government agencies has been one of the more controversial issues to resolve. Often, MMUs are at the center of this debate because they are the main entity with responsibility for reporting on overall market performance and competitiveness, market problems/flaws that need to be corrected, etc. Treatment of access to confidential data varies somewhat by ISO.

- The current PJM Operating Agreement rules prohibit PJM from providing Member confidential data to state regulators absent the consent of the Members whose data is being requested (Foster 2003). In response to a FERC Technical Conference in August 2003, PJM Members, state commissions, and PJM convened a Task Force to obtain input from stakeholders on this issue. That process has resulted in the general endorsement by the PJM Members Committee of a set of proposed provisions that will enable the "broadest possible" access to confidential market data by state public utility commissioners in the PJM footprint (PJM 2003b). Under the proposed provisions, individuals authorized by state public utility commissioners and regional state

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<sup>33</sup> See SSG-WI Market Monitoring Work Group, "West-wide Market Monitoring Recommendations," October 7, 2003; see Roles and Responsibilities of MME (section F).

committees may access confidential market data after signing a non-disclosure agreement (NDA). Data requests to the PJM market monitor must be made in writing and must identify: (1) the information that is being sought, (2) the people who will have access to the information, (3) the person who will be the custodian for the information, and (4) a description of the purpose for the request. In response to the request, the affected member or PJM has the option of filing a fast-track objection with FERC. The provisions allow authorized individuals who receive confidential data to discuss the data with the PJM MMU. While several key issues remain unresolved, final consideration and approval of the provisions by the PJM Members Committee is expected in early 2004.

- In New England, the ISO arranges a non-public meeting and publishes a quarterly report that will be made available to appropriate state agencies with jurisdiction over the competitive operation of electric power markets; the report is subject to confidentiality protections consistent with NEPOOL information policy. ISO-NE also will make a redacted version available to the public.
- The NYISO Market Monitoring Plan prohibits the NYISO Market Advisor from disclosing Protected Information to any entity without consent from that entity. The NYISO shall take all reasonable steps to ensure the continued protection of any confidential information that it may be required to submit to a state court or regulatory agency (e.g., prevent disclosure under the Freedom of Information Act (FOIA) or equivalent state freedom of information laws). In August 2000, the New York Public Service Commission (NYPSC) directed the NYISO to provide Department of Public Service staff with access to information to allow the NYPSC to understand the relationships among ISO software, market design, tariff provisions, operating rules and bids, and assess the efficiency of the system's operation (NYPSC 2000a; NYPSC 2000b). The NYPSC indicated that confidential material would be protected under New York's Public Service Law and that access to commercially sensitive and proprietary information would be disclosed only to a limited number of Department staff.<sup>34</sup> Since that decision, the NYISO and NYPSC have worked out various implementation issues, which include data access and security (e.g., several NYPSC staff have office space at the NYISO) and the categories of market data/information that NYPSC staff can access. Based on its market monitoring activities, the NYPSC staff offers the following advice on particularly valuable data to analyze: (1) review generator bids frequently, comparing them to estimates of marginal costs, (2) focus on high bids (or high uplift payments) and request explanations from the ISO for why they are reasonable, (3) examine the bills of generating companies and individual generators in order to detect unusually large payments or patterns of payments which may be indicative of a market power problem, and (4) prepare valid and timely estimates of Reference Prices as a means of assessing market power. (Reeder 2002).

In arguing for state access to wholesale market data, representatives from state agencies note that: (1) they often have statutory obligations to investigate anti-competitive market

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<sup>34</sup> The New York Public Officers Law (POL) section 15 of the Public Service Law and 16 NYCRR 6-1.3.



behavior, and (2) that state regulatory commissions serve as the “stewards of the retail marketplace” (Thomas 2003).<sup>35</sup> They also recognize the physical reality that the retail supply of electricity is heavily influenced by the wholesale market. State representatives note that market data may be provided to governmental agencies under Confidentiality Agreements and that state agencies have developed internal processes, such as non-disclosure certificates that are signed by state agency staff that provide additional assurance that confidential data will not be disclosed inappropriately. Finally, some states do not require release or disclosure of confidential proprietary information; terms of access are guided by their state public records law.

Market participants are obviously concerned with how confidential or commercially-sensitive information may be used by state agencies. Access to confidential market data can potentially be used by state agencies for general monitoring of market competitiveness, specific investigations of participant activities, or input into ongoing litigation. Moreover, market participants have legitimate concerns about the ability of state agencies to protect confidential information from FOIA requests made by various parties.

This issue is complex and potentially contentious so concrete approaches may help create the basis for workable solutions. The first issue is to define the “authorized state agencies” that may gain access to confidential market data. Is it limited to entities with statutory authority to represent consumer interests before FERC, such as public utility commissions and/or state attorney general offices? Should other types of state energy agencies be included as well? Second, to the extent possible, state agencies need to clearly articulate their purpose and the specific data that they are interested in obtaining. For example, if the state agency’s primary interest is assessment of overall competitiveness of the wholesale market, then periodic reports and private meetings with the ISO MMU which are subject to confidentiality provisions may be sufficient. The challenge comes when specific market problems/flaws arise, because they can’t be anticipated, and thus it is difficult to pre-specify the data requirements. Third, state regulatory agencies need to realistically assess their technical capabilities and staff resources to handle massive amounts of data on wholesale energy markets, given the data intensiveness of monitoring wholesale electricity markets. We believe that most state commissions would typically prefer useful information on wholesale electricity markets (e.g., analysis of broader trends, performance indices, metrics, etc) rather than massive amounts of undigested market data, except in cases when a market crisis occurs.

It is also important to recognize that this issue of access by state agencies to wholesale market data is part of a broader discussion of the appropriate policies for disclosure and

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<sup>35</sup> In Pennsylvania, 66 PA C.S. 2811 states that: “ The Commission shall monitor the market for the supply and distribution of electricity to retail customers and take steps as set forth in this section to prevent anti-competitive or discriminatory conduct and the unlawful exercise of market power.” Maryland PUC Code Ann 7-514 states: “On complaint or on its own motion, for good cause shown, the Commission may conduct an investigation of the retail electricity supply and electricity supply services market and determine whether the function of one of these markets is being adversely affected by market power or any other anti-competitive product. The Commission shall monitor the retail electricity supply and electricity supply services markets to ensure that the markets are not being adversely affected by market power or any other anti-competitive conduct.”

timely dissemination of information/data on wholesale electricity and related markets. Many analysts (including some of the MMUs interviewed) argue that given the ownership and institutional structure of the electricity industry, it is important to limit the disclosure of potentially sensitive market information that could be used to undermine competitive outcomes. Others, such as Prof. Frank Wolak, argue for more (not less) transparency and increased availability of timely data in electricity markets. Wolak maintains that all information related to the operation of wholesale energy market auctions should be public, including offers, dispatch, and actual grid operation (e.g., power flows and transmission congestion). Bilateral forward contracts should remain private. Not surprisingly, market participants have not been particularly supportive of the more transparent approach to data availability. Market participants are concerned about publicizing what they consider proprietary information, and ISOs are concerned that instant knowledge of all market behavior will lead to tacit collusion

### Summary: Lessons Learned

One of the market monitors highlighted key lessons learned, which we believe provides an excellent summary that may be useful for policymakers and market participants in the West that are grappling with approaches to market monitoring (Bowring 2003):

- 1) Electric markets (structure, behavior, and performance) are complex; it is necessary to pay attention to the complex interactions among multiple markets managed by the ISO (e.g., energy spot market and reserve markets) as well as bilateral contract markets.
- 2) It is important to create a Market Monitoring Unit (MMU) prior to actually implementing wholesale markets. This means putting into place confidentiality protocols, the procedures to gain data access, and complaint procedures prior to market opening. In addition, the MMU should include staff with diverse expertise (e.g., economics, power engineering, information technology) and whose core competencies include detailed understanding of electric market structure, physical infrastructure, and grid operations.
- 3) Market monitoring units must be seen as and function independently from RTO member's interests, and to the extent feasible from the RTO itself.
- 4) Market monitoring is data intensive, so automation of daily or short-term monitoring activities is essential.
- 5) Processes for a MMU to request market data, particularly non-RTO data, need to be strengthened.
- 6) Market monitoring process and corrective actions need to be timely and efficient. Active relationships that include ongoing reporting and briefings to market participants and policymakers are critical to success.

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## Appendix A. Metrics and Statistics for Long-Term Analysis

A variety of metrics can be used to study the behavior of electricity markets over the long-term. Several indices discussed in Section II can be adapted for this purpose by assessing changes in their values over time.<sup>36</sup> However, to help discern day-to-day changes in markets and operation from broader industry trends, it is useful to consider general metrics on the state of electricity markets. Long-term analysis metrics help create a more complete picture of the industry and can facilitate comparisons across time periods or geographical areas.

Appendix A outlines common metrics that are used to characterize general market structure and performance. These include a number of metrics identified by FERC through its notice of proposed rulemaking on standard market design (FERC 2002). In many cases, the long-term metrics can be derived from quantities that are readily accessible via the normal course of operations. It is useful to note that consistent reporting of long-term data in the market monitoring reports can enable independent, outside analysis of market behavior.

We begin with total system costs, which when compared to prior years gives an indication of long-term trends in energy costs. Average energy costs have the added advantage of comparison across regions. Table A-1 provides example data for the ISOs during the period between 2000 and 2002.

Total wholesale energy and ancillary service costs is a measure of costs from wholesale energy production and ancillary services (i.e., regulation, spinning, and non-spinning reserves). Year-to-year trends are useful for comparison, as are the trends among the different categories of costs (e.g., fuel costs).

Average wholesale energy and ancillary service costs provide a measure of costs, accounting for demand levels, on a per megawatt basis. It is calculated by dividing the total cost of provision (including all costs for facilities, labor, fuel, etc.), by the amount of energy provided. The result is the average per-unit energy cost. Persistently high prices in wholesale energy markets during periods when no scarcity of supply exists may indicate a lack of competitiveness.

Average energy costs provide fundamental information on energy costs. There are many variants, including load-weighted and fuel-cost adjusted. The overall level of costs is a good indicator of market performance, though costs must be interpreted carefully because of the multiple factors that may affect them. Trends in average energy costs can be viewed across years and between regions.

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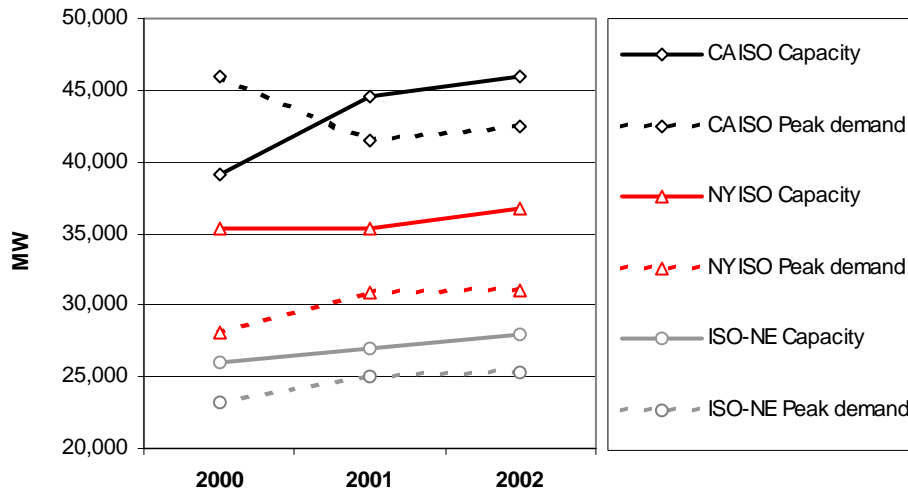
<sup>36</sup> For example, prices may be reported as a time-averaged value such as the average price for electricity during 2002. The residual supply index will be reported by the frequency that a certain threshold is exceeded.

**Table A-1.** Annual Wholesale Energy Costs in the ISOs, 1999 through 2002

Year	Metric	PJM*	NYISO	ISO-NE**	CAISO****
2002	Total cost		~4.6b		\$10.1b
	Avg. cost	\$31.60/MWh	\$49.77/MWh		\$43/MWh
2001	Total cost		~4.6b		\$26.8b
	Avg. cost	\$36.65/MWh	\$51.39/MWh	\$34.80/MWh	\$118/MWh
2000	Total cost				\$27.0b
	Avg. cost	\$30.72/MWh		\$33.20/MWh	\$113/MWh
1999	Total cost				\$7.4b
	Avg. cost	\$34.06/MWh		\$33.25/MWh	\$33/MWh

**Notes:** Empty cells indicate that the information was not publicly available. PJM provides load-weighted, average LMP (see 2002 PJM State of the Market Report, pg 43). NYISO provides an approximate total market cost for 2001-02, which includes energy, ancillary services, congestion, losses, and uplift expenses (see 2002 NYISO State of the Market Report, pg 3). The ISO also provides an “all-in” average price for 2001-02, which includes energy and ancillary service costs. ISO-NE provides fuel-adjusted load-weighted ECP (see ISO-NE Annual Market Report, pg 46). CAISO provides total wholesale cost of energy and ancillary services (MM\$) and average wholesale cost of energy and ancillary services (\$/MWh load) (see CAISO 2002 Annual Report on Market Issues and Performance, pgs. 3-6 and 3-10).

General system data related to total capacity, new supply, peak demand, and reserve margins are also useful metrics, although their values may not change significantly on an annual basis. Figure A-1 presents representative values for the ISOs.



**Notes:** ISO-NE: capacity data from ISO-NE, peak data from RPET02 ([www.ksg.harvard.edu/hepg/Papers/ISONE\\_region.transm.exp.plan\\_11-7-02.pdf](http://www.ksg.harvard.edu/hepg/Papers/ISONE_region.transm.exp.plan_11-7-02.pdf)); CAISO capacity data (2000-01) and peak demand from CAISO. 2002 capacity is an estimate from 2002 monthly staff report ([www.energy.ca.gov/reports/700-02-003F/](http://www.energy.ca.gov/reports/700-02-003F/)); NYISO data from NYISO and EIA.

**Figure A-1.** Capacity and peak demand in the CAISO, NYISO, ISO-NE



Total system capacity, the installed capacity adjusted for all current outages, is a measure of system generating resources. Total capacity is compared with peak demand, while trends in capacity can be viewed across years.

Net capacity addition provides a measure of change in generation resources. Capacity additions (less retirements) are compared with increases in load to track needed supply. It is helpful to distinguish new capacity on the basis its role in the market (baseload, intermediate, peaker) and fuel type.

System peak demand provides a measure of system demand requirements. Peak demand can refer either to the load at a given moment (e.g. a specific time of day) or to an average load over a given period of time (e.g. a specific day or hour of the day). Peak demand is compared across years, or against available generating resources in a given year.

System reserve margin is the difference between available capacity and peak demand. Current and anticipated reserve margin provides a critical measure of system security in the short and long-term.

Available demand response capacity is a measure of available price responsive load. Available DR capacity can be used to assess whether demand response can impact (i.e., improve) market competition. Total demand-side resources available in the PJM Region during 2002 were 2,460 MW, almost four percent of peak demand.

Fuel costs have a particular meaning in the energy industry: the cost of the *heat content* of the fuel. Costs are calculated by dividing the total cost of the fuel by its BTU content, then multiplying the result by one million. Fuel costs represent trends in fuel prices that will be reflected in wholesale/average energy costs, as well as electricity prices.

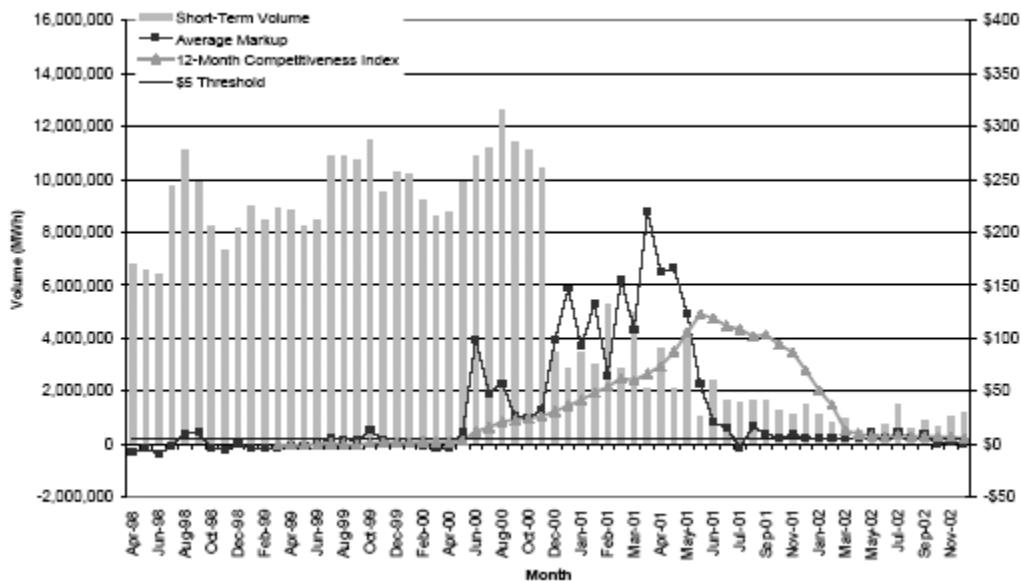
Congestion costs provide a measure of transmission capability to economically serve the market. If there is regional disparity in electricity production costs, then transmission lines will become congested in order to transport lower-cost power.

The amount of energy traded in the markets provides one indicator of market activity. Participants purchase energy through the day-ahead market or the real-time (i.e., spot) market. Demand not supplied through the market is met by contracts and self-generation. Market volume can be expressed as averages, MWh, or percent of load. Comparisons can be made between energy traded ahead versus transactions in real time.

12 month competitive index (12MCI) is a volume-weighted, 12-month moving average of hourly market price over a competitive baseline price; if the difference exceeds a pre-specified critical value, automatic regulatory intervention occurs. Advocates believe that 12MCI (often referred to as a “guardrail to competition”)

provides a transparent standard to identify unjust prices in wholesale markets (see F. Wolak, B. Barber, J. Bushnell, and B. Hobbs 2002; and F. Wolak 2003). By filtering short-lived behavior -- which may not be competitive, but has little impact if short-lived -- the index provides a longer-term perspective on market competitiveness.

CAISO's Department of Market Analysis has proposed to use 12MCI as a standard monitoring metric. DMA assume that the market is competitive provided that the 12MCI is below a specified standard of \$5/MWh. As shown in Figure A-2, the 12MCI for the period April 1998, through November 2002, fluctuates between \$5.69 and 50.91/MWh, implying that some degree of market power exists (see CAISO Annual Report on Market Issues and Performance, 2003).



**Figure A-2.** 12-month competitive index (from CAISO Dept. of Market Analysis 2003)

Revenue adequacy for new generation provides an indication of how much revenue a new generator may expect to earn in the market. This metric is then compared with estimates of how much revenue is required to attract new generation. The metric can be compared with expected costs for a new plant to evaluate the market incentive for new generation: if the revenue adequacy is high enough, new generation is viable. This metric, when combined with an analysis of existing capacity and future demand, can help determine if the market will attract needed generation.