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Analysis of Data Release Practices in Centrally-Dispatched Electricity Markets

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EXECUTIVE SUMMARY

PJM Interconnection retained CRA International to evaluate data release practices in wholesale electricity markets. The study's underlying objective was to examine the balance struck by other wholesale markets in providing information, and from this to draw lessons that might apply to PJM's data posting practices.

CRA staff collected data and interviewed personnel for 12 U.S. and international centrally-dispatched electricity markets identified by PJM and CRA. The set of respondent organizations was neither by design nor outcome a statistically representative sample of the world's organized electricity spot markets. Nevertheless, the sample included all of the other organized electricity markets in North America, three in the Asia/Pacific region, and markets in South America and Europe, and was diverse in many respects, including size, products traded, spot market timeframes, locational model, and the requirement for balanced schedules.

The study revealed a wide diversity in the practices employed by market operators and administrators to release system and market data to market participants and other stakeholders. Some of this diversity stemmed from the variety in market design and structure across the various markets, some of it is a result of differing philosophies or perspectives on the part of stakeholders and rule makers, and some of the diversity is due to differences among sets of legacy market rules that are vestiges of original designs created before anyone had much practical experience operating these sorts of markets.

In this report, we discuss the relationship between information release and economic efficiency. While economic theory can identify the potential for information disclosure to hinder, rather than promote, competitive behavior, it cannot determine with specificity the *amount* of information or the *timeliness* of release (i.e., lag) that may be considered "safe" in a given market. Likewise, although none of these markets could be considered a controlled experiment from which we can establish a clear relationship between information disclosure and overall levels of competitiveness, there is certainly some value in knowing whether PJM's practices are in the back, middle, or front of the pack relative to other markets. To the extent that other markets have taken a more aggressive approach to information disclosure and have thus far not suffered the competitive harm that theory suggests is possible, this may be evidence that PJM could also adopt more aggressive information releases with limited risk of harming competition. Further examination is necessary, however, to establish whether the lessons from other markets can reasonably be expected to apply to PJM. As part of this study, we reviewed public analyses of the market structures in other markets to investigate whether policy makers there faced competitive concerns similar to those in PJM.

This study of centrally-dispatched electricity markets around the world revealed a wide diversity in the practices employed by market operators and administrators to release market data to market participants and other stakeholders. Generally, our findings show that the

release of data by PJM exceeds that of many of the other markets we examined in this study, and is generally on a par with comparable markets in the U.S.

Our survey of other electricity markets indicates a range of data posting practices, but does not by itself reveal why — or even whether — those practices are considered optimal for each market. More importantly, the survey does not reveal whether policymakers would have adopted those same practices if market conditions were like those in PJM. Our review of public analyses shows that some markets are fundamentally different from PJM, whereas others appear to offer closer analogs. None of the public analyses allow us to address the specific question of whether other markets have a greater or lesser potential for profitable coordinated multi-firm behavior.

None of the markets surveyed can be said to perform substantially better as a result of their approach to information release. Although the interviews revealed broad support for more information being released rather than less, none attributed competitive outcomes primarily to the information available in the market. To the contrary, few if any of the markets had evaluated information disclosure explicitly for its effects on competition or market efficiency. In other words, this study cannot conclude that PJM's current data posting practices are lagging behind industry practice, and are suffering a loss of efficiency or competitiveness as a result.

Even though PJM's current practices are not necessarily inefficient, the survey also shows that other markets do provide more information than PJM and do not appear to suffer from uncompetitive behavior. Of course, one cannot simply assume that experience in other markets will be readily applicable to PJM, or that practices found to be appropriate elsewhere will necessarily be appropriate in PJM. A review of published analyses suggests that ISO-NE and MISO may offer the most relevant comparisons with PJM, based on the broad market metrics common to the types of analyses generally undertaken in "state of the market" reports. Further independent analysis is necessary before concluding that these are truly valid analogues, as the public reports available to us do not use consistent methodologies across the markets, and offer varying approaches to evaluating market structures below the aggregate (i.e., market-wide) level. To the extent that (a) further analyses supports a finding of comparable market structures and comparable competitiveness concerns; and (b) analysis of actual experience in these markets indicates that the additional information improves competition or efficiency – or at least is not harming them – then the experience in these markets could be considered meaningful and applicable to PJM. We would regard emulation of the data release practices in such other, relevant markets — assuming no indication of inefficiency due to the information release practices — as a moderate strategy.

While a moderate strategy is based on emulating the relevant "best practice," information disclosure that goes beyond current practice would necessarily be considered an aggressive approach. First, whether specific information (released with a given time lag in relation to market operation) can be exploited to the detriment of market efficiency is largely an empirical question. Second, adopting an experimental approach to testing the adequacy of increased information requires that the market operator be able to identify whether the potential harmful

effects are, in fact, occurring. Given that most market monitoring efforts have focused on the behavior of single firms acting independently, the ability to evaluate the competitive impacts of increased information disclosure may be limited at present. Finally, the ability to detect harmful consequences would need to be complemented by the ability to measure the benefits of the additional information.

We examined PJM's practices with respect to specific categories of data and compared the manner in which those data are released relative to that of the other markets we studied. In this report, we analyzed the respondent markets' data release practices, for the most part, by looking at where they fell relative to each other along the following three dimensions: general concept (e.g., offers, generator operation, etc.), specification (specific data element(s), degree and manner of aggregation, degree of obfuscation, etc.), and timeliness of posting (i.e., lag).

With regard to the first of these dimensions — general concept — we selected and addressed five areas: supply offer data, demand bid data, generator operational data, load data, and transmission data. PJM's current approach to the release of supply offer data, demand bid data, generator operational data, and load data is among the more conservative we found (relative, however, to the other markets that publish these data at all). With regard to transmission data, PJM's current data release is among the most extensive.

As part of this assignment, PJM requested that we recommend alternatives to its current data release practices. Although we present a number of options for consideration by PJM, we emphasize that our review of publicly available analyses — as well as our discussions with the respondent organizations — is insufficient to support a recommendation that PJM modify its current data release practices or adopt any of the specific alternatives developed. The alternatives are presented in the following table.

Type of Data	Potential Modifications to Practice: more transparent →		
	Option A	Option B	Option C
Generator Offer and Demand Bid Data	Reduce 6-month lag for existing data; provide less specific data sooner	Post bids and offers after 30 to 60 days; retain masking	Post bids and offers by name within one day
Generator Operational Data	Post masked unit-specific commitment data / operational parameters after 180 days or less	Post masked unit commitment and schedule data and unmasked unit-specific outage data after 30 to 60 days	Post unmasked unit-specific commitment, schedule, dispatch, actual output, actual and forecast outages within one hour
Load Data		Post forecast, scheduled, and actual load by EDC in real time	Post scheduled load by LSE in real time
Transmission Data		Post flow data for more interfaces	Post real time operating limits; post flow data for more interfaces

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1. INTRODUCTION AND BACKGROUND

PJM Interconnection retained CRA International to evaluate data release practices in wholesale electricity markets, and to advise whether PJM should modify its own data posting practices.

The characteristics of data release or posting practices include the amount, detail, promptness, and access to market-related information. Modern wholesale electricity markets are complex, and involve a voluminous amount of information related to demand, offers to supply, technical parameters of generation, state of the transmission system, and reliability requirements. Moreover, electricity markets are not "one shot" operations, but involve inter-temporal dependencies; e.g., the ability of a generator to produce electricity in one hour depends on whether it produced electricity in the prior hour.

If the operator of one of these markets were to communicate only individual instructions to generate as well as announcing the price in each interval, the operation of the market would be that of a proverbial black box. Results would inevitably be counterintuitive or downright inexplicable, undermining confidence in the market, and discouraging participation in it. At the same time, the burden of investigating the proper functioning of the market would fall on the very limited number of individuals who had the information necessary to conduct such an evaluation.

Not surprisingly, operators of and stakeholders in these markets have made efforts to ensure that a substantial amount of operational market data is available to the public. The more transparent the operation of the market, the more likely improvements will be made and the more confidence participants will have transacting in that market. The recognized beneficial effects of information disclosure are often balanced against concerns about how much information is too much: Could information be exploited by participants to produce *less* competitive outcomes? In the clearing-price auctions that characterize current wholesale electricity spot markets, suppliers have an incentive to offer their power at the lowest price at which they are willing to produce. Participants who offer power at higher prices — under competitive circumstances — risk being undercut by a competitor, and thus risk passing up profitable opportunities to generate electricity. Additionally, in a perfectly competitive market, there is no benefit to bidding higher than this level since, by assumption, no individual market participant can affect the price. Real markets are not perfect, however, and if information exists that allows a participant to anticipate circumstances in which it *can* raise the price and in which it does *not* face the risk of being undercut by a competitor, then the incentive to offer its supplies at the lowest acceptable price is significantly blunted.

For PJM, as well as for other markets subject to the jurisdiction of the U.S. Federal Energy Regulatory Commission (FERC), certain standards of data release practices are specified in their FERC-approved tariffs. The FERC requires the electricity spot markets under its jurisdiction, through their tariffs, to disclose specified sets of market information. This information includes generator offers, albeit with a six-month delay. In setting this six-month

delay, FERC explained it was attempting to balance the benefits of increased transparency against the potential harm from facilitating uncompetitive behavior, and the need to protect commercially sensitive data.[1] Only recently (January 2007), ISO New England became the first FERC-jurisdictional market to propose shortening this delay to three months.[2] A review of other markets can, among other things, illuminate whether FERC's historical approach to releasing generator offer data still reflects best practice.

2. STUDY OBJECTIVE AND SCOPE

The broad objective of this engagement is to examine the balance struck by other wholesale markets with regard to the provision of information, and draw out lessons that may apply to PJM's own data posting practices.

PJM and CRA identified a set of U.S. and international electricity markets to include in the study, shown in Table 1. Markets in italics were specified by PJM, while other markets were recommended by CRA. The UK market was considered but rejected, as the market has evolved to a primarily bilateral structure, and its rules differ fundamentally from those of PJM and the other markets studied.

Table 1: Power Markets Included in the Study

North America	Latin America	Europe	Asia/Pacific
Alberta (AESO)	Argentina (CAMMESA)	*Nord Pool*	*Australia (NEMMCO)*
California (CAISO)	Colombia (MEM)	UK*	New Zealand
Texas (ERCOT)			Singapore (NEMS)
New England (ISO-NE)			
Midwest (MISO)			
New York (NYISO)			
Ontario (IESO)			

* Considered but excluded from study

PJM's request for proposals stated the study objective as "conduct[ing] an extensive, contextual comparative analysis of market structures and data posting practices in domestic and international centrally dispatched electricity markets." To gauge the relevance of other

[1] *See, e.g.,* Order Conditionally Accepting Tariff and Market Rules, Approving Market-Based Rates, and Establishing Hearing and Settlement Judge Proceedings, 86 FERC ¶ 61,062 of 27 January 1999.

[2] ISO New England Inc. and New England Power Pool, ISO New England Information Policy Revision, Docket No. ER07-444-000, January 18, 2007.

markets' practices to PJM, it is important also to gather basic information regarding each market — the "market structures" mentioned by PJM — such as the basic market model, the size, the number of participants and concentration of capacity ownership, the types of generation technology, and the nature of the products being traded.

In addition to gathering the pertinent information on other markets' data posting practices, PJM asked CRA to make specific recommendations regarding alternatives changes PJM's own data posting practices. Thus, we present a range of alternatives for modifying PJM's data release practices based on the observed practices in other markets.

3. STUDY APPROACH

CRA's approach consisted of the following major tasks:

- Design of a survey instrument to collect pertinent information on market structures and data posting practices.
- Collect data to populate the survey instrument for each of the identified markets in the study.
- Conduct telephone interviews with personnel at each market studied in order to (a) complete the survey instrument; and (b) gather additional information on how the data release practices were developed and whether they are considered by the market operators themselves to strike the appropriate balance.
- From the completed surveys and interviews, identify the range of current data posting practices in the markets studied.
- Analyze the findings and provide recommendations to PJM on possible changes to its own data posting practices.

The design of the survey instrument went through a number of iterations. The final instrument selected was much simpler and less lengthy than the initial designs, as a result of concerns on the part of PJM and CRA staff that the initial design would take too long to administer, and might reduce the response rate.

Data were mostly collected by CRA staff prior to the telephone interviews. CRA staff (based in the U.S., Wellington, and Melbourne) familiar with the design of the selected markets conducted the interviews. The interviews allowed us to discuss with relatively high-level market administration staff their general and specific data posting philosophy, practices, history, and experience, as well as learn about any planned changes to those practices. Additionally, the interviews enabled us to verify the detailed data we had collected, and to fill in any gaps in our knowledge.

4. SUMMARY OF FINDINGS

CRA collected data and interviewed personnel for 12 of the 13 target markets selected.[3] The set of respondent organizations is neither by design nor outcome a statistically representative sample of the world's organized electricity spot markets. Nevertheless, it includes all of the other organized electricity markets in North America, three in the Asia/Pacific region, and one each in South America and Europe.

Table 12 (in Appendix A) lists the individual respondents within each organization in our study. In all cases except two — Alberta and New Zealand — the respondents were staff members of the entities running the respective markets. Because in Alberta and New Zealand, the market operators have roles that are relatively narrowly defined and rather mechanical,[4] we spoke with personnel within the separate organizations there responsible for developing and administering the market rules.

4.1. MARKET STRUCTURE AND CHARACTERISTICS

The respondent markets are diverse in many respects, e.g., size, products traded, spot market timeframes, locational model, and the requirement for balanced schedules. The diversity of the respondent markets with respect to these attributes is illustrated by Figure 1 and Table 2 through Table 4. We've included PJM in many of the figures and tables for reference.

Table 2 illustrates that the most common market model used by the respondent markets is the same used by PJM — a nodal market in which most generation is centrally committed and dispatched. The color codes used in this table to identify the market model are maintained in subsequent tables for reference. Table 3 shows the breakdown of energy and ancillary service spot market settlement in various timeframes. Table 4 shows the prevalence of markets for installed capacity and transmission rights. Finally, Figure 1 illustrates the relative size of the markets by peak demand, ranging from 6 GW to 116 GW, in comparison to PJM's 145 GW.

With respect to most of the attributes listed above, PJM and the other three eastern U.S. markets are similar, as the figures and tables illustrate. The structure of most of the remaining markets differs from that of PJM with respect to the locational model used for pricing (zonal or single-price), and the products traded (predominantly energy). With respect

[3] We were unsuccessful in soliciting a response from CAMMESA, the Argentine electricity market operator. Additionally, much of the data posted by CAMMESA requires secure access to the organization's website, which we were not able to obtain.

[4] In the case of New Zealand, operation of the system and market is shared according to function by a number of entities, each of which makes available data of one kind or another. These entities include Transpower, the grid company and M-Co, the market operator.

to the remaining attributes, the markets other than those in the eastern U.S. are a mixed bag, as shown by the figures and tables.

The degree to the respondent markets differ in structure from PJM has implications for the way in which we interpret our findings regarding data release practices, which we will discuss in Section 5.2.

Table 2: Market Model Employed by Each Respondent Market and PJM

Centralization of Scheduling	Locational Pricing Model		
	Nodal[a]	Zonal	Single Price
Most generation is centrally committed / dispatched	ISO-NE NYISO MISO New Zealand **PJM** Singapore	Australia Nord Pool	Alberta Colombia IESO[b]
Self-balanced schedules with thin real-time balancing market[c]		CAISO ERCOT	

[a] *While prices in these systems are all calculated and published on the nodal basis, in many cases certain market participants (e.g., load servers) pay either a zonal or system-wide average price.*

[b] *IESO uses a single internal zone and multiple external zones for pricing, but does calculate nodal prices as part of its operation.*

[c] *In the near future, both CAISO and ERCOT have plans to switch to a nodal locational model, as well as to centralize their unit commitment and dispatch.*

Table 3: Energy and Ancillary Spot Market Time Frames*

Market	Number of Respondent Markets with Settlement in Given Time Frame		
	Day-Ahead	Day-Of	Real Time
Energy	6	3	10
Ancillary Services	5	3	5

** Although not included here, PJM operates day-ahead and real-time energy and ancillary service markets.*

Table 4: Operation of Installed Capacity and Transmission Rights Markets by Each Respondent Organization and PJM

Operator[a]	Installed Capacity	Transmission Rights
Alberta (AESO)		
Australia (NEM)		b
CAISO		✓
Colombia (MEM)	c	
ERCOT		✓
IESO		✓
ISO-NE	✓	✓
MISO		✓
New Zealand		
Singapore (NEMS)		
Nord Pool	d	
NYISO	✓	✓
PJM	✓	✓
TOTAL (excl. PJM)	2	7

[a] *Color indicates market model employed, from Table 2.*

[b] *The Australian market auctions rights to transmission settlement residual revenues, but not transmission rights* per se.

[c] *The Colombian market administers a capacity payment, but this is not a "capacity market" as the term is used in North America.*

[d] *Some of the transmission system operators within Nord Pool reportedly administer installed capacity requirements and payments, but there is no system-wide structure.*

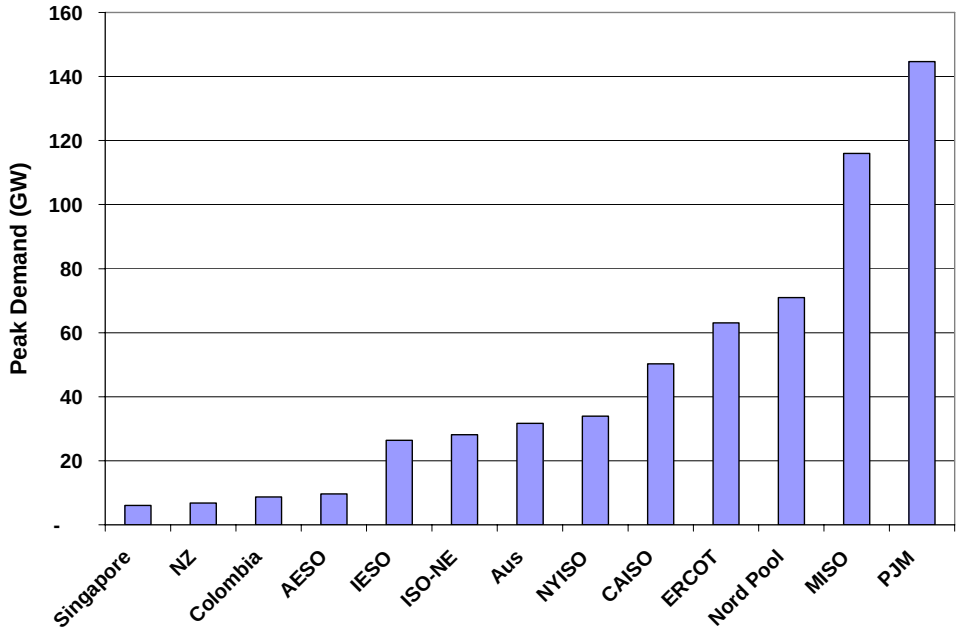

Figure 1: Relative size of markets

4.2. DATA RELEASE PRACTICES

Table 5 through Table 10 illustrate the wide range of data posting practices we observed with respect to several key issues, along with PJM's current practice in each of these areas. In order for the discussion to be meaningful and useful, our focus is on those data elements and manners of posting where we found one or more of the following to be true:

- the specific data were common to PJM and the comparison markets
- practice varied widely across markets
- practice exceeded or was more liberal than that of PJM
- practice changed recently or was in flux
- practice involved market participant-specific data

Our findings reveal that the ways in which market participant-specific data (e.g., supply offers, generator output, transmission rights bids and offers) are released vary widely across markets. We also found that data release practices have been liberalizing considerably in several markets, and differ significantly from PJM's current practice, which we discuss in detail below. Beyond the question of whether these data are released at all in a given market, we found that the manner of release of such data varies primarily in three ways: (i) the time lag between when the data could be made available and when they are made available, (ii) the degree to which identities are obfuscated, and (iii) the granularity of the data (e.g., unit vs. portfolio level). The remainder of this section describes our findings in detail.

4.2.1. Supply Offer and Demand Bid Data

Supply offer data. Eight of the 12 markets we surveyed publish supply offer data on a unit-, plant-, or portfolio-specific basis, with varying degrees of identity obfuscation, as shown in Table 5. Of those eight, half include identities and half mask identities, as the table indicates. Both the time lag until posting and the degree of obfuscation vary considerably across markets. As the table shows, PJM ranks among those markets with the most conservative practices, short of not posting any supply offer data at all.

Demand bid data. As Table 6 shows, only five of the 12 markets surveyed publish demand bid data. None of the remaining seven markets feature a day-ahead settlement, however, so for those markets, demand bids (excluding bids for price-responsive load) would not be relevant. PJM publishes an aggregated demand bid curve (as well as aggregated virtual bids and offers) with a 180-day lag.

4.2.2. Generator Operational Data

Six of the 12 markets under study publish one or more forms of market participant-specific generator operational data. These time series data can include generator schedules, unit commitment and dispatch data, generator output, and in some cases, generator availability and scheduled/unscheduled outage data. Table 7 lists which markets release which data,

and shows the time lag before publication. Identities are generally either provided or not; NYISO's posting of generator operational parameters was the only instance of masking we found.

Although only five of the 12 markets provide generator operational data, the ones that do provide it generally include a lot of detail and release the data relatively quickly. ERCOT until recently provided entity-specific data only after a delay of 180 days; as a result of a recent Texas PUC rulemaking, it is improving the timeliness with which it provides the data, using a phased approach, as indicated in the table (and described more fully below). As the table shows, PJM's current approach is apparently the most conservative of those observed, excluding those markets that publish no data at all in this area.

Only AESO, IESO, and New Zealand provide unit-specific generator outage and availability data in close to real time.

4.2.3. Load and Load Forecast Data

Table 8 displays the nature of load and load forecast data that are posted by the various markets, along with the timeframes for posting. There was not a lot of variation among the various practices for posting load data. Differences included whether or not forecasts are posted and how far into the future they go, system-wide vs. zonal aggregation, and the posting of scheduled load, a concept only present in day-ahead markets or those in which market participants submit balanced schedules.

Of all the markets examined, ERCOT has the most aggressive posting practice with regard to load data, in that it posts market-participant-specific schedules at the zone/portfolio level relatively soon after they are submitted. MISO is more conservative than its neighbors in the East in that it does not disaggregate load data by sub-region or zone within the MISO footprint. PJM's practice is mixed — metered hourly zonal load data are published approximately every two weeks, while forecast and estimated real-time load at the control area level are published with less of a lag.

4.2.4. Transmission Data

Table 9 shows that except for AESO, Colombia, Singapore — all of which post only outage data — PJM and most of the other markets we studied post a wide range of transmission-related data. Indeed, none of the markets we looked at post types of transmission data not posted by PJM. PJM is therefore among the most aggressive in this area. One exception to this characterization is that, unlike some other markets (e.g., NYISO) PJM posts flows for only a subset of the major monitored interfaces within its control area.

From our own experience in using transmission modeling data published by system operators (e.g., operating limits and contingency constraints), we know that accuracy can vary widely, data published by just a single source can be inconsistent, and the data as published are

often not usable "as is." A detailed evaluation of the quality of technical transmission modeling data published by the markets we looked at was beyond the scope of our study.

4.2.5. Provision of Future Price Information

As shown in Table 10, market participants have access to projections or estimates of real-time prices for the following operating day in roughly half of the markets surveyed. This is accomplished primarily through a day-ahead market settlement process.

4.2.6. Installed Capacity Market Data

Given that of the 12 markets we examined, NYISO and ISO-NE are the only two with installed capacity (ICAP) markets, and given that the ICAP market designs there and in PJM are still in a great deal of flux and have few similarities, we felt that a comparison of the data release practices employed would not be that useful. It may make sense to revisit this issue at a future time once these market designs have stabilized and have been in place for a while.

Table 5. Supply Offer Data Postings: Lag and the Degree of Obfuscation[a]

Degree of Obfuscation	Posting Time Lag						
	At Market Close	1-Day Lag	2-Day Lag	2-Week Lag	30-Day Lag	90-Day Lag	180-Day Lag
Unit-specific offers with IDs		Australia Colombia		New Zealand			
Aggregated by portfolio/zone, with IDs					ERCOT		
Price-setting offers only, with IDs			ERCOT				
Masked unit-specific offers (permanent pseudo-IDs)						ISO-NE (pro-posed)[c]	CAISO[b] ISO-NE NYISO MISO **PJM**
Aggregated by zone or system	AESO		ERCOT			Nord Pool	PJM[d]

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[a] *Two respondent markets do not post supply offer data: Singapore and IESO.*

[b] *According to CAISO, market participants report being able to discern identities easily, based on size and bidding behavior.*

[c] *FERC rejected ISO-NE's proposal, as discussed in Section 4.3. The actual lag would have been approximately 90-120 days, depending on the day of the month.*

[d] *Virtual supply offers are aggregated.*

Table 6. Entity-Specific Demand Bids for Energy: Lag and the Degree of Obfuscation

Degree of Obfuscation	Posting Time Lag						
	At Market Close	1-Day Lag	2-Day Lag	2-Week Lag	30-Day Lag	90-Day Lag	180-Day Lag
Asset-specific bids with IDs							
Aggregated by portfolio/zone, with IDs					ERCOT		
Masked asset-specific bids (permanent pseudo-IDs)						ISO-NE (proposed) **	CAISO* ISO-NE NYISO MISO
Masked bids (changing IDs)							
Aggregated by zone or system			ERCOT				**PJM**

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** According to CAISO, market participants report being able to discern identities easily, based on size and bidding behavior.*

*** FERC rejected ISO-NE's proposal, as discussed in Section 4.3. The actual lag would have been approximately 90-120 days, depending on the day of the month.*

Table 7. Generator Operational Data Postings: Lag and the Nature of Data

Nature of Data	Posting Time Lag						
	1-Hour Lag	1-Day Lag	2-Day Lag	30-Day Lag	60-Day Lag	90-Day Lag	180-Day Lag
Hourly energy and A/S schedules, resource plans, actual output, dispatch instructions, IDs		Aus.[c]			ERCOT (3/1/08)	ERCOT	ERCOT (prior to 3/1/07)
Hourly actual output, availability, IDs	IESO						
Hourly actual output (bus level), scheduled & unscheduled outages by unit with IDs, reserve MW[a]	NZ[b]	NZ					
Unit-specific outage data with IDs	AESO Sing.	Nord Pool[f]					
Unit commitment & schedule data, no IDs or masks	AESO						
Unit-specific operational parameters, unit commitment data, masked							NYISO
Aggregate generator outage data	MISO[g] **PJM**[h]			AESO[e] Sing.			**PJM**[e]
Aggregate resource output			ERCOT[d]				

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[a] *Scheduled outages are posted as soon as they are scheduled.*

[b] *By subscription.*

[c] *Includes availability data.*

[d] *By settlement interval, by zone.*

[e] *EFORd by month, by fuel type and technology.*

[f] *Includes current and forecast generator outages for plants > 100 MW.*

[g] *7-day hourly forecast of total generation on outage*

[h] *Forecast daily aggregate generator outages for next three months; this practice appears to have ceased in late February 2007.*

Table 8. Load Data Postings: Lag and the Nature of Data

Nature of Data	Posting Time Lag				
	Real Time	1-Hour Lag	1-Day Lag	4-Day Lag	Other Lag
Forecast, scheduled, and actual load by zone or subzone, and by LSE/QSE	ERCOT[d]		ERCOT[e]		
Forecast, scheduled, and actual load by zone or subzone	ISO-NE[i] NYISO[l]				
Forecast and actual zonal or subzonal load	Aus.[a] CAISO[b] **PJM[n]**	Nord Pool[k]		IESO[f] ISO-NE[i] **PJM[o]**	**PJM[p]**
Forecast, scheduled, and actual system load	MISO[j] **PJM[h]**				
Forecast and actual system load	AESO IESO[g] NZ[m]				Colombia[c]

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[a] *Hourly forecast extends seven days.*

[b] *Includes 5-day peak and pump forecast by IOU, 2-day ahead hourly system forecast,*

[c] *Unrestricted access to actual monthly load data with 30-day lag; more granular and timely data via restricted access only.*

[d] *Includes 3-day hourly forecast load profiles by retail customer class and zone.*

[e] *Includes Hourly scheduled load by QSE by zone, 15-minute backcast load profiles by retail customer class and zone.*

[f] *Hourly actual zonal load.*

[g] *Actual load and day-ahead system load forecast.*

[h] *7-day system hourly load forecast.*

[i] *Real-time hourly actual load by zone delayed 4 days; day-ahead scheduled load available upon publication of DA market results. MISO does not publish any load data for sub-regions or zones within the MISO footprint.*

[j] *Day-ahead, real time, and 7-day forecast of hourly system load.*

[k] *Actual load only; no forecast available.*

[l] *7-day hourly zonal forecast; actual RT and cleared DA load.*

[m] *Actual and forecast hourly load available by subscription.*

[n] *7-day control area hourly load forecast*

[o] *Estimated hourly control area load (3-day lag).*

[p] *Metered hourly zonal load published approximately every two weeks.*

Table 9. Comparison of Transmission Data Posted for Each Market

Type of Data	Market[a]										
	AESO	Aus.	CAISO	ERCOT	IESO	ISO-NE	MISO	NZ	Nord Pool	NYISO	PJM
Operating or planning interface limits		✓	✓	✓	✓	✓[e]	✓	✓	✓	✓	✓[c]
Load flow model		✓	✓	✓	✓	✓[b]	✓[b]	✓		✓[b]	✓[b]
Transmission outage data	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
TTC, reservations, ATC	✓[d]		✓	✓	N/A	✓	✓		✓	✓	✓
Binding transmission constraints and their shadow prices		✓		✓	✓	✓	✓	✓		✓	✓
Interface flows (internal)		✓	✓	✓	✓			✓	✓	✓	✓[c]
Interface flows (boundary)	✓[d]	N/A	✓		✓	✓	✓	N/A	✓	✓	✓
Congestion rent collected		✓	✓	✓	✓	✓	✓			✓	✓
Losses costs, revenues, and over-collection		✓	N/A	N/A	✓	✓				✓	N/A

[a] Colombia and Singapore are not listed here; the only transmission data published by the system operators there are for transmission outages.
[b] Available through the NERC MMWG.
[c] For a limited subset of internal interfaces, one to three months after the fact.
[d] Some of these data are made available by AESO's neighbors, BCTC, and SaskPower.
[e] Internal interface limits accessible by market participants only.

Table 10: Method of Providing Future Price Information

Day-Ahead Market	Project/Estimate Real-Time Prices for Following Day	No Day-Ahead Market or Projections
ISO-NE NYISO MISO Nord Pool **PJM**	IESO New Zealand	Alberta Australia CAISO Colombia ERCOT Singapore

4.3. INSIGHTS GAINED THROUGH THE INTERVIEWS

Generally, we found through our research and discussions with market administration or oversight personnel that while data posting practices in the markets we examined have evolved over the last decade — in many cases to accommodate changes in market design or advances in information technology — they have remained largely unchanged from their initial state. Notable exceptions were as follows:

- **ERCOT**. As the result of a rulemaking proceeding initiated by the Texas PUC, ERCOT has radically reduced the delays for posting various types of bid and offer data, as well as generation operational data. The 30-day lag for posting zonal aggregate bid/offer curves, was reduced to two days; the 180-day lag for QSE-specific balancing energy and ancillary service bids and offers was shortened to 30 days, and the 180-day lag for other QSE-specific information such as schedules and generator operational information was reduced to 90 days until March 1, 2008 when it becomes 60 days.[5] Finally, ERCOT is now posting the price-setting offers for each zone, two days after operation. A portion of the initial rulemaking,[6] which featured shorter posting time lags, was challenged by two market participants, who obtained a court order staying the implementation of the new transparency provisions.[7] The court subsequently lifted the stay as applied to the 48-hour disclosure of the highest offer price selected or dispatched by ERCOT for each interval (but did not lift the stay related to other entity-specific information). Rather than waiting for further

[5] ERCOT TAC Recommendation Report, 697PRR-12, March 8, 2007.

[6] *Rulemaking Concerning Resource Adequacy and Market Power in the ERCOT Power Region*, Project No. 31972, Order, as published in the September 8, 2006 edition of the *Texas Register* (31 TexReg 7317).

[7] (*Constellation Energy Commodities Group, Inc. v. Public Utility Commission of Texas,* Cause No. 03-06-00552-CV, Texas Court of Appeals, Third District, Order of September 29, 2006; *City of Garland v. Public Utility Commission of Texas,* Cause No. 03-06-00571-CV, Texas Court of Appeals, Third District, Order of September 29, 2006.

consideration of this issue by the court, the commission decided that it should re-examine the previously-adopted disclosure requirements, and proposed the amendment ultimately adopted.

- **ISO-NE**. On January 18, 2007, ISO-NE made a Section 205 filing with the FERC proposing to revise its Information Policy to reduce the lag with which ISO-NE posts demand bid and supply offer data from 180 days to the first day of the fourth calendar month after the month for which the bids and offers were in effect (i.e., a lag of three to four months depending on when in the month the trading day falls).[8] The FERC, however, subsequently rejected ISO-NE's filing.[9]

- **IESO**. In the Fall of 2002, a stakeholder process led to the expansion of data release there. This brought about the release of hourly generator output and availability data one hour after the fact, and reduced the lower threshold for publishing unit- rather than station-level data to 20 MVA.

- **New Zealand**. In late 2006, a controversial decision was made to release half-hourly metered demand data for each day at 10:00 the following morning. There are currently numerous initiatives to publish more information, e.g., enhancing access to demand information, and the publication of reserve offers.

- **Nord Pool**, as a result of proposed EU rules, may standardize the MW size threshold above which current and forecast outages for plants must be published. Currently this varies between 100 and 200 MW depending on the transmission owner; the value is proposed to be fixed at 100 MW.

- **NYISO** created a system called DSS, designed to enable market participants to reconcile their own settlement statements, thereby reducing the workload on NYISO staff, and to provide a common reference for claims or disputes. NYISO is currently in the process of opening their Data Mart for use by non-market participants. The system allows flexible user-specified queries of most data stored and published by NYISO.

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[8] ISO New England Inc. and New England Power Pool, ISO New England Information Policy Revision, Docket No. ER07-444-000, January 18, 2007.

[9] Order Rejecting Tariff Sheet, 118 FERC 61,224, issued March 29, 2007. The Commission, with one commissioner dissenting, rejected ISO's filing "despite [ISO-NE's] claims, both in its initial application and its answer, that [the] proposal is supported by the conclusions of the Joint Board and that the ISO-NE's Internal Market Monitoring Unit and Independent Market Monitoring Unit each determined a three month lag to be reasonable…" The Commission found that ISO-NE had not provided adequate information to determine that the proposed tariff revision is just and reasonable and not unduly discriminatory or preferential, and stated that "there [was] insufficient basis in the record to address the arguments raised by [a number of intervening generators] that a shorter lag may increase opportunities for inappropriate strategic market behavior."

- **NYISO** had once combined zonal load data for zones J and K (New York City and Long Island) due to concerns by a market participant that load data for its zone was commercially sensitive. The concerns disappeared over time, and NYISO began to publish load data for the zones individually.

Generally, respondents expressed the belief that more information is better, the onus to demonstrate otherwise has often fallen on those seeking to limit data release.

In Ontario, the dominant market position of Ontario Power Generation (OPG) — as well as concerns for the potential for collusion — was cited as the reason why bidding information is not disclosed. OPG may also have resisted releasing dispatch information, which initially was published with a six-month lag, though that has since been shortened to a one-hour lag for large generators.

New Zealand has been cautious in weighing the transparency benefits of information disclosure against the potential harm of facilitating collusion or other uncompetitive behavior. A two-week delay period was seen as striking the right balance for publication of reserve market bids (matching the release of energy market bids).

The aspect of data posting that was anticipated to be most controversial centered on the release of participants' bid and offer information. The surveys and interviews bore out that across the various markets, there is great diversity in the levels of detail and identity obfuscation, the restrictions on access, and the timing of the release of bidding information. What was not expected is the relative lack of rationale for the different bidding information release policies that are observed. The majority of the existing data posting practices related to bidding information have been in place, largely unchanged, since the inception of each market. Very few of the markets have revisited the issue of bidding information release and its importance to competitive behavior, and when they have done so, the specific practices chosen were not the result of any kind of rigorous economic analysis, if such were even possible.

In addition to there being a limited number of instances in which market operators have sought to expand the publication of bidding data, there were also few instances in which the posted data were reduced, and these were for the most part due to market design changes. In Alberta, for example, a restructuring of the market institutions a few years ago prompted a proposal to cease publication of aggregate offer information after the market closed. This was widely opposed and the proposal was ultimately abandoned. Part of the sentiment, according to the Market Surveillance Administrator, was that this information would then be known to a few market participants.[10] Equal access to information was ultimately retained, as this

[10] For example, some participants would have significant information by virtue of owning a large fraction of the assets in the market. Additionally, there are commercial information vendors who can install field measurement devices to monitor line loadings at generator substations, and thereby infer the dispatch level of the plants.

principle was seen as an important element of making markets “fair, efficient, and openly competitive.”

CAISO reports to have had no pressure to improve the masking of participants’ bids, which are posted but with the identity of the bidder and each generating unit replaced by pseudo-IDs. The pseudo-IDs have not been difficult to decode, effectively providing complete or nearly complete bidding information to the public. CAISO has not been asked to adopt more complex masking practices, indicating that disclosure of bids is not considered damaging by participants.

Alberta used to post a real-time graphic display of the supply stack and demand, allowing everyone to see how close conditions were to steep sections of the supply curve. While this graph is no longer posted, much of the necessary information continues to be available, including real-time plant availability and output, as well as real-time demand. When coupled with prior-hour supply curve information, the Alberta MSA readily acknowledges that most participants have a good idea of what the supply conditions are in real-time. Nevertheless, neither the Market Surveillance Administrator nor the market operator believes the information undermines competition. By posting the information, the Alberta market operator gives equal access to information that would otherwise be known only to certain participants. Real-time output information, for example, is often supplied by commercial information vendors such as Genscape. Due to its significant cost, this information would be available only to some participants. Indeed, the high cost of the information makes it possible that it would be purchased only by those entities able to exploit the information. Prior-hour offer information is something only the market operator could provide. However, due to the concentrated ownership of physical generating assets, some market participants would have significantly more offer information than others. In other words, it is not merely a question about *whether* this information is known or not, but rather whether it is known to *all* participants, or just a select few. Additionally, Alberta’s market rules have evolved to limit the ability of generators to modify their offers close to real time. This restricts their ability to exploit real-time market information.

It should also be noted that Alberta has relatively high levels of price-responsive load (approximately 3%-4% of peak demand), perhaps providing additional confidence that attempts to exploit operational information will be disciplined by consumers as well as by other suppliers.

5. A FRAMEWORK FOR EVALUATING DATA RELEASE PRACTICES

Given the results of CRA's survey of data release practices in other markets, in this section we turn to how this information can be used to inform development of PJM's own practices. Specifically, it is important to determine the relevance of other markets' experience to PJM, together with the guidance provided by economic theory on the role of information in promoting competitive behavior.

In this section, we address the following topics:

- economic literature on the role of information;
- evaluating policies in other electricity markets; and
- tailoring information to policy objectives.

5.1. DATA RELEASE AND ECONOMIC THEORY

There is substantial economic literature on the role of information in markets. There are two broad themes that are relevant to the issue of data posting practices in electricity markets. The first is the role of information in promoting efficient outcomes. The second is the role of information in enabling uncompetitive and hence less efficient outcomes.

5.1.1. Information and Economic Efficiency

The concept of economic efficiency entails three broad dimensions:

- **Productive efficiency** is achieved when production is done at least cost.
- **Allocative efficiency** is achieved when a product is consumed by those who value it the most.
- **Dynamic efficiency** involves optimal investment over time. That is, do opportunities exist for investments to be made that yield normal (vs. above or below normal) returns to the investor?

Productive and allocative efficiency are short-run concepts, dealing with the use of existing resources. At any given price, productive efficiency requires that all producers with a marginal cost below that price actually produce, and that all consumers who value the product at above its marginal cost actually consume it.

Dynamic efficiency is a longer-term concept, as it deals with whether the capital stock of production and consumption adapt properly over time to realize the maximum returns. There

can be both inefficient *over*-investment (e.g., investments that yield a below-normal return for the risk entailed) as well as inefficient under-investment (e.g., a failure to undertake investments that would have yielded normal or above-normal returns).

Information plays a strong role in promoting both short-run and long-run efficiency. For example, the dynamic constraints on thermal generating plants mean that the decision to start a unit depends on prices over several hours, or even over several days. It is not sufficient to know the price in the current hour only; start-up decisions will depend on the expectation of prices over a given planning horizon. Information on transmission availability, generation availability, fuel prices, and forecast load are all necessary inputs to developing those expectations. PJM operates as a centralized processor of virtually all information about the system in the short run, and its scheduling and commitment programs use a large amount of information in deciding how to operate the system at lowest cost subject to security constraints, using supply offers and other necessary input data. Centralized markets can promote productive efficiency by synthesizing available information on behalf of participants. Market participants do not need a lot of information to create efficient operating schedules: ideally, the market does it for them. The extent to which productive efficiency is actually achieved depends on the accuracy of the bid, offer, and operational information provided by market participants, market participants' ability to represent their costs and constraints through the information they provide, and the ability of the decision algorithms to model and achieve the operating objectives of the participants.

While the ability to participate in a centralized market may support efficient short-run decisions, participants must still have sufficient information to develop expectations over other time horizons. This is necessary for participation in forward markets for energy or transmission rights, as the value of the forward contracts is dependent on future spot prices. Efficient forward markets therefore require that participants have information that is relevant to future spot prices. If market participants face information costs or have incomplete information they may have trouble forming efficient expectations of prices. This will, in turn, lead to allocative inefficiency in forward prices, which — in cases where final consumer prices are based on forward prices — are as important as or more important than final spot prices. For example, in New Jersey and some other PJM states, rates paid by certain retail consumers are set using an auction. The prices bid in the auction by suppliers will be determined by the expected future spot prices at the time of delivery. If these expectations are inefficient, then so will final consumer prices, leading to allocative inefficiency.

Information release is also likely to be a determining factor in achieving dynamic efficiency. Investors need to have a great deal of information in order to assess investments, whose returns will ultimately be determined by LMP payoffs. Do potential investors have all of the information they need to form efficient long-term expectations of LMPs and forward capacity prices?

5.1.2. Information and Market Power

One characteristic of an idealized "efficient market" is that there should be perfect and costless information: all market participants should know everything that is possible to be known about the future. Does increasing the amount of information release, therefore, *always* improve market efficiency?

As a theoretical matter, the answer, sometimes, is *no.* In the short term, increasing the amount of information released could in some cases increase the scope for uncompetitive behavior. This concern has been raised and considered in a few of the markets surveyed.

The concern is easy to understand: the more that sellers know about how their own production decisions will affect the market price, the more easily they can pursue an objective of individual profit maximization. Preventing sellers from developing this knowledge would therefore appear to hinder deviations from competitive behavior, or at least make them more risky. Of course, under conditions of perfect competition, there is no ability for an individual producer to affect the market price. This leads to an important conclusion: the potential for information to hinder competition depends, at least in part, on the underlying competitiveness of the specific market under consideration.

A second important factor to consider is that information provided by a market operator is only one source of information available to participants. Each participant obviously has information about its own resources. Information about other participants can also be inferred, either from fundamental characteristics (e.g., type of generating facility, age, or location) or from the observed behavior in the past. Finally, there are additional sources of information available to participants. This can include regulatory filings made when a facility was subject to regulation; sale documents for a facility that was sold in a divestiture process; environmental monitoring and compliance programs; and commercial information vendors. Concerns about the competitive effects of data release must therefore consider what information is already available, or potentially available, to participants.

The logical consequence is that the impact of data disclosure on competitive behavior depends critically on (a) the specific *unique* information to be disclosed; (b) the underlying competitiveness of the market; and (c) whether the information can facilitate uncompetitive outcomes.

5.1.3. Guidance from Economic Literature

Our review of economic literature did not reveal any published research specifically on the topic of information disclosure and competitiveness in electricity markets.[11] There is, however, substantial material dealing with this topic in general and theoretical terms. The broad conclusions from this research are:

[11] *See* Section 7, *Recommended Reading*.

- Information on aggregate prices, aggregate output and overall demand levels has a "small negative effect (if any)" on social welfare;
- Information on the specific output quantities and prices of individual market participants has a "strong negative effect" on welfare; and
- Private communication regarding future plans has a "strong negative effect" on welfare.[12]

These broad guidelines indicate that information on overall market conditions — market clearing prices, total quantities, etc. — carry a lower risk of facilitating uncompetitive behavior than information that reveals the specific actions of an individual firm.

5.2. MAKING VALID CROSS-MARKET COMPARISONS

While economic theory can identify the potential for information disclosure to hinder, rather than promote, competitive behavior, it cannot determine with specificity the *amount* of information or the *timeliness* of release that may be considered "safe" in a given market. Likewise, none of the markets studied in our survey — individually or collectively — can be considered a controlled experiment from which we can establish a clear relationship between information disclosure and overall levels of competitiveness.

Nevertheless, there is value to knowing whether PJM's practices are in the middle, back or front of the pack relative to other markets. To the extent that other markets have taken a more aggressive approach to information disclosure and have thus far not suffered the competitive harm that theory suggests is possible, this may be evidence that PJM could also adopt more aggressive information releases with limited risk of harming competition. Further examination is necessary, however, to establish whether the lessons from other markets can reasonably be expected to apply to PJM.

For example, the Colombian practice of posting generator offer data the morning after the day-ahead market closes should not be immediately regarded as assurance that prompt offer posting can be implemented in other markets with no ill effects. First, the dominance of hydro resources in the Colombian generation sector stands in stark contrast to PJM's predominantly thermal system. Second, there is significant involvement of municipal and federal governments in the Colombian generation sector, primarily through operation of the major reservoirs as well as some generating stations. Both of these factors indicate that generators' willingness or ability to exploit current information in Colombia may be very different from that in PJM.

12 *See* Nitsche, Rainier and von Hinten-Reed, Nils, "Competitive Impacts of Information Exchange," Charles River Associates, June 2004, p. 6.

Additionally, as we describe in Section 4.3, some U.S. markets have enacted or proposed new rules increasing the level of information disclosed to market participants. In ERCOT, for example, the new rules have only recently been implemented; therefore little direct experience with market conduct under the new rules exists. Nevertheless, we reviewed public analyses of the market structures in other markets to investigate whether policy makers there faced competitive concerns similar to those in PJM.

PJM's 2006 *State of the Market Repor*t indicates that PJM, as a whole, is not highly concentrated, and that offer-capping (due to failing the three pivotal supplier test in the market overall) is relatively rare.[13] ERCOT's 2005 *State of the Market Report*, however, reveals a market characterized by having a single pivotal supplier in the majority of hours.[14] This does not appear to be a concern raised in PJM's *State of the Market* report.

The *Annual Markets Report* for ISO-NE indicates that, as in PJM, market-wide measures of concentration or single pivotal supplier tests do not indicate significant market power concerns.[15] The daily HHI averaged 700, and never exceeded 800. Additionally, according to the report, there were only 311 hours in which a supplier was pivotal in the ISO-NE market during 2005. Other metrics, including estimates of markup over costs, also support the conclusion that the market is generally competitive, though sub-zones show higher concentration levels.[16]

The *State of the Market Report* for MISO (whose posting practices are similar to those of PJM in many respects) also shows relatively few hours of pivotal supply when evaluated in aggregate. Like PJM, it does report a higher incidence of local pivotal supplier in its sub-markets, as well as in its so-called "broad constrained" areas. MISO reports that the Wisconsin Upper Michigan System (WUMS) sub-market, for example, has a pivotal supplier in 80% of hours in which load exceeds 60 GW (75 percent of hours); the East and West regions have pivotal suppliers in about 20% of hours. Also, the majority of constraints, in the majority of hours, reportedly had pivotal suppliers in terms of needing at least some participation by a supplier to relieve the constraint.[17]

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[13] See 2006 *State of the Market Report* at pages 39 (for concentration) and 41 (for offer capping).

[14] See *ERCOT 2005 State of the Market Report* at page 141.

[15] See *2005 Annual Markets Report* for ISO-NE, pages 120-121 (for HHI values); pages 124-125 (for pivotal supplier analysis); and pages 125-126 (for price benchmark analyses).

[16] These values should be regarded with caution, as the text of the report suggests that imports from other load zones or from outside ISO-NE are ignored in calculating the zonal HHI. See page 120, regarding Vermont's high HHI values.

[17] See *2005 State of the Market Report, the Midwest ISO* at pages 73-92.

PJM's annual market report is the only one to include a metric of whether a multi-firm group of suppliers would be pivotal if they acted in concert. The lack of a similar metric prevents any inferences to be drawn as to whether multi-firm coordination was explicitly considered in developing the data posting proposals of MISO or ISO-NE.

We have not found detailed metrics for markets outside the United States. We are therefore unable to conclude whether the more aggressive data release practices implemented in other markets were founded on market characteristics applicable to PJM.

An additional consideration in making cross-market comparisons is that of causality. Assuming a market was found to have more aggressive data posting as well as being regarded as "more competitive" than PJM, it is not necessarily the case that more aggressive data posting was the reason for the improved outcomes. Indeed, it may be that the more aggressive data postings are appropriate only because the market is more competitive in the first place.

In summary, our survey of other electricity markets indicates a range of data posting practices, but does not by itself reveal why — or even whether — those practices are considered optimal for each market. More importantly, the survey does not reveal whether policymakers would have adopted those same practices if market conditions were like those in PJM. Our review of public analyses shows that some markets are fundamentally different from PJM, whereas others appear to offer closer analogs. None of the public analyses allow us to address the specific question of whether other markets have a greater or lesser potential for profitable coordinated multi-firm behavior. Consequently, additional independent analysis is necessary to determine whether the structures in other markets are sufficiently similar to those in PJM to conclude that the experience of those other markets may be relevant to PJM.

5.3. DATA RELEASE AND POLICY OBJECTIVES

In the course of our study and interviews, respondents cited a general preference for providing more market information rather than less. This is generally a well-supported notion, as information promotes transparency, confidence in market institutions and processes, and enables all interested parties to analyze, comment on and challenge all aspects of market operations and behavior by participants.

Somewhat surprisingly, however, there was little nuance to the broad commitment to "more information." Consider, for example, the policy objective of shoring up confidence in the centralized dispatch decisions. The information likely to promote this goal would be a very detailed level of data permitting interested parties to replicate the decisions made in light of the information available. This information would include, for example, a network model, information on available transmission, information on expected load (including the assumed spatial distribution of it), and resource-specific information on dynamic constraints, unit availability, start-up conditions as well as offers. This granular information, however, need not be recent nor does it need to be provided for a long span of time. Providing the detailed

information for a select number of hours representing a range of different conditions, and which was sufficiently old to be no longer sensitive would likely suffice to allow market participants to carry out extensive testing on their own.

This stands in contrast to information released in markets seeking to make offer behavior transparent. The detailed level of information on demand or transmission availability is likely to be less important, especially if this information was not known to market participants at the time the bids or offers were submitted. Additionally, information is not limited to a few hours, as behavior in all hours is important, and data over spans of time are needed to permit identification of deviations from prior patterns. Furthermore, prompt release of data is cited as necessary to allow prompt challenges to be raised and competitive responses to be developed.[18]

The information to be released is highly dependent on the underlying policy goal to be pursued. Modifications to data posting practices should therefore begin with a clear identification of the problem to be addressed through the modification.

5.3.1. Privacy Considerations

The publication of additional information on market operations will inevitably entail the dissemination of information previously known only to certain parties. This will likely provoke significant opposition, for at least three reasons. First, the holder of private information may perceive the information to confer a competitive advantage in the market. Second, the holder of the private information may have made a significant investment to develop the information, and may find the value of the investment diluted by the broad (and free) dissemination of the information. Third, the holder of the private information may perceive that the information is excessively revealing of its own business strategy, costs, or capabilities. There is likely significant overlap among these categories, as they are not mutually exclusive.

Such arguments are not entirely without merit. Information on generator offers, for instance, essentially reveals the lowest price a seller was willing to accept for its energy production. This can undermine negotiating positions in bilateral transactions. After all, there is no disclosure of information contemplated regarding the maximum price a buyer is willing to pay for energy (unless the buyer bids explicitly in the spot markets, which most load does not). Information on generation outages may similarly be said to undermine a generator's efforts to procure replacement power, since potential sellers will know the generator is in a short position.

These arguments cannot simply be disregarded. First, they will inevitably arise in any stakeholder or regulatory proceeding seeking to modify the current data posting practices. Second, any market participant who feels that additional disclosure is, in fact, harmful will

[18] "Publication of reserve offers," Electricity Commission Consultation Paper, New Zealand Electricity Commission, 30 November 2006, p. 13.

have additional incentive to avoid participating in the markets that lead to the disclosure of concern. For example, generators may elect to rely increasingly on self-commitment rather than provide the detailed — but disclosable — information needed to achieve optimum centralized unit commitment. What is to be gained from efficiency may be sacrificed for privacy.

6. CONCLUSIONS AND RECOMMENDATIONS

Our study of centrally-dispatched electricity markets around the world revealed a wide diversity in the practices employed by market operators and administrators to release system and market data to market participants and other stakeholders. Some of this diversity stems from the variety in market design and structure across the various markets, some of it is a result of differing philosophies or perspectives on the part of stakeholders and rule makers, and some of the diversity is simply due to differences among sets of legacy market rules that are vestiges of original designs created before anyone had much practical experience operating these sorts of markets.

Generally, our findings show that the release of data by PJM exceeds that of many of the other markets we examined in this study, and is generally on a par with comparable markets in the U.S. It is more useful to look at PJM's practices with respect to specific categories of data and compare the manner in which those data are released relative to that of the other markets we studied. Those comparisons are made in Section 4 of this report, in which we compare the nature and timeliness of PJM's data release to that of the other markets similar enough in design to make such comparisons meaningful.

6.1. CHARACTERIZATION OF RECOMMENDATIONS

Among PJM's objectives in commissioning this study were to learn about the state of the art in data release by similar markets, and to examine whether experience elsewhere and application of relevant principles of economics could be used to guide decisions as to how to modify PJM's data release practices.

At one level, none of the markets surveyed can be said to perform substantially better as a result of their approach to information release. While the interviews revealed broad support for more information being released rather than less, none attributed competitive outcomes primarily to the information available in the market. To the contrary, few if any of the markets had evaluated information disclosure explicitly for its effects on competition or market efficiency. In other words, this study cannot conclude that PJM's current data posting practices are lagging behind industry practice, and are suffering a loss of efficiency or competitiveness as a result. Maintaining the status quo would therefore not be unreasonable if one were guided solely by the current experience in other markets.

Even though the status quo is not necessarily inefficient, the survey also shows that other markets do provide more information than PJM and do not appear to suffer from

uncompetitive behavior. Of course, one cannot simply assume that experience in other markets will be readily applicable to PJM, or that practices found to be appropriate elsewhere will necessarily be appropriate in PJM. A review of published analyses suggests that ISO-NE and MISO may offer the most relevant comparisons with PJM, based on the broad market metrics common to the types of analyses generally undertaken in "state of the market" reports. Further independent analysis is necessary before concluding that these are truly valid analogues, as the public reports available to us do not use consistent methodologies across the markets, and offer varying approaches to evaluating market structures below the aggregate (i.e., market-wide) level. To the extent that (a) further analyses indicate comparable market structures and comparable competitiveness concerns; and (b) analysis of actual experience in these markets indicates that the additional information is not harming competition or efficiency, the experience in these markets could be considered meaningful and applicable to PJM. We would regard emulation of the data release practices in such other, relevant markets — assuming no indication of inefficiency due to the information release practices — as a moderate strategy.

While a moderate strategy is based on emulating the relevant "best practice," information disclosure that goes beyond current practice would necessarily be considered an aggressive approach. First, whether specific information (released with a given time lag in relation to market operation) can be exploited to the detriment of market efficiency is largely an empirical question. Theory cannot determine, for example, whether the proper lag time for release of offer information is one month rather than six months. Second, adopting an experimental approach to testing the adequacy of increased information requires that the market operator be able to identify whether the potential harmful effects are, in fact, occurring. Given that most market monitoring efforts have focused on the behavior of single firms acting independently, the ability to evaluate the competitive impacts of increased information disclosure may be limited at present. Finally, the ability to detect harmful consequences would need to be complemented by the ability to measure the benefits of the additional information.

6.2. SPECIFIC RECOMMENDATIONS

As part of this assignment, PJM requested that we recommend alternatives to its current data release practices. Although we present the following options for consideration by PJM, we emphasize that our review of publicly available analyses — as well as our discussions with the respondent organizations — is insufficient to support a recommendation that PJM modify its current data release practices or adopt any of the specific alternatives presented.

In Section 4.2, we analyzed the respondent markets' data release practices by comparing them to each other along the following three dimensions: general concept (e.g., offers, generator operation, etc.), specification (specific data element(s), degree and manner of aggregation, degree of obfuscation, etc.), and timeliness of posting. The space of existing practice, then, is defined by the extent we observe along each of these three dimensions. By constructing alternatives for increasing PJM's data release within the range of each parameter, using PJM's current practice as a basepoint from which data release might be

modified, we can then develop a number of alternatives for consideration by PJM management and stakeholders.

With regard to the first of these dimensions — general concept — we have selected and addressed five areas in the subsections that follow: generator offer data, demand bid data, generator operational data, load data, and transmission data.

6.2.1. Spot Market Supply Offer Data

To recap, the range of practice with regard to the release of spot market supply offer data is shown in Table 5. Relative to the rest of the field (of markets that publish these data at all), PJM's current approach is among the more conservative.

An aggressive alternative would be to reveal all offers, by unit, on a time lag equal to the shortest we have seen in the applicable markets, in this case Australia and Colombia, both of which publish such data within one day.

A less aggressive variant (yet still more aggressive than PJM's current practice) would be to shorten the six-month lag for detailed unit-specific data, but to provide less specific data on an even quicker timeline. This might be identification of the marginal unit(s) upon market closing (similar to the practice newly adopted by ERCOT), and/or posting some kind of aggregate supply curve (tricky in a nodal system, but doable since this is only meant to be informative). A middle ground may be to move to a 30- to 60-day lag for full bid postings, yet retain the current masking practice.

6.2.2. Spot Market Demand Bid Data

Table 6 shows the range of practice we observed for spot market demand bid data. As the table shows, PJM's practice in this area is among the most conservative we observed, excluding those markets that publish no demand bid data at all.

An aggressive change to PJM's current approach would be to reveal all demand bids, by bidder name, on a time lag equal to the shortest we have seen in the applicable markets, in this case ERCOT, which publishes such data after 30 days.

A less aggressive approach would be to reduce the six-month lag for detailed load-specific data, but to provide less specific data on a quicker timeline, e.g., posting some kind of aggregate demand curve. A middle ground may be to move to a 30- to 60-day lag for full bid postings, yet employ the same masking practice PJM uses for supply offers and virtual bids and offers.

6.2.3. Generator Operational Data

Table 7 shows the range of practice with regard to the release of generation operational data. As the table shows, PJM's current approach is the most conservative of those observed, excluding those markets that publish no data at all in this area.

An aggressive increase in PJM's release of generator operational data would be to reveal unit-specific commitment, schedule, dispatch, and actual output, as is done by Australia, along with actual and forecast outages, as is done by Nord Pool, and within one hour, as is done by IESO.

A less aggressive approach would be to emulate NYISO by providing masked, unit-specific unit commitment data and operational parameters, perhaps with a 180-day lag like that of NYISO, or a shorter one. An approach somewhere in the middle might be to emulate AESO by publishing unidentified (even by pseudo-ID) unit commitment and schedule data, and unit-specific outage data with identities, but with a 30- to 60-day lag.

6.2.4. Load Data

Table 8 displays the range of practice with regard to load data. As the table shows, PJM's current practice is among the more conservative in three ways. First, load data by zone are not made available until as late as two weeks or more after the fact, whereas other eastern U.S. markets publish these data with considerably less delay. Second, PJM disaggregates load forecasts only to the control area level, rather than the load zone level.[19] Third, PJM does not publish load scheduled in the day-ahead market at all.

An aggressive alternative approach would be to adopt ERCOT's practice, and also include CAISO's practice of publishing forecast pumped storage loads. A less aggressive approach would be to adopt the practice used by ISO-NE and NYISO: providing load and forecasts at the zonal or EDC level.

6.2.5. Transmission Data

As we discussed in Section 4.2.4, PJM's current transmission data posting practice is as extensive as any we observed. As we noted in the discussion of our findings, however, an exception to this characterization is that unlike some other markets, PJM posts flows for only a subset of the major monitored interfaces within its control area. PJM could therefore increase its data release in this area by posting flow data for more interfaces. Additionally, we know from experience and prior discussions with PJM staff that PJM's thermal operating limits for voltage- or stability-limited interfaces change in real time based the results of studies conducted by operations staff, but that these changing limits are not posted. Posting

[19] PJM's load forecasts do go out seven days, however, which is longer than most.

changes to operating limits in real time is another way for PJM to increase transparency in this area.

Table 11. Summary of Potential Modifications to Practice

Type of Data	Potential Modifications to Practice (more transparent)		
	Option A	Option B	Option C
Generator Offer and Demand Bid Data	Reduce 6-month lag for existing data; provide less specific data sooner	Post bids and offers after 30 to 60 days; retain masking	Post bids and offers by name within one day
Generator Operational Data	Post masked unit-specific commitment data / operational parameters after 180 days or less	Post masked unit commitment and schedule data and unmasked unit-specific outage data after 30 to 60 days	Post unmasked unit-specific commitment, schedule, dispatch, actual output, actual and forecast outages within one hour
Load Data		Post forecast, scheduled, and actual load by EDC in real time	Post scheduled load by LSE in real time
Transmission Data		Post flow data for more interfaces	Post real time operating limits; post flow data for more interfaces

7. RECOMMENDED READING

Our review of the economic literature on information disclosure and competitiveness included the following sources.

European Federation of Energy Traders, "Transparency of information about the availability and use of infrastructure and the promotion of competition in European wholesale power markets." EFET updated position, May 2006. www.efet.org.

Newbery, David, "Towards more transparency in the Dutch electricity sector." Memo on behalf of the Dutch Market Surveillance Committee to DTe, 25 October 2001.

Nitsche, Rainier and von Hinten-Reed, Nils, "Competitive Impacts of Information Exchange," Charles River Associates, June 2004.

Vives, Xavier, “Information Sharing: Economics and Antitrust.” Occasional Paper No. OP 07/11, IESE Business School, University of Navarra, January 2007.

Vives, Xavier, “Information Sharing Among Firms” Occasional Paper No. OP 07/3, IESE Business School, University of Navarra, October 2006.

APPENDIX A. RESPONDENT ORGANIZATIONS AND INDIVIDUALS

CRA would like to thank, in addition to the staff of PJM, the following organizations and individuals for their cooperation in performing this study.

Table 12. Respondent Organizations and Individuals

Market	Location	Interviewee	Title	Organization
Alberta Electric System Operator (AESO)	Alberta	Mike Nozdryn-Plotnicki	Manager, Market Monitoring	Market Surveillance Administrator
		Colleen Fairhead	Senior Market Analyst	AESO
California Independent System Operator (CAISO)	California	Darren Lamb	Senior Market Design Specialist	CAISO
Electric Reliability Council of Texas (ERCOT)	Texas	Matt Mereness	Technical Specialist, ERCOT Market Operations Support	ERCOT
Independent Electricity System Operator (IESO)	Ontario	Peter Lafoyiannis	Supervisor, Market Information Services	IESO
ISO New England (ISO-NE)	New England	Janine Dombrowski	Manager, Emerging Markets, Market Monitoring	ISO-NE
Midwest ISO (MISO)	Midwest US	Deepal Rodrigo	Engineer	MISO
National Electricity Market (NEM)	Australia	Murray Chapman	Head of Strategic Projects	National Electricity Market Management Company (NEMMCO)
New Zealand Electricity Market	New Zealand	Tim Street	Senior Advisor, Wholesale	New Zealand Electricity Commission
New York Independent System Operator (NYISO)	New York	Michael Martin	Manager, Energy Market Products	NYISO

Market	Location	Interviewee	Title	Organization
National Electricity Market of Singapore (NEMS)	Singapore	Luke Peacocke	Corporate Analyst	Energy Market Company (EMC)
		Paul Poh	Head of Market Administration	EMC
Nord Pool	Scandinavia	Micke Hovmoller	Head of Market Data Services	Nord Pool
Mercado de Energia Mayorista (MEM)	Colombia	Monica Jurado	Information Management Specialist	XM