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DOE
GEM-SET
Government
Energy
Market
Segment
Evaluation
Tool

Final Report

GEMSET Regional Segmentation Analysis:

Characterization of the PJM Region

DRAFT

June 2001

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The United States Department of Energy
National Energy Technology Laboratory

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NOTICE

Summary

PJM Interconnection, LLC. (PJM) is the largest centrally dispatched electric control area in North America, and the third largest in the world. Only the control regions of the country of France and those for Tokyo Electric in Japan dispatch more megawatts of electric generation. Established in 1927, PJM today handles the dispatch of over 56,000 megawatts of electric capacity, controlling the generation of 535 units serving areas located mostly in Pennsylvania, New Jersey, Maryland, and parts of Virginia, Delaware, and the District of Columbia.

This is a report about how electric power is sold. It describes the competitive electric market in PJM's territory. The report discusses the responsibilities of PJM, which is that region's independent system operator (ISO). As ISO, PJM is responsible for that region's electric integrity, unit dispatch and reliability, and administering the pricing mechanisms for delivery of all power.

With the implementation of the PJM Open Access Transmission Tariff on April 1, 1997, PJM began operating the nation's first regional bid-based energy market. PJM enables participants to buy and sell energy, schedule bilateral electric sale transactions, and reserve transmission service. PJM provides the accounting and billing services for these transactions. PJM's operations are a model for many other regions contemplating —or recently converted to— bid-based electric market operations.

This report describes how PJM operates now, and includes PJM's conjecture about how load might grow, and be met by planned construction.

This report is one of a series describing the market conditions that exist, and that are forecast as part of the Department of Energy's (DOE) government energy market segment evaluation tool (GEMSET) project. Others in the series describe other regions.

GEMSET forecasts for PJM and other areas will be presented in future reports in the series, where the GEMSET evaluation team makes reasoned conjecture of what might occur in the electric power market in this region in the future under a range of possible future energy price and economic circumstances.

Based on an hour by hour evaluation of the fiscal year October 1999 – September 2000, the average price of electricity in the region was $ 24.42/MWh (May 2000 to April 2001= $ 33.27/MWh). However, this average price does not indicate all of the important circumstances for competitive electric sales. There were also peak periods totaling only 49 hours in the year, where the market price peaked above $ 100.00/MWh (333 hours for year ending April 2001). While these few brief excursions in peak price represent a relatively small fraction of the year, these same price peaks sometimes result in very significant financial aspects to energy suppliers and consumers. In this time frame, these peaks resulted in a total of only $ 0.80/MWh influence on that average price. In previous years, it had a greater influence on the overall price indicator for potential suppliers.

This report includes the following discussions:

- Section 1 describes the PJM region.

- Section 2 describes the energy prices throughout the most recent year, with histograms that characterize the price duration persistence in the region. This is the region's historical demand and price data, with information about energy prices, generation mix, and baseload and peaking demand.

- Section 3 discusses how generation is managed and paid for within the region.

- PJM is required to provide open access to its transmission grid by FERC Order 888. While any qualified company can add generation, the process is not automatic. Rather, a sequence of approvals is needed before new generation can be added. PJM's procedures for this approval are summarized in Section 4.

- Finally, Section 5 gives PJM's forecasts and projections on demand growth, and on the capacity additions that are committed in the region. Other reports in this GEMSET series then analyze these PJM forecasts, and assess them in the context of several future scenarios of factors influencing demand, generation mix, and price.

These data are dynamic, and what is reported here represents only a "snapshot" of information that existed a month prior to this report's issue date, November 2000. Periodically, the PJM region will be revisited, and this report revised as time moves on.

The reader should check with the DOE project manager, Patricia Rawls, to see if there is a more recent issue of this report, or to discuss any related information that might be available about the region, or about the GEMSET project data.

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You are reading Revision 1 of this report, issued in November 2000.

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ACKNOWLEDGMENTS

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PI&T = Parsons Infrastructure & Technology Group Inc.

Abbreviations and Acronyms

Term	Meaning
COE (meaning 1)	in economic sections: the cost of electricity, the levelized busbar cost of electric production including amortized capital, operating, and maintenance costs
combustion turbine, CT	a synonym for gas turbine, used interchangeably
DOE	United States Department of Energy
EFORd	demand equivalent forced outage rate
eGADS	electronic generator availability data system; an electronic data system allowing the posting of data regarding a generating unit's availability record
EIA	the Energy Information Administration of the DOE
EPRI	the Electric Power Research Institute
EPA	U.S. Environmental Protection Agency
FERC	Federal Energy Regulatory Commission
FGD	flue gas desulfurization, a sulfur emission control device
GADS	generator availability data system; see "eGADS"
gas turbine, GT	a synonym for combustion turbine, used interchangeably
GEMSET	government energy market segment evaluation tool
GNP	gross national product
GT	gas turbine (a synonym for combustion turbine)
GTCC	natural gas fueled gas turbine combined cycle
HHV	higher heating value of a fuel including the heat released if all of the water vapor in the combustion products were condensed
IPP	an independent power producer, an unregulated electric generating company
IRP	integrated resource plan
ISO	independent system operator; a regulated body that dispatches all competitive electric generation on the high voltage transmission grid within its service region; they operate the grind, administer the power pools power transfers, select the lower cost generation bid into the pool according to the pool's

operating rules, and maintains the integrity of the electric transmission grid

LCC......................................local control center

LHV......................................lower heating value of a fuel, the heat released if all of the water vapor in the combustion products remained as steam

LMP......................................locational marginal price

MAAC..................................Mid-Atlantic Area Council, a reliability council

MCR.....................................maximum continuous rating

MVA.....................................megavolt amperes

MVAR..................................megavolt-ampere-reactive

MWe.....................................electrical megawatts

MWth...................................thermal megawatts

NETL....................................the U.S. Department of Energy's National Energy Technology Laboratory

NOPR...................................notice of proposed rulemaking

NOx......................................nitrogen oxides, types of air pollutant, mainly NO and NO_2

....non-utility generator, a competitive, unregulated independent electric power producer

OTAG...................................Ozone Transport Assessment Group

OTR.....................................Northeast Ozone Transport Region

Parsons I&T, PI&T............Parsons Infrastructure & Technology Group Inc., a global business unit of Parsons Corporation, an engineering/ construction company; part of the DOE team that prepared this report

PCD......................................particulate emission control device

P.E.......................................licensed professional engineer

PJM......................................Pennsylvania, New Jersey, Maryland, or PJM Interconnection LLC, an ISO.

PSC......................................local state Public Service Commission

RACT...................................reasonably available control technology (pollution control)

RMCP...................................regulation market clearing price

RTO......................................regional transmission owner

SOx......................................sulfur oxides, types of air pollutant, mainly SO_2

VAR......................................volt-ampere-reactive

1. PJM Region

This section discusses the Pennsylvania, New Jersey, Maryland regional segmentation used in the DOE GEMSET market analysis model. This region is served by a single ISO. PJM is one of the best examples of a region operating as a competitive electric market, and is significantly different from other regions, particularly those still using a regulated utility operations environment, where new generation options are approved by a commission or regulatory body. Instead, under a competitive market like that in PJM, new generation is at more of a risk than a regulated market. New generation here is met by investors seeking profit due to sale price opportunities, and their perception of persistence of electric sales price in the region remaining sufficiently above their production costs to prove profitable.

In the PJM region, most of the electric sales are pre-arranged by bilateral agreements, with the rest sold on the day-ahead or hour-ahead markets, which provide the market signals that guide and limit the value of the private bilateral sales.

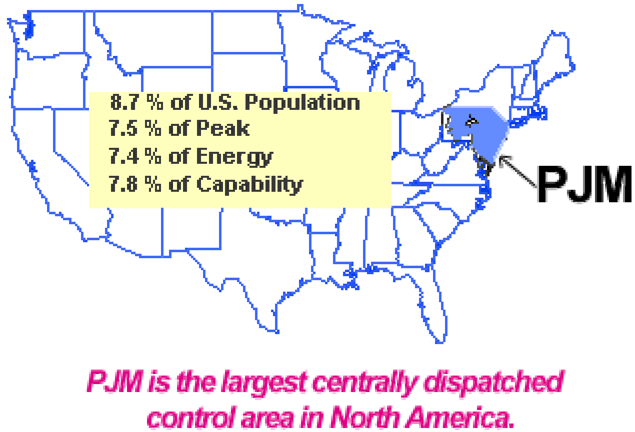
1.1 The Independent System Operator: PJM Interconnection

The Pennsylvania, New Jersey and Maryland (PJM) region's electric power is dispatched competitively. The independent system operator (ISO) for this region is PJM Interconnection, LLC. In addition to generation provided by the local distribution company, which had generation resources, and bilateral agreements for generation between a supplier and a generator, approximately 15 percent of the total requirements for electric power is done on the basis of spot market purchases.

1.2 Territory

PJM Interconnection is responsible for the day-to-day operation of the largest centrally dispatched electric system in North America, Exhibit 1-1.

Exhibit 1-1
The PJM Region



picture courtesy of PJM

The PJM service area includes all or part of:

- Pennsylvania,
- New Jersey,
- Maryland,
- Delaware,
- Virginia and the District of Columbia.

Six state and district regulatory commissions and the Federal Energy Regulatory Commission (FERC) have jurisdiction within the PJM control area. With over 170 members including every segment of the electric power industry, PJM characterizes its market as one of the most liquid and active energy markets in the country.

1.3 PJM's Responsibilities

All ISOs have the principal responsibility for the safe and reliable operation of the transmission system. Even though electric generation is competitive within a region, an ISO is not competitive. An ISO operates as a monopoly, controlling all of the generation within a region, and correctly so. Operating for the public good means an ISO is a regulated entity. As regulated entities, they are charged with ensuring the fair and reliable supply of energy from generating resources to wholesale customers.

Since the PJM region is a competitive electric market, PJM Interconnection also is charged with administering the competitive wholesale energy market for the region, and, under the provisions of FERC Order 888, with facilitating open and fair access to transmission.

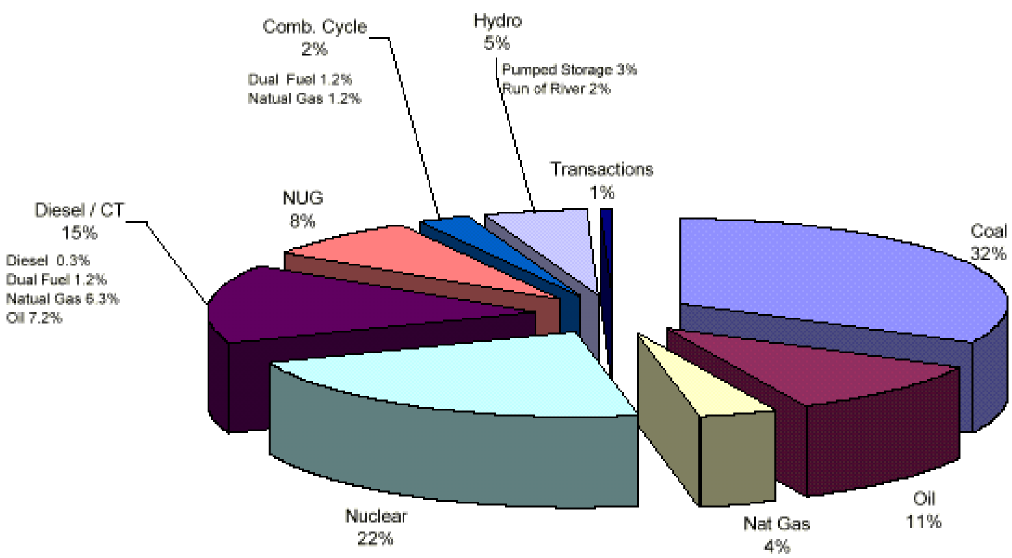
2. Historical Data

This section describes how PJM now operates. These data were current as of October 2000, when this section was last revised.

2.1 Generation Mix

The installed capacity of PJM increased by 445 MW during 1999. PJM summer net installed capacity as of 12/31/99 was 57,996 MW. The short-term outlook for capacity additions sum to 19,189 megawatts by the end of 2003 based on recent studies, and listed projects in the queue process dictated by PJM. Most of the new generation additions are being supplied by non-Load Serving Entities, and are predominately combined cycle units.

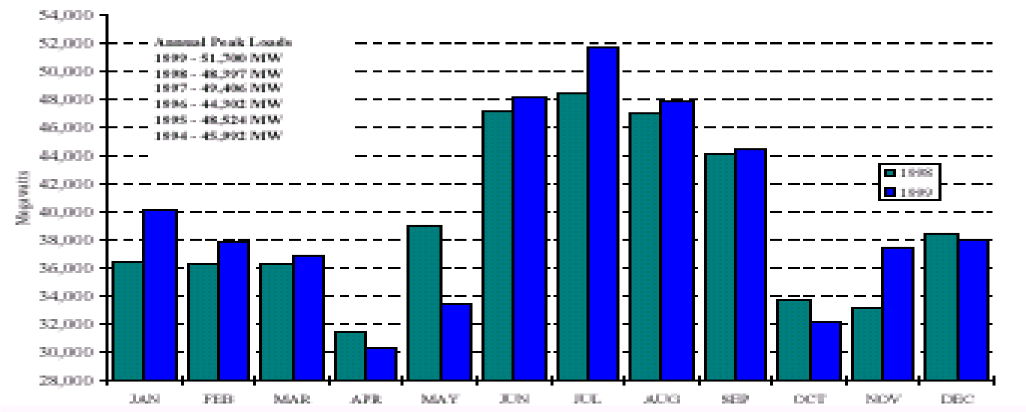
Installed Capacity by Fuel Type
as of 12/31/99



2.2 Demand

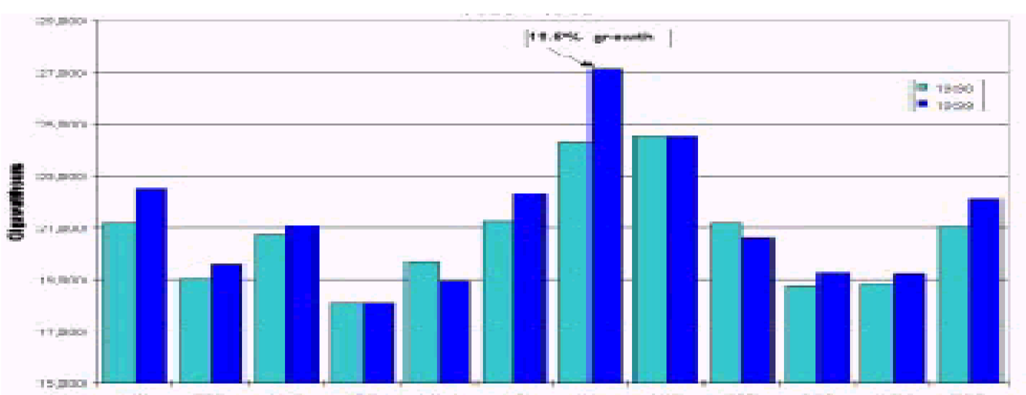
The PJM 1999 peak load of 51,700 MW was set on July 6, 1999 at 14:00. The increase was 4.4 percent over the previous all-time peak of 49,406 MW set on July 15, 1997. PJM exceeded the all-time record on two days in July (July 6 and July 19,1999).

Peak Load Comparisons
1998-1999



The 1999 net energy for load was 255,457 GWh, an increase of 2.8 percent over the 1998 value of 248,533 GWh. The graph contains a month-by-month comparison of 1998 and 1999 Net Energy for load. The growth for the peak month of July was 11.8 percent over the previous July.

Net Energy for Load Comparison
1998-1999



2.2.1 Baseload

As shown under the capacity graph, there is almost 30,000 MW of nuclear and coal-fired generation on the PJM system. Given that the minimum load on the system is almost 18,000 MW, the typical daily requirement for baseload power will range around 25,000 MW and should be covered by that type of generation. In fact, during the last year, 60 percent of the hours are below the total generation of the two types of base load generation.

2.2.2 Peaking

On a peaking basis, there are only 500 hours where the demand is above the 80 percent level of the peak hour on the system (1999), and represents approximately 10,000 MW of peak load. PJM has sufficient peaking capability in diesels, gas turbines, and hydro to cover this amount of peaking requirements over the next several years.

2.3 Price Duration

The curves that follow show the average hourly day-ahead prices of the PJM Zone, that is, the average prices posted for every hour over the period from October 1999 through September 2000. These data are posted by PJM Interconnection, from their Internet file transfer protocol web site:

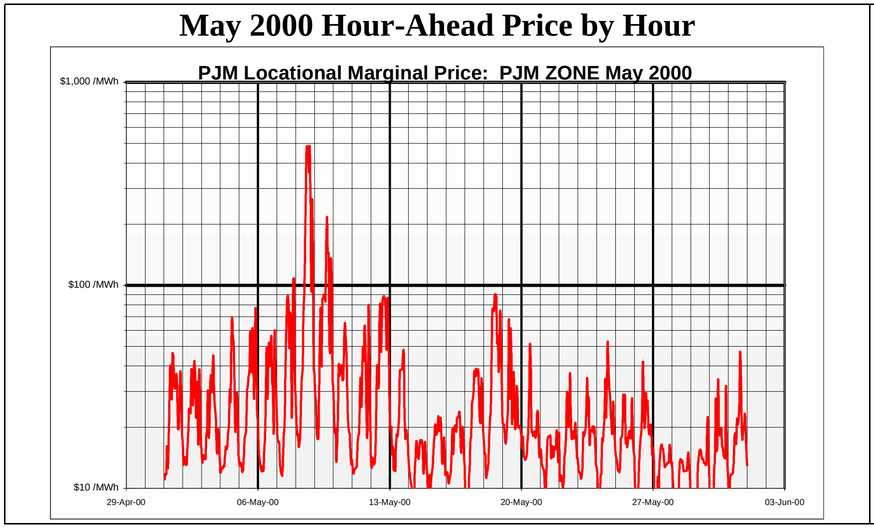
ftp://www.pjm.com/pub/account/lmpmonthly/index.html

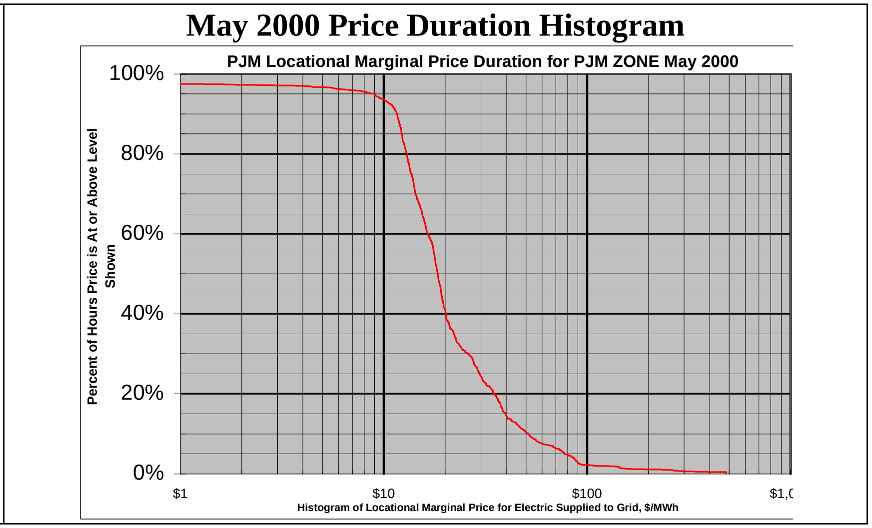
These data are listed on an hour-by-hour basis. The GEMSET team collected these data, then sorted them into a price duration histogram for each month. The data for an entire year's span was then developed. The results of this assessment are presented in the subsections that follow.

2.3.1 By Month

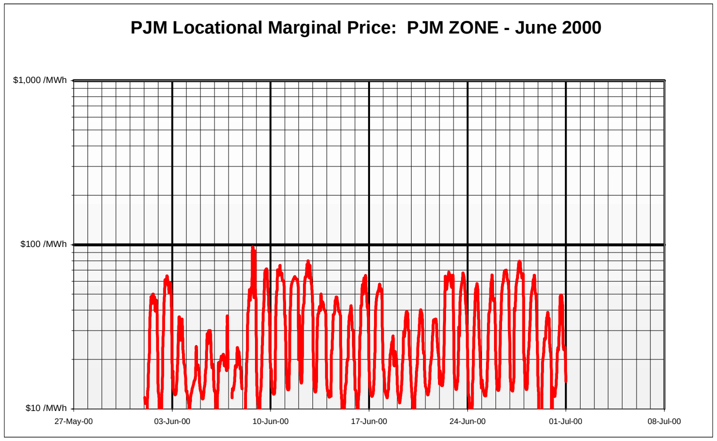
The GEMSET team took PJM Interconnection hour-ahead locational marginal price data from their Internet web site, and developed price duration curves for PJM. These were for the PJM Zone, which averages the prices at all of the hubs. Exhibit 2-1 below shows the month-by-month data for a one-year period.

Exhibit 2-1
Monthly Hour-by-Hour PJM Day-Ahead Market Prices, and Price Duration Histograms – May 2000 –April 2001

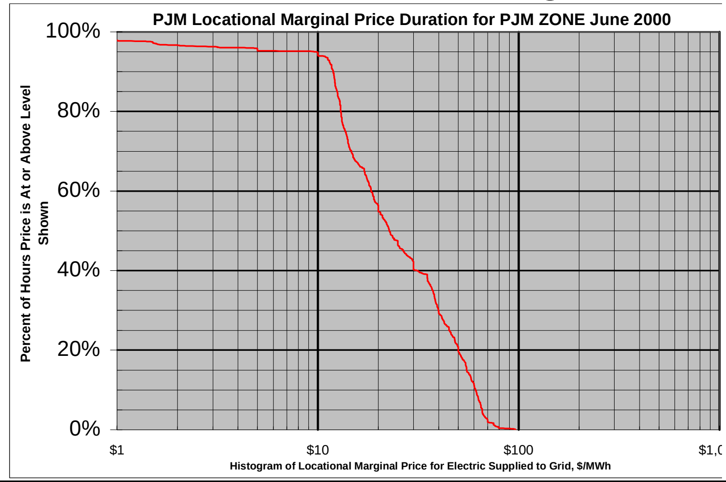




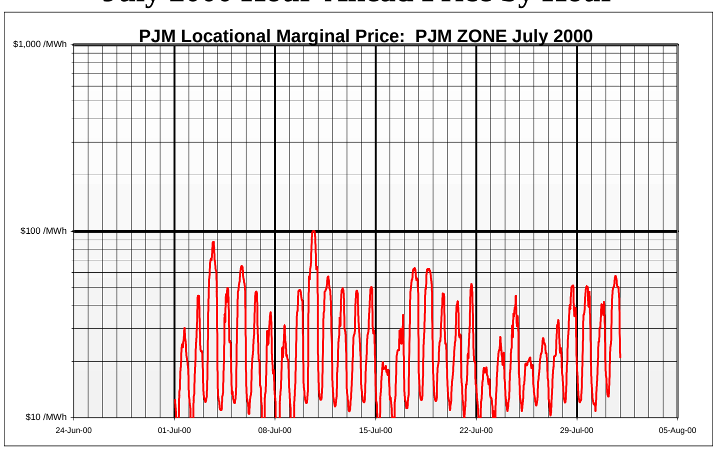
June 2000 Hour-Ahead Price by Hour



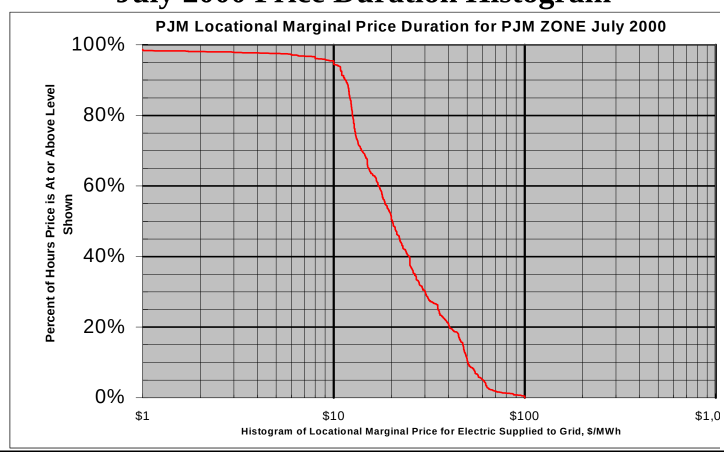
June 2000 Price Duration Histogram



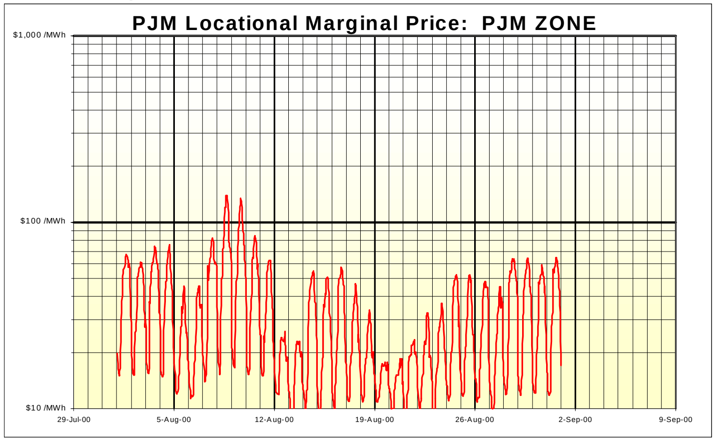
July 2000 Hour-Ahead Price by Hour



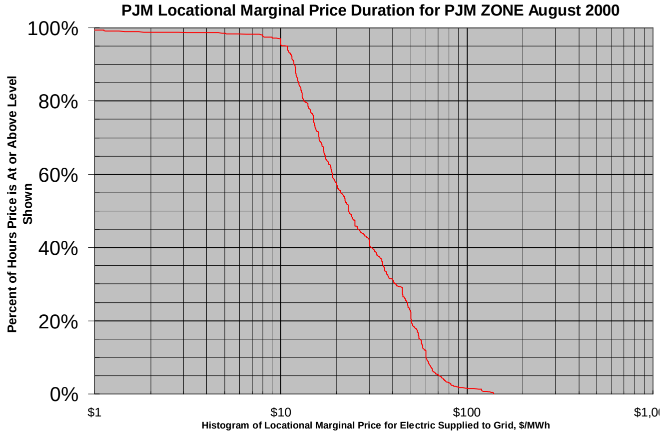
July 2000 Price Duration Histogram



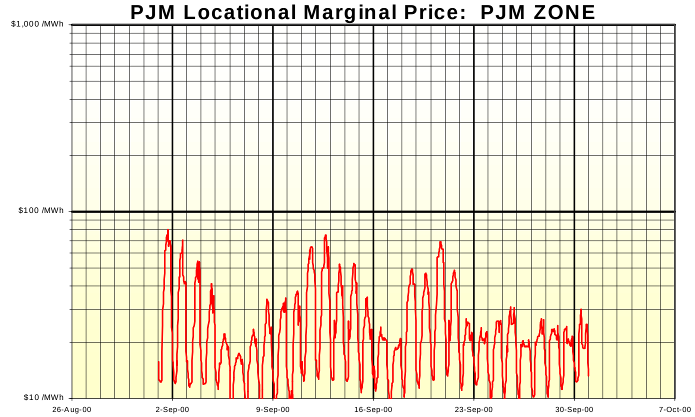
August 2000 Hour-Ahead Price by Hour



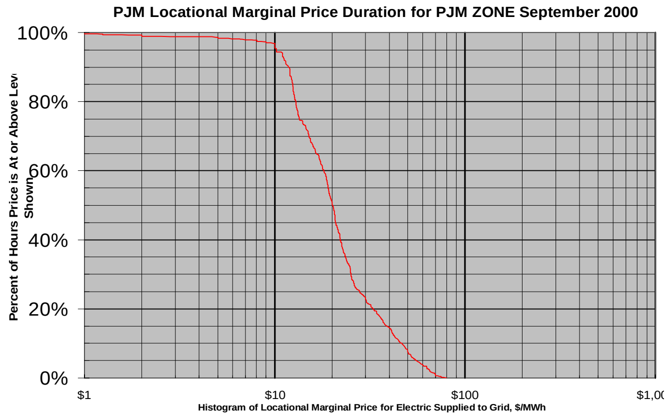
August 2000 Price Duration Histogram



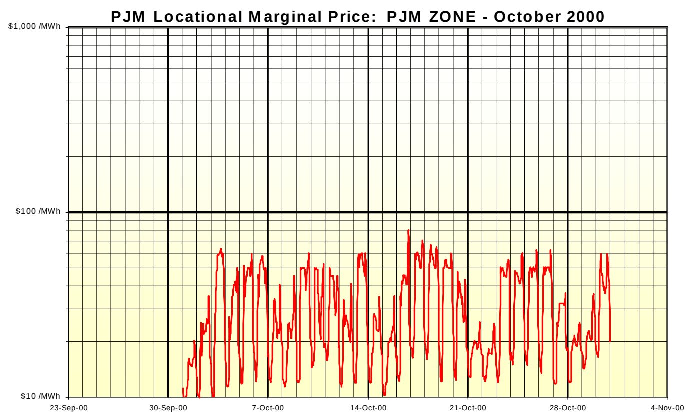
September 2000 Hour-Ahead Price by Hour



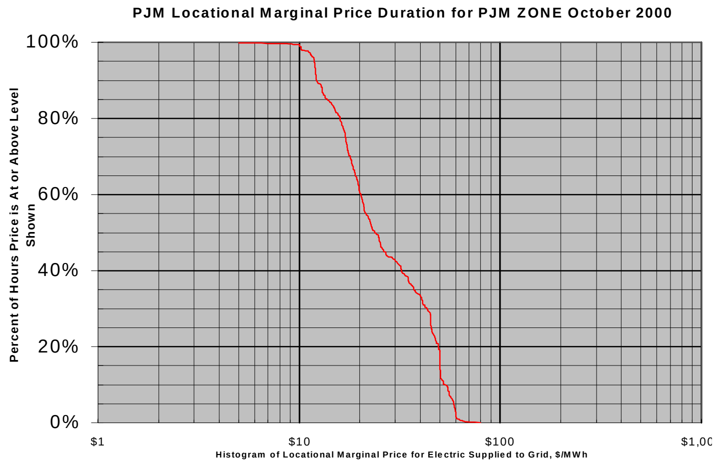
September 2000 Price Duration Histogram



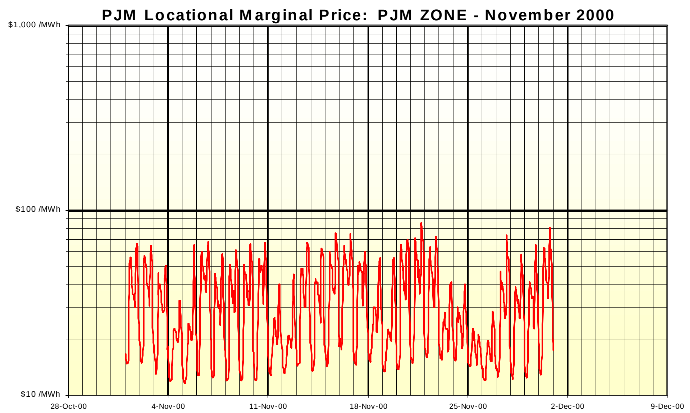
October 2000 Hour-Ahead Price by Hour



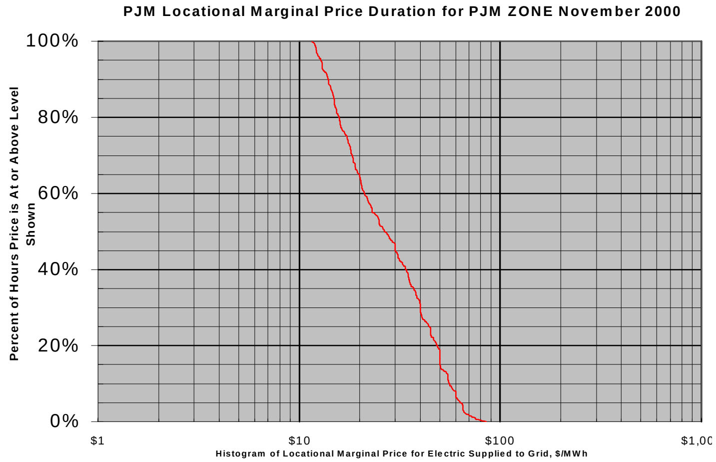
October 2000 Price Duration Histogram



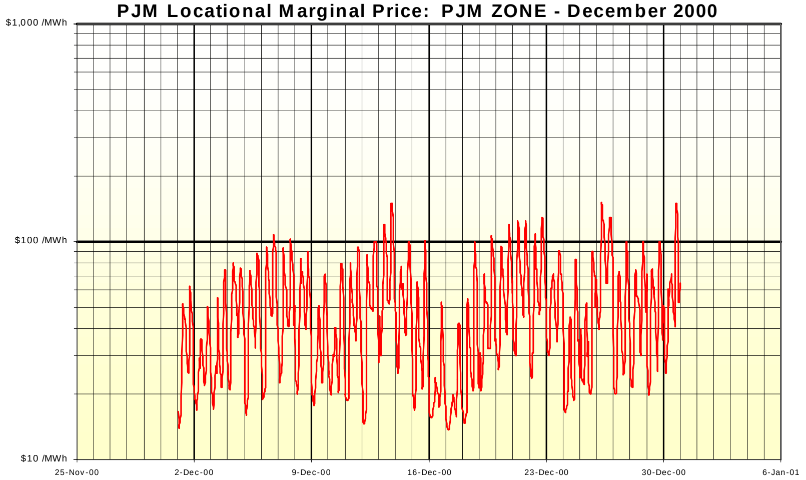
November 2000 Hour-Ahead Price by Hour



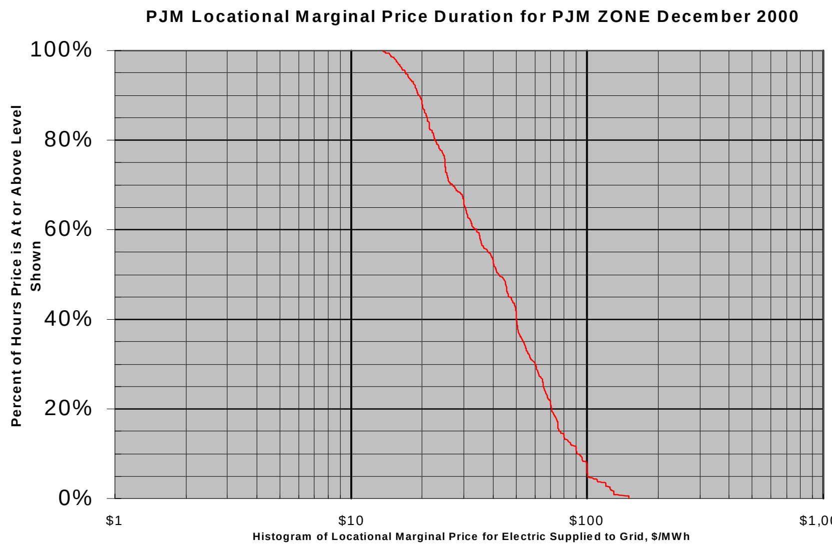
November 2000 Price Duration Histogram



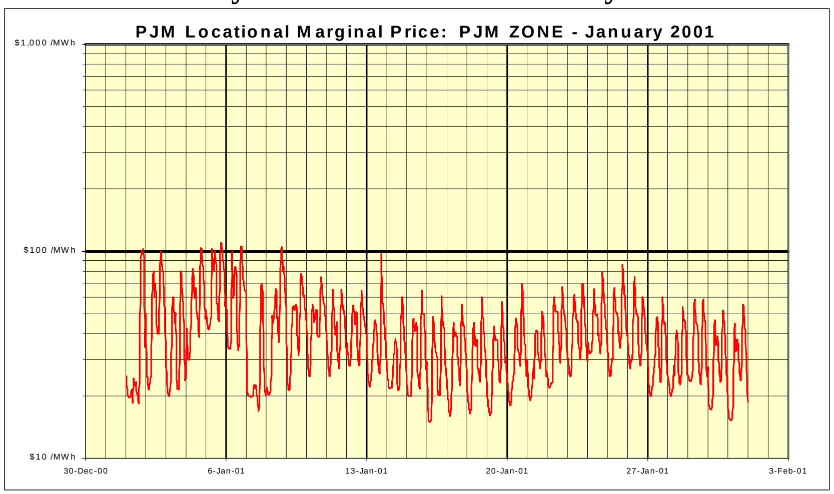
December 2000 Hour-Ahead Price by Hour



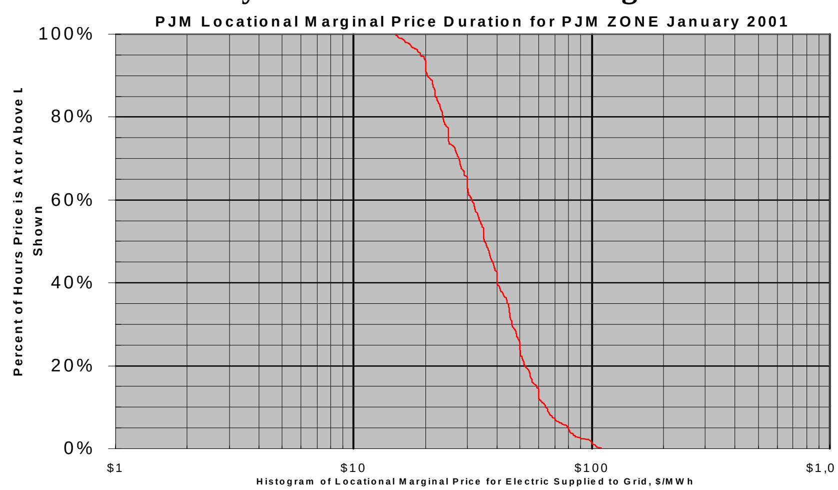
December 2000 Price Duration Histogram



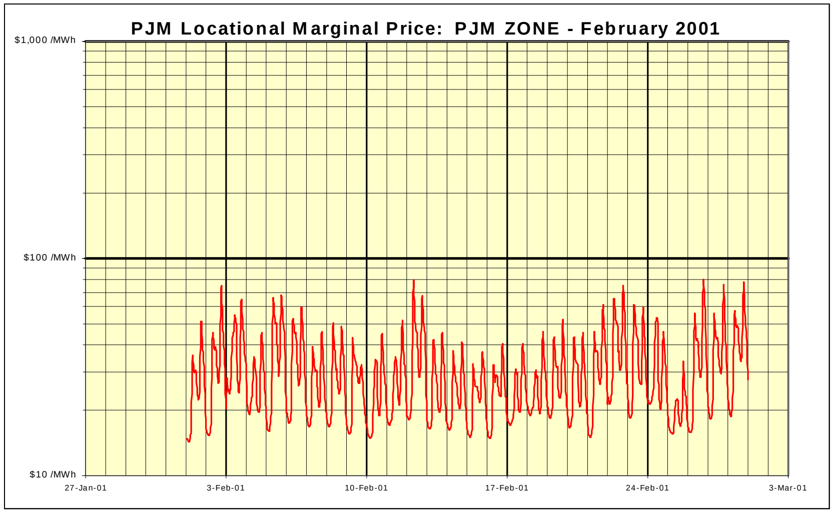
January 2001 Hour-Ahead Price by Hour



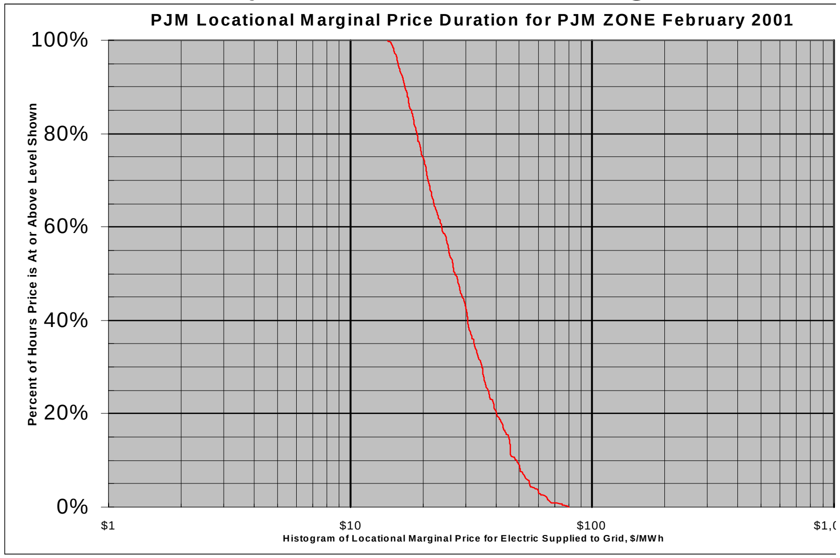
January 2001 Price Duration Histogram



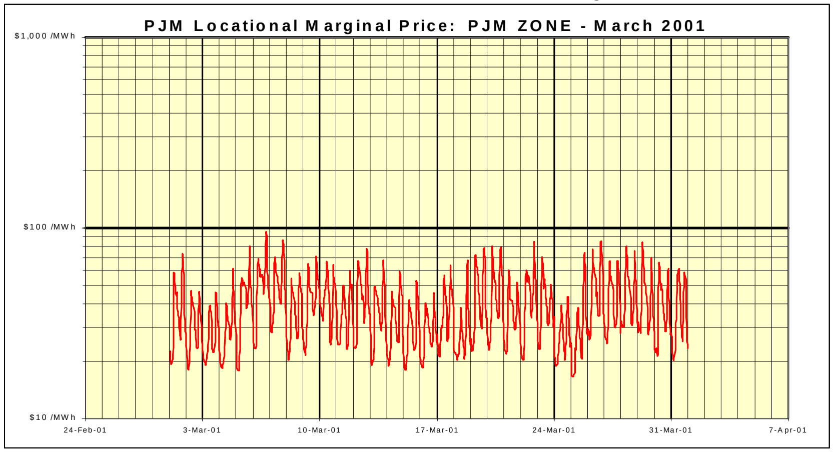
February 2001 Hour-Ahead Price by Hour



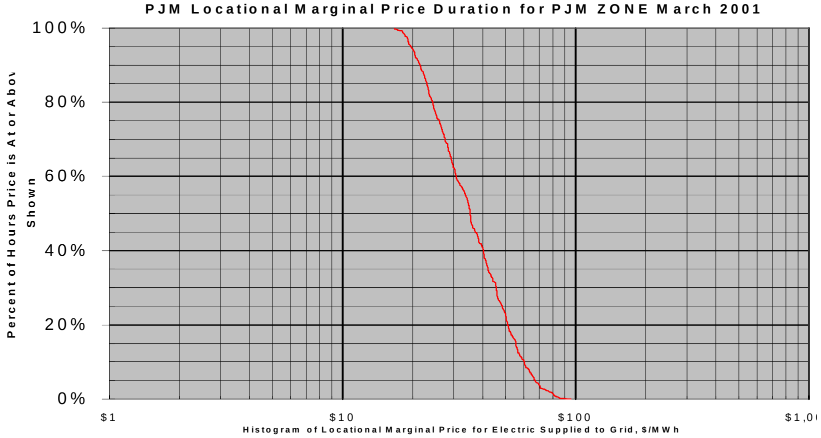
February 2001 Price Duration Histogram



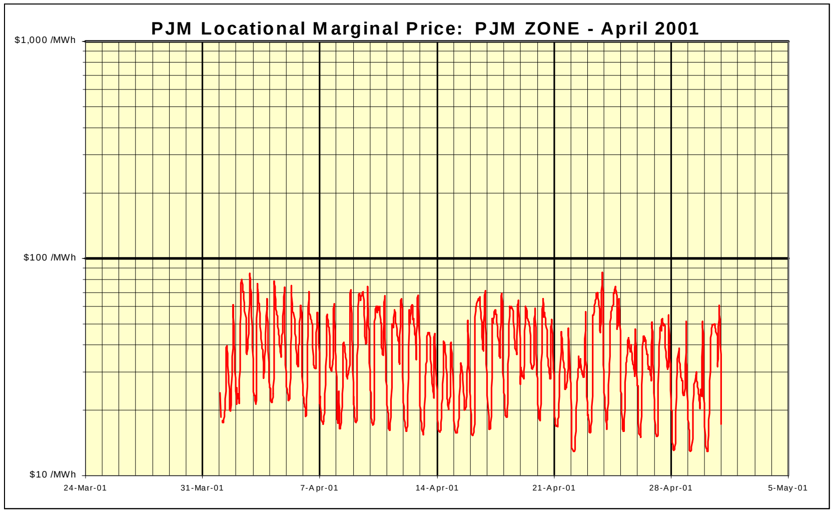
March 2001 Hour-Ahead Price by Hour



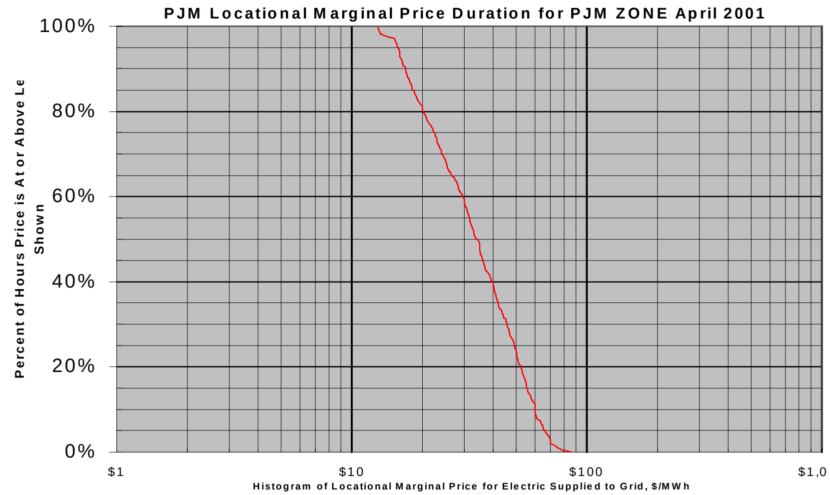
March 2001 Price Duration Histogram



April 2001 Hour-Ahead Price by Hour



April 2001 Price Duration Histogram



2.3.2 Characterization of One-Year's Data

A composite of the month-by-month data was assembled that gives one year's worth of data. This is shown in Exhibit 2-2. This year's worth of data was developed into an annual price duration curve, Exhibit 2-3. Exhibit 2-4 shows the price demand profile for this one-year period.

Exhibit 2-2
Hourly Prices for the Most Recent 1-Year Period

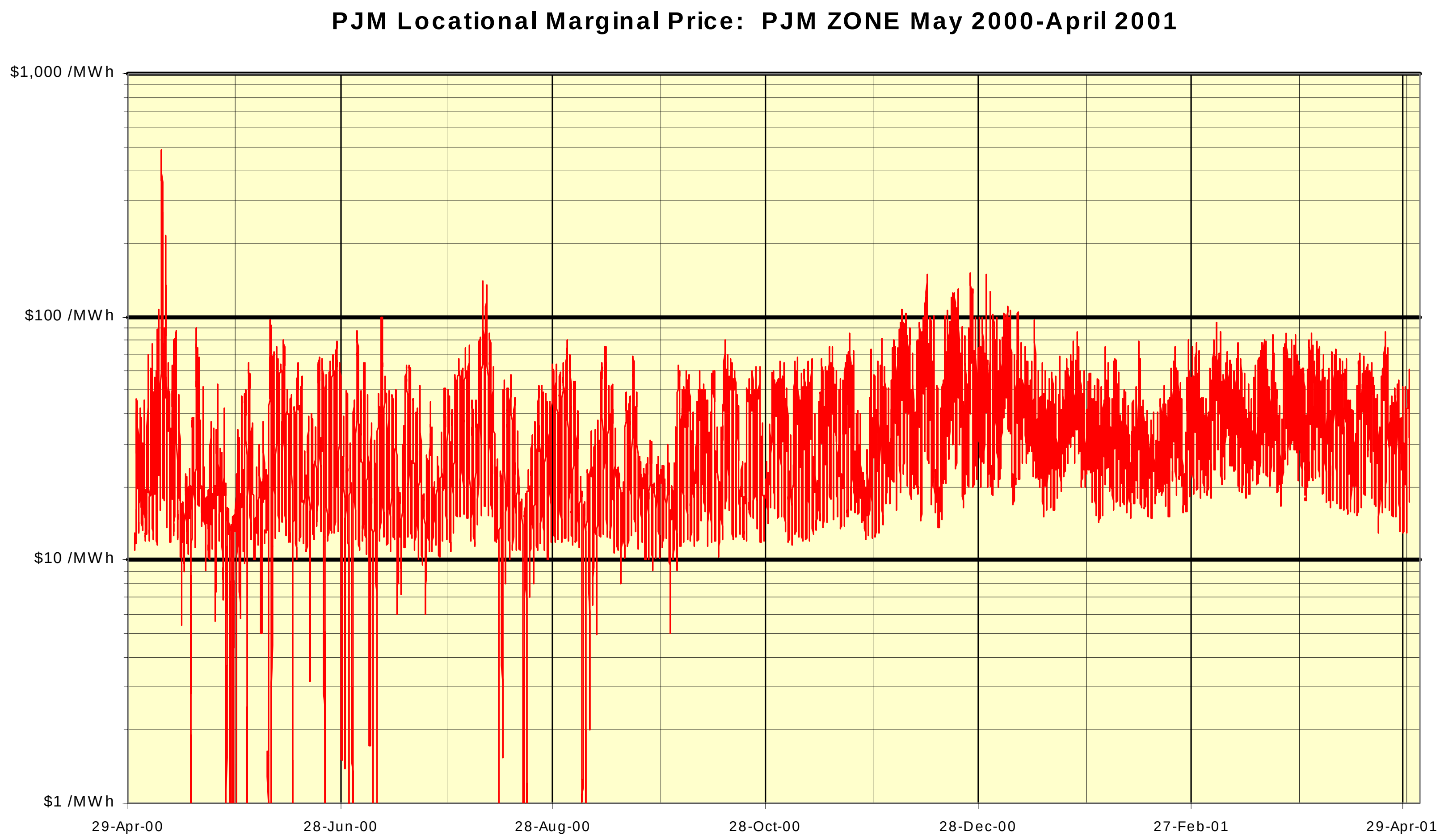


Exhibit 2-3 PJM Price Duration Histogram May 2000 – April 2001

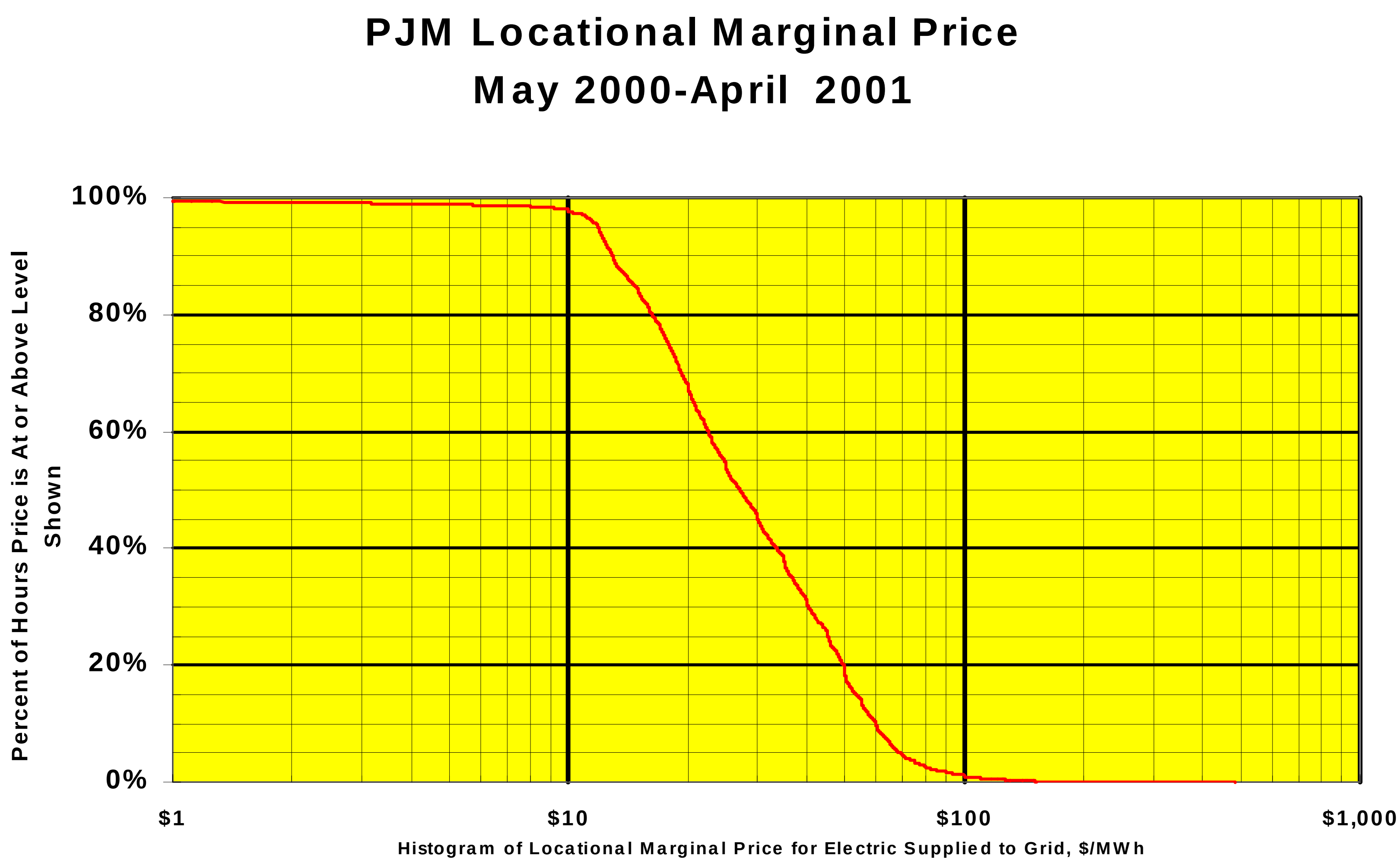
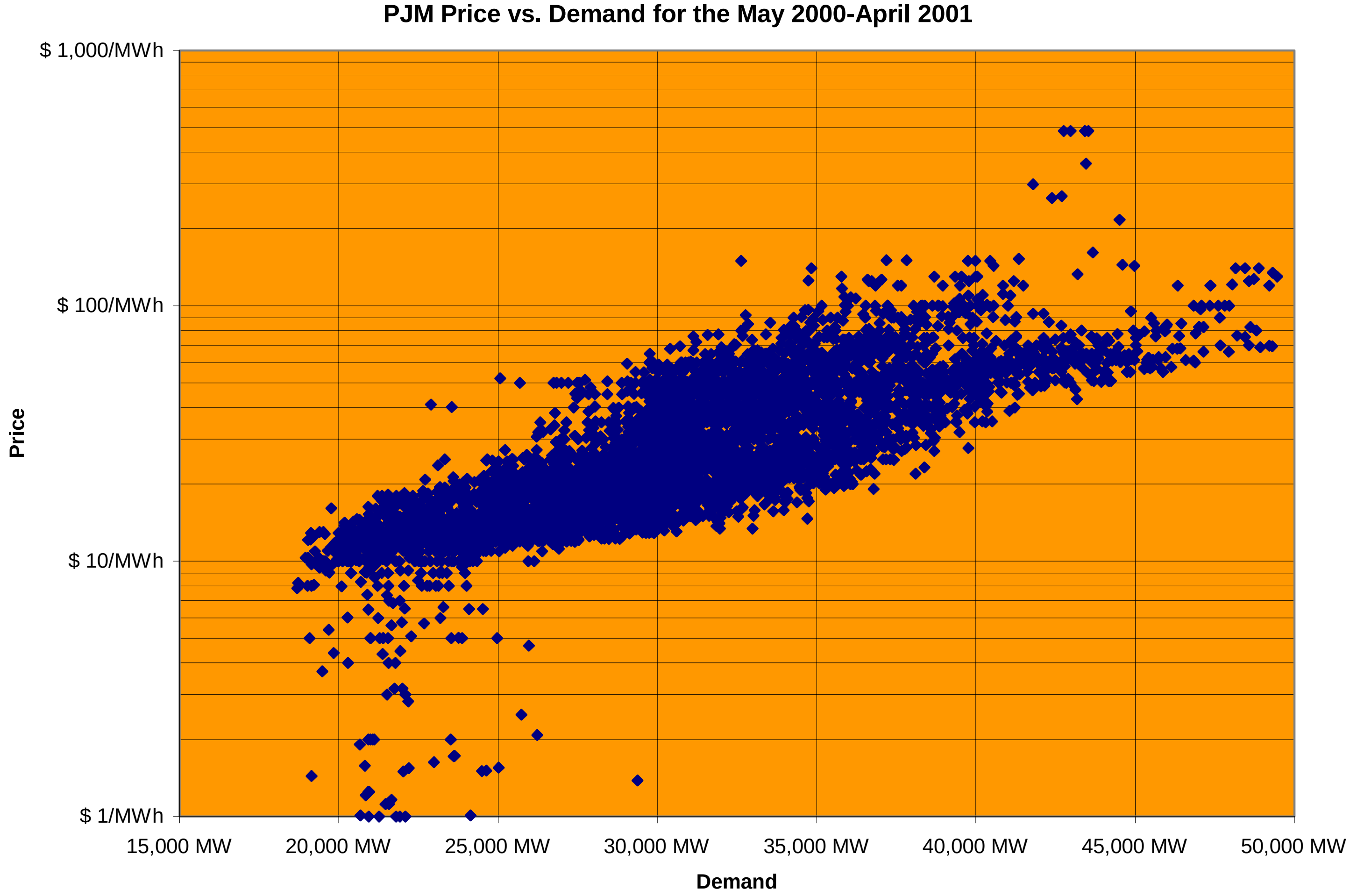


Exhibit 2-4
Price vs. Demand Profile



3. Generation in PJM

Generators in PJM may:

- Sell generation directly into PJM and receive payment at locational marginal price (LMP).
- Sell capacity bilaterally or through the Capacity Credits Market.
- Sell Regulation into the market-based regulation market (effective June 1, 2000) and be in a position to participate in other future Ancillary Services Markets.
- Sell energy from their unit to areas outside of PJM.
- Self-schedule their generation to serve their load obligation.

This section discusses how electric generation capacity is managed within PJM, and how the owners of that capacity are compensated.

3.1 Generator Compensation

Generating resources selected to run for the next day are paid at the hourly locational marginal price (LMP) for their generation bus at the settlement time (1600 hours) of the day-ahead market. This day-ahead financial credit is adjusted for actual performance during the real-time market based on actual hourly average LMP. Generating resources that are selected to run for PJM are guaranteed compensation for their entire offer price or cost, including applicable startup and no-load components, through operating reserve credits. Generating resources that self-schedule regulation capability are compensated at the regulation market clearing price (RMCP). Units that are bid into the regulation market are compensated at the higher value of either RMCP or the regulation bid plus lost opportunity cost. Other ancillary services markets may be developed by PJM in the future.

3.2 Capacity Credit Markets Participation

Generators that serve as PJM capacity resources may submit bids to the PJM daily capacity credit market or periodic monthly and longer-term capacity credit markets. On a daily basis, any excess capacity is required to be bid into the capacity credit market. Bids are submitted using the Internet tool "PJM eCapacity." The computer tool enables generators to create bilateral capacity transactions or submit capacity modifications to increase or decrease the installed capacity rating of a unit. The application also allows load serving entities to enter active load management modifications, and view peak load and obligation data.

3.3 Generator Performance Data and Unforced Capacity Accounting

Generators that serve as capacity resources must initially submit design data in hard copy followed by monthly electronic data regarding its performance to the generator availability data system (eGADS). PJM eGADS, an Internet application, allows generators to submit and view outage data. Every month PJM uses the most recently available 12-month history of GADS data to calculate the demand equivalent forced outage rate (EFORd) for each generating unit. This measure of unit availability is used to convert the installed capacity rating of the unit to an unforced capacity rating for use in the PJM capacity markets for the next month. The unforced capacity rating of a unit is defined as the installed capacity multiplied by (1-EFORd). For example, a unit with an installed capacity rating of 100 MW and an EFORd of 10 percent would have (1-EFORd) equal to 0.9, resulting in an unforced rating of 100 MW multiplied by 0.9, or 90 MW.

In addition to the initially submitted design (pedigree) data, all generator owners must submit the following monthly performance and event data into PJM eGADS by the 20th of the following month:

- **Outage Event Data** – Record of times and causes for a unit being out of service.
- **Generation Performance Data** – Monthly generation, service hours, fuel consumption.

Additional specification on submitting each type of data can be found in the PJM eGADS User Manual.

3.4 Generator Testing

Generating units must be tested on a routine basis to verify their performance. Summer rating tests are conducted during June, July, or August, and winter tests are conducted in December, January, or February. Tests must be conducted based on PJM guidelines, with reports submitted to PJM in September and March. Details for these PJM generation member requirements can be found in the Manual on Rules and Procedures for Determination of Generating Capability.

3.5 Coordination of Operation

Real-time coordination of operations between PJM and the generation facility is essential for maximum efficiency. Every generator that is interconnected with and synchronized to the transmission system must coordinate its operation with PJM and provide all necessary and requested information and equipment status to assure that the electrical system can be operated in a safe and reliable manner. This coordination encompasses, but is not limited to:

- Supplying generator net MW and MVAR output.
- Supplying frequency and voltage levels.
- Scheduling the operation and outages of facilities including synchronization and disconnection.
- Providing data required for operations and system studies.
- Notifying PJM of any condition that inhibits its operating in a reliable manner.
- Providing documented startup and shutdown procedures including ramp-up and ramp-down.
- Following PJM-directed plant operation during emergency and restoration conditions.
- Following PJM-directed operation during transmission-constrained conditions.

The generator owner must develop operating principles and procedures for its facility, coordinated with PJM requirements. The owner must also provide the necessary training and certification for appropriate employees, and provide facilities for necessary communication with PJM.

3.6 Generator Operations Under Emergency Operating Conditions

While the smooth running of PJM under normal circumstances is an important technical and economic function, the stable operation of the grid under abnormal circumstances and during emergencies is one of the most critical elements and responsibilities of PJM operations. In order to maintain system reliability during emergency operations, it is critical that generators respond to directives from PJM. During an emergency, as determined/declared by the Local Reliability Center or PJM, PJM requires that each generator respond as promptly as possible to all directives from the Local Reliability Center and PJM with respect to all matters affecting the operation of the facility including, without limitation, the following:

- Thermal overload of electrical circuits (actual or contingency), and/or
- High- or low-voltage conditions (actual or contingency).

The Local Reliability Center may also direct the generator to:

- Adjust (increase or decrease) the facility energy and/or reactive output, and/or
- Connect or disconnect the facility from the PJM electrical system and/or deviate from the prescribed voltage or reactive schedules.

During emergencies, the generator and PJM maintain communications and contact during all PJM or Local Reliability Center's emergency operations. When the Local Reliability Center has determined that the emergency conditions have been alleviated, the facility will be allowed to return to normal operations consistent with good operational practice. In order to safely restore the transmission system following a facility outage, the facility isolated from the PJM electrical system must reconnect only under the direction of the Local Reliability Center.

Emphasis on Operator Training to Improve Reliability. Training of operators is essential to promote reliable operations. Formal training programs are available and periodically offered to generator personnel including dispatchers, generator operators and others who control generator output and/or transmission assets. Training includes but is not limited to PJM System Operator Procedures, PJM Emergency Operating Procedures, data reporting requirements, and switching and related transmission issues. The North American Electric Reliability Council has developed a system operator certification program. In the future, PJM may require a generator owner to employ certified system operators to participate in the PJM. PJM intends to offer both core and optional courses for generator personnel to further ensure reliable system operations. Additional details regarding PJM System Operations can be found in the PJM Manual on Dispatching Operations.

3.7 Interconnecting

PJM is connected on all sides by other power pools that vary in their role as an ISO. PJM is concerned where projects result in significant restraints to the movement of power from one region to another. As an example, it has been recognized for years that there is a need for another transmission corridor from the western part of Pennsylvania to the east. Within the region itself, it is the responsibility of the ISO to ensure that power moves from the generating resources to the demand centers. There are a variety of ways to move the power, and it is the decision of the PJM as the region's ISO to ensure that it happens.

As previously discussed, the coordination of all movements is the responsibility of PJM. This is especially true when power is moved from one region to another to take advantage of load diversity. In this manner, generation resources can be optimized based on market signals for demand and supply. It is the interconnections that allow this optimization.

4. Adding New Generation Capacity in PJM

This section discusses the PJM approval hurdles needed by any generating company owner planning to add any interconnected generation in the region.

4.1 Existing Generation

New owners of existing generators in PJM need to review proposed business practices with PJM and execute an interconnection service agreement with PJM. These units are not subject to the process for studying the impact of new generation unless pre-existing capacity injection rights for the unit are not transferred with the change of ownership. Existing generating units that will have changes to their output capability are required to submit an interconnection request, executed feasibility study agreement, and $10,000 deposit following the same procedure as new generation. These projects will be placed into a queue and will be evaluated under the same study procedure as new generation.

4.2 Feasibility Study

The feasibility study is an analysis procedure used by PJM to assess the practicality and costs involved to incorporate a generating unit into PJM. The analysis is limited to load flow analysis of the more probable contingencies and short circuit studies and does not include grid stability. The study focuses on determining preliminary estimates of type, scope, cost, and lead time for construction of facilities required to interconnect the project. Results are provided to the applicant and the affected transmission owners and are published on the PJM web site. PJM maintains the confidentiality of the applicant in these reports. After reviewing the results of the feasibility study, the applicant decides whether or not to pursue the system impact study. If the applicant decides to proceed, a system impact study agreement must be submitted to PJM with a $50,000 deposit. Proof is required of initial application for required air permits, if any, and the applicant must identify whether the project is to be connected as a capacity or energy-only resource. New generation applicants may request either of two forms of interconnection service, capacity or energy-only service. Energy-only status allows the generator to participate in energy markets based on locational prices. Capacity status is based on providing sufficient transmission capability to ensure deliverability to network load within PJM and to satisfy various contingency criteria established by the Mid-Atlantic Area Council (MAAC). Specific tests performed during the feasibility and system impact studies identify upgrades required to satisfy these criteria.

4.3 System Impact Study

The system impact study is a comprehensive analysis of the impact of adding the new generation to the Interconnection, and its deliverability to PJM load. The study identifies the system constraints relating to the project and the attachment facilities, local upgrades, and network upgrades. The study refines and more comprehensively estimates cost responsibility and construction lead times for facilities and upgrades. Relationships are studied between the new generator, other planned new generators in the queues, and the existing Interconnection as a whole. This Study also encompasses an analysis of existing firm and non-firm transmission service requests. The results of the study will be provided to all applicants who had projects evaluated in the study project, and to affected transmission owners, and will be posted on the PJM web site. While confidentiality obligations are honored by PJM, the identity of the applicants at this stage is not considered confidential in these reports. The identity of all applicants, and the size and location of projects for which system impact studies have been completed are published on the PJM web site. After reviewing the results of the study, the applicant must make a decision on whether or not to continue with the project.

4.4 Facilities Study

Upon completion of the system impact study, PJM furnishes a facilities study agreement to the applicant. The facilities study agreement provides the estimated cost responsibility and estimated completion date for the study. It may also define milestone dates that the proposed project must meet to retain its assigned priority. If the applicant decides to proceed, the executed facilities study agreement is returned to PJM accompanied by the required deposit. The deposit at this stage will be either $100,000 or the estimated amount of its cost responsibility for the facilities study, whichever amount is higher. Upon completion of the facilities study, PJM provides a good faith estimate of the cost to be charged to the applicant for attachment facilities, local upgrades and network upgrades necessary to accommodate the project, and an estimate of the time required to complete construction of the facilities and upgrades. PJM will furnish an interconnection service agreement to be executed by the applicant. In order to proceed with an interconnection service agreement, the applicant must demonstrate within 60 days of receipt of the facilities study that it has met certain milestones. The applicant must show that it has entered fuel delivery and water agreements, if necessary, and that it controls any necessary rights-of-way for fuel and water interconnections. It must have obtained any necessary local, county, and state site permits; and signed a memorandum of understanding for the acquisition of major equipment. In addition, the regional transmission owner (RTO) may also require that a separate interconnection agreement be executed between the applicant and the RTO regarding construction of facilities and upgrades, parallel operation of the two systems, and other matters generally included in accordance with good utility practice. The agreements and studies referred to above are more fully described in Part IV of the PJM Interconnection, LLC Open Access Transmission Tariff available from FERC or from the PJM web site at http:/www.pjm.com.

5. PJM 15-Year Projections

This section describes PJM's assessment about how the region is projected to operate over the next 15 years. This projection is based on the current planning reported by PJM.

These PJM data are assessed, and used as the basis for the region's forecast made by the GEMSET team. That GEMSET forecast for the PJM region is described in a separate report that provides a future estimate of the prospects for power technologies. That separately reported GEMSET information forecasts expectations for technologies, demand, fuels, financial and other pertinent data that are assimilated into the GEMSET model. This report, however, does not include those GEMSET conjectures. Rather, it discusses only what PJM believes will occur in their region. This section discusses the following PJM projections:

- Section 5.1 gives PJM demand and energy growth projections for the region, beginning on page 25.
- The committed new generation capacity and interconnection additions for PJM are described in Section 5.2, beginning on page 26.
- Finally, Section 5.3 documents PJM's generation interconnection request queue list, which begins on page 28; this shows the status of all generation expansion projects seeking PJM approval on the date this was prepared in July 2000.

5.1 Demand and Energy Growth Projection

For planning purposes, PJM provides a demand and energy forecast by month for the next 15 years. Below, for the period indicated, the monthly peak demand for each year and the average demand are provided as baseline projections assuming normal weather patterns. It should be noted that, during the hot spell experienced in July of 1999, the actual peak demand was 51,700 MW. On the energy side (GWh), the projections were almost identical to the actuals.

Additional calculations are provided to indicate any significant changes in the forecast. Based on those calculations, PJM's load factors were fairly consistent, as were the annual growth rates in demand and energy, Exhibit 5-1.

Exhibit 5-1
PJM Load Factor Forecast

Year	Peak Demand	Average Monthly Demand	Total Energy GWh	Average Monthly Energy	Annual Load Factor	Monthly Load Factor	Annual Growth Demand	Annual Growth Energy
1999	49,751	40,639	254,987	21,247	58.50%	71.62%	---	---
2000	50,520	41,241	258,859	21,572	58.49%	71.65%	1.52%	1.50%
2001	51,370	41,921	268,826	21,944	58.52%	71.71%	1.65%	1.70%
2002	52,182	42,582	267,951	22,329	58.62%	71.83%	1.56%	1.73%
2003	52,992	43,232	271,685	22,636	58.52%	71.73%	1.53%	1.36%
2004	53,836	43,908	278,230	23,019	58.57%	71.82%	1.57%	1.66%
2005	54,713	44,604	280,506	23,376	58.53%	71.79%	1.60%	1.52%
2006	55,578	45,309	284,900	23,742	58.52%	71.78%	1.56%	1.54%
2007	56,460	46,007	289,336	24,112	58.50%	71.79%	1.56%	1.53%
2008	57,325	46,698	293,958	24,496	58.54%	71.86%	1.51%	1.57%
2009	58,202	47,392	297,988	24,828	58.44%	71.77%	1.51%	1.34%
2010	59,056	48,077	302,308	25,192	58.44%	71.78%	1.45%	1.45%
2011	59,910	48,757	308,661	25,555	58.43%	71.80%	1.42%	1.42%
2012	60,782	49,445	311,286	25,941	58.46%	71.87%	1.43%	1.49%
2013	61,648	50,232	315,481	26,290	58.42%	71.70%	1.41%	1.33%
2014	62,536	50,929	319,934	26,661	58.40%	71.71%	1.42%	1.39%
2015	63,424	51,630	324,451	27,038	58.40%	71.74%	1.40%	1.39%

Overall, PJM expects to experience an increase in required capacity of about 13,600 MW over the next 15 years. This represents an increase of almost 30 percent over that time period. When retirements are taken into consideration, PJM estimates that almost 20,000 MW of new capacity will be required through 2015.

5.1.1 Baseload Demand Projections

With the projections provided by PJM from their planning departments, it is apparent that little diversity is expected in their load characteristics between now and 2015. Annual and monthly load factors remained relatively constant over the time period of their analysis. Therefore, based on the projections provided, baseload requirements will only increase by approximately 10,000 MW through year 2015. It is expected that this baseload generation will be provided by the few coal-fired projects currently planned and on life extensions and rehabilitation on existing thermal units fueled by coal in the region.

5.1.2 Peaking Demand Projections

With the peak load increasing to almost 13,000 MW in the next 15 years, PJM's actual peak load generation requirements will likely increase by about 3,000 MW to almost 13,000 MW from today's 10,000 MW level. PJM expects all of that new generation will be supplied by combustion turbines fueled by natural gas.

5.2 Committed PJM Capacity Additions

PJM has responsibility for Regional Transmission Expansion Planning and oversees the process of adding new generation resources to the PJM system. PJM created a model for analyzing regional electric generation needs, determined procedures for evaluating individual proposals, and defined "generation request queues" for proposed projects. Links to the current request queues as well as documentation on the procedures are shown here. The Transmission Expansion Advisory Committee meets periodically to review progress on regional expansion planning. In addition, related information can be found under the RAA Reliability Committee.

Generators in PJM may:

- Sell generation directly into PJM and receive payment at locational marginal price (LMP).
- Sell capacity bilaterally or through the Capacity Credits Market.
- Sell Regulation into the market-based regulation market (effective June 1, 2000) and be in a position to participate in other future Ancillary Services Markets.
- Sell energy from their unit to areas outside of PJM.
- Self-schedule their generation to serve their load obligation.

5.2.1 New Generation Projects

A company proposing a new generation project does not need to become a PJM member until the project is close to commercial operation. Submission of an Interconnection Application and Feasibility Study Agreement is the first step in this process, after which the project will be assigned a queue position based on the date of submission. Following the feasibility study, the project may be withdrawn or continued to the impact study phase.

5.2.2 Interconnection Service Agreements

New project owners need to execute an Interconnection Service Agreement with PJM Interconnection, LLC. This agreement defines the rights and responsibilities for construction of facilities and upgrades to accommodate the project. New owners of existing generating units must also execute an Interconnection Service Agreement with PJM. A separate Interconnection Service Agreement is needed with the local electric distribution company or transmission owner regarding construction of facilities, parallel operation of the two systems, and other matters in accordance with good utility practice.

These agreements define specifically the equipment and responsibilities of each party. The structure and detail contained in the interconnection agreements is very important to all parties involved. Some of the issues considered as the parties develop the agreements include:

- Identification of who will design and construct facilities and upgrades (including completion schedules).
- Specification of any special operating restrictions that are a condition of interconnection necessary to meet reliability criteria.
- Identification of who will own and who will maintain equipment – e.g., transformers, instantaneous metering, billing metering.
- Identify what provisions are there to assure agreement of parties for billing metering readings.
- Establish who provides routine meter calibration/verification.
- Identify if the generator is connected to a PJM Open access tariff facility. If not, distribution services should be contracted from host utility.
- Establish who will provide the systems to interface with PJM.
- Establish what data are to be provided to the distribution company's local control center (LCC).
- Describe what arrangements are required by the distribution company for the unit to operate for distribution reasons.
- Establish what services the seller will provide until new buyer systems are in place and ownership is transferred.
- Establish who will provide station power and light. This should be contracted unless buyer qualifies as load serving entity. PJM is a wholesale supplier only.

5.2.3 New Generation

As specified in the PJM Open Access Transmission Tariff, Section 36, when a new generation owner approaches PJM to connect a new project to the PJM system, an interconnection request must be submitted along with a signed feasibility study agreement and a non-refundable deposit of $10,000. The Request must describe the location, size, equipment configuration, in-service date, and proof of right to control the site for the proposed project. The project is then placed into a queue. Queue positions are determined by the date of submission of the interconnection request. The applicant is obligated to pay the actual costs of studies conducted by PJM on its behalf, and the non-refundable deposit of $10,000 is applied to those costs as work is completed.

5.3 Generation Interconnection Request Queues

In order to maintain a logical and efficient manner in which new generation is added to the system, PJM has established a queue setup that establishes positions by network requirements and timing for new generation projects. Currently there are four queues in place representing over 30,000 MW of planned additions to the PJM system. Exhibit 5-2 below gives the projects and their sizes and location, listed in the order in which they were received and the status of their evaluation by PJM.

Exhibit 5-2
PJM's Queue Establishing the Order of Construction of New Generation ***(as of July 2000)***

	Queue Date	PJM Substation	(MW)	C/E	Status§	Feasibility Study	Impact Study	Facilities Study
A1	4/1/1997	South Lebanon 230 kV	673*	C	FE	South Lebanon 640	South Lebanon 673	
A2	4/1/1997	Oak Hall 138 kV	315	C	ISA	Oak Hall 312	Oak Hall 312	
A3	4/1/1997	Linden 230kV or 138kV	120	C	FE	Linden 120	Linden 120	
A4	4/1/1997	Linden 230kV or 138kV	750	C	FP	Linden 750	Linden 750	
A5	4/1/1997	Bergen	500	C	FE	Bergen 750	Bergen 500	
A6	4/1/1997	Kearny	750	C	FP	Kearny 750	Kearny 750	
A7	5/1/1997	Dickerson	120	C	FE	Dickerson 120	Dickerson 120	
A8	6/1/1997	Susquehanna 230kV	50	C	FE	Susquehanna 230kV 50	Susquehanna 230kV 50	
A9	6/1/1997	Susquehanna 500kV	50	C	FE	Susquehanna 500kV 50	Susquehanna 500kV 50	
A10	6/2/1997	Glory 115kV	6	C	N/A	Glory 6	Glory 6	
A11	7/30/1997	Harwood 230 kV	35	C	FE	Harwood 250	Harwood 201	
A12	8/20/1997	Martins Creek 230 kV	600	C	FE	Martins Creek 600	Martins Creek 600	
A13	11/26/1997	Mickleton 230 kV	803	C	FE	Mickleton 803	Mickleton 803	
A14	1/1/1998	Sewaren	500	C	FP	Sewaren 500	Sewaren 500	
A15	1/20/1998	Sayreville 230 kV	765	C	FE	Sayreville 765	Sayreville 765	
A16	3/3/1998	Eagle Point 230 kV	-	-	W	Eagle Point 800	Eagle Point 800	Withdrawn
A17	5/8/1998	Linden 230 kV	1100	C	FP	Linden 1100	Linden 1100	
A18	5/11/1998	North Temple 230 kV	557	C	FE	North Temple 557	North Temple 557	
A19	5/15/1998	Eddystone 230 kV	521*	C	FE	Eddystone 440	Eddystone 521 (Amended)	Eddystone 521
A20	7/9/1998	Juniata 500 kV	-	-	W	Juniata 485	Withdrawn	
A21	8/17/1998	Chichester 230 kV	725	C	FP	Chichester 725	Chichester 725	
A22	8/20/1998	Hudson 230 kV	750	C	FP	Hudson 750	Hudson 750	
A23	10/13/1998	New Castle 138 kV	-	-	W	New Castle 257	Withdrawn	
A24	10/28/1998	South River 230 kV	-	-	W	South River 725	Withdrawn	
A25	10/30/1998	Hosensack 500 kV	1000	C	FE	Hosensack 1000	Hosensack 1000	
A26	11/2/1998	Linden 230 kV or 138 kV	180	C	FP	Linden 600	Linden 180	
A27	11/4/1998	Passyunk 230 kV	515	C	FP	Passyunk 725	Passyunk 515	
A28	11/4/1998	Dover	100	C	FE	Dover 100	Dover 100	
A29	11/18/1998	Colora Tap 230 kV	465	C	FE	Colora Tap 400	Colora Tap 465	
A30	12/3/1998	Colora Tap 230 kV	465	C	FE	Colora Tap 650	Colora Tap 465	

Exhibit 5-2
PJM's Queue Establishing the Order of Construction of New Generation ***(as of July 2000)*** *(continued)*

	Queue Date	PJM Substation	(MW)	C/E	Status§	Feasibility Study	Impact Study	Facilities Study
A31	12/22/1998	Peckville/Varden 69kV	44	C	FE	Peckville/Varden 60	Peckville/Varden 43.7**	
A32	1/12/1999	Montour #1	14	C	N/A	Montour 14	Montour 14	
A33	1/12/1999	Montour #2	14	C	N/A	Montour 14	Montour 14	
A34	1/12/1999	Brunner Island 230 kV	14	C	ISAP	Brunner Island 14	Brunner Island 14	
A35	1/13/1999	North Bangor 34.5kV	10	C	ISAE	North Bangor 10	No.Bangor 10	
A36	1/27/1999	Hunterstown 500 kV	1100	C	FP	Hunterstown 1358	Hunterstown 1358	
A37	1/27/1999	Sayreville 230 kV	-	-	W	Sayreville 749	Withdrawn	
A38	1/27/1999	Erie West 345 kV	871*	C	FE	Erie West 765	Erie West 765	
A39	1/27/1999	Pequest River 115 kV	-	-	W	Pequest River 73	Withdrawn	
A40	1/27/1999	TMI 500 kV	-	-	W	TMI 1271	Withdrawn	
A41	1/27/1999	TMI 500 kV	-	-	W	TMI 765	Withdrawn	
A42	1/27/1999	Atlantic 230 kV	447	C	FE	Atlantic 449	Atlantic 447	
A43	1/27/1999	Portland 230 kV	558*	C	FP	Portland 472	Portland 472	
A44	1/27/1999	Shelocta 230 kV	-	-	W	Shelocta 402	Withdrawn	
A45	1/27/1999	Oyster Creek 230 kV	-	-	W	Oyster Creek 752	Withdrawn	
					W	Oyster Creek 867	Withdrawn	
A46	1/27/1999	Gilbert 115 kV	-	-	W	Gilbert 100	Gilbert 100	Withdrawn
A47	2/3/1999	Perryman 230kV or 115kV	-	-	W	Withdrawn	Withdrawn	
A48	2/3/1999	East Towanda 230kV	750	C	FE	East Towanda 750	East Towanda 750	
A49	2/3/1999	West Hempfield 230kV	-	-	W	West Hempfield 750	Withdrawn	
A50	2/3/1999	Bayonne	60	C	FP	Bayonne 120	Bayonne 60	
A51	2/3/1999	Camden	60	C		Camden 258	Camden 60	
A52	2/3/1999	Linden 230kV or 138kV	180	C	FP	Linden 396	Linden 180	
A53	2/3/1999	Titusville	25	C	FE	Titusville 25	Titusville 25	
A54	2/9/1999	TMI 230 kV	45	C	ISAP	TMI 30	TMI 45	
A55	2/22/1999	Lakewood 230kV	500	C	FE	Lakewood 500	Lakewood 500	
A56	3/8/1999	Pedricktown 230kV	-	-	W	Pedricktown 500	Withdrawn	
A57	3/8/1999	Edgemoor	-	-	W	Edgemoor 500	Edgemoor 500	Withdrawn
A58	3/29/1999	Hawkins Gate / Oak Grove 230kV	-	-	W	Hawkins Gate/Oak Grove 450	Withdrawn	

Exhibit 5-2
PJM's Queue Establishing the Order of Construction of New Generation ***(as of July 2000)*** *(continued)*

	Queue Date	PJM Substation	(MW)	C/E	Status§	Feasibility Study	Impact Study	Facilities Study
A59	4/1/99	Emilie	540	C	FP	Emilie or Wheel-Mercer 540	Emilie 540	
A60	4/8/1999	Hunterstown 500 kV	-	-	W	Hunterstown 679	Withdrawn	
A61	4/14/1999	Hawkins Gate / Oak Grove 230kV	-	-	W	Hawkins Gate/Oak Grove 450	Withdrawn	
B1	4/29/99	Dickerson	398	C	IE	Dickerson 398		
B2	4/30/99	Morgantown	80	C	IE	Morgantown 80		
B3	4/30/99	Hosensack 230kV	750	C				
B4	4/30/99	Oyster Creek	-	-	W	Oyster Creek 800	Withdrawn	
B5	4/30/99	Wayne-Homer City 345kV	250	C	IP	Wayne-Homer City 250		
B6	5/10/99	Wayne-Homer City 345kV	-	-	W	Wayne-Homer City 525	Withdrawn	
B7	6/2/99	Keystone 500kV	300	C		Keystone 300		
B8	6/9/99	Friedensburg 69kV	-	-	W	Friedensburg 5	Freidensburg 5	Withdrawn
B9A	6/10/99	Burlington 138kV	168***	C	IE,FEA	Burlington 168		
B9B	6/10/99	Burlington 138kV	336	C	IP			
B10	6/10/99	Keystone 500kV	600	C	IE	Keystone 600		
B11	6/14/99	Keystone 500kV	-	-	W	Withdrawn		
B12	6/14/99	Limerick 500kV or 230kV	500	IE		Limerick 500		
B13	7/2/99	Lakewood 230kV	9	C		Lakewood 9		
B14	7/6/99	Arnold 115kV	15	C	IP	Arnold 15		
B15	7/12/99	Morgantown/Oak Grove 230kV	550	C	IE	Morgantown/Oak Grove 550		
B16	7/12/99	Morgantown/Oak Grove 230kV	550	C	IE	Morgantown / Oak Grove 550		
B17	7/17/99	Freehold 34.5kV	2.1	E	FP	Freehold 2.1		
B18	7/23/99	Limerick-Cromby 230kV	750	C	IP	Limerick / Cromby 750		
B19	7/30/99	Melrose 34.5kV	20	C	IP	Melrose 20		
B20	8/7/99	Elm St. 115kV	70	C				
B21	8/9/99	South Reading 230kV	925	C				
B22	8/11/99	Gould St. 34.5 kV	-	-	W	Gould St. 9.9	Withdrawn	
B23	8/21/99	Siegfried/Allentown 138kV	5	C	N/A	Seigfreid/Allentown 5	Seigfreid/Allentown 5	

Exhibit 5-2
PJM's Queue Establishing the Order of Construction of New Generation ***(as of July 2000)*** *(continued)*

	Queue Date	PJM Substation	(MW)	C/E	Status§	Feasibility Study	Impact Study	Facilities Study
B24	9/7/99	Oak Grove 13.8kV	-	-	W	Oak Grove 6.8	Withdrawn	Withdrawn
B25	9/20/99	Cromby	1000	C	IP	Cromby 100		
B26	9/20/99	Hunlock Creek 66kV	50	C	IE	Hunlock 44.7		
B27	11/03/99	Portland 230kV	362	C				
B28	11/12/99	Muddy Run 230kV	160	C	IE	Muddy Run 160		
B29	11/15/99	Perryman 230kV/115kV	750	C				
B30	11/22/99	Emilie 230kV	605	C				
B31	11/22/99	Brunner-West Hempfield 230kV	600	C				
B32	11/23/99	TMI 500kV**	650	C				
B33	11/23/99	Steelton 230kV**	650	C				
B34	11/23/99	Seward 230kV	304	C				
B35	11/24/99	South Akron 230kV	350	C				
B36	11/24/99	South Akron-Prince 138kV	100	C				
B37	11/24/99	Hosensack-Upper Hanover 69kV	90	C				
B38	11/24/99	Elroy 69kV	100	C				
B39	11/24/99	Quarryville 69kV	90****	C				
B40	11/24/99	West Hempfield 69kV	90	C				
B41	11/24/99	Prince 138kV	90	C				
B42	11/29/99	Susquehanna 230kV	500	C				
B43	11/29/99	Homer City-Wayne 345kV	284#	C				
B44	11/29/99	Elko-Forrest 230kV	240	C				
B45	11/29/99	Peckville 230kV	555	C				
B46	11/29/99	Conowingo 230kV	36	C	IP	Conowingo 36		
B47	11/29/99	Edgemoor 230kV	550	C				
B48	11/30/99	Graceton 230kV	550	C				
B49	11/30/99	Erie South-Warren 230kV	500	C				
B50	11/30/99	Morgantown 69kV	500	C				
B51	11/30/99	Wayne 345	500	C				
B52	11/30/99	Woodbridge 138kV	540	C				

Exhibit 5-2
PJM's Queue Establishing the Order of Construction of New Generation *(as of July 2000)* *(continued)*

	Queue Date	PJM Substation	(MW)	C/E	Status§	Feasibility Study	Impact Study	Facilities Study
	Queue Date	PJM Substation	(MW)	C/E	Status^	Feasibility Study	Impact Study	Facilities Study
C1	12/17/99	Linden 138kV	436*	C	FP		Linden 436	
C2	1/6/00	South Lebanon 230kV	47	C				
C3	1/11/00	Morgantown/Oak Grove 230kV	550	C				
C4	1/11/00	Morgantown/Oak Grove 230kV	550	C				
C5	1/24/00	Somerset 34.5kV	3.75	E	ISAP	Somerset 3.75	Somerset 3.75	
C6	1/26/00	Susquehanna 230kV**	500	C				
C7	1/31/00	Salem 500kV	26	C				
C8	1/31/00	Hope Creek 500kV	69	C				
C9	2/04/00	Fairlawn 26.4kV	37	C				
C10	2/08/00	Erie East 230kV	100	C				
C11	2/25/00	Mifflintown 69kV	9.9	C				
C12	3/15/00	Graceton 230kV (phase II)	550	C				
C13	3/15/00	Graceton 230kV (phase III)	550	C				
C14	3/15/00	Homer City-Quemahoning 230kV	550	C				
C15	3/27/00	Friedensburg 69kV	5	C	FE	Friedensburg 5	Freidensburg 5	
C16	3/28/00	Garman-Westover South 115kV	13.5	C				
C17	3/28/00	Somerset 115kV	4.5	C				
C18	3/28/00	Philipsburg 34.5kV	4.5	C				
D1	4/6/00	Engleside 69kV	1.6	C				
D2	4/7/00	Edgemoor	10	C			Edgemoor 10	
D3	4/17/00	Harwood 69kV	93*	C				
D4	5/26/00	Peckville 69kV	1	C	ISAE		Peckville 1	
D5	6/15/00	E Carbondale 69kV	70	E				
D6	6/19/00	Eclipse 115kV	5	C	ISAE		Eclipse 5	
D7	6/23/00	Blueball 69kV	8	C	ISAP		Blueball 8	
D8	7/3/00	Kearny 230kV	168**	C				
D9	7/24/00	Southwest 13kV	11	C				

Exhibit 5-2
PJM's Queue Establishing the Order of Construction of New Generation ***(as of July 2000)*** *(continued)*

	Queue Date	PJM Substation	(MW)	C/E	Status§	Feasibility Study	Impact Study	Facilities Study
D10	7/26/00	NIH 13kV	22	E				
D11	7/26/00	Clayton 138kV	100	C				
D12	7/27/00	Cambria Slope	10	C				
D13	7/27/00	Deep Run 34.5kV	15	C				
D14	7/28/00	Red Lion 230kV	190***	C				
D15	7/28/00	RedLion 500kV	550	C				
D16	7/28/00	Steelton 230kV	550	C				
D17	7/28/00	Steelton 230kV	550	C				
D18	7/28/00	Hosensack 230kV	550	C				
D19	7/28/00	Brunner-West Hempfield 230kV	550	C				
D20	7/28/00	Brunner-West Hempfield 230kV	550	C				
D21	7/28/00	Hunterstown-Conemaugh 500kV	550	C				
D22	7/28/00	Hunterstown-Conemaugh 500kV	550	C				
D23	7/31/00	Keystone 500kV	500	C				
D24	7/31/00	East Towanda 230kV	650	C				
D25	7/31/00	Hay Road 69kV & 138kV	39	C				
D26	7/31/00	Burlington	550	C				
D27	7/31/00	Burlington	550	C				
D28	7/31/00	Passyunk 230kV	550	C				
D29	7/31/00	Derwood 13kV	3	C				

Exhibit 5-2
PJM's Queue Establishing the Order of Construction of New Generation *(as of July 2000) (continued)*

Queue Date	PJM Substation	(MW)	C/E	Status§	Feasibility Study	Impact Study	Facilities Study

§ Status column abbreviations

FP	Facility Study Agreement Pending	ISAP	Interconnection Service Agreement Pending
FE	Facility Study Agreement Executed	ISAE	Interconnection Service Agreement Executed
IP	Impact Study Pending	W	Withdrawn
IE	Impact Study Executed	N/A	Not Applicable