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## **The Potential of Regional Power Sector Integration**

### **PJM Interconnect | Developed Country Case Study**

**Submitted to ESMAP by:  
Economic Consulting Associates**

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## Abbreviations and acronyms

AE or AECO	Atlantic Electric Power Company, Inc.
AEP	American Electric Power
AP or APS	Allegheny Power Systems
BEA	Bureau of Economic Analysis
BGE	Baltimore Gas and Electric Company
CHP	Combined Heat and Power
DAY	Dayton Power and Light Company
DLCO or DUQ	Duquesne Light
DOE	United States Department of Energy
DOM	Dominion
DPL	Delmarva Power and Light Company
EIA	Energy Information Administration
EPA	Environmental Protection Agency
FERC	Federal Energy Regulatory Commission
FTR	Financial Transmission Rights
ISO	Independent System Operator
JCPL	Jersey Central Power and Light Company
LLC	Limited Liability Company
LMP	Locational Marginal Pricing
LSE	Load-Serving Entity
MC	PJM Members Committee
METED	Metropolitan Edison Company
MISO	Midwest Independent Transmission System Operator
MRC	Markets and Reliability Committee
NERC	North American Electric Reliability Council
NYISO	New York Independent System Operator
OATT	Open Access Transmission Tariffs
PECO	PECO Energy
PENELEC or PN	Pennsylvania Electric Company
PEPCO	Potomac Electric Power Company
PJM	Pennsylvania–New Jersey–Maryland Interconnection
PPL or PL	PPL Electric Utilities
PSEG or PS	Public Service Electric and Gas Company
RECO	Rockland Electric Company
RPM	Reliability Pricing Model
RPPWG	Regional Planning Process Working Group
RRS	PJM Reserve Requirement Study
RTEP	Regional Transmission Expansion Planning

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RTO	Regional Transmission Organization
TEAC	Transmission Expansion Advisory Committee
VEPCO	Virginia Electric and Power Company

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## Preface

This case study is part of an Energy Sector Management Assistance Program (ESMAP) project on Regional Power System Integration (RPSI). The objective of the project is to facilitate and accelerate RPSI projects in developing countries around the world. The project will draw on international experience and theoretical analysis in this area to provide a framework to assess:

- o the economic, financial and environmental benefits that can accrue to regional power trading;
- o the institutional and regulatory arrangements needed to sustain and optimize regional projects; and
- o the ways in which obstacles to integration have been successfully overcome.

The final output of the project will be an umbrella report, *Regional Power Sector Integration – Lessons from Global Case Studies and a Literature Review*. This review will summarize the 12 case studies and literature review undertaken and analyze common themes on barriers to RPSI and solutions to overcome them.

Economic Consulting Associates was contracted to execute the project. In doing so, we are working closely with ESMAP and World Bank staff, as well as government officials, utility, power pool, and regional economic community personnel, and others directly involved in implementing regional power schemes.

This and other 11 Case Studies are prepared as clear, factual presentations of the selected projects. The intent is to provide a direct, easily digestible description of each of the selected projects without imposing an analytic framework or making judgments about the degree of success. Such analysis will be undertaken at the global level, considering the entirety of experiences from the Case Studies, in the aforementioned umbrella report.

All 12 Case Studies follow a uniform structure to facilitate ease of comparison and reference from one Study to the next. Some sections are longer than others, depending on the specifics of the Study. Additionally, there is some cross-referencing within each Study.



# 1 Executive summary

## 1.1 Motivations/objectives for trade

When PJM was started in 1927 as a power pool, the motivation behind the interconnection was to be able to share generation resources and thus improve efficiency as well as minimize investments in generation and transmission capacity of the three utilities involved. The resulting power pool allowed utilities in Pennsylvania and New Jersey to share load. Meeting power demands in Philadelphia was the primary motivation for creating an interconnection and trading energy. In 1956 the arrangements were extended to Maryland, which was when the arrangements were renamed as PJM.

The essential beneficiaries of this arrangement were the utilities that formed the PJM pool. These benefits were gradually extended to more utilities in the Mid-Atlantic region of the USA.

The 1973 energy crisis led to a rethink in federal energy policy and the setting up of the Federal Energy Regulatory Commission (FERC) as an activist regulator of interstate energy commerce. The consequent development of open-access competition allowed the establishment of independent generation that greatly increased demands on the wholesale pool.

Another FERC initiative has been the development of independent system operators (and independent regional transmission organizations, RTOs). PJM was already independent because no single utility controlled it, but it was only formally declared an RTO in 2002. The RTO structure was followed by extension of PJM into a western region in 2002 with further expansion to the west and the south in 2004.

Expansion of the control area highlighted the importance of longer-distance transmission development.

## 1.2 The trade solution put in place

The initial arrangement of PJM was a simple power pool that sought to deliver least-cost dispatch of the mix of generation owned by the utilities in PJM.<sup>1</sup> With the growth of the arrangements both geographically and by the inclusion of nonutility traders, the organizational structure evolved. PJM became substantially independent from its utility owners in 1993 and was converted into a not-for-profit limited liability company in 1997. Its current management structure is a two-tier arrangement with a management board supervising day-to-day operation and reporting to an elected Members Committee (MC). Election to the MC is arranged into constituencies representing the different member

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<sup>1</sup> Throughout this case study “PJM” refers to the entity “PJM Interconnection LLC” or else to its predecessor entity. More general references such as to the “PJM area” can cover other entities such as generators or utilities trading through PJM markets.

interests: transmission owners, generation owners, electricity distributors, end-use customers<sup>2</sup> and pure traders.

PJM members can trade bilaterally or else can self-supply, but additional energy and capacity needs are made available through PJM operation of specific markets in energy, capacity and ancillary services. These markets are supported by information provision and analysis tools developed centrally by PJM as well as an independent market monitoring company that ensures transparency and effective competition are in place to protect the interests of all members. The main markets offered are:

- o **Day-Ahead Energy Market** in which hourly locational marginal prices (LMPs) are calculated for the next operating day based on generation offers, demand bids and scheduled bilateral transactions bid into a day-ahead auction.
- o **Real-Time Energy Market**, which is a within-day spot market in which current LMPs are calculated separately from day-ahead LMPs.
- o **Reliability Pricing Model**, a capacity market model that works as a market for capacity three years out. It works in conjunction with PJM's Regional Transmission Expansion Planning (RTEP) process. Its features are:
  - o Procurement of capacity commitments for both generation and transmission through competitive auction;
  - o Locational pricing for capacity that reflects constraints in the transmission system.
- o **Financial Transmission Rights (FTR) auctions** for participants to hedge their exposure to locational marginal pricing by buying FTRs that pay out differences between the prices at the entry and exit nodes of specific transmission paths.
- o **Transmission services**. PJM offers point-to-point firm and non-firm access services for specific bilateral routes from generators to loads. The fees for transmission fund PJM.

### 1.3 Current status and future plans

PJM dispatches about 163,500 megawatts (MW) of generating capacity over 56,350 miles of transmission lines. More than 51 million people live in the PJM region. Since the opening of the regional wholesale market in 1997, PJM has administered more than \$103 billion in energy. PJM delivers about 700 TWh of energy a year and serves utilities in 13 states as well as the District of Columbia.

PJM has overseen an expansion in interstate trade with significant energy transferring from the states in the Great Lakes region of the USA to the deficit region of the fast-growing southern USA (i.e., Virginia and North Carolina) as well as to the heavily populated area of

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<sup>2</sup> Customers also compete in provision of demand management by contracting with their local utility.

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the original PJM Mid-Atlantic region. It has done this essentially by providing market-clearing facilities in energy and capacity.

PJM has ambitions to extend its area of operation by cooperation with neighboring system operators in New York and the Midwest. However, to fulfil these ambitions, PJM still needs to address issues of price differentials between regions. It set up its locational marginal pricing market in 1998. This provided pricing signals for location of generation and demand management as well as requirements for transmission investment. However, it also created local monopolies in generation, which it managed by capping generation bids during periods when congestion set differential prices.

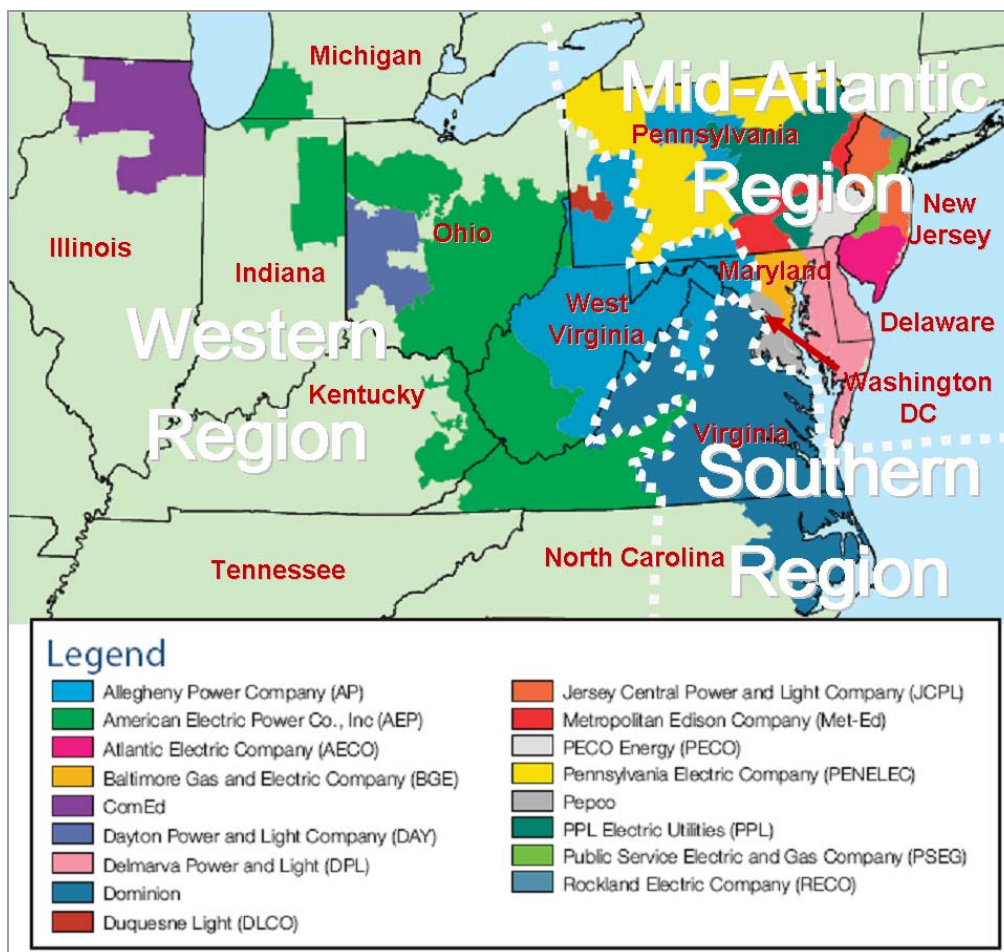
In 2007, PJM began operation of its Reliability Pricing Model, which operated as a buy auction for forward commitments to deliver new generation and transmission. It modelled locational signals to reward development in energy deficit areas. This model signals an acknowledgement that locational marginal prices in an energy market are not likely to deliver sufficient generation and transmission to ensure reliable operation of the system. However, the model still fails to deliver sufficient reward to transmission investment that relieves congestion, and so significant price differentials between regions persist.

## 2 Context for trade

### 2.1 Economic and political context

PJM Interconnection is a not-for-profit, member-driven integrated power pool responsible for wholesale electricity in all or parts of Delaware, Illinois, Indiana, Kentucky, Maryland, Michigan, New Jersey, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia and the District of Columbia.<sup>3</sup>

Figure 1 Utility Control Areas and Regions in PJM



Source: PJM

PJM Interconnection operates the world's largest competitive wholesale electricity market. As of 2005, the PJM area had over 56,070 miles of transmission lines and 1,082 generation

<sup>3</sup> PJM stands for Pennsylvania-Jersey-Maryland, the original states in which it operated, but it has long operated in more than just these states and has extended into several more states since 2002.

sources. PJM dispatches about 165,000 MW of generating capacity and delivers around 700,000 GWh of energy annually.

Figure 1 shows both the utilities involved and their respective zones of operation. The PJM control area covers only parts of many of the states in which PJM operates. Therefore, when state-level statistics are cited in this study, it must be remembered that these cover more than just the PJM area.

## Economic environment

Table 1 shows some economic indicators for the United States for the years 1965 and 2007 as well as selected current statistics for the states that wholly or partly participate in the PJM pool. In 1965 PJM first expanded to include more than the original three utilities. Because the PJM supply area covers only part of the territory of many of the states in which it has a presence, the numbers in Table 1 for the PJM states will tend to overstate the impact of PJM.

The USA is a rich country with a fully developed electricity sector. The available data suggest that the states in the PJM area are very close to the US average on a number of measures.

**Table 1 Indicators for the United States**

	USA 1965	USA 2007	PJM States 2007	PJM States as % of USA 2007
Population (millions)	194	302	51	32.3%
Surface area (km <sup>2</sup> )	9,629,090	9,632,030	436,415	4.5%
GDP (US\$ billions)	712	13,751	4,352	31.9%
GNI per capita (PPP)	N/A	45,840	44,512	97.8%
GDP growth %	6	2.0	1.7	
Inflation (GDP deflator annual %)	3	3		
Exports (% of GDP)	5	11*		
Life expectancy at birth (years)	70	78		
Mortality rate under 5years (per 1,000)	28	8		
Electricity consumption (kWh per capita)	4,890	12,990	13,165	101%

Source: *World Development Indicators* (World Bank), 2007 data, US BEA

\* Data unavailable for 2007; instead 2006 data are used.

## Regulatory and political environment

US economic development was based on an abundance of primary energy sources for most of the 20<sup>th</sup> century. Dependence on coal gradually gave way to oil during the early 20<sup>th</sup> century mainly due to relative convenience. The oil crisis of 1973 highlighted a growing

dependence on imports of oil, and from then on there have been intermittent moves toward greater conservation and energy independence.

In electricity, there is a long history of development of grid connections, starting with a Niagara Falls power scheme in 1883. Therefore, the development of PJM in 1927 was based on a US track record of grid connection for utilities. This initial development therefore occurred during the era of passive legislation on energy.

The ownership structure of the electricity industry in America has changed over time. According to Tyson Slocum,<sup>4</sup> the old model consisted of vertically integrated monopolies regulated by a cost-of-service price control. Then: “Deregulation was triggered by a series of federal actions over several years, followed by decisions by America’s largest states to pass laws ordering the separation of power plants from the distributional utility.”

With separation of generation from distribution, states ceded regulatory authority to FERC (Federal Energy Regulatory Commission) over wholesale trading. In parallel with this, the energy crisis in the 1970s led to encouragement of alternative providers.<sup>5</sup> This was further promoted by the Energy Policy Act of 1992, which gave FERC authority to order utilities to buy from independent utilities.

Therefore, the regulatory environment broke down monopolies and encouraged trading companies to operate in a wholesale market largely free from state price controls.

In the general political environment, electricity availability is taken for granted. The industry is considered mature and stable. Supply failures (e.g., the August 2003 failure that cut supply to 50 million people on the East Coast) and price spikes (e.g., the California crisis of 2000 and 2001) can occur, but this will not usually be due to true lack of availability.

There was therefore no particular direct political or social driver leading to a regional power pool. The benefits of interconnection were mainly perceived by the utilities themselves. The driver for the PJM power pool therefore came from commercial interests.

## 2.2 Supply options

Figure 2 gives energy resources, both indigenous and importable, for each of the states where some, or all, of the load is served by PJM.

The data in Figure 2 give an indication of resource availability. For example, the gas energy imported is for all uses in the state and not just for electricity generation – there are no significant gas resources indigenous to the region. The figure shows:

- o There are significant surpluses of coal in Kentucky and West Virginia.
- o Washington DC, Delaware, Maryland, North Carolina and Tennessee have relatively little primary energy resource.

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<sup>4</sup> [Slocum \(2008\)](#), October

<sup>5</sup> Slocum cites the 1978 Public Utility Regulatory Policy Act as leading to this.

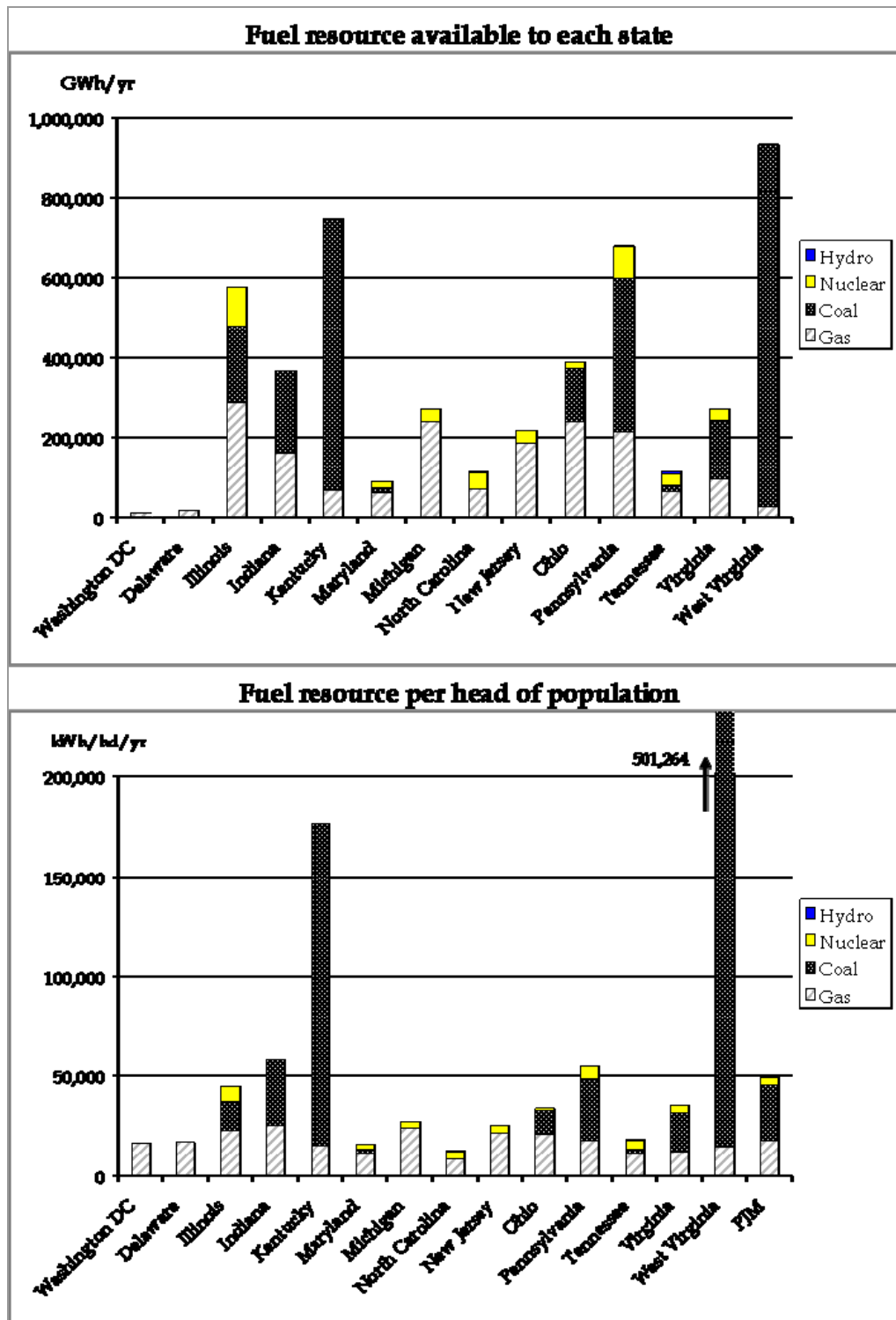
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Nuclear and hydro play only a small part in available energy resources, with reliance mainly on thermal energy sources.

The data suggest that there is advantage in electricity transfers from resource-rich areas to other areas, but it should be noted that availability of primary energy sources within a state and local generation are not vital to regional development – any resource needed can be readily imported.

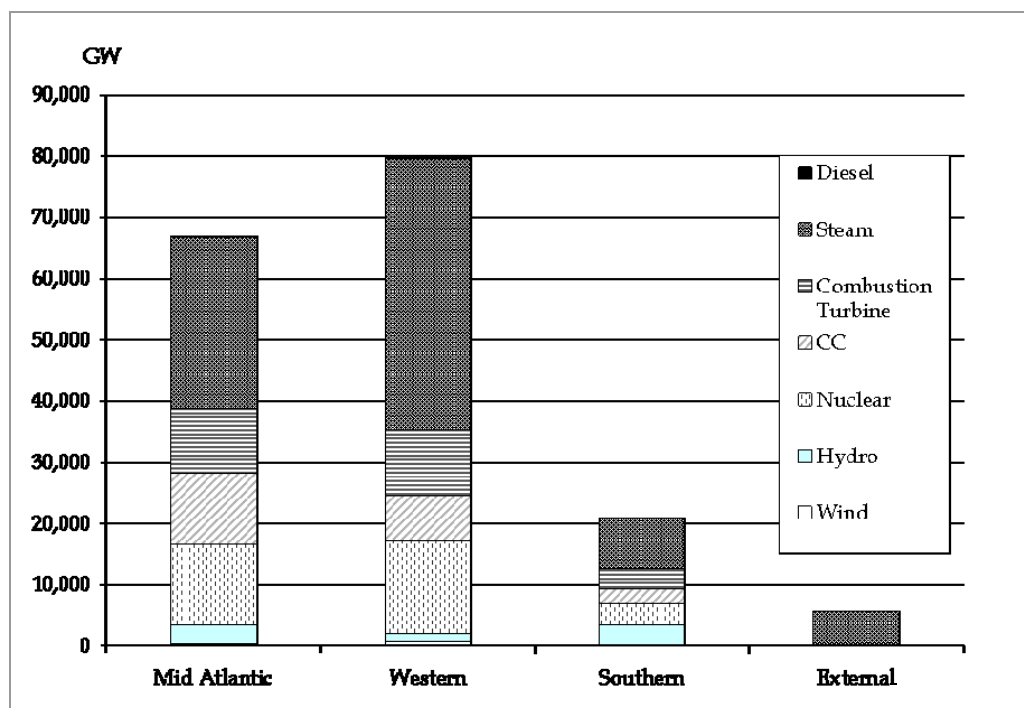
Figure 3 gives generation capacity in each main PJM region as of December 2008. It highlights the importance of steam generation (coal-fired) in the PJM generation mix, with the Western region relying significantly on coal mined in West Virginia and Tennessee, while the Mid-Atlantic region uses coal mined in Pennsylvania.

Figure 2 Resources Potentially Available for Electricity Generation, 2007



Source: EIA



**Figure 3 Generation Capacity by PJM Region**


Source: *State of the Market Report for PJM: Energy Market, Volume 2, 2008*, p. 163<sup>6</sup>

## 2.3 Demand

Table 2 shows annual load in the PJM area in recent years. Figure 4 shows growth in annual load in the states in which PJM operates. PJM accounted for about 54% of load in the states in which it operates, although there is considerable variation in PJM's share in individual states. Demand growth averaged 3.3% per year in the states where PJM control areas in the PJM Mid-Atlantic region are located. In the Western region states, demand growth was slower at 2.7%, while in the Southern region states, demand growth averaged 4.7% per year.

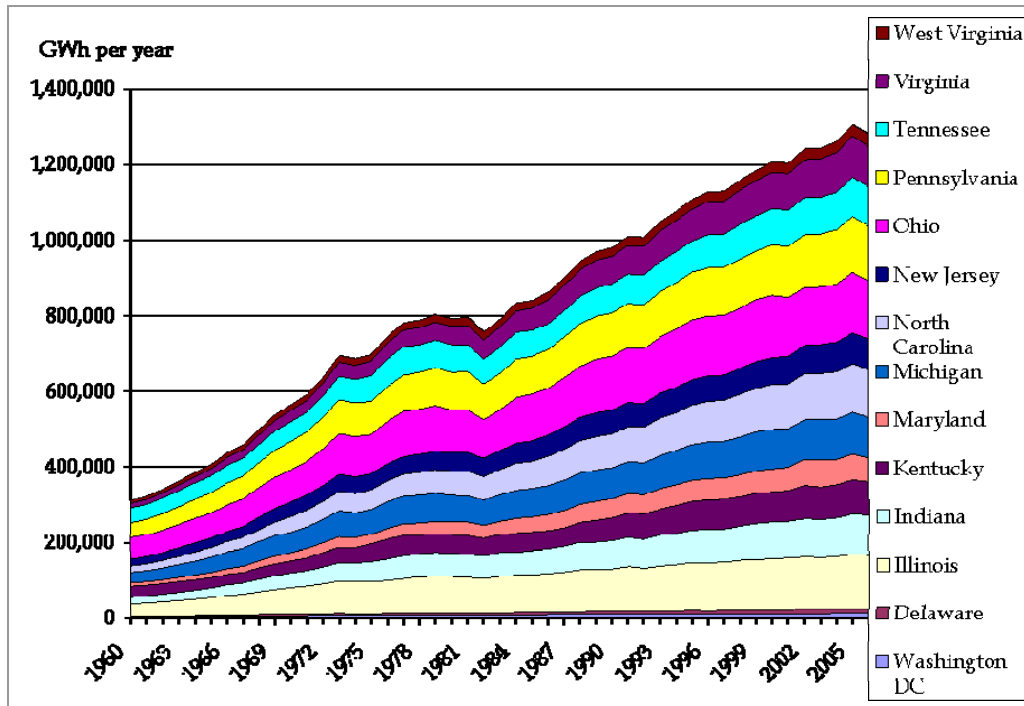
**Table 2 PJM Historical Load**

Year	Annual Net Load (GWh)
2005	682,441
2006	694,989
2007	724,541
2008	711,893

Source: PJM (accessed on 4.22.2009)

<sup>6</sup> The underlying data for the figure, including by utility control zone, are given in Table 6 in Annex A1; the regional groupings of PJM control areas are given in Table 11 in Annex A2.

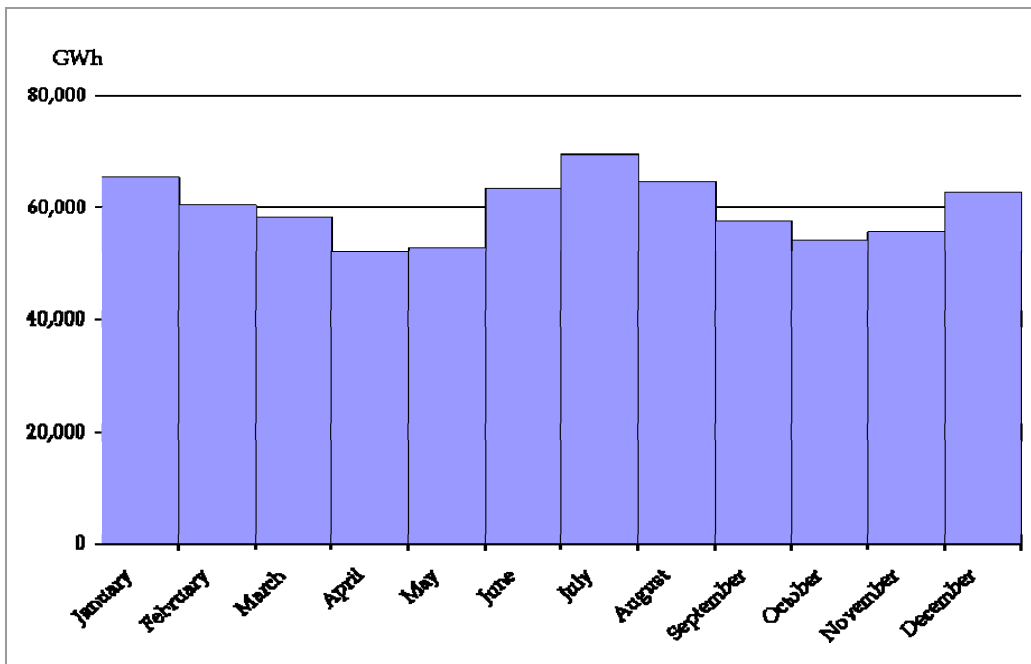
Figure 4 Growth in Demand in States Where PJM Operates



Source: EIA

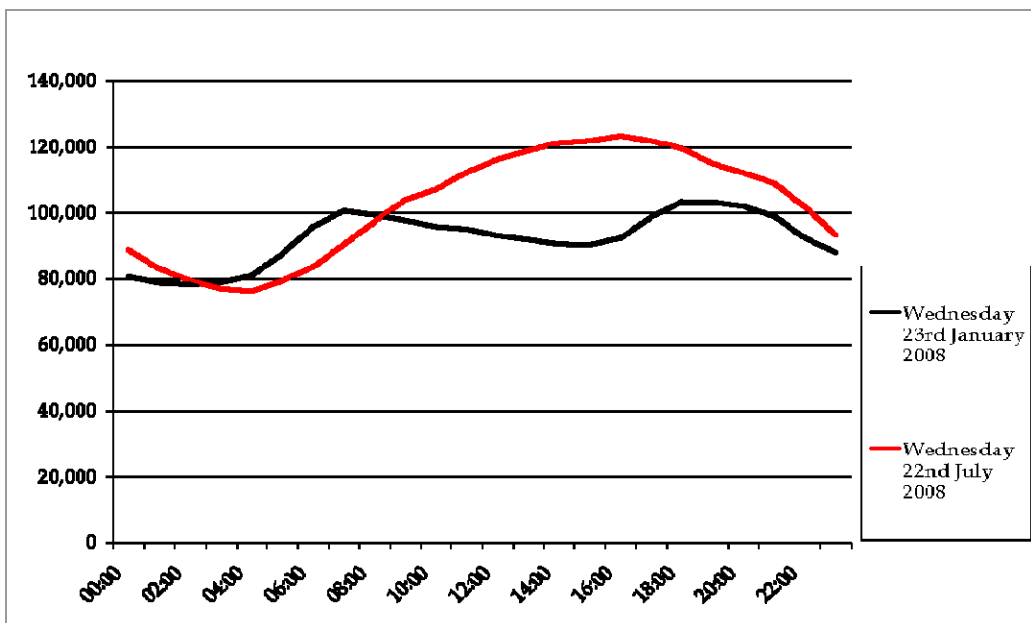
Figure 5 shows monthly load shape for the PJM regional transmission organization (RTO) control area, and Figure 6 gives typical summer and winter load shapes, showing how the PJM control area has a summer peak.

**Figure 5 Monthly Demand in the PJM RTO Area, 2008**



Source: PJM

**Figure 6 Daily Load in the PJM RTO Area, Summer and Winter Days**

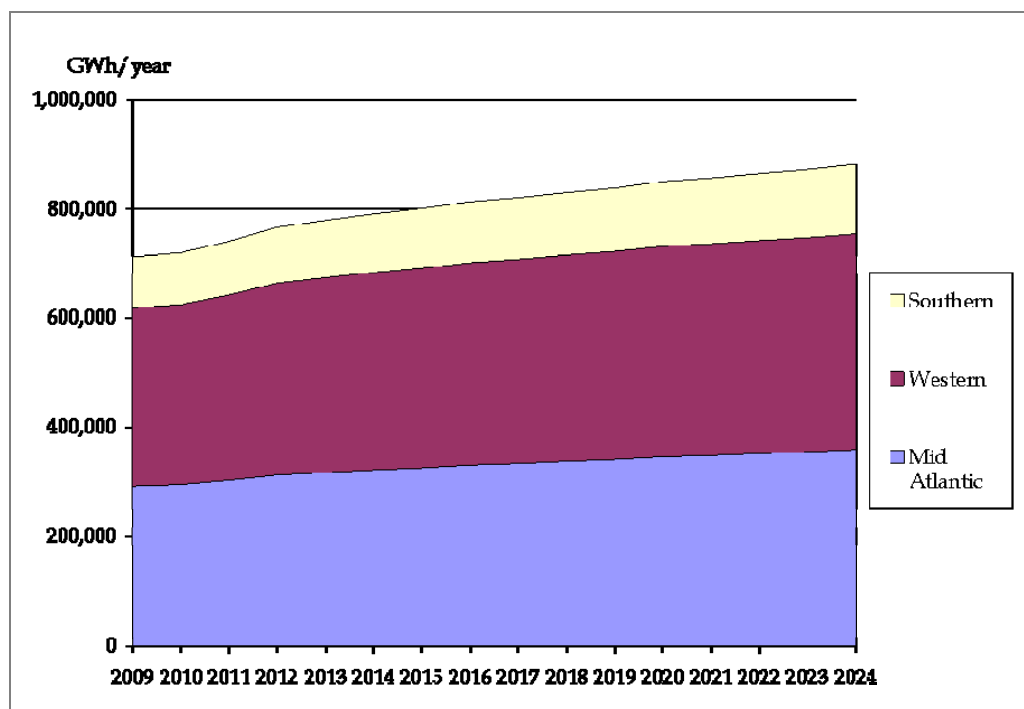


Source: PJM

PJM load forecasts are given in Figure 7. Annual growth of 1.4% per year is predicted for the PJM RTO area, with the fastest growth (1.4% per year) in the Southern region. Growth in the

Western region is forecast as slightly slower than the average at 1.3% per year while the Mid-Atlantic region is forecast to grow at 1.4% per year.

**Figure 7 Regional Demand Forecast**



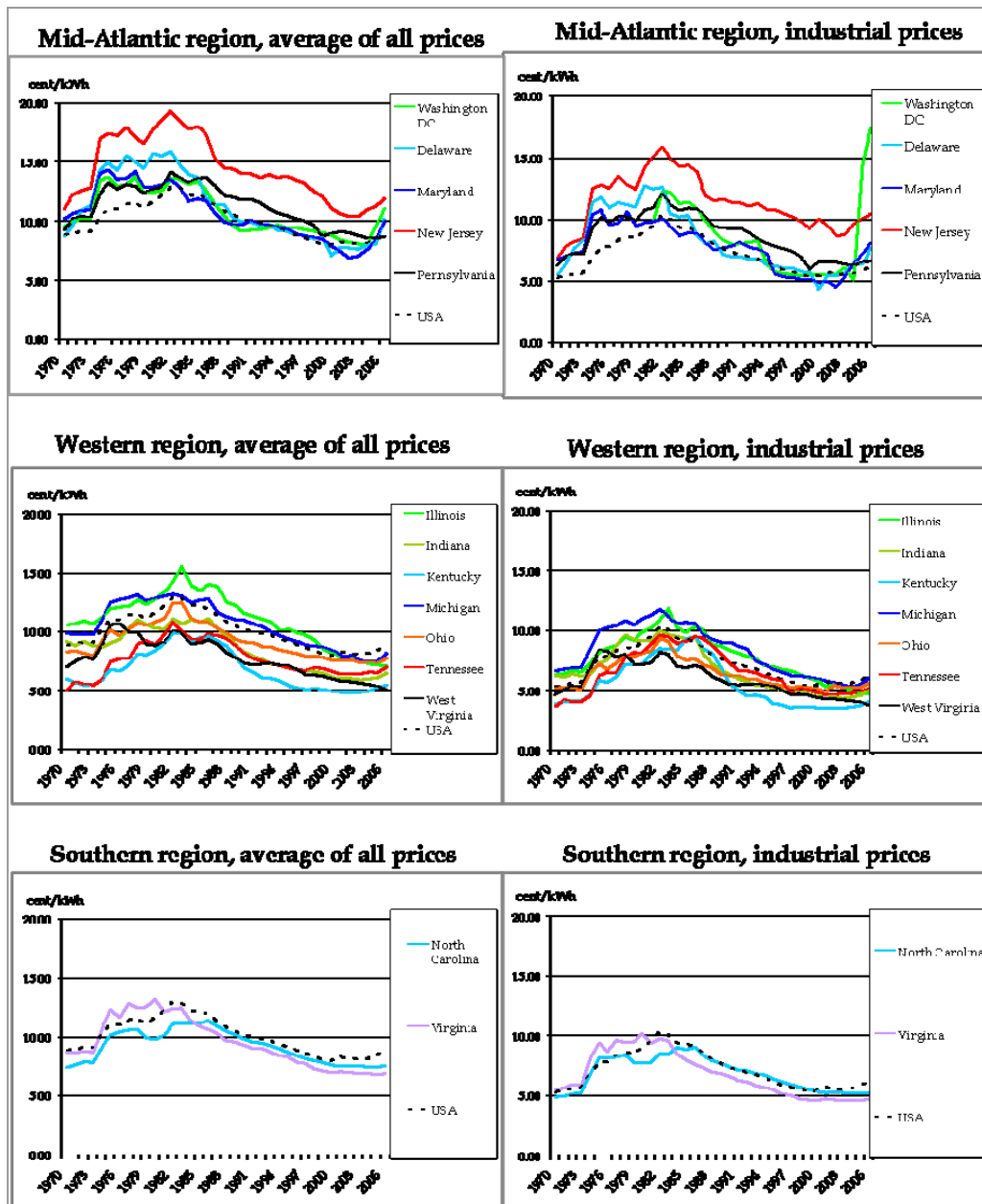
Source: PJM, "Load Forecast Report, 2009"<sup>7</sup>

## 2.4 Energy tariffs

In theory, regional power pools and related cross-border power transfers will promote convergence of consumer prices between regions, especially for larger-scale industrial consumers. Figure 8 explores this by plotting prices for the different states in which PJM has a presence. The data have been adjusted to 2006 values using the US Consumer Price Index. Figure 8 does not indicate convergence of prices between states in the PJM area. Using the USA price for comparison, there is a persistent differential between states in the same region of the PJM area. There is also a persistent variation in price levels between PJM regions, with prices in the Mid-Atlantic region above the average for the USA, while in the Western and Southern regions of PJM, prices tend to be just under the USA average price for most states.

<sup>7</sup> See Annex A2, Table 11 for definition of regions. The data used, including data for individual zones, are given in Table 12

Figure 8 Inflation-Adjusted Prices in PJM states (2006 = 100)



Source: EIA

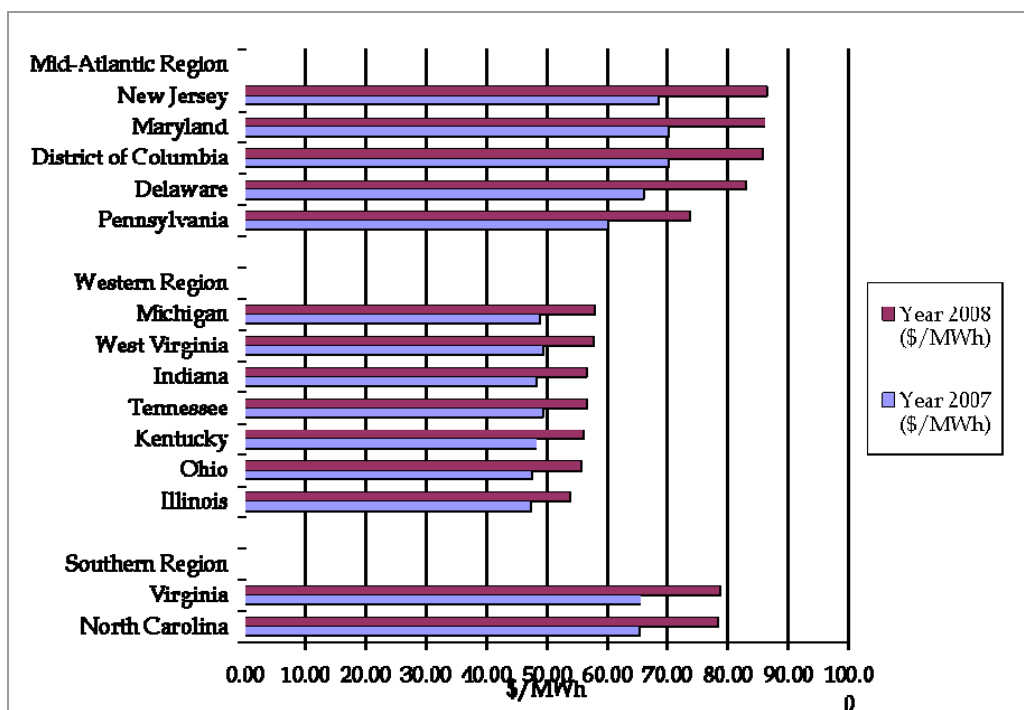
The retail price in any particular area is made up from a wholesale energy price with additional costs for transmission, distribution and tax.<sup>8</sup> In a common pooled area, the main expected convergence would be in wholesale prices.

Wholesale energy pricing in PJM settlements is done via the bid-based locational marginal pricing (LMP) approach. The LMP approach calculates the cost of supplying the next unit of

<sup>8</sup> In the PJM pricing methodology, the transmission costs are built into the wholesale prices.

energy at a specific location taking into account generation cost, transmission congestion and losses. Figure 9 shows how LMP prices differ from state to state for the years 2007 and 2008.

**Figure 9 Locational Marginal Prices by State, 2007 and 2008<sup>9</sup>**



Source: *State of the Market Report for PJM: Energy Market*, part 1, 2008, p.70

The wholesale price levels shown in Figure 9 partly explain differences in retail price levels between PJM regions, but do not, on the whole, explain differences within regions. The partial exception is the lower retail prices faced by consumers in Pennsylvania where the wholesale price is also lower.

The LMP methodology and its implications are discussed in Section 5.3.

Table 3 shows annual average day-ahead prices for the past five years.

<sup>9</sup> The data can be found on Table 13 in Annex 52.

**Table 3 Annual Average Day-Ahead Prices**

Year	Average Price (\$/MWh)
2004	41.69
2005	60.61
2006	50.07
2007	57.00
2008	69.88

Note: Source is PJM Western Hub (a basket of 109 buses from Erie PA to Washington, DC).

## 3 History of scheme

### 3.1 Overview including timeline/chronology

PJM was created in 1927 when three utilities decided to share their generating resources, forming the world's first cross-utility power pool.<sup>10</sup> PJM became an organization functionally independent of its utility members in 1993 when the PJM Interconnection Association was formed to administer the power pool. By 1997 PJM had become a completely independent organization. At that time, membership was opened to nonutilities and an independent board of managers was elected. Also, in 1997, PJM opened its first bid-based energy market, and the Federal Energy Regulatory Commission (FERC) approved it as the nation's first fully functioning independent system operator (ISO).<sup>11</sup> In 2001 it became the nation's first fully functioning regional transmission organization (RTO).<sup>12</sup>

**Table 4 Chronology of PJM Development**

Year	Event
1927	Three utilities in Pennsylvania and New Jersey realize the benefits of an interconnection and form a power pool.
1935	Federal Power Commission (created in 1930) becomes independent of government. Responsibilities included oversight of interstate electricity transfer and promotion of electrification.
1956	Baltimore Gas and Electric Company and General Public Utilities join the pool, which is renamed Pennsylvania-New Jersey-Maryland Interconnection, or PJM.
1965–1981	More utilities join; PJM continues being operated through the utilities.
1977	Federal Energy Regulatory Commission (FERC) replaces Federal Power Commission.
1978	Public Utility Regulatory Policy Act promotes energy procurement from 3 <sup>rd</sup> party generation
1992	Energy Policy Act empowers FERC to order utilities to buy from independent utilities.
1993	PJM becomes a neutral, independent organization; formation of PJM Interconnection Association.

<sup>10</sup> Utilities had started experimenting with least-cost dispatch once they had more than one power station, but this was the first where generation owned by different utilities was dispatched through a single dispatch process.

<sup>11</sup> ISOs operate, but do not own, transmission systems in order to provide open access to the grid for non-utility users.

<sup>12</sup> A Regional Transmission Organization (RTO) in the United States is responsible for moving electricity over large interstate areas. Like ISOs, they provide an open access system and operate but do not own transmission assets.



Year	Event
1996	FERC Order 888: "Promoting Wholesale Competition Through Open Access Non-discriminatory Transmission"  Services by Public Utilities; Recovery of Stranded Costs by Public Utilities and Transmitting Utilities
1997	PJM energy market commences as cost-based pool with market-clearing prices.  FERC approves PJM as the first fully functioning ISO in the US.
1998	PJM energy market based on LMP.
1999	PJM capacity markets start.  PJM FTR (Financial Transmission Rights) market introduced.
2000	PJM Regulation market commences.  Day-ahead energy market starts.  First program for customer load reduction.
2001	PJM becomes the first fully functioning RTO.
2002	PJM integrates Allegheny Power's five state transmission systems into the PJM Western region.  FERC approves PJM RTO status.
2003	Start of annual FTR auctions.
2004	ComEd, AEP and DAY Control Zones integrated into PJM.
2005	DLCO and Dominion Control Zones integrated into PJM.
2007	PJM holds first RPM (Reliability Pricing Model) auctions.  Marginal losses component added to Locational Marginal Prices.
2008	PJM starts Day-Ahead Scheduling Reserve market.  Separate Market Monitoring Unit created.

Source: Monitoring Analytics (2008a, 2008b)

## 3.2 Project concept, objectives, and development

The first PJM arrangements started in 1927 when three utilities realized the benefits and efficiencies that could be attained by interconnecting to share their generating resources. The resulting interconnection allowed Philadelphia Electric, Pennsylvania Power & Light, and

Public Service Electric & Gas of New Jersey to share load. The first goal of the interconnection was to meet power demands in Philadelphia.

More generally, the idea was to achieve economies of scale and to incorporate the benefits of diversity on both the generation side and the load side to drive down costs. When the three utilities signed the initial agreement it was based on an estimated savings of \$45 million for the time period 1927 to 1935.

PJM started out in 1927 as a simple agreement between utilities. The purpose of the power pool they created was to dispatch electric generating plants on a lowest-cost basis, thereby reducing the electric costs for all members of the pool. The initial pool had the city of Philadelphia as a primary load center with limited demand elsewhere in the region.

Significant expansion of the geographic region began in 1965 and led to the initial more serious consideration of transmission issues. Further transformation of the rules of the organization became necessary in 1978 when access to third-party generation had to be accommodated.

The current status as a regional transmission organization was approved in 2002, but the de facto operation of PJM Interconnection as an RTO can be dated from 1993 when the 1993 Operating Agreement was signed; this was later transformed into the current Operating Agreement when PJM converted from an association of utilities into a limited liability company. In its latest form, PJM Interconnection is a market operator that runs auctions and clearing markets that set wholesale prices for electrical energy, generating capacity, transmission capacity and several ancillary services. These markets cover both short-term energy markets and long-term capacity markets. In addition it undertakes long-term planning.

### 3.3 Feasibility studies done

PJM regularly carries out planning and feasibility studies. The PJM transmission feasibility study process currently embraces:

- o 2008 Regional Transmission Expansion Plan Report  
<http://www.pjm.com/documents/reports/rtep-report.aspx>

A central pillar of the PJM framework is the Regional Transmission Expansion Planning (RTEP) process, which identifies transmission system additions and improvements. Studies are conducted that test the transmission system against mandatory national standards and PJM regional standards. These studies look 15 years into the future to identify transmission overloads, voltage limitations and other reliability standards violations. PJM then develops transmission plans in collaboration with transmission owners to resolve violations that could otherwise lead to overloads and blackouts. This process culminates in one recommended plan – one RTEP – for the entire PJM footprint that is subsequently submitted to PJM’s independent governing board for consideration and approval.

- o Mid-Atlantic Power Pathway (MAPP)  
<http://www.pjm.com/documents/reports/rtep-report/~media/documents/reports/2007-rtep/2007-section3b.ashx>

This is a major proposed transmission investment. PJM RTEP analysis assessed the impact of the MAPP project on area load deliverability violations that are expected to occur over the 15-year planning horizon. All such plans require PJM approval.

PJM has a corresponding generation reserve planning process:

- o PJM Reserve Requirement Study, 2008  
<http://www.pjm.com/~media/committees-groups/committees/pc/20081015-item-04-2008-pjm-reserve-requirement-study.ashx>

The annual PJM Reserve Requirement Study (RRS) calculates the reserve margin that is required to comply with the Reliability Principles and Standards as defined in the PJM Reliability Assurance Agreement. This study is conducted each year. The study focuses on the process and procedure for establishing the resource adequacy (capacity) required to serve customer load with sufficient reserve for reliable service.

The results of the Reserve Requirement Study provide key inputs to the PJM Reliability Pricing Model (RPM). These values are used in the RPM auctions and are specifically used to determine the Variable Resource Requirement curve for the PJM Regional Transmission Organization (RTO). The Demand Resource Factor is used to determine the unforced capacity value of the two PJM load management products: Demand Resources that can be offered into the RPM auctions and Interruptible Load for Reliability that is nominated and certified prior to the delivery year.

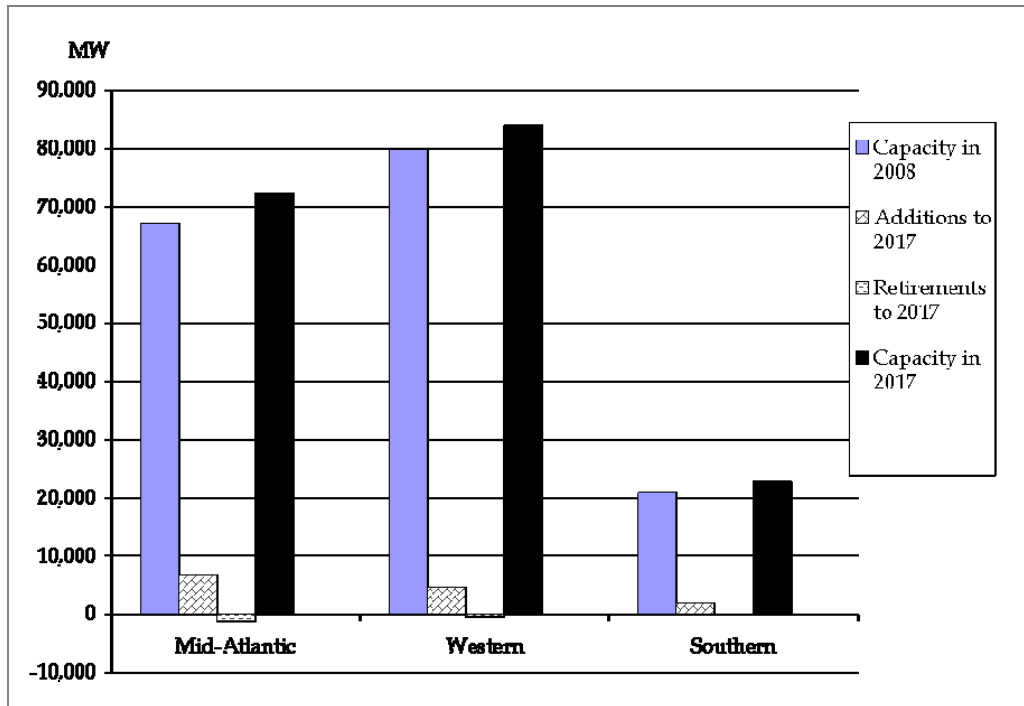
The results of the RRS are also incorporated into PJM's Regional Transmission Expansion Plan (RTEP) process.

### 3.4 Assets built and planned resulting (directly and indirectly) from scheme itself

In a scheme that has been in existence since 1927, all generation and transmission has been developed and renewed under the terms required for interconnection within the scheme. Looking ahead from the present, in the years to 2017, generation is planned to grow by 8% in the Mid-Atlantic region, by 5% in the Western region, and by 9% in the Southern region—an overall growth of 7%. Over that period, demand in the PJM region is forecast to grow by about 16%. The necessary generation additions which have been planned to 2017 are illustrated in Figure 10.<sup>13</sup>

<sup>13</sup> Based on PJM "Reserve Requirements Study, 2008"; Table 9 in Annex A1 is replicated from the study.

Figure 10 Capacity Additions by PJM Region to 2017



Source: PJM (data from Table 9 and Table 7)

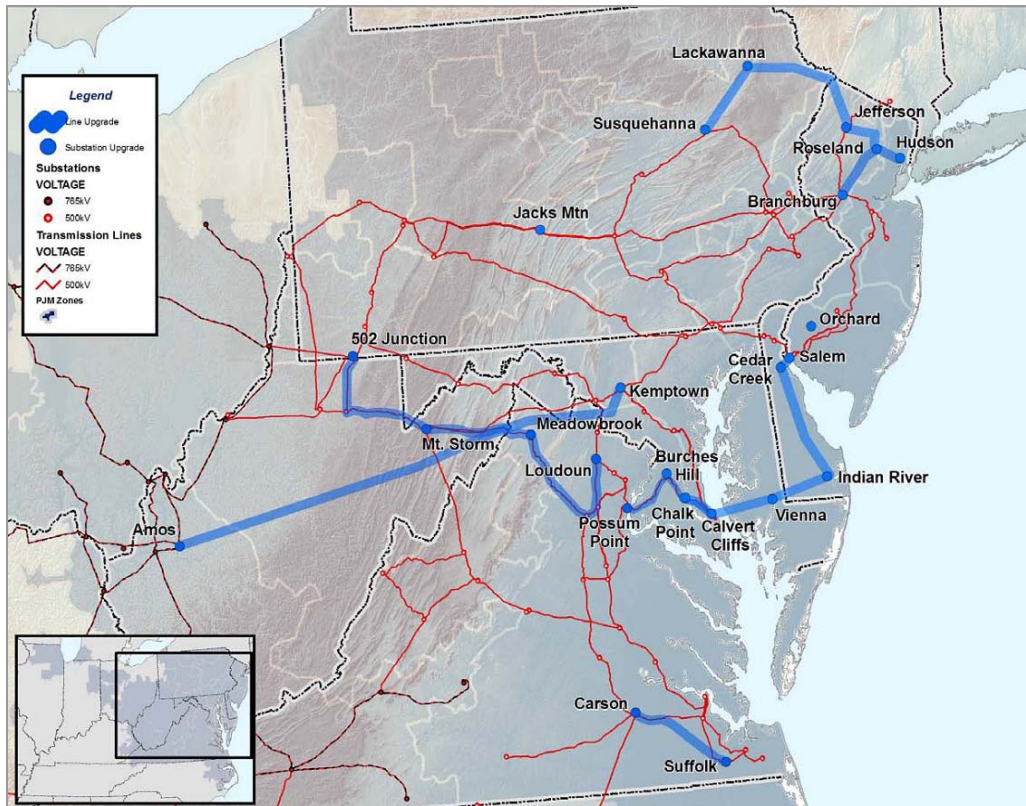
The transmission upgrades needed to meet demand are all planning driven within a framework of meeting the statutory North American Electric Reliability Council (NERC) Reliability Standards. The PJM Regional Transmission Expansion Plan (RTEP) is managed by the PJM Transmission Expansion Advisory Committee (TEAC) on an ongoing basis. The annual reports are summaries of plans approved in the preceding year.<sup>14</sup>

The 2008 *Regional Transmission Expansion Plan Report* states, "More than \$13.2 billion of transmission upgrades and additions, representing over 1,400 distinct transmission projects ranging from 69 kV to 765 kV, have been authorized by the PJM Board since the inception of the RTEP process in 1999, through December 2008. About \$11.3 billion of baseline transmission network upgrades across PJM ensure that established reliability criteria will continue to be met. At the same time, \$1.9 billion of additional transmission upgrades will enable the interconnection of more than 45,000 MW of new generating resources and merchant transmission projects."

Figure 11 reproduces the current approved reinforcements.

<sup>14</sup> See 2008 Regional Transmission Expansion Plan Report <http://www.pjm.com/documents/reports/rtep-report.aspx>

Figure 11 PJM Board-Approved Backbone Transmission Lines, 2008



Source: PJM 2008 *Regional Transmission Expansion Plan Report*, map 1.2, page 3.

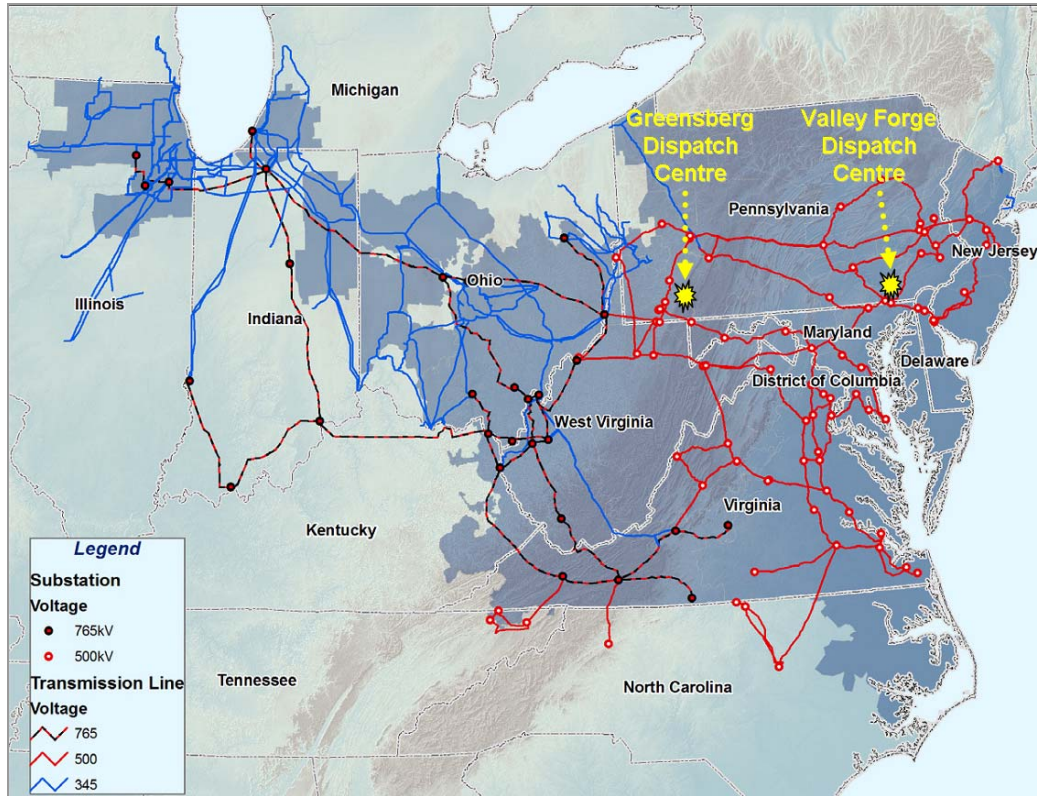
The projects considered include the **Mid-Atlantic Power Pathway (MAPP)** from Possum Point to Salem. It is a 500 kV line estimated to cost \$1.4 billion, due in service in 2013. There are five other reinforcements planned.

### 3.5 Interconnections and electricity trade

Figure 12 shows the PJM Interconnection LLC high-voltage transmission system. The system is dispatched from the Greensberg and Valley Forge dispatch centers, which work in close cooperation. The entire control area is therefore effectively dispatched as a single integrated system.



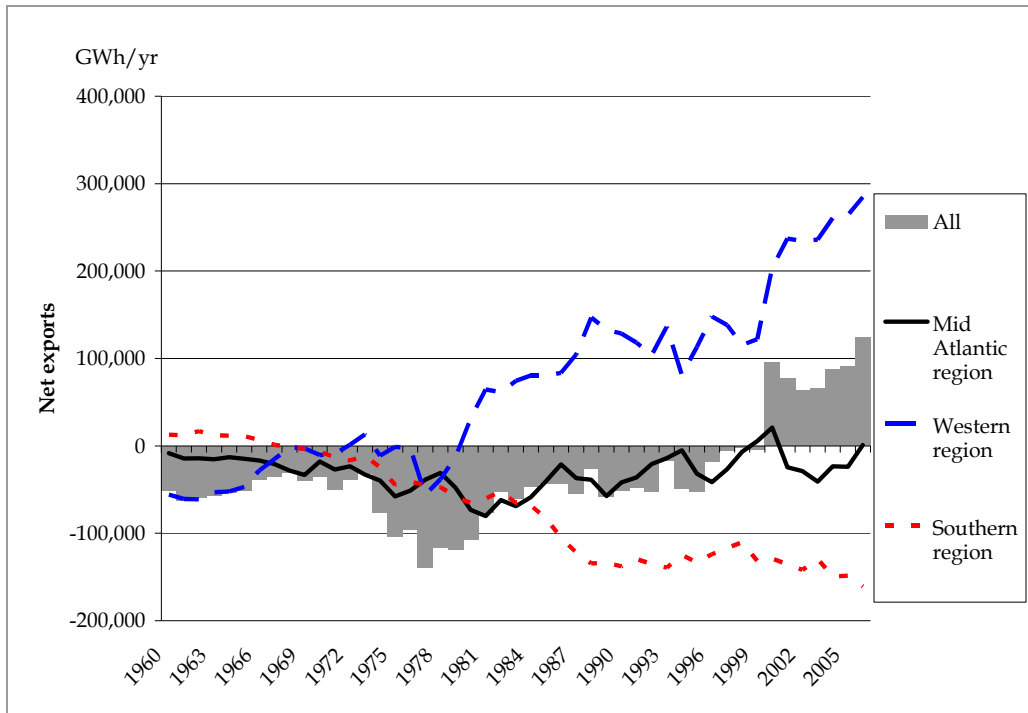
Figure 12 PJM Backbone Transmission System



Source: PJM 2008 *Regional Transmission Expansion Plan Report*.

Figure 13 shows EIA data for net exports by the states in which PJM has a presence. The pattern of inter-regional interchanges has changed considerably over the years, with the Western region becoming a significant exporter. The Southern region, with fast-growing demand, has become a net importer, while the Western region, with slower demand growth, has become a significant power exporter.

**Figure 13 Trends in Regional Net Energy Transfers<sup>15</sup>**

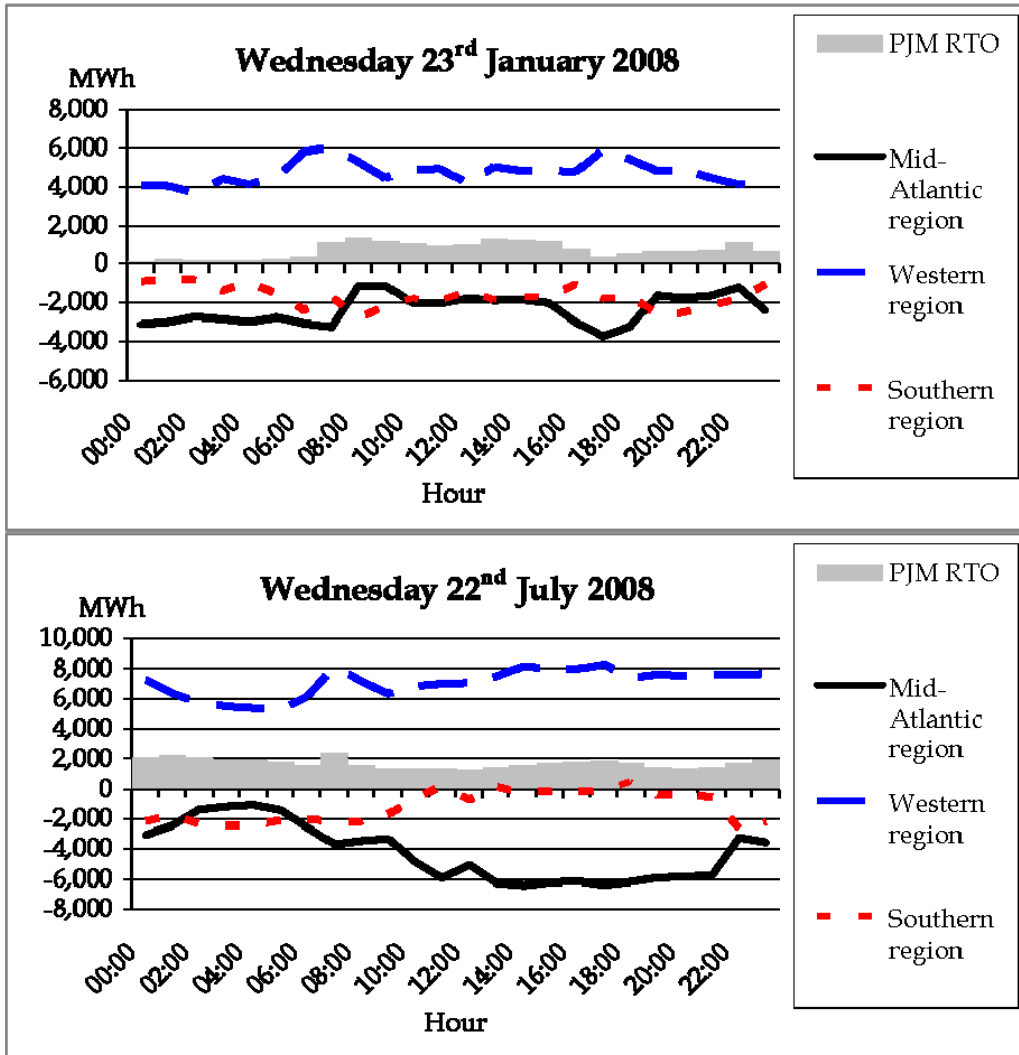


Source: EIA

Figure 14 shows hourly interchanges for typical summer and winter days and Figure 15 shows the monthly pattern of electricity transfer between PJM regions. The data are derived from PJM statistics of day-ahead scheduled interchange.

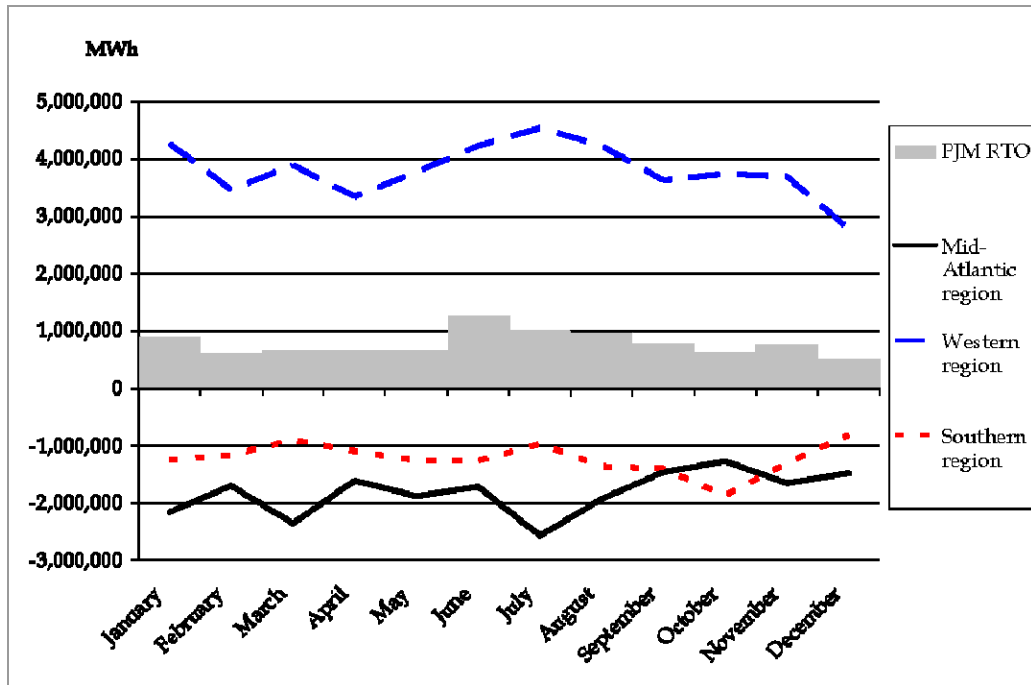
<sup>15</sup> Data for each state are given in Table 10 in Annex A1

Figure 14 Hourly Scheduled Day-Ahead Interchange



Source: PJM



**Figure 15 Monthly Pattern of Regional Transfer, 2008**


Source: PJM

The PJM market is essentially a day-ahead clearing market, and this is reflected in the hourly variation of inter-region transfers.<sup>16</sup> The Western region where the surplus generation is found seems to be providing a significant amount of the total seasonal and within-day flexibility that other regions need.

However, this is just a part of the overall surplus energy being transferred from the Western region. As a day-ahead market, it cannot effectively support long-term bilateral energy contracts. This problem was resolved in the PJM area soon after the single LPM clearing energy market commenced in 1997. The Financial Transfer Rights market commenced operation in 1999. In Section 5.1 a description is given of how these work to allow effective long-term bilateral contracts between participants in different regions or control zones.

### 3.6 Environmental and social issues

US environmental policy is implemented at the federal level by the Environmental Protection Agency (EPA). Until 2009, both state and federal environmental policy have been mainly restricted to rules governing pollution levels.

Over its history, environmental policy and renewable generation have played a very small role in development in the PJM area. However, in 2009, proposed connections of 48 GW of

<sup>16</sup> The PJM data give some transfer information for individual Western region control zones but not for the core PJM area of the Mid-Atlantic region, where all the statistics are presented in amalgamated form. Therefore, this analysis has been restricted to inter-regional transfers.

renewables capacity exceed the 44 GW of proposed connections of nonrenewable capacity. Nearly all proposed renewables are wind farms. If all the proposed renewables capacity is built, it will make a considerable contribution to output, noting that current total installed capacity connected to PJM is 165 GW.<sup>17</sup>

PJM is tracking renewable generation contributions and produces what it calls a “Dashboard” summarizing contributions since 2005.<sup>18</sup> It shows that, although hydro is the biggest contributor to renewables generation (7.1 TWh in 2008), wind is the fastest-growing technology. Even so, renewables will not have a significant impact on PJM operations for some time to come, and no significant plans have been made by PJM related to the ensuing reserve and dispatch issues that may arise.

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<sup>17</sup> Caution is needed in interpreting connection proposals – many proposals will not end up being developed.

<sup>18</sup> Renewable Energy Dashboard. <http://www.pjm.com/about-pjm/newsroom/renewable-dashboard.aspx>

## 4 Institutional arrangements

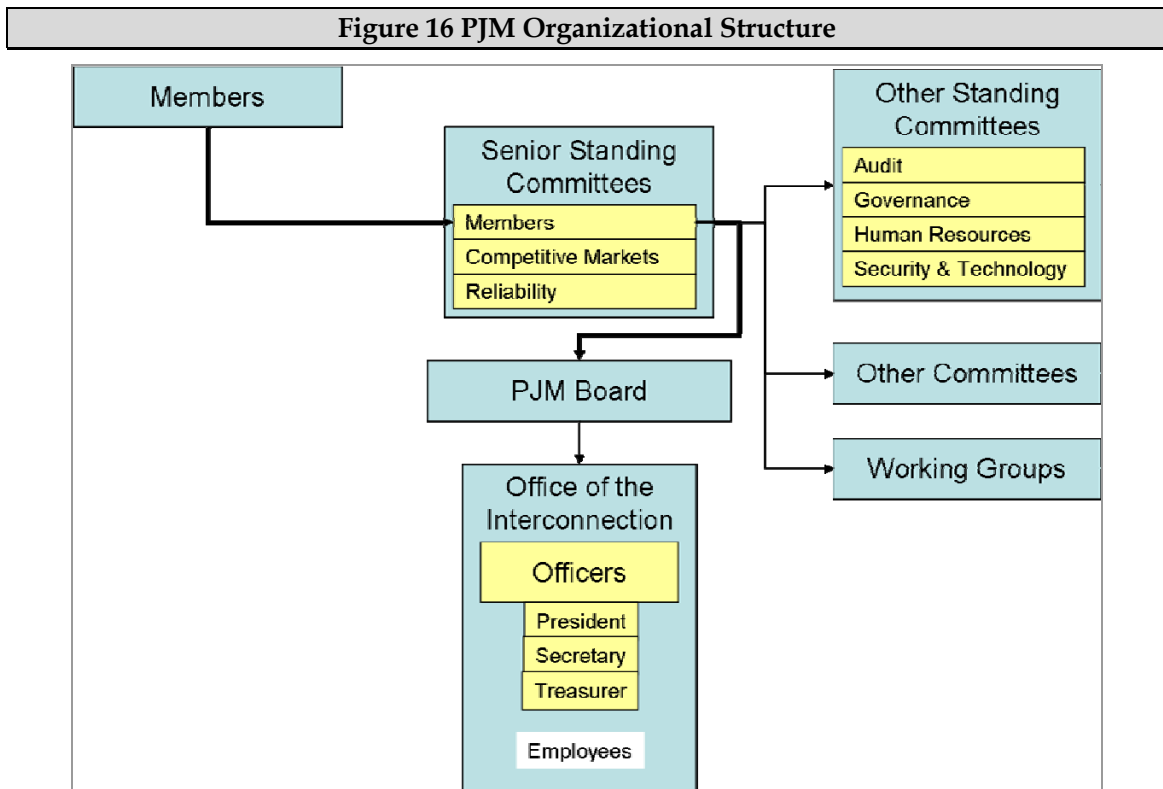
### 4.1 PJM governance arrangements

#### 4.1.1 Overview

The PJM governance structure has evolved as the nature of the organization has changed. This section describes only the current arrangements. PJM Interconnection LLC is a fully developed independent system operator (ISO) operating across state boundaries and covering the territories of several transmission owners. As a limited liability company incorporated in Delaware, it comes under that state’s jurisdiction, but for all practical purposes, it is regulated first by the Federal Energy Regulatory Commission (FERC) and also, for some issues, by the independent state regulatory commissions.

The governance structure is set out in, and put into effect by, the Operating Agreement that each market participant must sign. This then gives the market participant voting rights (unless joining as an affiliate or in a limited capacity) on the Members Committee.

#### 4.1.2 Governance structure



Source: Based on PJM Operating Agreement

PJM's governance structure was set up in such a way as to allow the ISO to have independence from the pressures of market participants in its decision-making process. To achieve independence, PJM relies on a two-tiered structure that includes a fully independent non-stakeholder Board of Governors (the PJM board) and a sectoral Members Committee to provide advisory support.

### **PJM Board**

The PJM board consists of nine voting members plus the president. It is responsible for maintaining system reliability and creating and maintaining competitive markets which do not allow any member or group of members to exert excessive influence. The PJM board is also in charge of operational matters. Members of the board cannot be affiliated with any party that has signed and is part of the PJM operating agreement. The Members Committee elects board members from a slate of candidates prepared by an independent consultant, not by the PJM members.

### **Members Committee**

The Members Committee (MC) consists of five sectors, which operate as electoral colleges. A member must decide in which sector its major interests lie (but other members can challenge where they believe that a member is in the wrong sector). The sectors represent the major types of participation:

- o Transmission owners – there are currently 58 (15 are voting members and the remainder are affiliates)
- o Generation owners – 117 (61 are voting members)
- o Electricity distributors – 42 (35 are voting members)
- o End-use customers – 26 (14 are voting members)
- o Other suppliers (i.e., traders and others that do not fit into another category) – 292 (224 are voting members).<sup>19</sup>

The MC reviews and decides upon all major changes and initiatives proposed by committees and user groups and provides advice and recommendations to PJM on all matters relating to:

- o The safe and reliable operation of the PJM grid,
- o The creation and operation of a robust, competitive and nondiscriminatory electric power market, and
- o Ensuring there is no undue influence over PJM's operations by any member or group of members.

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<sup>19</sup> The Operating Agreement describes "other suppliers" as traders in energy or capacity products who do not fit into any of the other categories.

The Members Committee meets at least annually.

## **Committees**

Committees are classified as senior committees and other committees. PJM's two senior committees are the Members Committee (MC) and the Markets and Reliability Committee (MRC). The MC provides advice and recommendations to the PJM board and the Office of the Interconnection on all matters relating to the safe and reliable operation of the PJM Control Area, the creation and operation of a robust, competitive and nondiscriminatory electric power market, and ensuring no undue influence over PJM's operations by any member or group of members. The MRC reports to the MC, as provided in the PJM Operating Agreement.

Other PJM committees monitor specific tasks on a continuing basis. These committees report to the senior committees.

Members appoint representatives to each committee.

Sectors have one vote each on senior standing committees.

## **Secretariat, administration and budget**

PJM Interconnection has a full-time secretariat known as the Office of the Interconnection. The senior officers are:

- o President, who supervises the Office of the Interconnection and is appointed by the PJM board on an annual contract
- o Secretary
- o Treasurer

According to the 2008 financial report, PJM Interconnection had an income of \$241 million.

PJM has about 600 employees.

### **4.1.3 PJM operations**

#### **Planning**

PJM operates an ongoing transmission planning function with a rolling 15-year planning horizon. As already noted in Sections 3.3 and 3.4, this is called the **Regional Transmission Expansion Plan** (RTEP). PJM maintains a standardized planning approach supervised by the Transmission Expansion Advisory Committee (TEAC). This committee reports to the PJM board for investment approvals.

The planning methodology is developed by the Regional Planning Process Working Group (RPPWG), which evaluates and makes recommendations to the Members Committee (MC) to reform the present interconnection queue and study process.

Planning is governed by the standards set by the North American Electric Reliability Corporation (NERC).<sup>20</sup> Some additional regional reliability standards may also apply. NERC standards relate to continuity of performance of the interconnected system. This means that there is no economic test governing the cost of any constraint. Therefore, investments are made to ensure that the reliability standards are met and are not driven by price differentials in markets either side of a constraint.

## Markets

PJM operates as an independent neutral operator of distinct electricity markets, with defined market rules. It provides analytical tools to its members as well as trading infrastructure in support of these markets and publishes operational data.

This section gives an overview of the markets set up. More details about the operational rules of the markets are given in Section 5.3. The main markets PJM operates are:

- o **Day-Ahead Energy Market.** This is a forward market in which hourly locational marginal prices (LMPs) are calculated for the next operating day based on generation offers, demand bids and scheduled bilateral transactions. Appended to the Day-Ahead Energy Market are the **Operating Reserve Business Rules**, which incentivize bidding close to expected real-time operation.
- o **Real-Time Energy Market.** This is a spot market in which current LMPs are calculated at five-minute intervals based on actual grid operating conditions. Real-time prices are available. PJM settles transactions hourly and issues invoices to market participants monthly.
- o **Reliability Pricing Model.** This is a capacity market model that works as a market for capacity three years out. It works in conjunction with PJM's Regional Transmission Expansion Planning (RTEP) process. Its features are:
  - o Procurement of capacity three years out through a competitive auction;
  - o Locational pricing for capacity that reflects constraints in the transmission system.
- o **Financial Transmission Rights (FTR) auctions.** FTRs are financial instruments that entitle the holder to a stream of revenues (or charges) based on the hourly congestion price differences across a specific transmission path in the Day-Ahead Energy Market.
- o **Synchronized Reserve Market.** Load-serving entities can meet their obligation to provide synchronized reserve to the grid by using their own generation, by purchasing it under contract with another party or by buying it on the Synchronized Reserve Market.
- o **Regulation Market.** Load-serving entities can meet their obligation to provide regulation to the grid by using their own generation, by purchasing the required

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<sup>20</sup> <http://www.nerc.com/>

regulation under contract with another party or by buying it on the Regulation Market.

- o **Transmission services.** PJM offers point-to-point firm and non-firm access services for specific bilateral routes from generators to loads. The fees for transmission fund PJM. They are set out in the PJM Open Access Transmission Tariff document.<sup>21</sup>

In 2008, PJM further supported market operation by spinning off its market monitoring unit into an independent company called Monitoring Analytics.<sup>22</sup>

### **Dispute resolution procedures**

PJM has defined dispute resolution procedures set out in Schedule 5 of its Operational Agreement. It includes mediation and arbitration processes. Arbitration decisions will be filed with the Federal Energy Regulatory Commission (FERC).

The PJM Operational Agreement is bound by US contract law.

## **4.2 Role of national governments and regional institutions**

The US Department of Energy (DOE) is in charge of “advancing the national, economic and energy security in the United States” ([www.energy.gov](http://www.energy.gov)). US federal policy on energy markets has been driven by various energy acts. The most important is possibly the Energy Policy Act of 1992. This gave wide powers to the Federal Energy Regulatory Commission (FERC), which has interpreted its role as encouraging the concept of the regional transmission organization (RTO). However, the development of the energy and capacity markets set up by PJM has been driven mainly by its members’ interests.

Individual states continue to have jurisdiction over retail tariffs.

## **4.3 Regulatory agencies**

The Federal Energy Regulatory Commission (FERC) was created through the Department of Energy Organization Act in 1977, when the Department of Energy was also established. Its predecessor, the Federal Power Commission, was abolished and its duties divided between FERC and the Energy Department.

FERC is an independent agency that regulates the interstate transmission of electricity, natural gas, and oil. FERC’s responsibilities with respect to electricity markets include:

- o Regulation of transmission and wholesale sales of electricity in interstate commerce

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<sup>21</sup> <http://www.pjm.com/documents/agreements/~media/documents/agreements/tariff.ashx>

<sup>22</sup> [www.monitoringanalytics.com](http://www.monitoringanalytics.com)

- o Licensing and inspection of private, municipal, and state hydroelectric projects
- o Ensuring reliability of high-voltage interstate transmission system
- o Monitoring and investigating energy markets
- o Using civil penalties and other means against energy organizations and individuals who violate FERC rules in the energy markets
- o Overseeing environmental matters related to natural gas and hydroelectricity projects and major electricity policy initiatives
- o Administering accounting and financial reporting regulations and conduct of regulated companies.

In the 1990s, following the Federal Energy Regulatory Commission (FERC) Order 880 that began the deregulation of the traditional utility companies, FERC began to develop the concepts of an independent system operator and a regional transmission organization, which allowed third-party entities to manage functions of the electric grid that were traditionally responsibilities of vertically integrated utility companies.

PJM was designated an RTO by FERC in 2001. FERC regulates PJM and approves its open access transmission tariff for the wholesale electricity market.

FERC is not involved with regulations for retail electricity tariffs, physical construction of electric generation, transmission, or distribution facilities nor the regulation of nuclear power plants (a task governed by the Nuclear Regulatory Commission).

#### **4.4 Role of outside agencies**

The North American Electric Reliability Council (NERC) is a transnational organization covering the United States as well as utilities in Mexico and Canada. It has no direct effect on trading within the PJM area but sets operational standards with which PJM must comply.

There are no other outside agencies of significant relevance to PJM.



## 5 Contractual, financial and pricing arrangements

### 5.1 Contracts

The primary contract governing PJM is the Operating Agreement, which is a civil contract between utilities. This defines membership of the market. However, the governance structure accommodates different types of member interests because there are effectively different types of contracts reflecting the different types of businesses participating in PJM.

#### Energy contracts

At the core of PJM is an agreement between mainly integrated utilities with both generation and load in a specific geographic area. The effective energy contract types recognized within the PJM area are:

- o **Self-supply.** Internal transfer from each utility's own generation to its own load-serving entity (LSE).<sup>23</sup> This accounted for 65.2% of all notified consumption in 2008. This is backed up by self-scheduling of a significant proportion of generation (43.1% in 2008).<sup>24</sup>
- o **Bilateral contract.** This is a transfer of energy between utilities in different zones. Bilateral contracts accounted for 14.6% of energy consumed in 2008.
- o **Spot sales.** Utilities bought 20.1% of their energy requirements through the PJM Day Ahead Energy Market in 2008.<sup>25</sup>

Pricing in self-supply or bilateral contracts is a private matter between the utilities involved, although the existence of the spot market will affect the pricing decisions made.<sup>26</sup>

#### Capacity contracts—generation

Load-serving entities (LSEs) have an obligation to provide generation capacity commitments sufficient to meet their share of predicted peak-hour demand. These generation commitments can be sourced from:

- o Own generation resources

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<sup>23</sup> A load-serving entity delivers energy to consumers. LSEs may be separate businesses but can also be the load-serving function of an integrated utility.

<sup>24</sup> Data are based on the Monitoring Analytics 2008 State of the Market Report, Volume 2

[http://www.monitoringanalytics.com/reports/PJM\\_State\\_of\\_the\\_Market/2008/2008-som-pjm-volume2.pdf](http://www.monitoringanalytics.com/reports/PJM_State_of_the_Market/2008/2008-som-pjm-volume2.pdf).

The reason why self-scheduling is so much less than self-supply is because some self-supplied capacity must still be offered into the day-ahead spot market if it has been developed with a forward commitment as defined under the PJM Reliability Pricing Model.

<sup>25</sup> Small volumes would also have been bought or sold in the real-time market

<sup>26</sup> Regulated companies will want their contracts for purchase of energy taken into consideration when setting regulated tariffs but the average wholesale spot prices will be the main benchmark used by the regulator when asked to approve tariffs, especially in the case of self-supply

- o Contracts for generation capacity
- o Capacity credits purchased in the capacity credits market.

The LSE obligation is locational; the generation must be physically deliverable at the relevant offtake point (i.e., any transmission needed from a remote location must be included in the declared commitment).

The PJM capacity credit contract was developed in 2007. Part of the planning process involves running the Reliability Pricing Model (RPM), which determines requirements for additional generation capacity (including reserves) and transmission upgrades as well as the locational price differentials that should be applied. Generators offer forward commitments to deliver energy from specific resources in a forward year in one of the following ways:

- o **Base residual auctions.** These are held in May for delivery in three years time. The capacity sold at auction is allocated to load-serving entities in the form of Financial Transmission Rights with price differentials determined by the RPM.
- o **Incremental auctions.** Up to three are held in the years between the base residual auction and the delivery year. The first and third incremental auctions cover adjustments to the amount of capacity in the forward commitment due to delays, cancellations or re-rating of the physical resource offered. The second incremental auction covers changes in the locational demand for resources between the base planning year and the delivery year.
- o **Bilateral contracts.** This market allows generators to procure resources to cover forward commitments made and allows LSEs to hedge against inadequate resource commitments. Additional generation resources and those covered by auctioned forward commitments can be sold in this secondary market. Bilateral contracts can be firm or non-firm. The non-firm contract is one where the seller only offers the capacity during periods where there is no congestion setting a differential energy price on the relevant point-to-point pathway.

### Capacity contracts—transmission

Financial Transmission Rights sold as forward commitments are allocated to load-serving entities in proportion to their peak demand levels. FTRs for generation that is not committed forward will also be allocated to LSEs in the same way. An FTR is essentially a right to transfer a certain volume of energy between two physical nodes on the system. As the name implies, this is a financial right rather than a physical right. The value of the FTR is an offset of locational marginal prices derived from the spot market. LMPs are described in Section 5.3. FTRs are tradable in the secondary market.

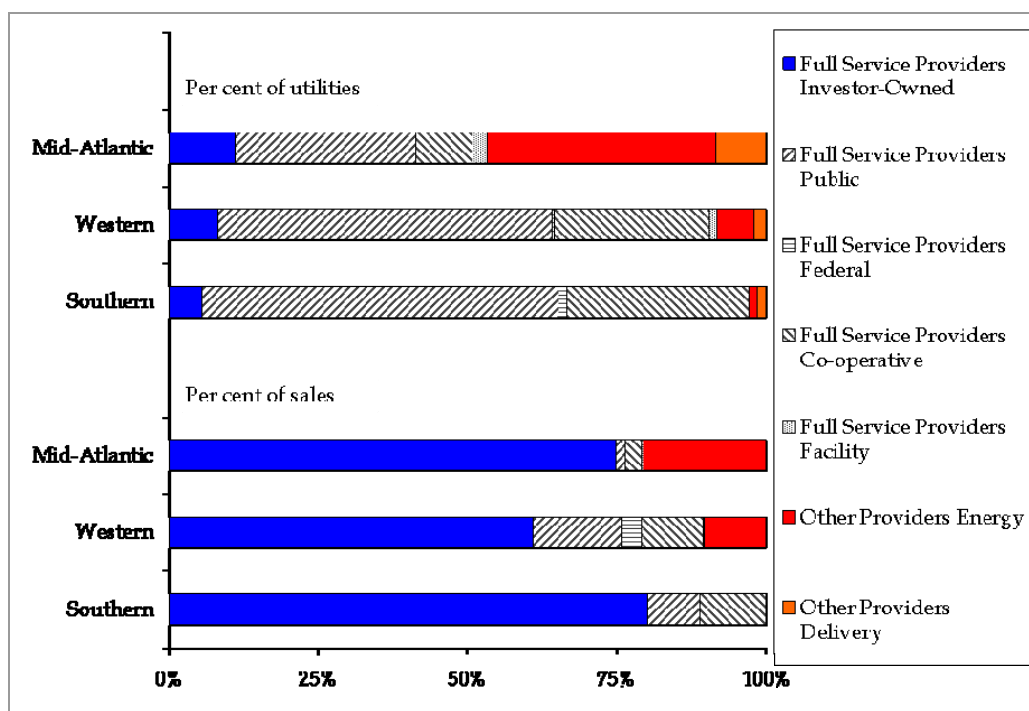
## 5.2 Ownership and finance

PJM Interconnection LLC is a limited liability company that owns no generation or transmission resources and never takes ownership of any of the energy transferred across the control area. It is a not-for-profit service provider to its members.

The structure of ownership of generation and transmission/ distribution assets varies considerably. Figure 17 shows that most energy is distributed and supplied by a small number of integrated utilities in the states in which PJM operates. However, these utilities are predominantly investor-owned. Only in the Mid-Atlantic region are competitive independent providers significant in energy delivery. The large numbers of publicly owned (including federally owned) and cooperatively owned utilities fail to have a significant impact on retail delivery volumes, although their impact at the very local level is significant for the consumers served.

The integrated utilities are the main owners of the transmission and distribution infrastructure and will be responsible for all investments in transmission.

**Figure 17 Ownership Structure of Load-Serving Entities, 2007<sup>27</sup>**



Source: EIA

Table 5 shows generation ownership in the different states. In the Mid-Atlantic region, nearly all the generation is owned by independent producers, but in the other regions, utilities own their own generation to a much greater degree. Therefore, in the Mid-Atlantic region most of the energy will be purchased under bilateral contract or from the spot market rather than by self-supply.

It should be noted that the utilities in the Western and Southern regions did not join PJM until 2002 or later. This may be a contributory factor in the differing generation ownership structure in comparison with the more established Mid-Atlantic region.

<sup>27</sup> See Annex A4, Table 14 and Table 15 for background data

**Table 5 Sales by Generation Ownership Type, 2007**

	Utility	Independent Power Producer & CHP
<b>Mid-Atlantic region</b>		
Washington DC	0%	100%
Delaware	1%	99%
Maryland	0%	100%
New Jersey	0%	100%
Pennsylvania	0%	100%
<b>Sub-total</b>	<b>0%</b>	<b>100%</b>
<b>Western region</b>		
Illinois	34%	66%
Indiana	89%	11%
Kentucky	88%	12%
Michigan	81%	19%
Ohio	65%	35%
Tennessee	97%	3%
West Virginia	74%	26%
<b>Sub-total</b>	<b>67%</b>	<b>33%</b>
<b>Southern region</b>		
North Carolina	95%	5%
Virginia	82%	18%
<b>Sub-total</b>	<b>90%</b>	<b>10%</b>
<b>Total</b>	<b>55%</b>	<b>45%</b>

Source: EIA

## 5.3 Pricing arrangements

### 5.3.1 Pricing principles

Wholesale prices and ancillary service prices should be set by competitive markets that are transparent and well informed. Analytical tools are supplied by PJM to help traders value all products. Generation should recover most of its fixed costs through contracts priced in the energy markets. However, the subsequent development of the Reliability Pricing Model suggests lack of faith in the ability of the market to deliver the required investment in the necessary time frame. One reason why insufficient investment may be forthcoming is that bidding in the day-ahead market is constrained to 10% above cost where congestion applies in order to limit local monopoly power of generation upstream of a transmission constraint.

There is a forward market for generation to commit to deliver and this provides some of the revenue for new generation investment. This same mechanism provides revenue for incremental transmission investments.

The cost of congestion is allocated to the parties who need to import energy across the congested route. However, the Reliability Pricing Model determines the amount and hence the value of extra capacity needed to provide secure operation of the system. The parameters of the model determine how much new generation and transmission capacity is needed, but it seeks to localize the costs of providing that capacity. The Reliability Pricing Model seeks to provide signals for merchant transmission investment but so far such independent investors have been very limited.

Fundamentally, PJM operates on the basis of short-run marginal costs and so does not seek to reduce price differentials between regions. The effect of its price signalling mechanism is to incentivize generation close to demand rather than incentivizing additional transit – the mechanisms for rewarding such transmission investment are not properly developed. Synapse Energy Economics reports:<sup>28</sup>

“There has been no significant merchant transmission activity within PJM, demonstrating that market signals alone are inadequate to produce such investments. The reasons for this are well understood. First, the presence of new transmission would reduce or eliminate the congestion costs (price signal) upon which the new transmission would depend, at least in part, to recover its embedded costs. Second, the benefits of such investments in terms of reduced transmission congestion are widely shared, and individual entities are reluctant to shoulder the burden themselves if there is no straightforward mechanism for sharing the cost.”

PJM mechanisms set wholesale prices. Retail prices are largely regulated and are set by state regulators.

### **5.3.2 Pricing mechanisms**

#### **Energy**

Energy pricing in PJM is done via the bid-based locational marginal pricing approach. The LMP approach calculates the cost of supplying the next unit of energy at a specific location taking into account generation cost, transmission congestion and losses. Essentially, if there is no transmission congestion, LMP prices should not differ over a given area. LMP pricing is meant to ensure open, transparent and nondiscriminatory transmission of energy.

LMP prices are set in the Day-Ahead Energy Market. All generators with capacity available (i.e., capacity not sold outside the PJM region, or as self-supply or under bilateral contract) must offer the capacity into the Day-Ahead Energy Market. Generation capacity that has been sold with a forward commitment contract (as described in Section 5.1) must be offered into the Day-Ahead Energy Market regardless of whether it has been sold under bilateral contract. Load-serving entities can offer demand-side bids into the market but will mainly be nominating the volume of energy they wish to buy in the Day-Ahead Energy Market.

Generators are free to set any price for their offers into the Day-Ahead Energy Market and are not constrained by costs. Monitoring Analytics LLC provides an annual market

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<sup>28</sup> Hausman et al. (2007)  
<http://www.appanet.org/files/PDFs/SynapseLMPElectricityMarketsExecSumm013107.pdf>

monitoring report<sup>29</sup> that investigates the extent to which market power may have been exercised in the setting of LMPs by generators.

The PJM system operator will then produce a market-clearing, least-cost schedule and will use curtailments on specific generation to assess the contribution of that generation to the marginal cost of serving load at each node. Generators are paid the LMP at their local transmission node, and LSEs pay the LMP at their local transmission node.

PJM's system operators conduct dispatch operations and monitor the status of the grid using telemetered data from nearly 74,000 reporting sites. PJM prepares extensive emergency and routine contingency scenarios, taking into account variables that could affect supply and demand such as weather conditions and emergency situations as well as the potential of equipment failures along with daily and seasonal demand fluctuations.

### **Capacity pricing**

With the energy market setting locational marginal prices, Financial Transmission Rights are made available for load-serving entities (LSE) to hedge the fluctuating cost of spot energy. FTRs are initially allocated to LSEs based on an assessment of peak demand, but they are tradable. The initial cost of an FTR is derived from sales in the auctions for forward commitments, but their value will be derived from the differential in LMP set for the node where the generation is injected into the system compared to the LMP set for the node where the demand is offtaken.

Although there are option products on offer, the FTR financial flows are derived from the price differential between nodes regardless of the direction of energy flow. Therefore, a party holding an FTR for a particular delivery route from Node A to Node B can pay a penalty if the LMP at Node A is higher than the LMP at Node B. FTRs are paid out or charged out regardless of whether energy has flowed under contract along the nodal route of the FTR.

### **Ancillary services**

PJM Interconnection also currently operates two markets for ancillary services:

- o **Synchronized reserves.** This service supplies electricity if the grid has an unexpected need for more power on short notice. The power output of generating units supplying synchronized reserve can be increased quickly; demand resources can also bid to supply synchronized reserve by reducing their energy use on short notice. Load-serving entities can meet their obligation to provide synchronized reserve to the grid by using their own generation, by purchasing it under contract with another party, or by buying it on the Synchronized Reserve Market.
- o **Regulation.** This service corrects for short-term changes in electricity use that might affect the stability of the power system. It helps match generation and

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<sup>29</sup> Monitoring Analytics (2008b)  
[http://www.monitoringanalytics.com/reports/PJM\\_State\\_of\\_the\\_Market/2008/2008-som-pjm-volume2.pdf](http://www.monitoringanalytics.com/reports/PJM_State_of_the_Market/2008/2008-som-pjm-volume2.pdf)

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load and adjusts generation output to maintain the desired frequency. Load-serving entities can meet their obligation to provide regulation to the grid by using their own generation, by purchasing the required regulation under contract with another party or by buying it on the Regulation Market.

## 6 Future plans

PJM is essentially a service provider to its members. Its growth and longevity are testimony to the services provided being useful to its members. As a service provider, it seeks to incrementally provide new tools and markets in which they can trade. The development of new markets and risk management tools make PJM the most sophisticated electricity trading market anywhere in the world.

The most significant recent development has been the Reliability Pricing Model (RPM), which links into PJM's regulatory obligation to plan and invest for future needs for reliable transmission and generation services. It satisfies this requirement by auctioning forward commitments to develop new facilities. However, it should be noted that the locational marginal pricing market that began operation in 1998 was intended to provide full incentives for investment in transmission, generation and demand-side response. The Financial Transmission Rights market that was introduced two years later effectively quantified the value of locational signals.<sup>30</sup> The introduction of the RPM signalled a belief that insufficient investment signals would come from the short-run energy market alone.

PJM has periodically expanded its membership since its inception. This fits into plans by FERC to develop a network of large regional transmission organizations to replace state-integrated utilities. Currently, PJM is one of the five RTOs.

For individual states, transmission should be operated by an independent system operator (ISO) according to the intentions of the Federal Energy Regulatory Commission (FERC). There are currently two ISOs. PJM has been in discussion with the Midwest Independent Transmission System Operator (MISO)<sup>31</sup> and the New York Independent System Operator (NYISO) about amalgamating markets.

There is no doubt that PJM offers a service valued by its member utilities. However, it is not designed to equalize pricing between utility areas. During times of economic hardship, this could be seen as a defect by politicians who may be loath to allow what they might perceive as excess profits flowing to monopoly businesses in local areas. This will limit the ability of future utilities to participate in PJM.

Going forward, the continuing challenges to PJM will include:

- o Meeting future changes in federal energy policy. The new presidency has ambitions to develop renewables and put more emphasis on conservation measures. Operation of a grid in which large volumes of wind are dispatched will put strains on existing market mechanisms, which rely on the system operator to provide physical balancing and to allocate costs of doing so fairly generally. More precise balancing incentives may be needed in the future.
- o Socialization of transmission investment costs. It seems clear that reliance on short-run locational marginal cost signals means that price differentials will

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<sup>30</sup> Locational marginal prices provide a single spot price covering both energy and locational generation and transmission costs.

<sup>31</sup> Despite its name, this should be classed as an RTO.



persist. The mechanism for rewarding specific transmission investments seems to be inadequate. The rewards for generators in low-cost regions selling to consumers in high-cost regions are not therefore being fully realized by those generators.

Outside of PJM's role as a wholesale transmission services provider is the development of retail competition. This is a challenge for regulation in the USA. The focus of competition policy has hitherto been driven by utilities that have little interest in allowing competing retailers within their delivery areas.

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<http://www.pjm.com/documents/agreements/~media/documents/agreements/oa.ashx>  
The PJM Operating Agreement governs how PJM operates. Members sign this agreement to be a part of PJM.

PJM: "By-Laws of PJM Interconnection, L.L.C."

<http://www.pjm.com/documents/~media/documents/corp-docs/by-laws.ashx> The PJM Bylaws, which are subordinate to the PJM Operating Agreement, include more detailed requirements of the governance and operation of the company; including, for example: composition of the PJM Board of Managers; frequency of Board meetings; standing PJM committees; and appointment of the company's officers.

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<http://www.pjm.com/documents/manuals.aspx> *The PJM manuals are the administrative, planning, operating and accounting procedures of the PJM Interconnection and are available below in PDF format. The previous version of each manual is also posted below for comparison of the changes that occurred between the current and prior version of the manual. Some that have been used in this study are located at:* <http://www.pjm.com/~media/training/nerc-certifications/m12v12.ashx>

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## A1 Electricity supply

As of December 2008, about 164,895 MW of generating capacity was available for dispatch in the area covered by PJM. Table 6 shows the capacity breakdown by fuel type as of 31 December 2008.

All-time peak demand occurred in the summer of 2006: 144,644 MW. Peak demand has decreased to 139,428 MW in 2007 and 130,100 MW in 2008. The reserve margin as of summer 2008 was 26% with reserve capacity of 34,079 MW.

**Table 6 PJM Installed Capacity by Fuel Source**

Fuel	MW	Percent
Coal	67,065	40.7%
Oil	10,715	6.5%
Gas	48,340	29.3%
Nuclear	30,468	18.5%
Solid waste	665	0.4%
Hydroelectric	7,476	4.5%
Wind	166	0.1%
<b>Total</b>	<b>164,895</b>	<b>100%</b>

Source: Monitoring Analytics (2008b), p. 156

Table 7 shows the capacity as of 2008 broken down by utility control zone. The total figure reported by PJM does not exactly correspond with the figure given in Table 6.

Table 8 shows generated energy distributed by fuel source for the year 2008.

Table 7 PJM Installed Capacity by Zone and Fuel Source

	CC	Combustion Turbine	Diesel	Hydro	Nuclear	Steam	Wind	Total
<b>AECO</b>	<b>155</b>	<b>528</b>	<b>17</b>	<b>0</b>	<b>0</b>	<b>1,108</b>	<b>8</b>	<b>1,816</b>
<b>BGE</b>	<b>0</b>	<b>872</b>	<b>0</b>	<b>0</b>	<b>1,735</b>	<b>2,897</b>	<b>0</b>	<b>5,504</b>
<b>DPL</b>	<b>1,088</b>	<b>801</b>	<b>88</b>	<b>0</b>	<b>0</b>	<b>1,825</b>	<b>0</b>	<b>3,802</b>
<b>JCPL</b>	<b>770</b>	<b>1,224</b>	<b>13</b>	<b>400</b>	<b>619</b>	<b>10</b>	<b>0</b>	<b>3,036</b>
<b>Met-Ed</b>	<b>1,370</b>	<b>417</b>	<b>0</b>	<b>19</b>	<b>786</b>	<b>819</b>	<b>0</b>	<b>3,411</b>
<b>PECO</b>	<b>2,497</b>	<b>1,503</b>	<b>6</b>	<b>1,618</b>	<b>4,492</b>	<b>2,022</b>	<b>0</b>	<b>12,138</b>
<b>PENELSC</b>	<b>0</b>	<b>332</b>	<b>35</b>	<b>495</b>	<b>0</b>	<b>6,805</b>	<b>119</b>	<b>7,786</b>
<b>Papco</b>	<b>1,134</b>	<b>1,317</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>4,781</b>	<b>0</b>	<b>7,232</b>
<b>PPL</b>	<b>1,674</b>	<b>462</b>	<b>34</b>	<b>568</b>	<b>2,289</b>	<b>5,515</b>	<b>113</b>	<b>10,655</b>
<b>PSEG</b>	<b>2,933</b>	<b>2,993</b>	<b>21</b>	<b>11</b>	<b>3,333</b>	<b>2,279</b>	<b>0</b>	<b>11,590</b>
<b>Mid Atlantic</b>	<b>11,621</b>	<b>10,449</b>	<b>214</b>	<b>3,111</b>	<b>13,274</b>	<b>28,061</b>	<b>240</b>	<b>66,970</b>
<b>AEP</b>	<b>4,272</b>	<b>2,773</b>	<b>0</b>	<b>1,011</b>	<b>2,093</b>	<b>21,015</b>	<b>0</b>	<b>31,164</b>
<b>APS</b>	<b>1,129</b>	<b>264</b>	<b>43</b>	<b>80</b>	<b>0</b>	<b>7,878</b>	<b>81</b>	<b>9,475</b>
<b>ComEd</b>	<b>1,790</b>	<b>6,404</b>	<b>0</b>	<b>0</b>	<b>11,448</b>	<b>7,094</b>	<b>734</b>	<b>27,470</b>
<b>DAY</b>	<b>0</b>	<b>1,316</b>	<b>44</b>	<b>0</b>	<b>0</b>	<b>4,805</b>	<b>0</b>	<b>6,165</b>
<b>DLCO</b>	<b>272</b>	<b>45</b>	<b>0</b>	<b>0</b>	<b>1,630</b>	<b>3,524</b>	<b>0</b>	<b>5,471</b>
<b>Western</b>	<b>7,463</b>	<b>10,802</b>	<b>87</b>	<b>1,091</b>	<b>15,171</b>	<b>44,316</b>	<b>815</b>	<b>79,745</b>
<b>Dominion</b>	<b>2,515</b>	<b>3,226</b>	<b>105</b>	<b>3,321</b>	<b>3,459</b>	<b>8,342</b>	<b>0</b>	<b>20,968</b>
<b>Southern</b>	<b>2,515</b>	<b>3,226</b>	<b>105</b>	<b>3,321</b>	<b>3,459</b>	<b>8,342</b>	<b>0</b>	<b>20,968</b>
<b>External</b>	<b>0</b>	<b>0</b>	<b>6</b>	<b>0</b>	<b>0</b>	<b>5,645</b>	<b>0</b>	<b>5,692</b>
<b>Total</b>	<b>21,599</b>	<b>24,477</b>	<b>411</b>	<b>7,323</b>	<b>31,904</b>	<b>86,364</b>	<b>1,055</b>	<b>173,334</b>

Source: State of the Market Report for PJM: Energy Market Volume 2, 2008, p. 163

Table 8 PJM Generation by Fuel Source

Fuel	GWh	Percent
Coal	404,719	55.0%
Oil	1,918	0.3%
Gas	53,552	7.3%
Nuclear	254,379	34.6%
Solid Waste	5,021	0.7%
Hydroelectric	12,341	1.7%
Wind	3,313	0.5%
<b>Total</b>	<b>735,244</b>	<b>100%</b>

Source: Monitoring Analytics (2008b), p. 157

Table 9 New and Retiring Generation Within PJM RTO, 2008-2017

Zone Name	Total Additions (MW)	Retirements (MW)	Total
AEC	897	0	897
AEP	2,011	0	2,011
Allegheny Energy (APS)	1,329	0	1,329
BGE	435	0	435
ComEd	1,135	299	836
Dayton	24	0	24
DomVP	1,840	0	1,840
DPL	251	178	73
JCPL	106	0	106
ME	296	0	296
PECO	1,000	0	1,000
PEPCO	1,017	790	227
PPL	1,221	0	1,221
PennElec	622	0	622
PSEG	887	355	532
<b>Grand Total</b>	<b>13,071</b>	<b>1,622</b>	<b>11,449</b>

Source: PJM, "Reserve Requirement Study 2008," Table II-8, p. 28

Table 10 Net Exports by US State, TWh

		1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
Mid-Atlantic Region	Washington DC	-5.6	-6.6	-7.2	-7.7	-8.1	-10.4	-9.9	-10.3	-7.7	5.2	-6.3	-10.2	-9.0	8.4	-9.7	-14.9
	Delaware	0.7	0.8	1.1	1.2	1.4	0.8	2.2	2.3	1.0	0.4	1.6	0.9	-0.6	0.3	3.3	1.5
	Maryland	-1.7	-2.7	-1.6	-0.5	0.0	5.2	4.7	5.5	3.0	3.0	-4.8	-8.5	-2.7	8.9	-1.9	-9.7
	New Jersey	-3.8	-3.5	-7.1	-7.3	-3.5	-5.3	-3.5	-9.4	-10.9	-11.7	-3.8	-17.1	-26.7	-29.0	-37.8	-69.7
	Pennsylvania	2.1	-0.3	0.7	-1.0	-0.8	5.0	-8.2	-8.7	-13.6	-13.9	-2.6	7.3	15.7	13.2	6.3	34.3
	Sub-total	-8.3	-14.3	-14.1	-15.3	-12.9	-14.7	-14.7	-20.9	-28.3	-33.3	-18.0	-27.2	-23.3	-32.9	-39.7	-57.9
Western region	Illinois	19.0	16.9	12.7	12.0	12.3	8.8	11.9	7.4	4.0	5.8	5.2	11.7	4.7	3.1	0.3	5.0
	Indiana	32.1	33.0	32.2	34.4	36.0	38.1	38.5	28.7	30.1	32.7	27.9	21.3	14.5	17.1	5.6	0.3
	Kentucky	-38.6	-37.1	-32.5	-20.8	-8.0	-1.2	1.1	9.1	1.1	8.8	26.1	30.5	27.7	20.8	21.0	-8.7
	Michigan	-11.4	-12.2	-10.8	-11.7	-10.9	-10.7	-6.2	-3.9	-6.7	-10.6	-11.6	-13.4	-25.5	-36.9	-33.7	-5.0
	Ohio	-49.0	-54.6	-52.6	-54.2	-56.9	-42.4	-47.5	-45.4	-42.8	-40.9	-49.5	-45.1	-57.1	-41.4	-62.0	-40.3
	Tennessee	-20.4	-24.7	-26.0	-31.2	-42.8	-46.3	-51.8	-47.5	-32.0	-38.6	-50.6	-51.1	-37.9	-34.6	-56.6	-73.1
	Wes: Virginia	12.4	18.1	16.9	18.6	18.4	16.7	26.0	36.3	45.1	51.5	52.4	60.3	84.4	105.1	114.7	120.3
Sub-total	-55.8	-60.6	-61.1	-52.9	-52.1	-47.1	-28.1	-15.2	-1.2	3.0	-18.5	-9.2	1.4	13.2	-11.3	-1.1	
Southern region	North Carolina	-0.5	-0.2	1.8	0.3	1.2	6.4	8.8	9.9	10.4	11.5	9.8	5.9	7.1	4.5	3.3	-21.9
	Virginia	13.3	12.4	15.0	11.6	10.5	4.6	-2.2	-8.3	-11.5	-19.0	-14.2	-19.4	-29.7	-16.0	-21.5	-22.6
	Sub-total	12.8	12.2	16.8	11.9	11.7	11.0	4.7	1.1	-1.0	-3.5	-4.4	-13.4	-16.6	-11.6	-18.8	-44.5
	All states	-61.3	-62.7	-64.4	-66.3	-63.3	-60.8	-38.2	-35.0	-30.6	-19.7	-34.9	-49.8	-38.5	-31.3	-35.8	-103.5
		1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Mid-Atlantic Region	Washington DC	-15.5	-14.4	-15.1	-18.1	-21.0	-22.0	-24.0	-24.8	-26.6	-27.1	-27.9	-28.3	-29.4	-31.0	-32.7	
	Delaware	1.6	1.8	2.5	1.6	1.1	8.0	4.4	10.4	8.2	6.3	3.9	3.9	3.4	0.3	-2.4	-1.5
	Maryland	-5.6	-3.3	-5.2	-8.0	-17.8	-25.0	-25.7	-22.0	-16.6	-30.7	-22.0	-34.9	-31.4	-30.6	-46.1	-48.1
	New Jersey	-71.0	-59.0	-67.5	-79.8	-74.0	-44.0	-42.9	-32.3	-38.5	-47.8	-32.4	-64.3	-73.6	-75.6	-85.6	-82.4
	Pennsylvania	39.2	36.5	52.5	56.6	38.6	22.6	46.2	50.1	63.1	78.4	113.4	86.9	91.1	98.4	141.3	128.7
	Sub-total	-51.2	-38.4	-38.9	-47.7	-73.2	-80.3	-62.0	-69.0	-58.6	-40.3	-21.2	-36.8	-38.6	-37.4	-41.7	-36.1
Western region	Illinois	16.5	8.6	11.7	2.1	-2.2	-3.1	-11.6	-12.3	-4.2	3.8	1.8	4.5	32.7	38.5	34.4	20.3
	Indiana	-4.1	-9.7	-14.8	-3.9	10.6	5.9	-0.7	10.3	49.2	30.8	26.6	20.6	26.7	29.1	55.7	46.9
	Kentucky	-6.2	-11.0	-1.1	-5.3	3.9	16.2	15.8	15.5	6.5	23.5	39.8	38.1	48.3	16.3	16.6	12.5
	Michigan	-17.0	-23.2	-5.0	-2.6	2.9	7.0	-7.3	-15.9	-21.5	-19.9	-17.8	4.2	0.7	8.3	7.8	30.3
	Ohio	-54.7	-73.1	-65.9	-53.5	-44.9	-40.0	-21.5	-37.4	-72.9	-78.4	-68.4	-63.1	-62.7	-76.5	-95.4	-83.1
	Tennessee	-67.4	-76.2	-65.5	-73.8	-73.2	-44.8	-44.3	-24.1	-34.9	-2.9	-57.6	-56.5	-60.0	-59.4	-34.9	-36.4
	Wes: Virginia	130.0	128.3	112.3	124.4	134.1	143.2	131.4	142.3	177.1	161.2	159.2	156.3	161.1	163.3	144.4	127.1
Sub-total	-2.9	-56.2	-34.2	-12.7	31.3	64.5	61.6	74.3	80.4	80.4	63.7	104.5	146.7	133.0	128.4	118.2	
Southern region	North Carolina	-12.1	-14.8	-20.9	-11.1	-9.2	9.8	5.8	-3.4	-3.0	-11.7	-29.5	-35.5	-44.6	-26.2	-51.2	-43.5
	Virginia	-38.9	-30.1	-26.2	-47.0	-55.9	-60.5	-57.9	-61.3	-65.3	-61.3	-75.5	-86.5	-89.7	-107.5	-86.7	-85.9
	Sub total	48.9	44.9	45.1	58.1	65.2	60.3	52.1	65.2	68.3	63.0	108.1	121.9	134.3	133.7	137.9	129.5
	All states	-95.1	-139.6	-116.2	-118.5	-107.0	-56.2	-32.2	-59.9	-46.4	-42.9	-42.6	-54.2	-26.2	-58.2	-51.2	-47.4
		1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	
Mid-Atlantic Region	Washington DC	-32.5	-33.2	-32.3	-32.9	-32.7	-32.7	-32.6	-33.3	-34.1	-34.5	-34.9	-34.3	-36.4	-36.7	-38.6	
	Delaware	-5.3	-4.9	-5.1	-4.5	-7.2	-12.6	-14.8	-15.3	-19.0	-17.9	-20.2	-19.3	-17.1	-16.7	-17.5	
	Maryland	44.7	42.3	42.9	48.1	49.6	45.4	37.9	40.6	46.0	53.0	76.8	74.9	61.5	61.0	50.7	
	New Jersey	-81.2	-75.5	-75.8	-86.8	-113.8	-64.9	-64.6	-65.7	-57.5	-43.1	-61.0	-76.1	-84.5	-84.2	-74.1	
	Pennsylvania	142.8	141.3	145.0	142.9	161.9	129.0	143.2	160.9	177.6	144.1	164.0	164.6	176.4	174.7	182.8	
	Sub-total	-20.7	-13.9	-3.1	-31.8	-41.4	-26.7	-4.7	5.5	20.9	-44.3	-28.9	-41.0	-23.2	-23.9	1.0	
Western region	Illinois	25.3	57.7	40.2	43.9	39.8	0.8	-4.7	71.5	108.4	120.1	118.6	134.5	133.6	123.6	131.7	
	Indiana	43.5	37.0	42.7	36.6	34.6	49.5	48.0	39.5	58.2	47.5	35.1	44.9	43.3	45.8	50.7	
	Kentucky	7.8	27.8	15.4	11.1	10.3	20.2	23.5	17.9	25.7	31.9	7.6	9.0	10.0	12.2	23.7	
	Michigan	0.8	25.8	-5.6	11.3	19.1	0.2	-26.8	-34.7	-30.2	4.6	7.6	-25.3	4.6	9.2	-4.8	
	Ohio	-73.1	-90.7	-114.4	-109.3	-95.2	-98.0	-85.5	-118.3	-94.5	-44.9	-70.9	-59.4	-56.7	-48.4	-27.7	
	Tennessee	-34.1	-62.4	-45.7	-24.7	-20.3	4.6	-12.6	-32.3	-33.3	-27.1	-43.1	-46.6	-38.9	-30.0	-56.4	
	Wes: Virginia	133.0	130.8	145.7	144.1	159.8	171.6	173.4	178.5	173.6	145.2	179.6	178.5	164.1	171.4	167.3	
Sub total	103.1	136.1	81.3	113.0	148.0	138.1	115.4	122.1	203.8	237.3	234.5	235.9	260.6	263.8	284.5		
Southern region	North Carolina	-50.1	-63.5	-40.1	-41.0	-34.8	-22.9	-26.7	-45.3	-42.7	-47.3	-43.4	-24.3	-42.2	-36.0	-39.4	
	Virginia	-84.9	-85.8	-84.6	-92.6	-89.2	-64.1	-83.6	-86.4	-86.2	-88.3	-99.5	-105.0	-107.1	-112.5	-121.7	
	Sub-total	-134.9	-139.3	-124.7	-133.6	-124.0	-116.9	-118.4	-131.8	-128.9	-135.6	-141.9	-129.3	-149.3	-148.5	-161.1	
	All states	-32.5	-17.2	-44.5	-52.3	-17.5	6.5	-1.7	-4.2	95.8	77.3	63.7	65.6	88.1	91.5	124.5	

Source: EIA

## A2 Electricity demand

Table 11 is derived from the PJM Load Forecast Report, 2009.<sup>32</sup> A regions map was given in Figure 1 on page 4. The zones are defined in the Reliability Assurance Agreement.<sup>33</sup>

**Table 11 PJM Regions and Zones**

Region	Utility	Abbreviation
<b>Mid-Atlantic</b>	Atlantic Electric	AECO
	Baltimore Gas & Electric	BGE
	Delmarva Power & Light	DPL
	Jersey Central Power & Light	JCPL
	Metropolitan Edison	METED
	PECO Energy	PECO
	Pennsylvania Electric Company	PENELEC
	Potomac Electric Power	PEPCO
	PPL Electric Utilities	PPL
	Public Service Electric & Gas	PSEG
	Rockland Electric (East)	RECO
UGI Utilities	UGI	
<b>Western</b>	American Electric Power	AEP
	Allegheny Power	APS
	Commonwealth Edison	COMED
	Dayton Power & Light	DAY
	Duquesne Lighting Company	DLCO
<b>Southern</b>	Dominion	DOM

Source: PJM, "Load Forecast Report, 2009"

<sup>32</sup> Report: <http://www.pjm.com/documents/~media/documents/reports/2009-pjm-load-report.ashx> Data: <http://www.pjm.com/documents/~media/documents/reports/2009-load-report-data.ashx>  
<sup>33</sup> <http://www.pjm.com/documents/agreements/~media/documents/agreements/raa.ashx>



**Table 12 PJM Annual Load Forecasts by Zone**

	Mid Atlantic										Western				Southern							
	AECO	BGE	DPL	ICPL	METED	FECCO	PE	PEPCO	PPL	PSEG	RECO	UGI	AEP	AFS	COMED	DAY	DLCO	Dom- inion	MID ATL- ANTIC	WEST- ERN	SOUTH- ERN	PJMRTO
<b>2009</b>	11,503	34,928	19,136	25,012	15,966	41,075	18,149	33,063	41,629	48,556	1,587	1,056	142,006	49,309	102,616	17,979	14,615	94,051	291,660	326,525	94,051	712,236
<b>2010</b>	11,765	35,520	19,230	25,571	16,153	40,962	18,252	33,391	41,822	49,328	1,609	1,057	142,454	50,176	104,175	18,014	14,562	95,372	294,660	329,401	95,372	719,433
<b>2011</b>	12,577	36,442	19,735	26,445	16,638	42,061	18,778	33,951	42,723	50,625	1,650	1,078	145,290	51,468	109,033	18,733	14,814	96,382	302,703	339,338	96,382	740,423
<b>2012</b>	13,366	37,054	20,397	27,469	17,191	43,377	19,426	34,655	43,879	52,109	1,694	1,106	149,273	52,674	115,402	19,718	15,190	102,277	311,723	352,257	102,277	766,257
<b>2013</b>	13,861	37,360	20,788	28,020	17,491	43,954	19,786	35,006	44,484	52,845	1,717	1,121	150,628	53,234	118,725	20,085	15,368	104,324	316,383	358,040	104,324	778,737
<b>2014</b>	14,190	37,944	21,161	28,503	17,759	44,557	20,197	35,404	44,940	53,576	1,741	1,129	151,951	53,882	121,300	20,312	15,587	106,246	321,141	363,032	106,246	790,419
<b>2015</b>	14,408	38,557	21,453	28,923	17,958	45,056	20,604	35,757	45,392	54,201	1,761	1,138	153,121	54,420	123,347	20,484	15,792	108,048	325,208	367,164	108,048	800,420
<b>2016</b>	14,659	39,308	21,805	29,426	18,201	45,684	21,096	36,241	45,898	54,988	1,785	1,147	154,634	55,141	125,647	20,710	16,047	110,327	330,238	372,179	110,327	812,784
<b>2017</b>	14,841	39,824	22,062	29,744	18,332	46,047	21,453	36,518	46,127	55,435	1,799	1,150	155,116	55,553	127,045	20,799	16,211	111,987	333,332	374,724	111,987	830,043
<b>2018</b>	15,055	40,450	22,401	30,122	18,514	46,515	21,882	36,913	46,483	55,999	1,819	1,154	156,021	56,155	128,730	20,920	16,412	114,075	337,307	378,238	114,075	829,620
<b>2019</b>	15,229	41,052	22,736	30,438	18,634	46,876	22,275	37,286	46,722	56,459	1,833	1,156	156,495	56,686	130,337	20,967	16,573	116,153	340,696	381,058	116,153	837,907
<b>2020</b>	15,445	41,814	23,167	30,851	18,851	47,400	22,757	37,791	47,173	57,173	1,857	1,164	157,804	57,539	132,435	21,143	16,802	118,677	345,443	385,723	118,677	849,843
<b>2021</b>	15,577	42,335	23,443	31,093	18,933	47,588	23,075	38,073	47,278	57,503	1,871	1,162	158,006	58,017	133,386	21,167	16,912	120,539	347,931	387,488	120,539	855,958
<b>2022</b>	15,737	42,985	23,792	31,420	19,053	47,877	23,442	38,467	47,504	58,008	1,888	1,164	158,655	58,673	134,446	21,245	17,063	122,817	351,347	390,082	122,817	864,246
<b>2023</b>	15,905	43,613	24,139	31,716	19,157	48,121	23,784	38,833	47,678	58,440	1,901	1,165	159,115	59,295	135,214	21,284	17,198	125,060	354,453	392,106	125,060	871,619
<b>2024</b>	16,122	44,357	24,560	32,108	19,328	48,499	24,194	39,309	48,003	59,027	1,919	1,168	159,966	60,082	136,311	21,360	17,374	127,671	358,594	395,093	127,671	881,358
<b>Annual Growth</b>	2.3%	1.6%	1.7%	1.7%	1.3%	1.1%	1.9%	1.2%	1.0%	1.3%	1.3%	0.7%	0.8%	1.3%	1.9%	1.2%	1.2%	2.1%	1.4%	1.3%	2.1%	1.4%

Source: PJM, "Load Forecast Report, 2009"

## A3 Prices

**Table 13 Day-Ahead Load Weighted LMP**

State	Year 2007 (\$/MWh)	Year 2008 (\$/MWh)	Difference (\$/MWh)	Difference as Percentage of 2007
Delaware	\$65.99	\$82.99	\$17.00	25.8%
Illinois	\$47.27	\$53.83	\$6.56	13.9%
Indiana	\$48.26	\$56.53	\$8.27	17.1%
Kentucky	\$48.09	\$56.02	\$7.93	16.5%
Maryland	\$70.07	\$85.98	\$15.91	22.7%
Michigan	\$48.73	\$57.83	\$9.10	18.7%
New Jersey	\$68.25	\$86.39	\$18.14	26.6%
North Carolina	\$65.10	\$78.13	\$13.03	20.0%
Ohio	\$47.43	\$55.72	\$8.29	17.5%
Pennsylvania	\$60.10	\$73.58	\$13.48	22.4%
Tennessee	\$49.30	\$56.50	\$7.20	14.6%
Virginia	\$65.42	\$78.63	\$13.21	20.2%
West Virginia	\$49.33	\$57.56	\$8.23	16.7%
District of Columbia	\$70.08	\$85.66	\$15.58	22.2%

Source: Market Analytics (2008a), p.70

## A4 Contracts

**Table 14 Number of Utilities by Ownership Type, 2007**

	Full Service Providers					Other Providers		Total
	Investor-Owned	Public	Federal	Co-operative	Facility	Energy	Delivery	
<b>Mid-Atlantic region</b>								
Washington DC	1	0	0	0	0	11	1	13
Delaware	1	9	0	1	0	11	1	23
Maryland	4	5	0	3	1	20	4	37
New Jersey	4	9	0	1	4	16	4	38
Pennsylvania	11	35	0	13	0	15	6	80
<b>Sub-total</b>	<b>21</b>	<b>58</b>	<b>0</b>	<b>18</b>	<b>5</b>	<b>73</b>	<b>16</b>	<b>191</b>
<b>Western region</b>								
Illinois	8	41	0	27	0	20	4	100
Indiana	6	72	0	41	0	0	0	119
Kentucky	4	31	1	24	1	0	0	61
Michigan	9	41	0	10	2	11	2	75
Ohio	8	85	0	25	0	6	6	130
Tennessee	3	62	1	25	4	0	0	95
West Virginia	11	2	0	3	0	0	0	16
<b>Sub-total</b>	<b>49</b>	<b>334</b>	<b>2</b>	<b>155</b>	<b>7</b>	<b>37</b>	<b>12</b>	<b>596</b>
<b>Southern region</b>								
North Carolina	3	72	1	32	0	0	0	108
Virginia	5	16	1	13	0	2	2	39
<b>Sub-total</b>	<b>8</b>	<b>88</b>	<b>2</b>	<b>45</b>	<b>0</b>	<b>2</b>	<b>2</b>	<b>147</b>
<b>Total</b>	<b>78</b>	<b>480</b>	<b>4</b>	<b>218</b>	<b>12</b>	<b>112</b>	<b>30</b>	<b>934</b>

Source: EIA

Table 15 Sales of Utilities by Ownership Type, 2007 (GWh)

	Full Service Providers					Other Providers		Total
	Investor-Owned	Public	Federal	Co-operative	Facility	Energy	Delivery	
<b>Mid-Atlantic region</b>								
Washington DC	4,181	0	0	0	0	7,929	0	12,110
Delaware	4,819	1,846	0	1,163	0	4,041	0	11,869
Maryland	33,240	777	0	4,425	25	26,924	0	65,391
New Jersey	63,102	1,222	0	155	1,279	16,176	0	81,934
Pennsylvania	136,504	1,493	0	2,613	0	10,963	0	151,573
<b>Sub-total</b>	<b>241,846</b>	<b>5,338</b>	<b>0</b>	<b>8,356</b>	<b>1,304</b>	<b>66,033</b>	<b>0</b>	<b>322,877</b>
<b>Western region</b>								
Illinois	71,676	7,062	0	5,870	0	61,447	0	146,055
Indiana	88,847	8,002	0	12,571	0	0	0	109,420
Kentucky	42,579	7,262	15,437	27,074	52	0	0	92,404
Michigan	93,346	7,306	0	3,224	478	4,293	0	109,297
Ohio	130,744	10,300	0	7,884	0	12,843	0	161,771
Tennessee	2,186	72,462	9,076	22,276	716	0	0	106,717
West Virginia	34,002	67	0	114	0	0	0	34,184
<b>Sub-total</b>	<b>463,380</b>	<b>113,111</b>	<b>24,513</b>	<b>79,013</b>	<b>1,246</b>	<b>78,583</b>	<b>0</b>	<b>759,848</b>
<b>Southern region</b>								
North Carolina	99,004	15,966	6	16,905	0	0	0	131,881
Virginia	96,441	5,100	10	9,974	0	44	0	111,570
<b>Sub-total</b>	<b>195,445</b>	<b>21,066</b>	<b>16</b>	<b>26,879</b>	<b>0</b>	<b>44</b>	<b>0</b>	<b>243,451</b>
<b>Total</b>	<b>900,671</b>	<b>139,515</b>	<b>24,529</b>	<b>114,248</b>	<b>2,350</b>	<b>144,660</b>	<b>0</b>	<b>1,326,176</b>

Source: EIA