

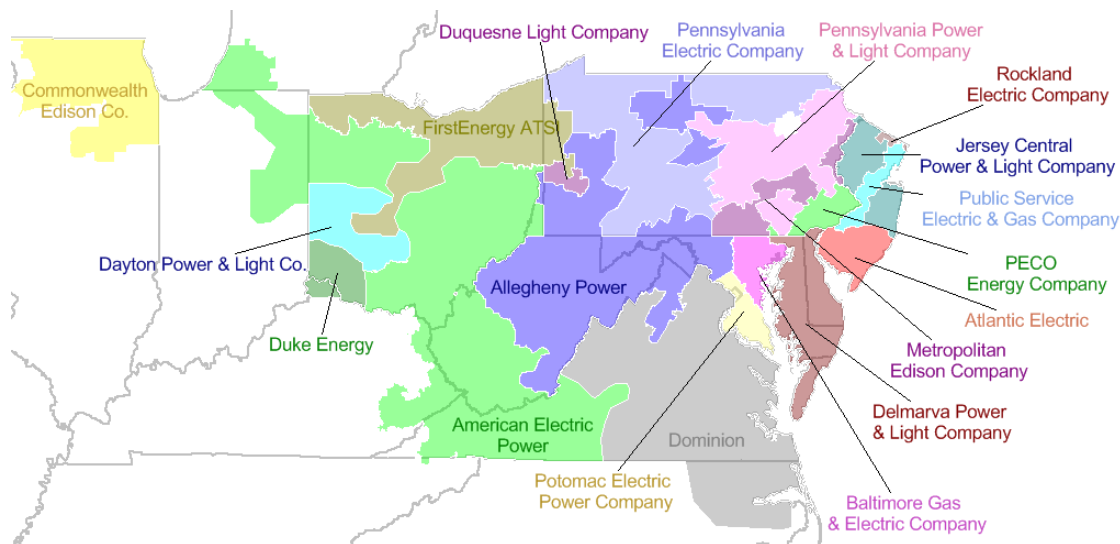


PJM Regional Transmission Operator

History and Geography of PJM

PJM Interconnection, LLC (PJM) is a Regional Transmission Organization (RTO)¹ that manages the high voltage transmission system and the wholesale electricity markets in all or parts of 13 states: Delaware, Illinois, Indiana, Kentucky, Maryland, Michigan, New Jersey, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia, and the District of Columbia (Exhibit 1). PJM's main objectives include the reliable generation and transmission of electrical energy at competitive prices while providing meaningful incentives for future generation and transmission expansion. Currently, PJM is the largest RTO in the world, dispatching about 185,600 MW of capacity over more than 65,000 miles of transmission lines to more than 60 million people and 750 member entities.² An all-time peak demand of 158,450 MW was set on July 21, 2011.

Exhibit 1 PJM utility service areas



Map developed by NETL. Source: ABB Velocity Suite³

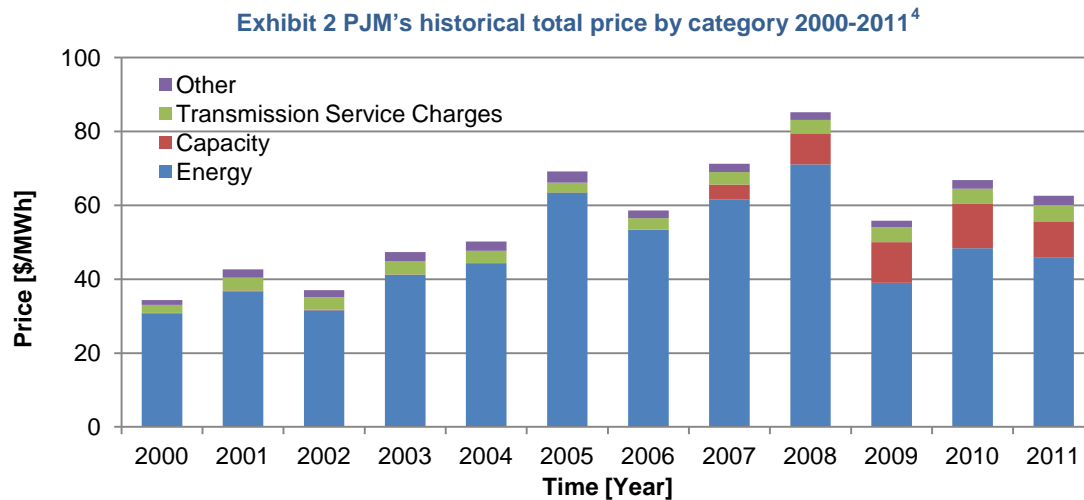
As an RTO, PJM's main responsibility is to operate a regional power grid by acting as a market clearinghouse and ensuring ongoing grid reliability. PJM operates the energy markets to serve load and meet reserve obligations with the lowest-cost resources possible, and has designed a locational market structure to ensure that transmission capability is used efficiently and that energy prices reflect the marginal cost of providing the service at each location. While the wholesale cost of electricity includes services to ensure reliable supply of power, as seen in Exhibit 2, the majority of the electricity price in PJM is dominated by energy services (i.e., the cost of generating power, which includes fuel costs, operation and maintenance for generators, reimbursement for the capital cost of generators). In 2011, approximately \$0.37/MWh was used to fund PJM administrative functions, as the majority of funds were

¹ Many of the technical terms used in this primer are defined in a companion *Glossary for Power Market Primers*.

² PJM. (2012). *2011 Annual Report* (April 2012). Retrieved on December 3, 2012, from <http://www.pjm.com/~media/about-pjm/newsroom/annual-reports/2011-annual-report.ashx>

³ ABB Velocity Suite. (2012). *Intelligent Map – PJM Transmission Zones*. Retrieved on November 29, 2012, from <https://velocitysuite.globalenergy.com/Citrix/MetaFrame/auth/login.aspx>

for energy generation (\$45.94/MWh), capacity payments (\$9.72/MWh), and transmission services (\$4.42/MWh).



Note: Other includes Operating Reserves (Uplift), Reactive, PJM Administrative Fees, Regulation, Transmission Enhancement Cost Recovery, Transmission Owner (Schedule 1A), Synchronized Reserves, NERC/RFC, Black Start, RTO Startup and Expansion, Day-Ahead Scheduling Reserve, Load Response, Transmission Facility Charges.

PJM Products and Services

PJM manages competitive markets that provide energy services and reliability services through an energy market, capacity market, transmission service charges, and an ancillary services market. In 2011, these markets aggregated billings of over \$35.9 billion across PJM's 750 market participants² or \$62.56 per MWh transmitted throughout the PJM service area

Energy Market

PJM's main role as an RTO is to coordinate an energy market by facilitating the continuous buying, selling, and delivering of wholesale electricity throughout the service area while acting as a data clearinghouse and dispatch decision maker. The energy market facilitates bilateral contracts between generators and load serving entities (LSE), as well as day-ahead, hour-ahead, and spot markets for power demand. In each market, PJM ensures adequate supply to meet projected (and actual) demand, taking into account all physical limitations of the system, including generator-maintenance schedules and transmission-capacity constraints. This is done by managing a locational marginal pricing (LMP) system in which prices are set at over 100 local nodes. The LMP system calculates a local price for the next marginal MWh of demand based on the operating status of generation facilities, including accounting for existing bilateral power delivery contracts as well as the availability of transmission assets to deliver power to specific nodes. In the absence of transmission constraints, all nodes would price at the lowest-priced generation resource. However, with the presence of transmission congestion, energy cannot flow to all points in the service area; hence, different prices occur at different nodes depending on the available generation assets and transmission capacity.

Capacity Market

The capacity market is designed to provide a long-term price signal to the market on a location-by-location basis in order to encourage development of generation assets, where current resources (either generation assets or transmission assets) are relatively scarce. Each utility in PJM's geography is required

⁴ Marketing Analytics, LLC. (2012). *2011 State of the Market Report for PJM*. Retrieved on November 29, 2012, from <http://www.pjm.com/documents/reports/state-of-market-reports/2011-state-of-market-reports.aspx>

to have the generating capacity to meet the expected demand (plus a reserve) in their service area. Utilities can meet this requirement with their own generation assets, by contracting for the capacity of other companies' generating assets, or by participating in PJM's capacity-market auction. In 2007, PJM instituted a reliability pricing model (RPM) as a means of pricing capacity for the capacity market auction. The RPM is designed to settle on locational prices that will stimulate investment in locations of the highest need (i.e., areas with relatively higher electricity prices) through the development of new sources of capacity—be it expansions of existing facilities, new generation assets, or demand response and energy-efficiency programs. Auctions are performed for capacity three years out (e.g., auction in 2011 for delivered capacity in 2014/15), and contracts are written for a year's worth of capacity availability.

Transmission Service Charges

Transmission service charges are payments to transmission asset owners based on the utilization of the owner's transmission lines. Tariffs for transmission are based on Federal Energy Regulatory Commission (FERC)-approved rates for interstate transmission lines, and on a state-by-state basis for intrastate lines (although typically state utility regulatory bodies follow FERC guidance to establish transmission tariffs).

Ancillary Services

Ancillary services are a key aspect of ensuring the reliability of the grid, and consist mainly of regulation services and synchronized reserve service. LSEs are required to provide regulation and synchronized reserve to the grid based on their demand, and can provide this service either through their own generation assets, by direct contract with another generation asset, or by participating in PJM's regulation market or synchronized reserve market. In each of these markets, resource owners submit offers to provide the service to PJM. PJM then optimizes the cost of these offers and, in conjunction with the expected supply and demand at each node, determines a clearing price for the service. Run by PJM's proprietary Synchronized Reserve and Regulation Optimizer, this also provides PJM with the direction to dispatch additional generation assets if/when incidental synchronization or regulation is insufficient to provide the necessary capacity.

Other Markets/Services

PJM offers a variety of other services to its members to facilitate markets and to ensure grid reliability, such as financial transmission rights, black-start service, demand response, and generation interconnection, among others.

Financial Transmission Rights: Financial transmission rights (FTR) is a financial contract used by market participants to hedge their exposure to transmission congestion. This contract can be thought of as a "reservation" for access to a specific transmission path (i.e., between LPM nodes) for a specific timeframe in the day-ahead market, but it does not actually correspond with a physical right to deliver energy. Rather, an FTR will create a revenue stream (or charges) based on the difference between two LMP prices at specific times. PJM facilitates four ways for market participants to obtain FTRs:

- Bid for FTRs in the long-term auction for FTRs ranging from one to three years
- Bid for FTRs in the annual auction, which includes FTRs for the entire transmission capacity
- Bid for leftover FTRs in the monthly auction, which includes the upcoming three months or any quarter in the remainder of the planning year
- Purchase/sell FTRs on the secondary market

Black-Start Service: Black-start service is essential to ensuring grid stability and reliability. It is a method of ensuring generation capacity exists to come on-line in the event of a total loss of power across the transmission system. PJM designates certain generators as "black-start units" based on an annual series of performance tests, which include the ability to start up and deliver power to the grid without an outside source of power, or to remain in operation at reduced output levels when disconnected from the grid. Once designated a black-start unit, generators are compensated based on cost-based payments for providing the service. This cost is paid on a pro-rata basis by all generators in the PJM region.

Demand Response: PJM is one of the first RTOs to incorporate demand response into the wholesale energy and capacity markets, allowing for retail customers to participate in the markets and receive compensation for the demand reductions they make. PJM works with qualified agents—Curtailment Service Providers (CSP)—who aggregate retail customers to participate in demand response and facilitate demand reductions. CSPs can participate in either day-ahead or real-time markets, by monitoring LMPs and providing demand reduction when LMPs are high, which is the equivalent of bidding in generating capacity at those times. Similarly, CSPs can bid their aggregated MW of load into the forward capacity markets. For example, in the 2011 three-year capacity auction, PJM secured 14,940 MW of demand response capacity for the 2014/2015 delivery year—the highest amount of demand response resources of any organized wholesale electricity market in the nation.

Generation Interconnection: To ensure reliability, PJM performs feasibility/reliability studies, coordinates the planning process for connecting new generation, and oversees the construction of the facilities necessary to interconnect new generation to the grid. These activities are part of PJM’s larger Regional Transmission Expansion Planning process, as new generation capacity must be factored in when considering generator retirements or transmission expansion/upgrades. These services are typically paid for by the owner of the new generation, on a cost-reimbursement basis.

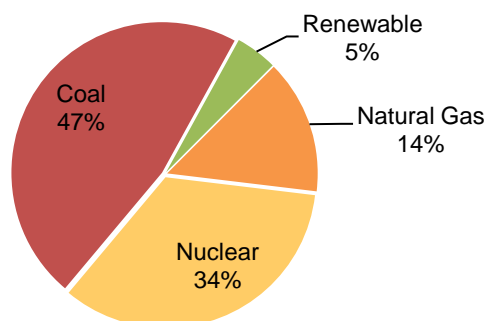
Tariff Administration

As an RTO, PJM is responsible for administering its “Open Access Transmission Tariff.” This tariff is filed with FERC, and outlines how PJM will determine rates for transmission service, evaluate and approve requests for transmission service, perform transmission impact studies, and coordinate use and administration with other transmission providers in the region, among other activities. With FERC’s approval of the tariff, PJM is the sole decision-making authority on the provision of transmission service in accordance with the tariff. However, in a case when a dispute cannot be solved internally by a senior designated representative of the transmission provider and a senior representative of the transmission customer, the dispute may be submitted to arbitration.⁵ The arbitrators are selected by the parties or by the American Arbitration Association if the parties cannot agree on the selection. The arbitrators are subject matter experts that do not have any business or financial relationship with the parties.

PJM Generation Profile

While PJM does not own or directly operate power generation facilities, it is responsible for managing scheduled outages for maintenance and maintaining reliable electricity service at the lowest cost possible, as provided by the different generators on the system. Thus, to maintain reliability, PJM continually evaluates the fuel mix of generation assets in the region. As seen in Exhibit 3, the majority of the region’s power comes from coal and nuclear generation facilities.

Exhibit 3 PJM generation (MWh) by fuel type (2011)⁶



⁵ PJM. (2013). *Open Access Transmission Tariff*. Retrieved on January 17, 2013, from <http://pjm.com/~media/documents/agreements/tariff.ashx>

⁶ Marketing Analytics, LLC. (2012). *2011 State of the Market Report for PJM (Table 2-2)*. Retrieved on November 29, 2012, from <http://www.pjm.com/documents/reports/state-of-market-reports/2011-state-of-market-reports.aspx>