



A CASE STUDY OF ELECTRIC COMPETITION RESULTS IN PENNSYLVANIA

REAL BENEFITS AND
IMPORTANT CHOICES
AHEAD

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EXECUTIVE SUMMARY

THE PENNSYLVANIA ‘ELECTRICITY GENERATION CUSTOMER CHOICE AND COMPETITION ACT’ WAS PASSED IN 1996, RESTRUCTURING THE STATE’S WHOLESALE AND RETAIL ELECTRICITY MARKETS. THIS REPORT EXAMINES THE IMPACTS OF THE RESTRUCTURING LAW TWENTY YEARS LATER . . . USING A VARIETY OF METRICS AND AVAILABLE DATA, WE ASSESS THE LAW’S PERFORMANCE AND IMPACT ON WHOLESALE AND RETAIL ELECTRICITY MARKETS IN PENNSYLVANIA, AND IDENTIFY KEY POLICY ISSUES AHEAD.

WHOLESALE OVERVIEW

Prices. In real terms, PJM Interconnection’s (PJM) average annual wholesale energy price of \$36.26 per megawatt hour (MWh) in 2015 was lower than the 2000 price of \$42.28/MWh (nominal price in 2000 was \$30.72/MWh). Regional natural gas hub prices are well correlated with PJM power prices, and the primary driver of the downward trend in power prices. Regulated generation is compensated on an average cost basis, while marginal costs in the market drive compensation for competitive generation. With gas generation as the primary marginal power resource, competitive wholesale markets have enabled sustained, low natural gas commodity prices to be passed through to electricity markets, benefitting power consumers and financially harming some generators.

Capacity Resources. PJM’s capacity market helps to ensure sufficient resources are available for reliability. From 1995 through 2015, there was a 17 percent net increase in installed capacity within PJM. Over this time period, 54.1 gigawatts (GWs) of capacity has entered the market and 24.7 GWs of capacity exited the market. Some of these resources entered the market as new delivery zones were integrated into PJM’s system. In addition to installed capacity within the PJM footprint, PJM has other capacity tools available, including for example, imports/export, demand response, and energy efficiency.

For PJM delivery years (June 1 through May 31) beginning 2007/2008 through 2014/2015, the majority (65.4 percent) of new capacity was market funded, and the remainder (34.6 percent) was funded by non-market (i.e. cost of service regulated) investment. Market funding is expected to increase to 85 percent for the period spanning delivery years 2015/2016 through 2018/2019, with the remaining 15 percent projected to be non-market funded.

Pennsylvania-based installed capacity increased 18 percent from 1996 to 2014, representing a 7.1 GWs of installed capacity. This includes 15.1 GWs of new capacity entry and 8 GWs of capacity exit. In addition, Pennsylvania installed capacity grew by more than 1.8 GWs in 2015 and there are over 5.5 GWs of capacity currently under construction.

PJM’s resource adequacy planning activities develop parameters (e.g. target installed reserve margin) for the capacity market, to help ensure reliability. PJM has consistently procured a reserve margin greater than its target installed reserve margin, a trend widely observed across reliability organizations.

Operational Efficiency. Numerous academic studies have identified improved generator operational efficiencies (e.g. increased thermal efficiency, reduced reactor outages) and reduced labor and non-fuel costs as benefits of wholesale restructuring. PJM data indicates the pool-wide rate of generator outages has generally decreased since restructuring. In 1996, the pool-wide equivalent demand forced outage rate (EFORd)—a metric for the probability that a generator will not be available when needed—for PJM was 11 percent, in 2015 the EFORd was 6.9 percent.



Fuel Mix and Output Growth. Compared to 2005 levels in PJM, coal-fired generation in 2015 had decreased by more than 16 percent, while natural gas-fired generation increased by 20 percent. In 2005, coal (55 percent) was the dominant fuel source for generated power in PJM, followed by nuclear (34 percent) and natural gas (5.3 percent). By 2015, nuclear (35.7) was the dominate fuel source in PJM, followed by coal (35.2 percent) and natural gas (22.9 percent). From 2005 to 2015, annual MWhs generated in PJM increased by 10.8 percent, representing a compound annual growth rate (CAGR) of 0.94 percent over this 11 year period.

Compared to 1996 levels, coal-fired output from Pennsylvania generators in 2014 dropped by 16.8 percent, while natural gas fired generation increased by 26 percent. In 2005, coal (55.5 percent) was the dominant fuel for power generated in Pennsylvania, followed by nuclear (35 percent) and natural gas (5 percent). By 2014, coal (35.7 percent) and nuclear (35.6 percent) were close to equally sharing the dominant generator fuel position in Pennsylvania, followed by natural gas (24 percent). From 1990 to 2014 in Pennsylvania, annual generation increased by 26 percent, representing a CAGR of 0.92 percent over this 15 year period.

Environmental Emissions. Between 2005 and 2015 in PJM, on a pounds of emission per MWh basis, carbon dioxide emissions decreased by 21 percent, nitrogen oxides decreased by 70 percent, and sulphur dioxides decreased by 81 percent. These reductions were attributed to reduced use of coal-fired generation. Between 2005 and 2014 in Pennsylvania, on a total metric tons of emissions basis, overall carbon dioxide emissions fell by 21 percent, nitrogen oxide emissions fell by 31 percent, and sulphur dioxide emissions fell by 74 percent.

RETAIL OVERVIEW

National Pricing Overview. Prior to restructuring, Pennsylvania's retail electricity prices were 15 percent higher than the national average. As of 2015, the statewide annual average retail price of electricity was 0.1 percent below the national average. On a statewide annual average basis, over the time period reviewed (2001 through 2015), retail electricity prices to Pennsylvania's residential and industrial customers tended to be above national averages, while prices to the commercial sector tended to be below the national average.

Pennsylvania Commercial and Industrial Retail Prices. During full implementation of restructuring (from 2011 to 2014), statewide average annual retail electricity rates (on a cents per kilowatt hour basis) to commercial and industrial shopping customers were generally lower than utility default service rates, providing these customers with the potential for cost savings from retail shopping. From 2000 to 2014, statewide average annual distribution rates to the commercial and industrial sectors have generally decreased (on a nominal basis), and have not kept pace with inflation. This has provided additional cost savings to these sectors.

Pennsylvania Residential Retail Prices. During full implementation of restructuring (from 2011 to 2014), statewide average annual retail electricity rates to residential shopping customers were higher than

utility default service rates. From 2000 to 2014, average annual distribution charges to the residential sector increased at rates exceeding the rate of inflation.

Data limitations impact this conclusion. Competitive retail suppliers argue many retail offerings provide additional attributes (e.g. renewable energy, discounts and incentives) that command higher prices, making comparison with standard utility service inappropriate. Supporters of utility default service argue higher retail supplier costs and greater market volatility drive cost premiums. More research is needed to determine the magnitude to which these factors contribute to the observed residential price differential.

Further analysis helps to understand restructuring outcomes for the residential sector.

Cost Impacts of Retail Restructuring for Smaller Customers.

Residential and small commercial generation and transmission prices and total bundled bills from 1996 (prior to restructuring) were adjusted for inflation and compared to January 31, 2016 default utility prices.

The results indicate that retail restructuring has benefitted most small commercial and residential customers, through utility-offered default service products. Residential generation and transmission default utility prices were 2 to 41 percent lower than 1996 inflation adjusted generation and transmission prices for Duquesne, MetEd, PECO, Penelec, Penn Power, and PPL. For West Penn Power, the 2016 default utility generation and transmission price was 7 percent higher than the 1996 inflation adjusted generation and transmission price. For the small commercial sector, 2016 default generation and transmission prices were 5 to 56 percent lower than 1996 inflation adjusted generation and transmission prices for Duquesne, MetEd, PECO, PECO summer, Penelec, PPL, and West Penn Power, whereas the 2016 default price was 9 percent higher than the 1996 adjusted price in Penn Power.

These benefits were primarily achieved by requiring utilities to purchase energy, capacity, and related services in competitive wholesale markets, rather than through cost-of-service regulated generation. Residential customers taking restructured default generation and transmission service from their local utility have the potential to save over \$818 million in 2016, compared to inflation-adjusted 1996 regulated generation and transmission costs.

The total bundled bill analysis—which examined default generation and transmission prices as well as distribution prices—yielded interesting results. Total bundled bills for residential customers in 2016 were 16 to 21 percent lower than 1996 inflation adjusted total bills for Duquesne, PECO, and Penn Power. However, 2016 total bundled bills were 4 to 12 percent higher than 1996 adjusted total bundled bills for MetEd, Penelec, PPL, and West Penn Power. These data indicated that for total bundled bills, increases in distribution prices were outstripping savings realized from restructuring's lower generation and transmission prices in some areas. Recall, on a statewide annual average basis, distribution prices to the commercial and industrial sector have trended down over time, while residential distribution prices have trended up.



Further analysis was required to better understand residential distribution price trends, even though the restructuring law did not change the way these rates are regulated.

Distribution Price Analysis. An analysis of delivery prices to the residential sector was performed, comparing 1996 inflation adjusted delivery prices to 2016 delivery prices for PA distribution utilities. The analysis found that for West Penn Power, escalating generation, transmission, and delivery prices are driving total bill increases beyond 1996 inflation adjusted levels. For MetEd, Penelec, and PPL, increases in delivery prices are likely overwhelming savings realized from default generation and transmission price savings, resulting in 2016 total bills being higher than 1996 inflation adjusted total bills. Duquesne Light and PECO residential customers are experiencing total bundled bill savings in 2016, compared to 1996 adjusted total bills, due to default generation and transmission price savings that have overcome delivery price increases. Penn Power residential customers have experienced total bundled bill savings in 2016 compared to 1996 adjusted total bills, due to 2016 default generation, transmission and delivery prices savings compared to 1996 adjusted prices.

Retail Shopping Statistics. Shopping statistics were examined and found to be consistent with many contemporary observations. Shopping penetration is highest in the industrial sector with most electric distribution company (EDC) territories seeing over 80 percent of customers shopping. Commercial sector shopping ranged from 30 to 50 percent of EDC customers. Residential sector shopping ranged from 22 to 46 percent among EDC territories.

Residential Retail Product Offerings. Retail offerings to the residential sector were examined to understand non-monetary benefits that may be available to the residential sector from shopping, which were not available prior to restructuring. Restructuring has provided residential customers in each Pennsylvania distribution company territory examined with new options about rates and rate plans, including between 57 and 138 competitive offerings per area. Most of these new plans were fixed or variable rate plans. In addition, restructuring has opened the possibility for innovative rate and product offerings to be made available to the residential sector. By far, renewable energy plans have been the most widely offered innovative product available to residential customers. There have been far fewer innovative rate and product offerings available related to unlimited usage flat bill, discounts and incentives, and net metering plans. Many innovations that were expected (e.g. time of use, energy efficiency and conservation) are either not available or not listed on the PA PUC's www.PaPowerSwitch.com shopping website.

Universal Service. The restructuring law's implementation orders required significant increases to Customer Assistance Program (CAP) and Low Income Usage Reduction Program (LIURP) funding. These increases (required from 1999 through 2002) are documented for each EDC, along with post-restructuring program

funding trends. Comparing 2014 LIURP funding levels with 2002 inflation adjusted levels, we find LIURP Met-Ed, Penelec, PennPower, PPL, and West Penn program funding has increase at or above the rate of inflation, while Duquesne Light and PECO program funding levels have not kept pace with inflation. For 2014 CAP program funding, we found all EDC program spending has kept pace with inflation.

POLICY CHOICES AHEAD

The report outlines just seven key issues impacting Pennsylvania's retail and wholesale markets, where policy choices will likely be needed in the short to medium term. It is necessarily an incomplete discussion. Good policymaking will ensure that generation markets are competitive, electricity becomes cleaner, and power remains affordable and reliable.

In examining future solutions, there are opportunities to develop policy solutions that synergistically address multiple challenges, but these solutions will take creativity, cooperation, and coordination across traditional jurisdictional boundaries and will likely depart from existing paradigms.

Key policy choices impacting retail markets include creating a sustainable utility business model for the future, developing a modern, resilient, and secure grid that can accommodate the next generation of electricity service, leveraging new market opportunities such as transportation electrification, and making choices about utility default service.

Key policy choices impacting wholesale markets include maintaining market efficacy in the face of state policy interventions, making decisions about the ever-evolving capacity market in light of an increasingly complex set of resources and stakeholder needs, and integrating and optimizing the value of distributed energy resources for wholesale power markets.

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SECTION I: WHOLESALE MARKET PERFORMANCE

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SECTION HIGHLIGHTS

Energy Market

- In real terms (i.e. 2015 dollars), PJM's annual average wholesale energy price in 2015 (\$36.26/MWh) was lower than it was in 2000 (\$42.28/MWh).
- PJM's annual average wholesale energy price in nominal terms was \$30.72/MWh in 2000.
- There is close correlation between natural gas price changes and PJM power price changes, and a downward price trend observed in both markets.
- The competitive wholesale market has been able to pass through low natural gas commodity prices in the form of lower electricity prices (benefitting consumers, but financially harming generators).

Capacity Market and Resources

- From 1995 through 2015, there was a 17 percent net increase in installed capacity within PJM. Over this time period, 54.1 GW of capacity entered the market and 24.7 GW of capacity exited the market.
- Some of these resources entered the PJM market as new delivery zones were integrated into PJM's system, complicating data analysis over the time period examined.
- PJM has other capacity tools available, beyond internal installed capacity, including imports/exports, demand response, and energy efficiency.
- From delivery years 2007/2008 through 2014/2015, the majority (65.4 percent) of new capacity has been market funded, and the remainder (34.6 percent) has been funded by non-market (i.e. cost-of-service regulated) investment. Market funding is expected to increase to 85 percent for the period spanning delivery years 2015/2016 through 2018/2019, with the remaining 15 percent being non-market funded.
- Pennsylvania-based installed capacity increased 18 percent from 1996 to 2014 representing a 7.1 GW of installed capacity. This includes 15.1 GW of new capacity entry and 8 GW of capacity exit.

- In addition, Pennsylvania-installed capacity grew by more than 1.8 GW in 2015 and there is over 5.5 GW of capacity currently under construction.

Reliability

- PJM's Resource Adequacy Planning activities develop parameters for the capacity market, to help ensure reliability. PJM has consistently procured a reserve margin greater than its target installed reserve margin, a trend widely observed across reliability organizations.

Operational Efficiencies

- Numerous academic studies have identified benefits of restructuring, including improved generator operational efficiencies (e.g. increased thermal efficiency, reduced reactor outages), and reduced labor and non-fuel costs.
- PJM data indicates that since restructuring, the pool-wide rate of generator outages has generally decreased. In 1996, this outage rate (i.e. the EFORD) for PJM was 11 percent; by 2015 the EFORD was 6.9 percent.

Generation Fuel Mix

- Compared to 2005 levels, coal-fired generation in PJM had decreased more than 16 percent by 2015, while natural gas-fired generation increased 20 percent by 2015.
- In 2005, coal (55 percent) was the dominant fuel source for generated power in PJM, followed by nuclear (34 percent) and natural gas (5.3 percent). By 2015, nuclear (35.7) was the dominate fuel source, followed by coal (35.2 percent), and natural gas (22.9 percent).
- Compared to 1996 levels of generation, coal-fired output from Pennsylvania generators dropped 16.8 percent by 2014, while natural gas-fired generation increased by 26 percent.
- In 2005, coal (55.5 percent) was the dominant fuel for power generated in Pennsylvania, followed by nuclear (35 percent) and natural gas (5 percent). By 2014, coal (35.7 percent) and nuclear (35.6 percent) were close to equally sharing the dominant fuel position, followed by natural gas (24 percent).



Environmental Emissions

- Between 2005 and 2015 in PJM, on a pounds of emissions per MWh basis, carbon dioxide emissions decreased by 21 percent, nitrogen oxides decreased by 70 percent, and sulphur dioxides decreased by 81 percent. These reductions were attributed to reduced use of coal-fired generation.
- Between 2005 and 2014 in Pennsylvania, on a total metric tons of emissions basis, overall carbon dioxide emissions fell by 21 percent, nitrogen oxide emissions fell by 31 percent, and sulphur dioxide emissions fell by 74 percent.

INTRODUCTION

This section uses available data to examine the performance of PJM's wholesale markets using metrics including pricing, capacity resources, reliability, generator operational efficiency, fuel mix, and environmental emissions. Some of these metrics are directly impacted by PJM markets, whereas others are indirectly effected. Where possible, Pennsylvania-specific data is examined to identify state-level impacts.

BACKGROUND ON PJM

PJM interconnection (PJM) is the regional transmission organization that manages the flow of wholesale electricity through 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. PJM operates the competitive wholesale electricity market and high voltage electricity grid within its jurisdiction to ensure reliability, and engages in long-term regional transmission planning processes to identify changes to the grid needed to ensure reliability.

PJM began in 1927, as an interconnection effort between three utilities. In 1997, PJM became the first independent system operator (ISO) approved by the Federal Energy Regulatory Commission (FERC) and opened its first bid-based energy market.¹ By 2001, PJM became the nation's first fully functioning regional transmission organization (RTO),² operating transmission systems over multiple states to advance the development of competitive wholesale power markets (PJM Interconnection n.d.).

FERC Order 2000 identified the following expected benefits of regional transmission organizations:

1. Increased efficiency through regional transmission pricing and elimination of rate pancaking (imposition of multiple transmission charges across separately owned systems)
2. Improved congestion management
3. More accurate estimates of available transmission capacity
4. More effective management of parallel path flows
5. More efficient planning for transmission and generation investments

6. Increased coordination among state regulatory agencies
7. Reduced transmission costs
8. Facilitation of the success of retail access programs
9. Facilitation of the development of environmentally preferred generation in states with retail access programs
10. Improved grid reliability
11. Few opportunities for discriminatory transmission practices

FERC further concluded that these benefits would increase transmission grid efficiencies and improve power market performance, leading to lower prices for electricity consumers (Federal Energy Regulatory Commission 1999).

ENERGY MARKET

Through competitive auctions, the wholesale electricity market secures enough power supply to meet demand at the lowest cost. This enables PJM to keep the lights on at any given time, at the least cost possible given available resources. In simple terms, the energy market process works by generators submitting bids to PJM based on their variable costs to supply power. PJM then accepts the lowest cost bids until enough supply is procured to match demand. The last unit to clear the market establishes the per megawatt hour market price of electricity at that time period, which all suppliers are then paid. Generators with costs lower than the clearing price collect revenues above their variable costs. This provides a powerful incentive to maximize profits by increasing capacity factors (i.e. run units as long as possible to increase revenues and reduce average fixed costs) while keeping variable costs low (i.e. submit competitive bids to ensure units are dispatched).

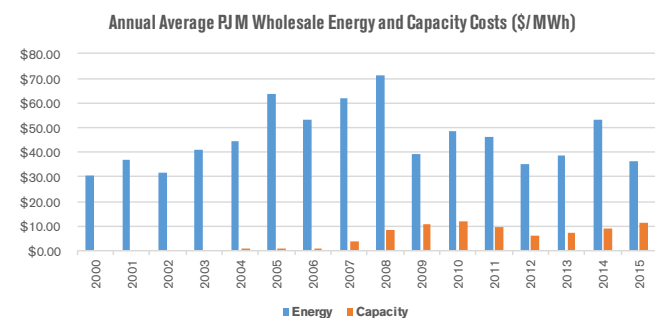


Figure 1 - Annual Average PJM Wholesale Energy and Capacity Costs (\$/MWh)

Figure 1 shows annual average RTO-wide wholesale energy and capacity costs, in dollars per megawatt hour (Ott 2016). Energy and capacity prices are the two largest components of the total price of wholesale power. In real terms, PJM's wholesale energy prices in 2015 (\$36.26/MWh) are lower than they were in 2000 (\$42.28/MWh).

- PJM's wholesale energy prices in nominal terms were \$36.26/MWh in 2015 and \$30.72/MWh in 2000.

¹ FERC's Orders No. 888/889 offered the concept of ISOs as a way for existing power pools to provide non-discriminatory access to transmission.

² FERC Order 2000 promoted the voluntary formation of RTOs

- Adjusting 2000 energy prices for inflation through 2015 yields a real value of \$42.28, which is higher than the 2015 actual energy price. Therefore, over this time period, wholesale energy-only prices have not kept pace with the rate of inflation.
- From 2004 through 2006, capacity prices ranged from 3 to 8 cents per MWh and are therefore not visible in the figure above.

In general terms, compensation to regulated generators is based on average costs, while restructured generation is compensated based on marginal system costs. Therefore, restructured markets will deliver higher or lower prices compared to regulated generation, depending on the clearing price of marginal resources. In PJM, natural gas fired generation is typically on the margin, making the price of natural gas extremely influential on energy market outcomes.

Figure 2 compares annual non-weighted average PJM around-the-clock real-time LMP prices (2004 – 2015) to annual non-weighted average day-ahead natural gas prices for select northeast, non-New York hubs (2002 – 2015) (SNL Energy 2016).³ These data show the close correlation between natural gas price changes and PJM power price changes. More specifically, how a reduction in the price of natural gas has corresponded to a reduction in PJM power prices. Low natural gas prices from unconventional shale has enabled competitive markets to pass through savings from these decreasing prices (benefiting consumers, but financially harming generators).

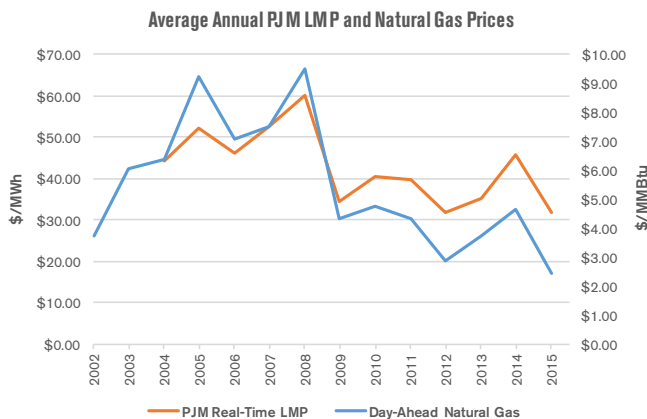


Figure 2 - Average Annual PJM LMP Prices and Natural Gas Prices

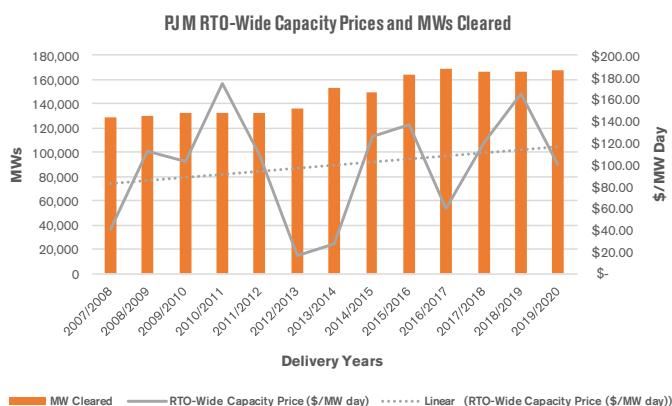


Figure 3 - PJM RTO-Wide Capacity Prices and MW Cleared

³ Natural gas hubs include: Dawn Ontario, Dominion N, Dominion S, Lebanon, Leidy, Parkway Ontario, TCO pool, TETCO M2, TECO M3, Transco Z5, Transco Z6 non-NY.

⁴ The Fixed Resource Requirement (FRR) option (also referred to as the self-supply option) is an alternative to PJM's Requirement to participate in the RPM and is available to certain load serving entities.

Table 1, reproduced from Monitoring Analytics 2015 State of the Market Report, shows the annual average cost components of the total per MWh price for wholesale power. Energy, capacity, and transmission services are the largest cost categories, making up over 95 percent of the total annual average cost of wholesale power.

| Category | 2014 | | 2015 | | 2014 to 2015 Percent Change |
|--|---------|------------------|---------|------------------|-----------------------------|
| | \$/MWh | Percent of Total | \$/MWh | Percent of Total | |
| Load Weighted Energy | \$53.14 | 74.2% | \$36.16 | 63.6% | (31.9%) |
| Capacity | \$9.01 | 12.6% | \$11.12 | 19.6% | 23.5% |
| Transmission Service Charges | \$5.95 | 8.3% | \$7.08 | 12.5% | 19.0% |
| Transmission Enhancement Cost Recovery | \$0.42 | 0.6% | \$0.51 | 0.9% | 19.2% |
| PJM Administrative Fees | \$0.44 | 0.6% | \$0.44 | 0.8% | 0.1% |
| Energy Uplift (Operating Reserves) | \$1.18 | 1.6% | \$0.38 | 0.7% | (67.7%) |
| Reactive | \$0.40 | 0.6% | \$0.37 | 0.7% | (6.0%) |
| Regulation | \$0.33 | 0.5% | \$0.23 | 0.4% | (28.8%) |
| Capacity (FRR) | \$0.20 | 0.3% | \$0.13 | 0.2% | (38.7%) |
| Synchronized Reserves | \$0.21 | 0.3% | \$0.12 | 0.2% | (41.4%) |
| Day Ahead Scheduling Reserve (DASR) | \$0.05 | 0.1% | \$0.10 | 0.2% | 115.5% |
| Transmission Owner (Schedule 1A) | \$0.09 | 0.1% | \$0.09 | 0.2% | 1.2% |
| Black Start | \$0.08 | 0.1% | \$0.06 | 0.1% | (15.5%) |
| NERC/RFC | \$0.02 | 0.0% | \$0.03 | 0.0% | 19.5% |
| Non-Synchronized Reserves | \$0.02 | 0.0% | \$0.02 | 0.0% | 2.1% |
| Load Response | \$0.02 | 0.0% | \$0.02 | 0.0% | (15.2%) |
| RTO Startup and Expansion | \$0.01 | 0.0% | \$0.01 | 0.0% | (49.0%) |
| Transmission Facility Charges | \$0.00 | 0.0% | \$0.00 | 0.0% | 134.6% |
| Emergency Load Response | \$0.06 | 0.1% | \$0.00 | 0.0% | (98.9%) |
| Emergency Energy | \$0.01 | 0.0% | \$0.00 | 0.0% | (100.0%) |
| Total | \$71.62 | 100.0% | \$56.86 | 100.0% | (20.6%) |

Table 1 - Total Price of Wholesale Power per MWh, by Category for 2014 and 2015
(Monitoring Analytics, 2016)

CAPACITY MARKET AND RESOURCES

PJM's capacity market exists to ensure sufficient resources are available to maintain grid reliability. The capacity market is structured by the reliability pricing model (RPM) that includes a 3-year forward Base Residual Auction, up to three subsequent Incremental Auctions, and an ongoing Bilateral Market for resource providers (e.g. to manage shortfalls).⁴ Implementation of the RPM began for the June 1, 2007 through May 31, 2008 delivery year. The goal of PJM's reliability pricing model (RPM) is to generate capacity prices reflective of system reliability requirements in a transparent manner and far enough in advance to allow for a meaningful response (i.e. infrastructure investments) to these data.

Figure 3 shows megawatts cleared in PJM's annual base residual auctions for capacity, as well as the RTO-wide clearing prices for each annual auction (PJM Interconnection 2016). These data indicate a degree of capacity market price volatility, an overall increasing price trend, and an overall increasing trend of total annual MWs procured.



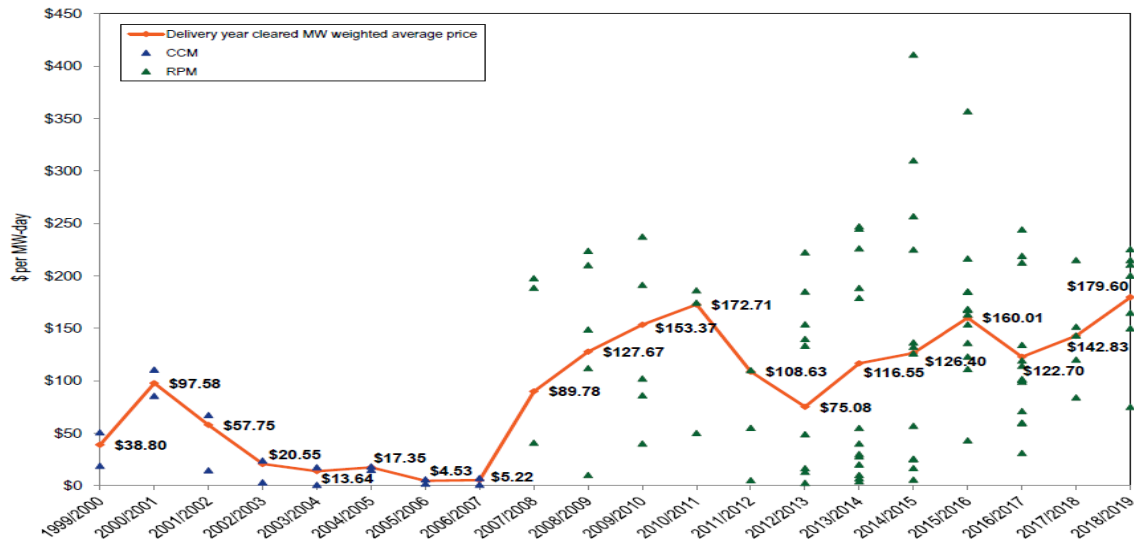
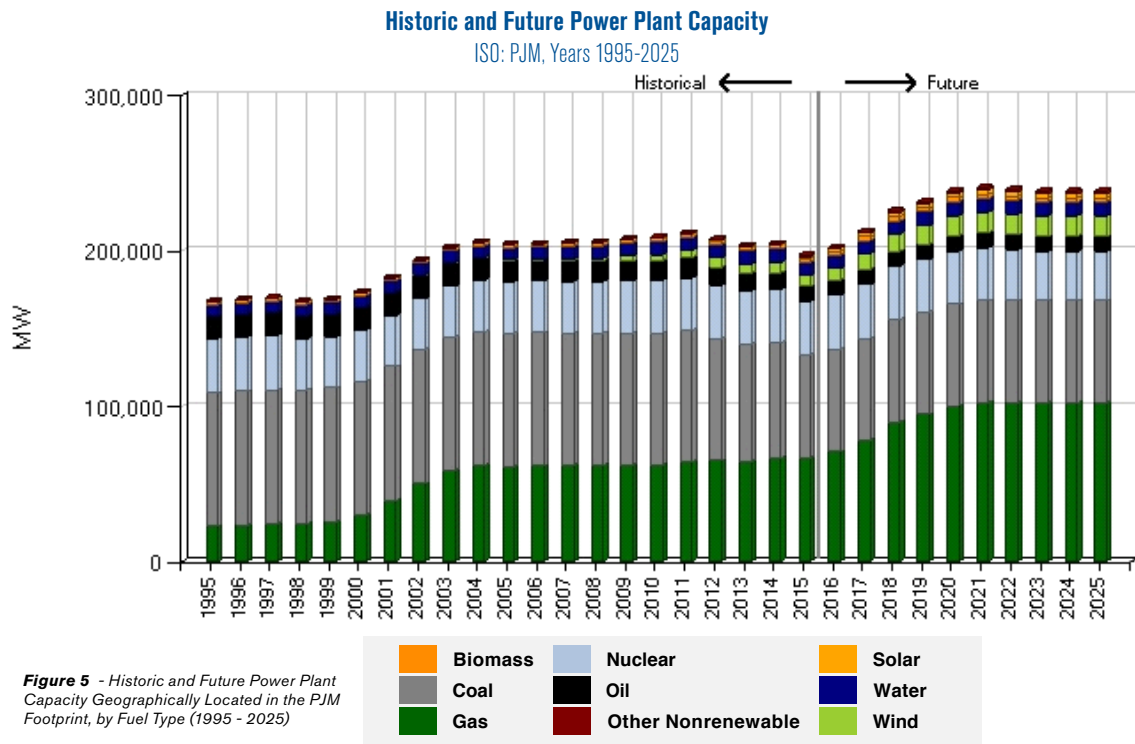


Figure 4 - History of PJM Capacity Prices 1999/2000 through 2018/2019 (Monitoring Analytics, 2016)

Figure 4, reproduced from Monitoring Analytics 2015 State of the Market Report, shows cleared MW weighted average capacity market prices for each delivery year for the entire history of PJM capacity markets (Monitoring Analytics 2016). The Capacity Credit Market (CCM) was put in place in 1999 by PJM as part of the transition to a regional wholesale electricity market. The CCM featured an RTO-wide price that did not reflect locational differences and operated primarily under daily and monthly timeframes. According to PJM, the CCM construct resulted in volatile prices, concerns over market manipulation, and (during the later years of the CCM) insufficient revenues to incent new investment (PJM Interconnection 2009). These and other concerns led to the development of the RPM to replace the CCM.

Figure 5 shows historic operating installed capacity by fuel type that is geographically located within PJM from 1995 to 2015, and projections of future installed capacity additions (based on actual planned or under construction projects) in PJM from 2016 through 2025. Installed capacity data for PJM was supplied by SNL Energy's energy supply database for historic and future power plant capacity (SNL Energy 2016). SNL's data is developed by aggregating additions and retirements in its database of power plants, according to planned year of completion. Power plants located in PJM can be dispatched into PJM or other power market regions (e.g. MISO).



- There was a 17 percent net increase in capacity between 1995 (167.6 GW) and 2015 (196.9 GW), representing approximately 29.3 GW. By 2015, total installed capacity did decrease from the 211.7 GW high reached in 2011
- As discussed later in the section, some of these supply resources (and related load) were the result of new zones integrating into PJM's territory.
- Capacity additions from 1995 to 2015 in PJM came primarily from natural gas (44.2 GW), wind (6.7 GW), water/hydro (1.3 GW), and solar (1.1 GW). In addition to other resources, this represents a total of 54.1 GW of capacity entry.
- Capacity reductions from 1995 to 2015 in PJM came primarily from generation using coal (-19.5 GW), petroleum products (-4.8 GW), and nuclear (-0.4 GW). This represents about 24.7 GWs of capacity exit.

In addition to generation resources, PJM's capacity market has also procured a significant amount of demand-side (e.g. load reduction) capacity resources.

Figure 6, reproduced from PJM's 2016 Demand Response Operations Market Activity Report, overall identifies an increasing trend of demand response participation as a capacity resource, adding an excess of 10 GWs of capacity in some years (PJM Interconnection 2016). Section III – Policy includes a related discussion about how recent capacity market reforms may impact this trend, and the role of demand side resources as capacity supply.

Table 2 shows energy efficiency capacity (e.g. reduced load demand from measures that require less energy inputs to deliver the same output levels of work) in MWs clearing PJM's capacity market, indicating another significant demand-side resource providing capacity supply. These data were taken from Monitoring Analytics 2015 State of the Market Report (Monitoring Analytics 2016).

Generation capacity data from Monitoring Analytics New Generation Capacity report was also examined as a complement to the SNL Energy data (Monitoring Analytics 2016). Though covering a shorter time period, this information provides greater detail into generation capacity resource data and also share insights into market versus non-market investments.

| | 2012/ 2013 | 2013/ 2014 | 2014/ 2015 | 2015/ 2016 | 2016/ 2017 | 2017/ 2018 | 2018/ 2019 |
|----------------------------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|
| Energy Efficiency Cleared | 568.9 | 679.4 | 822.1 | 922.5 | 1,117.3 | 1,338.9 | 1,246.5 |

Table 2 - PJM Energy Efficiency Clearing Capacity Market by Delivery Year, MW (Monitoring Analytics, 2016)

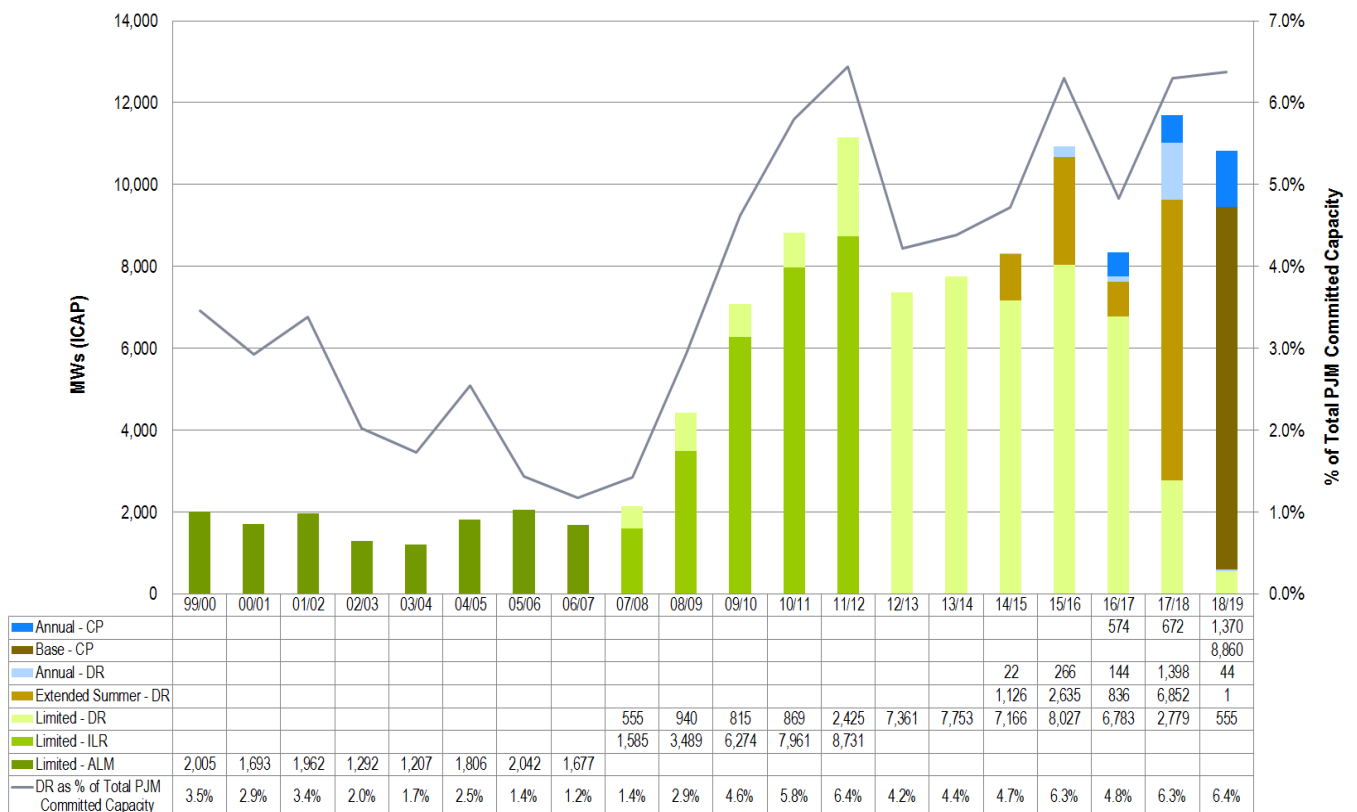


Figure 6 - PJM Demand Response Committed MW by Delivery Year

| | ICAP (MW) | | | | | Net Total Change |
|-----------|---------------|------------|--------------------------------|--------------------------------|-------------|------------------|
| | Net Additions | Net Losses | Net Change in Capacity Imports | Net Change in Capacity Exports | Integration | |
| 2007/2008 | 1,767.7 | 1,007.3 | (96.7) | 143.9 | 0.0 | 519.8 |
| 2008/2009 | 1,928.1 | 1,227.4 | 871.1 | (1,702.9) | 0.0 | 3,274.7 |
| 2009/2010 | 571.5 | 643.6 | 68.6 | 735.9 | 0.0 | (739.4) |
| 2010/2011 | 2,354.5 | 1,726.1 | 187.2 | (427.0) | 11,821.6 | 13,064.2 |
| 2011/2012 | 3,786.8 | 3,071.5 | 262.7 | (1,374.5) | 3,607.4 | 5,959.9 |
| 2012/2013 | 709.9 | 4,419.7 | 841.8 | (17.3) | 2,680.0 | (170.7) |
| 2013/2014 | 683.5 | 4,447.7 | 2,229.2 | 21.6 | 0.0 | (1,556.6) |
| 2014/2015 | 3,516.4 | 11,663.9 | 946.9 | 73.3 | 0.0 | (7,273.9) |
| Total | 15,318.4 | 28,207.2 | 5,310.8 | (2,547.0) | 18,109.0 | 13,078.0 |

Figure 7 - PJM Generation Capacity Changes 2007/2008 through 2014/2015 (Monitoring Analytics, 2016)

Figure 7, reproduced from the Monitoring Analytics report, shows generation capacity available to PJM for delivery years 2007/2008 through 2014/2015.

During this time period (delivery year 2007/2008 through DY 2014/2015), Monitoring Analytics reported that internal installed capacity within PJM decreased by 12.8 GW, as deactivations (i.e. exits) overwhelmed additions (i.e. entry). Over roughly the same time period (calendar year 2008 through calendar year 2015), the SNL data for capacity located within the PJM geographic footprint yielded a 8.8 GW reduction in installed capacity. It is unclear why there is a 4 GW discrepancy between these data however, one potential reason is the SNL data is reported by calendar year and the Monitoring Analytics data is reported by PJM delivery year.

The Monitoring Analytics data shows various additional tools, beyond internal installed generation capacity, that are available to PJM, for example:

- Use of imported and exported capacity yielding 2.76 GW of additional of net import capacity available to PJM.
- Integration of new zones into the PJM footprint, for example the 18.1 GW addition from ATZI Zone integration in delivery year 2011/2012.⁵
- The Monitoring Analytics report also notes the decrease in generation capacity was offset in the PJM capacity market in part by demand response and energy efficiency resources (detailed in **Figure 6** and **Table 2** above).
- Overall, the impacts of internal generation loss, net imports, and integration of new zones yielded a 13 GW increase in PJM's reported available generation capacity over the time period examined.⁶

Beyond highlighting important factors in understanding capacity resources available to PJM, the above referenced data serve as a basis for understanding Monitoring Analytics analysis of funding sources for these capacity investments.

Figure 8, reproduced from the Monitoring Analytics New Generation Capacity report, shows that for the 15.3 GW of new capacity (including new, reactivations and uprates) offered between delivery year 2007/2008 and 2014/2015, approximately 65.4 percent was funded through market investments and 34.6 percent was funded through non-market investments (i.e. financed through cost-of-service regulation).

| Funding and Supplier Type | ICAP (MW) | | | | | | | |
|---------------------------|-----------|---------|---------------|---------|---------|---------|-----------------|---------------|
| | New | Percent | Reactivations | Percent | Uprates | Percent | Total Additions | Total Percent |
| Market | | | | | | | | |
| Merchant | | | | | | | | |
| Solar and Wind | 670.1 | 6.8% | 0.0 | 0.0% | 65.7 | 1.3% | 735.8 | 4.8% |
| Other | 3,745.6 | 38.3% | 171.2 | 39.8% | 1,192.8 | 23.4% | 5,109.6 | 33.4% |
| Total | 4,415.7 | 45.1% | 171.2 | 39.8% | 1,258.5 | 24.7% | 5,845.4 | 38.2% |
| Utility | | | | | | | | |
| Solar and Wind | 347.0 | 3.5% | 0.0 | 0.0% | 65.5 | 1.3% | 412.5 | 2.7% |
| Other | 1,059.9 | 10.8% | 200.8 | 46.7% | 2,503.2 | 49.1% | 3,763.9 | 24.6% |
| Total | 1,406.9 | 14.4% | 200.8 | 46.7% | 2,568.7 | 50.4% | 4,176.4 | 27.3% |
| Market Total | 5,822.6 | 59.5% | 372.0 | 86.5% | 3,827.2 | 75.0% | 10,021.8 | 65.4% |
| Non Market | | | | | | | | |
| Municipal/Coop | | | | | | | | |
| Solar and Wind | 69.7 | 0.7% | 0.0 | 0.0% | 0.0 | 0.0% | 69.7 | 0.5% |
| Other | 896.8 | 9.2% | 0.0 | 0.0% | 98.2 | 1.9% | 995.0 | 6.5% |
| Total | 966.5 | 9.9% | 0.0 | 0.0% | 98.2 | 1.9% | 1,064.7 | 7.0% |
| Utility | | | | | | | | |
| Solar and Wind | 0.0 | 0.0% | 0.0 | 0.0% | 33.7 | 0.7% | 33.7 | 0.2% |
| Other | 2,998.0 | 30.6% | 58.0 | 13.5% | 1,142.2 | 22.4% | 4,198.2 | 27.4% |
| Total | 2,998.0 | 30.6% | 58.0 | 13.5% | 1,175.9 | 23.1% | 4,231.9 | 27.6% |
| Non Market Total | 3,964.5 | 40.5% | 58.0 | 13.5% | 1,274.1 | 25.0% | 5,296.6 | 34.6% |
| Grand Total | 9,787.1 | 100.0% | 430.0 | 100.0% | 5,101.3 | 100.0% | 15,318.4 | 100.0% |

Figure 8 - New, Reactivated, and Upgraded Generation Capacity Resources by Funding and Supplier Type, 2007/2008 through 2014/2015 (Monitoring Analytics 2016)

⁵ Additional integrations, which add both new capacity and load, include: Allegheny Power's five-state transmission system (2002), American Electric Power, Commonwealth Edison and Dayton Power & Light (2004), Duquesne Light and Dominion (2005), ATZI (2011) and EKPC (2013).

⁶ Monitoring Analytics notes that data for new capacity provided by PJM is often reported in terms of offered capacity and may not be reflective of actual capacity that comes into service.

Figure 9, reproduced from the Monitoring Analytics New Generation Capacity report, shows that for the 17 GW of projected new generation capacity resources expected between 2015/2016 through 2018/2019, approximately 85 percent will be market funded through private funding, while 15 percent will be non-market funded through cost-of-service regulation.

| Funding Type | Funding Source | Cleared MW (ICAP) | Percent |
|--------------|-----------------|-------------------|---------|
| Market | Private funding | 14,450.8 | 85.0% |
| | Total | 14,450.8 | 85.0% |
| Non Market | Cost of service | 2,555.2 | 15.0% |
| | Total | 2,555.2 | 15.0% |
| Grand Total | | 17,006.0 | 100.0% |

Figure 9 - Projected New Generation Capacity Resources by Funding Type and Funding Source, 2015/2016 through 2018/2019 (Monitoring Analytics, 2016)

Figure 10 shows Pennsylvania-based installed capacity from 1990 through 2014. Installed capacity data for Pennsylvania was supplied by U.S. EIA (U.S. EIA 2015).

- Data in Figure 10 indicate that from 1996 to 2014, installed nameplate capacity in Pennsylvania grew by 18 percent representing an increase of over 7.1 GWs of installed nameplate capacity.
- During this time period, significant capacity increases were realized from natural gas (12.1 GW), wind (1.3 GW), nuclear (0.6 GW) and other generation resources. Over this time period, total new resource entry in Pennsylvania was 15.1 GW.
- At the same time, significant capacity losses were incurred from coal (-5.1 GW), petroleum (-2.7 GW), and other gas (-0.1 GW) generation resources. Total resource exit from Pennsylvania was 8 GW.

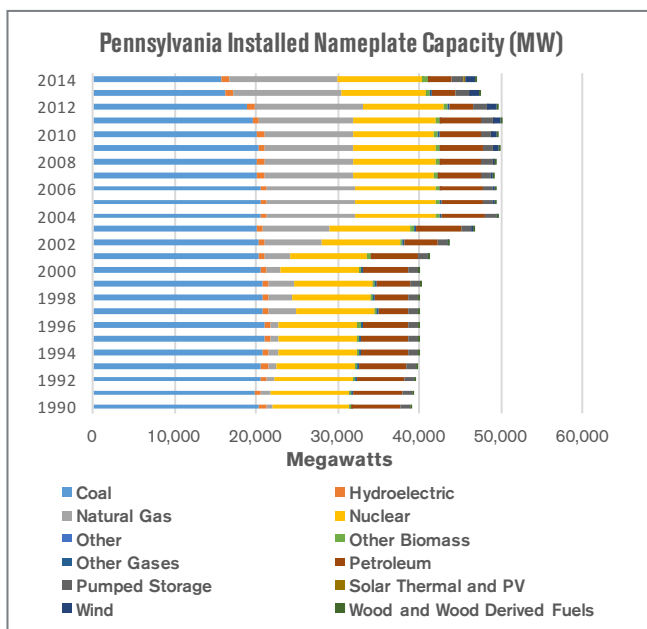


Figure 10 - Installed Nameplate Capacity Located in Pennsylvania, by Fuel Type (MW)

⁷ Projects include Andromeda One and Morgantown Generation Station biomass plants, and Beaver Dam Gas, Panda Liberty, Patriot Power, and Roundtop gas plants.

⁸ Projects include Ringer Hill Wind Farm, Alpaca Gas Project, Caithness Moxie Freedom, Lackawanna Energy Center, Milan Gas Project, Panda Hummel Station, Westmoreland Generating Station, Wolf Run, and York 2.

⁹ A reserve margin is (capacity – demand)/demand, where capacity is the forecasted maximum amount of supply available and demand is the forecasted peak demand.

¹⁰ Developed by the North American Electric Reliability Corporation (NERC) and ReliabilityFirst (BAL-502-RFC-02).

SNL Energy data was used to identify existing large-scale generation projects that began operations after December 31, 2014, and therefore were not captured in the U.S. EIA data (SNL Energy 2016). These units began operations between October 2015 and July 2016 and include two biomass plants representing 5.6 MW of installed capacity and four natural gas plants representing 1,806 MW of capacity.⁷

According to SNL Energy data, there are 9 large scale generation projects currently under construction in Pennsylvania, including eight natural gas plants representing 5,517 MW of capacity, and one wind plant representing just under 40 MW of capacity (SNL Energy 2016).⁸

RELIABILITY

PJM engages in regional transmission expansion planning to identify improvements and additions to the transmission system needed to ensure reliability. The capacity market is PJM's primary tool to ensure future resource adequacy for reliability. PJM has a Resource Adequacy Planning process that develops key assumptions and metrics for use in conducting capacity market functions, including establishing a reserve margin, forecasting peak load, identifying a reliability requirement (reserve margin times forecasted peak load) and other inputs. In simple terms, the reserve margin is an amount of excess capacity procured to maintain reliability.⁹ PJM's reserve margin requirement is based on industry guidelines and standards for reliability,¹⁰ and an annual reliability and planning analysis performed by PJM. The industry standard reserve margin established by the North American Electric Reliability Corporation (NERC), is 15 percent for predominately thermal-based systems (North American Electric Reliability Corporation 2016), which is based on a loss of load expectation (LOLE) of one day in 10 years.

Figure 11 shows target installed reserve margins and actual capacity reserve margins procured by PJM. These data show that PJM procures capacity reserve margins greater than its reference target installed reserve margins, indicating excess capacity. This phenomenon is widely apparent across U.S. reliability regions (U.S. Energy Information Administration 2012) (North American Electric Reliability Corporation 2016).

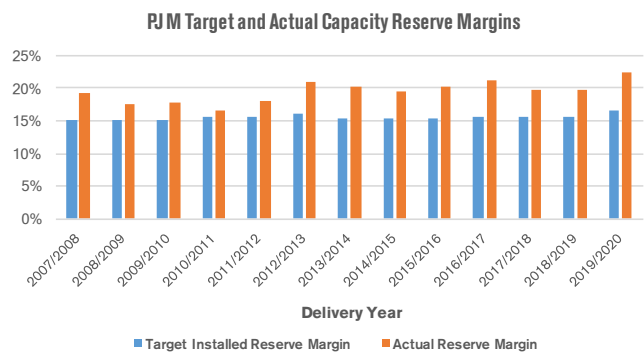


Figure 11 - Target and Actual Capacity Reserve Margins for PJM Base Residual (MW) Actions, by Delivery Year

OPERATIONAL EFFICIENCIES

PJM estimated it delivers \$2.8 to \$3.1 billion in annual benefits to customers in its footprint owing to a host of features unique to a regionally coordinated competitive electricity market and electricity grid (PJM Interconnection 2015). These benefits are broken down in the following manner:

- Managing transmission constraints (\$100 million/year)
- Efficient regional transmission planning (\$375 million/year)
- Reducing new generation investment through reduced reserve margin requirements (\$1.1 to \$1.4 billion/year)
- Replacing old, inefficient generation resources with newer, more efficient resources (\$600 million/year)
- Expanded dispatch areas and the perfect dispatch initiative provide energy production cost savings (\$525 million/year)
- Reduced and less costly regulation and synchronized reserve services from larger market scope (\$100 million/year)

Wholesale restructuring has led to improvements in generation unit performance and efficiency. As previously detailed, PJM's energy market compensates all generators supplying electricity at a given time the market clearing price (i.e. the price paid to the last, highest-cost unit dispatched). This provides a powerful incentive for baseload units to run as frequently as possible, while keeping costs low. The following academic studies provide a few examples:

- Craig and Savage studied 950 investor- and municipally-owned fossil-fueled generation plants across states from 1996 to 2006, to measure how competition impacts operational efficiency these plants. They found thermal efficiency to be 9 percent higher for both investor and municipally owned plants in states that implement full competition (wholesale and retail), compared to non-restructured states (Craig and Savage 2013).
- Bushnell and Wolfram examined U.S. Environmental Protection Agency's Continuous Emissions Monitoring System (CEMS) data from 1997 to 2003 to examine operational efficiency changes at 1031 fossil fuel units resulting from change of ownership (e.g. utility to non-utility) and strengthening of incentives (e.g. through rate freezes imposed during early restructuring that prompted efforts to conserve costs). The study found changes in incentives rather than changes in ownership where the main driver of efficiency improvements – quantified to be a 2 percent reduction in heat rates at units examined. (Bushnell and Wolfram 2005)
- Davis and Wolfram examined data from 48 nuclear reactors that were divested between 1999 and 2007 as a result of restructuring, as well as data from the remaining 55 non-divested nuclear reactors. They found that deregulation and market consolidation (i.e. three large companies control one third of U.S. nuclear capacity) are associated with a 10 percent increase in operating performance of nuclear capacity, which was achieved primarily by reducing the frequency and length of reactor outages (Davis and Wolfram 2012). The study also indicates that

these efficiency improvements lead to a substantial increase in electricity output (40 billion KWhs annually) valued at \$2.5 billion annually and leading to a 35 million metric ton annual reduction in carbon dioxide by displacing fossil fueled generation.

In addition, Fabrizio, Rose, and Wolfram examined large steam turbine and combined cycle plant data owned by private and public entities in regulated and restructured markets. The researchers found that investor-owned plant operators most exposed to the competitive forces of restructuring reduced labor and non-fuel expenses by 3% to 5% (holding energy output constant), compared to other investor-owned operators. Compared to government and cooperatively owned plants in areas insulated from restructuring, these labor and non-fuel costs reductions increased to 6% to 12%, holding output constant (Fabrizio, Rose and Wolfram 2007).

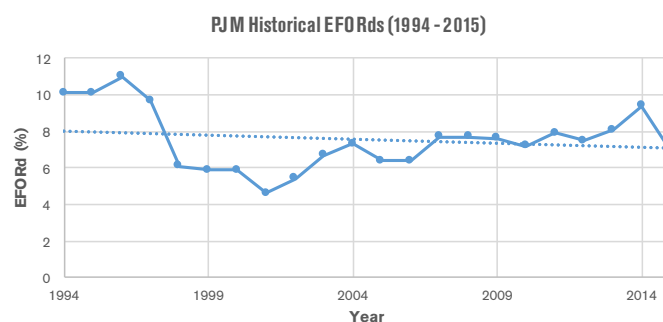


Figure 12 - PJM Historic Equivalent Forced Outage Rates, 1994 - 2015 (Falin 2016)

Figure 12 shows PJM's annual capacity-weighted average equivalent forced outage rates when in demand (EFORds) for generators participating in PJM capacity markets from 1994 through 2015 (Falin 2016).¹¹ EFORd is the probability a generator will fail in part or completely when it is needed. EFORd rates help PJM understand the portion of installed capacity that is not likely to be available when needed, (i.e. unforced capacity).

These EFORd data show a steep downward trend in generator forced outage rates soon after implementation of restructuring. In 2014, there is a spike in the EFORd, related to the polar vortex. There is a downward trend in the EFORd over the time period observed. In 1996, the EFORd for PJM was 11 percent, in 2015 the EFORd was 6.9 percent.

GENERATION FUEL MIX

Over the time periods examined, both PJM and Pennsylvania experienced a significant reduction in coal-fired power output, while natural gas-fired generation increased.

PJM Fuel Mix

From 2005 to 2015, the generation fuel mix in PJM changed considerably, as coal use declined and natural gas use increased.¹²

¹¹ As new zones integrated into PJM, historic generator availability data system (GADS) performance information was provided to PJM, as available. Insofar as this occurred, EFORd figures may reflect performance data for these new zones prior to integration.

¹² PJM data includes the following definitions for various fuels. Captured methane includes landfill gas and coal mine gas. Oil includes residual, distillate, kerosene, jet fuel, waste and pet coke. Solid waste includes municipal solid waste and tire derived waste. Wood waste includes black liquor, wood and wood waste solids. The categories of biomass (including solids, liquids and gases), other gases, and other fuels were excluded from the graph due to negligible percentage contributions to system mix.



Percentage of PJM System Mix, By Fuel Type

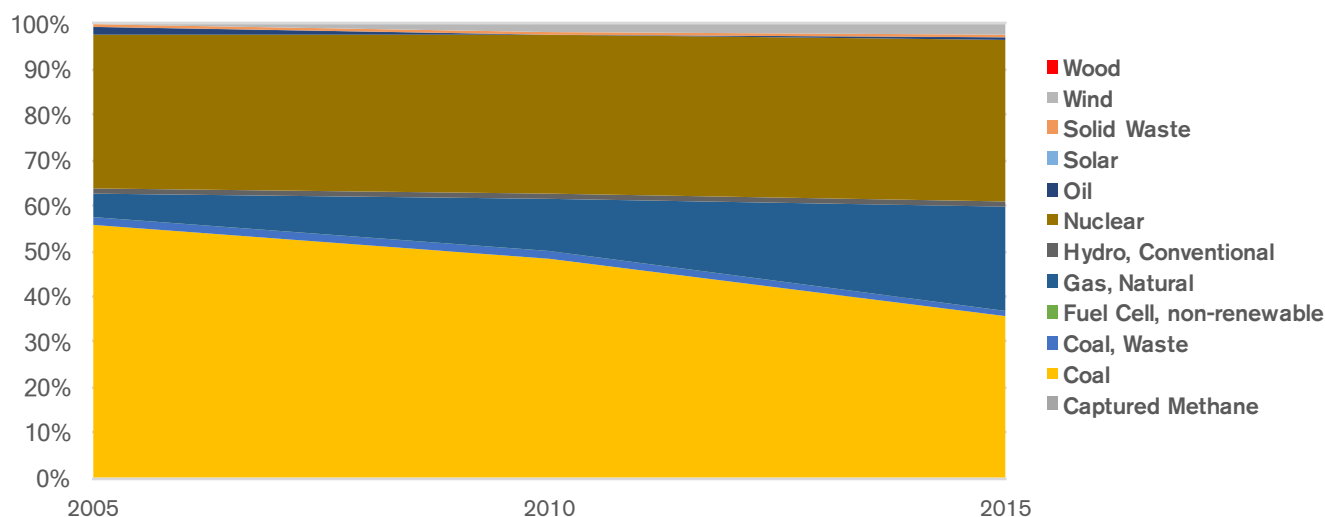


Figure 13 - PJM Power Pool Generation Fuel Mix by Percentage (2005 – 2015)

Compared to 2005 output levels, coal-fired generation in PJM decreased more than 16 percent by 2015, while natural gas-fired generation increased 20 percent by 2015. In terms of percent of total PJM system mix, **Figure 13** shows that:

- In 2005, coal-fired power plants fuel over 55 percent of PJM's power supply, followed by 34 percent from nuclear, 5.3 percent from natural gas, 1.6 percent from waste coal, and 1.5 percent from oil.
- In 2010, coal fueled 48.2 percent of the power supply, followed by 35 percent nuclear, 11.4 percent natural gas, 1.6 percent waste coal, and 1.28 percent wind.
- By 2015, nuclear power became the dominate source of power in PJM supplying 35.7 percent of the pool's power, followed by 35.2 percent from coal, 22.9 percent from natural gas, 2.13 percent wind, and 1.3 percent waste coal.

Figure 14 shows that from 2007 through 2015, Pennsylvania-based generation made up anywhere from a low of 19.6 percent up to a high of 21.9 percent of total annual PJM load (Monitoring Analytics 2015).

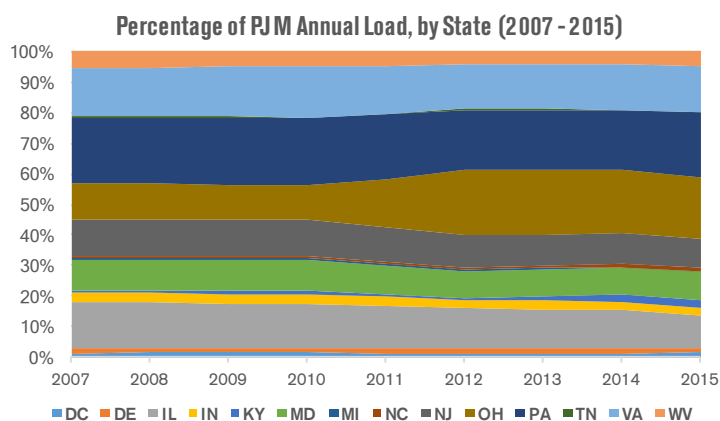


Figure 14 - Percentage of PJM Annual Load, by State (2007 - 2015)

¹³EIA includes the following definitions for fuel sources. Coal includes all coal types (e.g. anthracite, bituminous, etc) and waste coal. Other includes non-biogenic municipal solid waste, batteries, chemicals, hydrogen, pitch, purchased steam, sulfur, tire-derived fuels, and miscellaneous technologies. Other Biomass includes biogenic municipal solid waste, landfill gas, sludge waste, agricultural byproducts, other biomass solids, other biomass liquids, and other biomass gases (including digester gases and methane). Other Gases includes blast furnace gas, propane gas, and other manufactured and waste gases derived from fossil fuels. Petroleum includes distillate fuel oil (all diesel and No. 1, No. 2, and No. 4 fuel oils), residual fuel oil (No. 5 and No. 6 fuel oils and bunker C fuel oil), jet fuel, kerosene, petroleum coke, and waste oil. Wood and Wood Derived Fuels includes paper pellets, railroad ties, utility poles, wood chips, bark, red liquor, sludge wood, spent sulfite liquor, and black liquor, with other wood waste solids and wood-based liquids.

Consumption load growth also occurred over this time period in PJM. Data on the number of annual GATS certificates generated was used as a proxy for annual megawatt hour output levels in PJM.

- From 2005 to 2015, annual MWhs generated in PJM increased by 10.8 percent.

This represents a compound annual growth rate (CAGR) of approximately 0.94 percent over this 11 year period. As mentioned previously, the integration of new zones in the PJM system added both new capacity supply resources, as well as load demand. Therefore new zone integration contributed to the growth observed.

Generation fuel mix data for PJM was available for 2000 through 2015 through PJM Environmental Information Services (PJM-EIS) Generation Attribute Tracking System (GATS) public reports as the system mix (PJM-EIS 2016).

Pennsylvania Fuel Mix

Like PJM, Pennsylvania's generation fuel mix changed considerably over time, with the trend of reduced coal power output and increased natural gas fired output emerging between 2005 and 2010, and advancing thereafter.

Figures 15 and 16 show how Pennsylvania's generation mix and output have changed over time. Compared to 1996 levels of generation, coal-fired output from Pennsylvania generators dropped by 16.8 percent by 2014, while natural gas fired generation increased by 26 percent.¹³ As a percent of total Pennsylvania-based generation mix:

- In 1990, coal-fired power plants produced over 60 percent of Pennsylvania's generation output, with nuclear producing 32.9 percent, petroleum at 2.9 percent, and natural gas and conventional hydro each contributing 1.6 percent. This fuel mix supply was fairly consistent, with minor aberrations, through 2000.



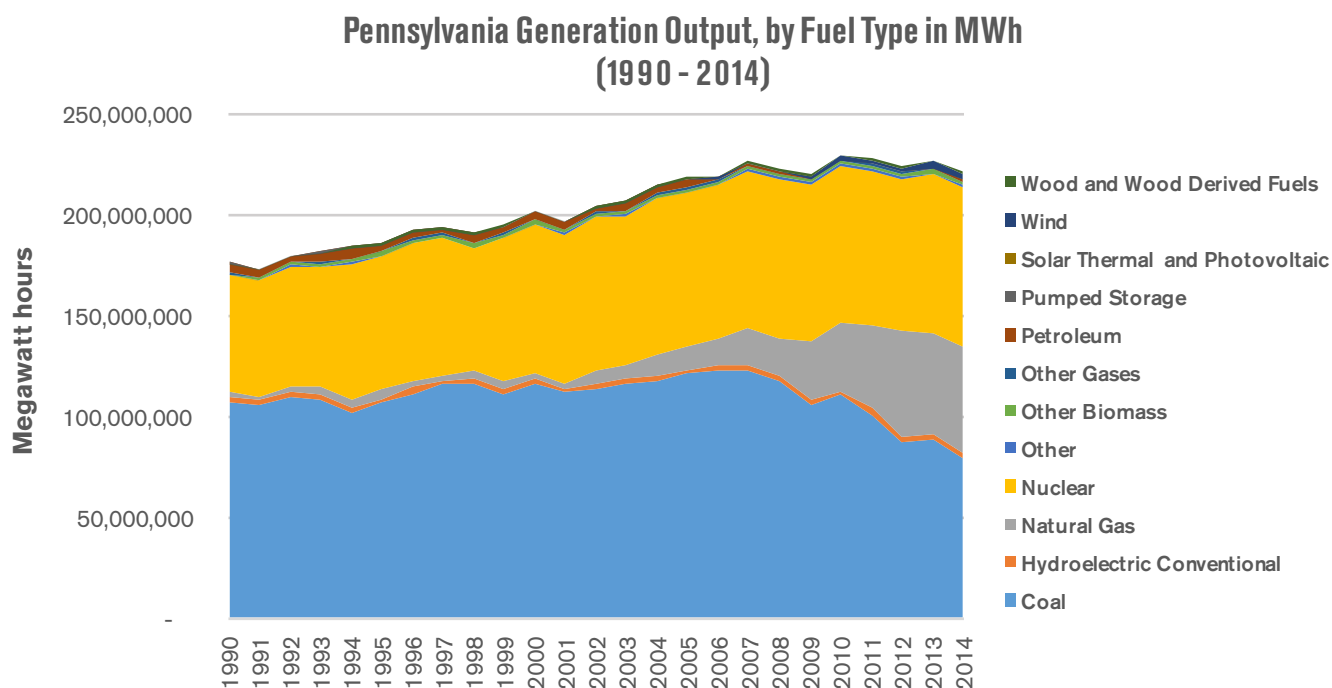


Figure 15 - Pennsylvania Generation Output by Fuel Type in MWh (1990 - 2014)

- By 2005, coal supplied 55.5 percent of Pennsylvania's generation output, followed by 35 percent nuclear, 5 percent natural gas, 2.3 percent petroleum, and 1 percent conventional hydroelectric.
- In 2014, coal-fired power plants supplied only 35.7 percent of Pennsylvania's generation output, followed by 35.6 percent from nuclear, 24 percent from natural gas, 1.6 percent from wind, and 1.2 percent from conventional hydroelectric.

Consumption load growth occurred over the time period examined in Pennsylvania.

From 1990 to 2014, total annual generation in Pennsylvania increased by 26 percent.

- This represents a CAGR of 0.92 percent per year.

Available data for Pennsylvania's generation fuel mix covered a longer time period (1990 to 2014) compared to data available for PJM, and was supplied by the U.S. Energy Information Administration (U.S. EIA 2015).

ENVIRONMENTAL EMISSIONS

The data below shows how emissions of certain environmental air pollutants have decreased considerably after implementation of restructuring. The primary drivers of these air quality emissions reductions include, for example, air quality regulations, clean energy

policies (e.g. portfolio standards, tax credits, grants), and coal to natural gas fuel switching in the power sector.

For coal to natural gas switching, restructuring has provided a platform where generators compete to perform. This has enabled newer, more efficient plants (e.g. combined cycle natural gas plants) to outcompete older, less efficient plants (e.g. some older coal, gas, and oil plants), resulting in entry of the former and exit of the latter. This has contributed to the reduction of air pollution emissions.

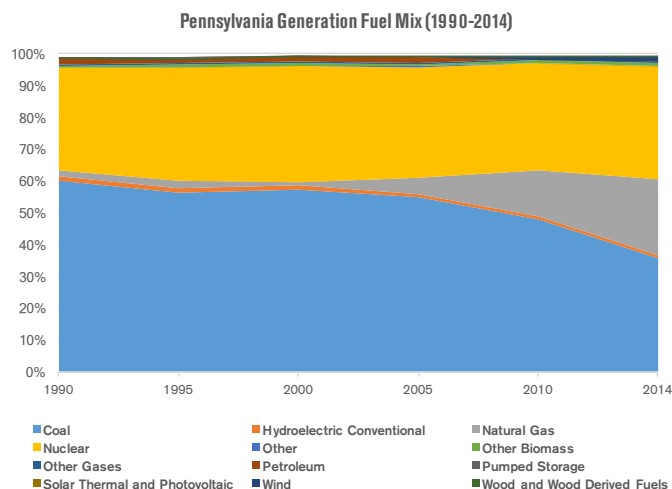


Figure 16 - Pennsylvania Generation Fuel Mix (1990 - 2014)

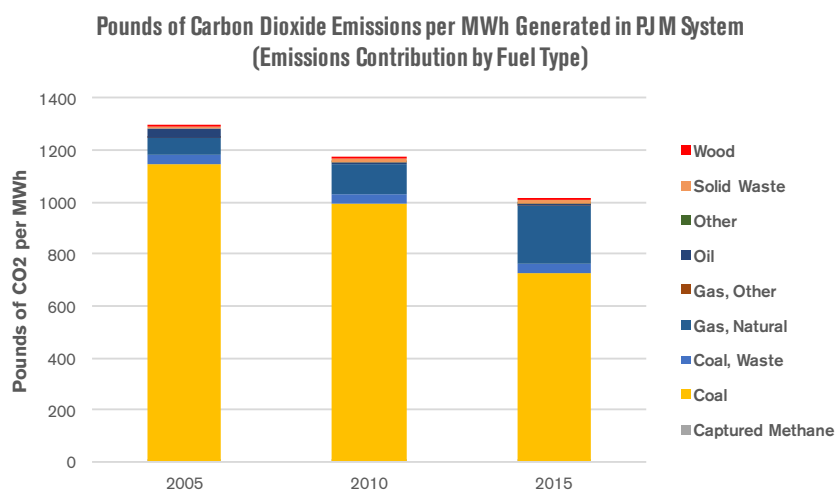


Figure 17 - Pounds of Carbon Dioxide Emissions per MWh Generated in PJM System, by Fuel Source

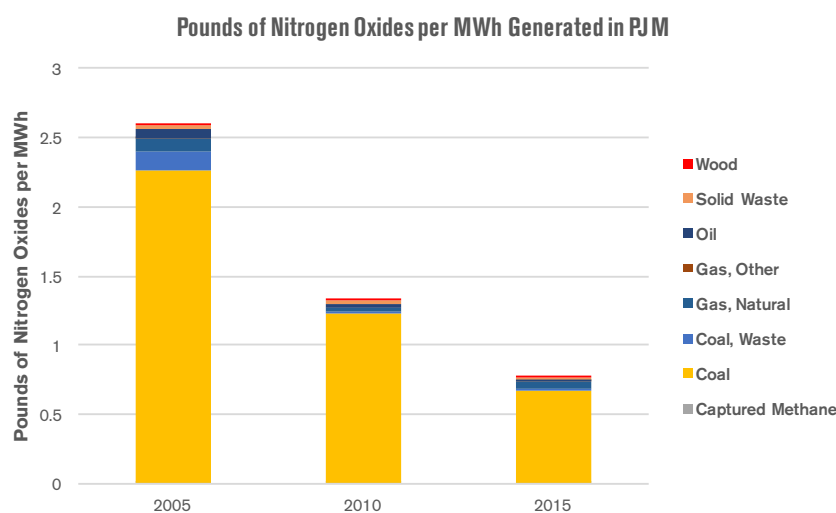


Figure 18 - Pounds of Nitrogen Oxides per MWh in PJM System, by Fuel Source

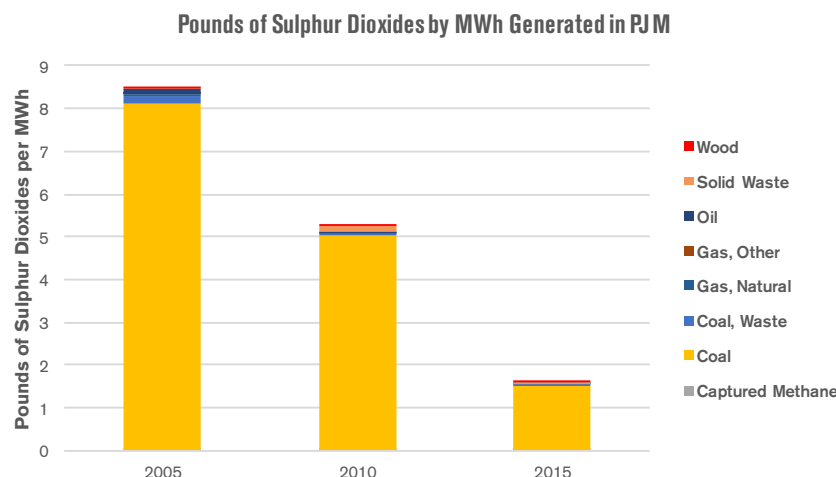


Figure 19 - Pounds of Sulphur Dioxide emissions by MWh Generated in PJM, by Fuel Source

PJM System Mix Emissions

Figure 17 identifies the generator fuel sources in PJM's system that contribute to carbon dioxide emissions. These PJM-EIS data are presented in a pounds of CO₂ emissions per megawatt hour format which is derived from taking total carbon dioxide emissions (in lbs of CO₂) and dividing that by total generation output (MWhs) in the PJM system.

Figure 17 shows that from 2005 to 2015, carbon dioxide emissions in PJM decreased by 21 percent, on a pounds of CO₂ per MWh basis. Most of the decrease in carbon dioxide emissions can be attributed to a reduction in emissions from coal-fired generation.

Figure 18 indicates that emissions of nitrogen oxides in PJM have decreased by 70 percent from 2005 to 2015. These data indicate that a reduction in emissions from coal-fired generation is primarily responsible for these reductions.

Figure 19 indicates that emissions of sulphur dioxides in PJM have decreased by 81 percent from 2005 to 2015, with these reductions being primarily attributed to a decrease in emissions from coal-fired generation.

Data for environmental emissions from the PJM power pool came from PJM-EIS and are presented on a pounds per megawatt hour basis (lbs/MWh), meaning the emissions data represent a RTO-wide average for each MWh of power supplied by the PJM power pool (PJM-EIS 2016). Data from PJM-EIS was only available for 2005 through 2015.



Emissions of CO₂ from Pennsylvania Power Sector (Metric Tons)

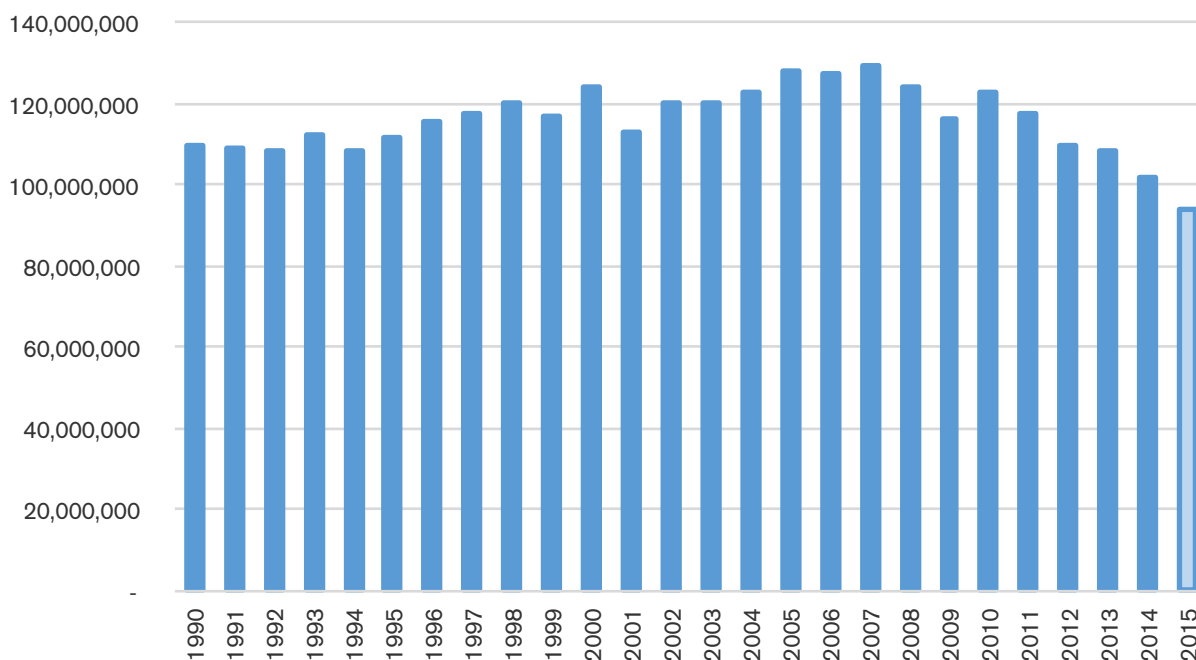


Figure 20 - Carbon Dioxide Emission from Pennsylvania's Power Sector in Metric Tons (1990 - 2015)

Pennsylvania Electric Power Emissions

Environmental air emissions in Pennsylvania decreased after restructuring.

Figure 20 indicates that levels of carbon dioxide emissions from Pennsylvania-based generation in 2014 represents a 7 percent reduction from 1990 levels, a 12 percent reduction from 1996 levels, and a 21 percent reduction from 2005 levels. Data for 2015 carbon dioxide emissions was taken from SNL Energy (SNL Energy 2016) and are provided herein as a reference, whereas data from 1990 to 2014 was supplied by the U.S. EIA (U.S. EIA October 15 2015).

The 21 percent reduction of carbon dioxide emissions from Pennsylvania-based generation from 2005 to 2014 is comparable to the 21 percent reduction in carbon dioxide emissions (on a lbs/MWh basis) in the PJM system from 2005 to 2015 shown in **Figure 17**.

Figure 21 shows significant reductions in nitrogen oxides and sulphur dioxide emissions from Pennsylvania based generation. In 2014, sulphur dioxide emissions were 78 percent lower than 1990 levels, 75 percent lower than 1996 levels, and 74 percent lower than 2005 levels. In

2014, emissions of nitrogen oxides were 72 percent lower than 1990 levels, 56 percent lower than 1996 levels, and 31 percent lower than 2005 levels.

EIA data for environmental emissions of carbon dioxide, nitrogen oxides, and sulphur dioxides were presented in metric tons on a total annual basis. In order to provide a more direct comparison to PJM emissions data presented on a lbs/MWh basis, the state-based data had to be converted from metric tons to pounds, then divided by total Pennsylvania based generation in megawatts hours.

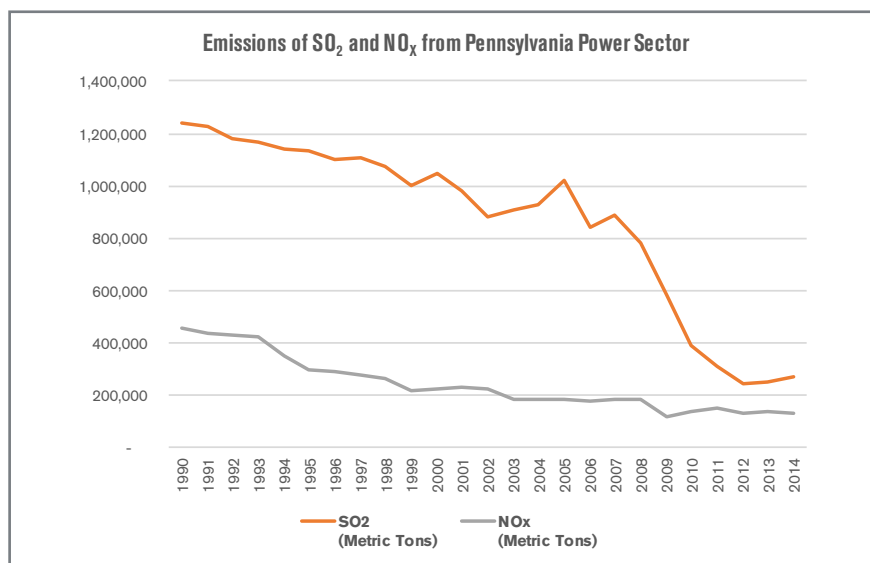


Figure 21 - Sulfur Dioxide and Oxides of Nitrogen Emissions from Pennsylvania's Power Sector in Metric Tons (1990 - 2014)

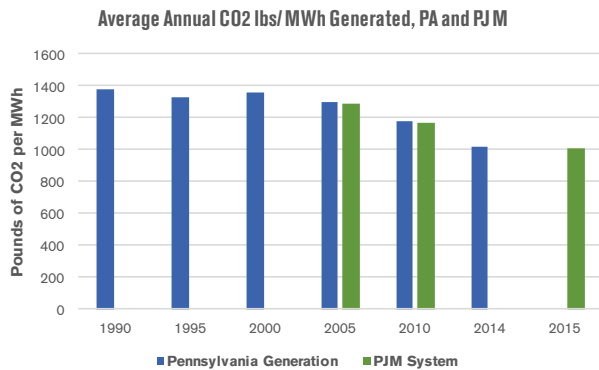


Figure 22 - Average Annual Pounds of Carbon Dioxide Emissions per MWh from Pennsylvania and PJM Generation

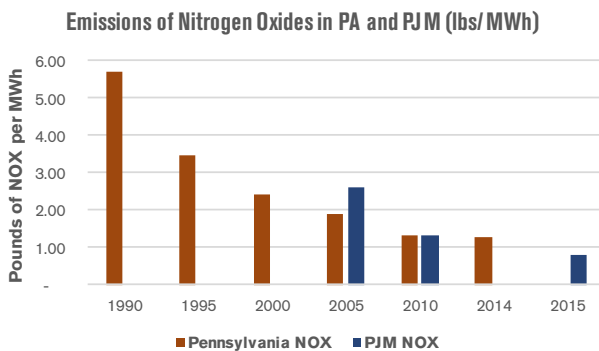


Figure 23 - Emissions of Nitrogen Oxides in PA and PJM (lbs/MWh)

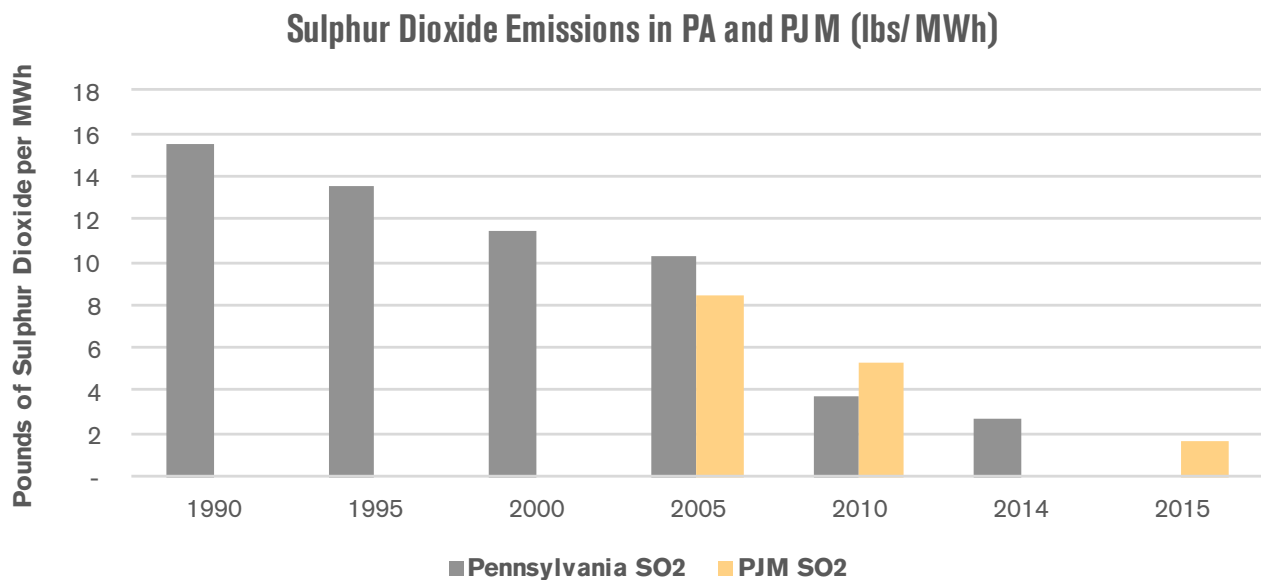


Figure 24 - Sulphur Dioxide Emissions in PA and PJM (lbs/MWh)

Figure 22 compares Pennsylvania and PJM carbon dioxide emissions data on a pounds per MWh basis, indicating that Pennsylvania carbon emissions are just slightly higher than PJM carbon emissions when examined using the pounds of CO₂/MWh units. EIA did not have carbon emissions data available for Pennsylvania for 2015.

Figure 23 compares Pennsylvania and PJM NO_x emissions data on a pounds per MWh basis, indicating that Pennsylvania NO_x emissions were lower than PJM NO_x emissions in 2005, and slightly less to about equal to PJM NO_x emissions in 2010. Pennsylvania NO_x data was not available for 2015. However, Pennsylvania NO_x emission in 2014 were higher than PJM NO_x emissions in 2015.

Figure 24 compares Pennsylvania and PJM sulphur dioxide emissions data on a pounds per MWh basis, indicating that Pennsylvania SO₂ emissions were higher than PJM SO₂ emissions in 2005 and lower than PJM SO₂ emissions in 2010. EIA did not have SO₂ emissions data available for Pennsylvania for 2015. However, Pennsylvania SO₂ emissions in 2014 were higher than PJM SO₂ emissions in 2015.

Environmental emissions data for Pennsylvania were taken from the U.S. EIA's detailed state data table for U.S. electric power industry estimated emissions by state from 1990-2014 (U.S. EIA October 15 2015). Annual Pennsylvania-based generation in megawatt hours was provided by U.S. EIA's detailed state data tables (U.S. EIA 2015). Data for Pennsylvania-based emissions in 2015 was taken from SNL Energy's state emissions database and covers plants required to report hourly to U.S. EPA's Continuous Emissions Monitoring System (SNL Energy 2016).

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SECTION II: RETAIL OVERVIEW

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SECTION HIGHLIGHTS

Overall Pricing Observation

- In 2015, statewide average all-sector retail price of electricity in Pennsylvania was 0.1 percent below the national average, compared to 15 percent above the national average before restructuring.

Residential Customer Pricing Observations

- As shown in Table 1, the benefits of retail restructuring provided the potential for residential “Default Customers” (i.e. customer taking generation and transmission service from their local utility) to save over \$818 million dollars in 2016 (assuming all customers remain with default utility service over the time period examined).
- These benefits were realized as restructuring required utilities to purchase power and related services for Default Customers in competitive wholesale markets, rather than from cost-of-service regulated generation resources.
- On a statewide annual average basis, residential “Shopping Customer” (i.e. customers that receive generation and transmission service from a competitive retail supplier) prices exceeded Default Customer prices during full statewide implementation of retail restructuring.
 - Competitive retail suppliers note Shopping Customer products may not always be comparable to Default Customer products, as the former may include unique attributes (e.g. renewable energy, or discounts and incentives) that command price premiums. However, supporters of Default Customer products argue Shopping Customer products can expose customers to greater market price volatility and may not be able to compete on price due to higher costs (e.g. marketing). More research is needed to understand the magnitude to which the factors above contribute to observed price differentials in Pennsylvania.
- On a statewide annual average basis, distribution prices to the residential class have increased over time at a rate that exceeds inflation, and these distribution rates make up over 50 percent of

the delivered price of power to this sector.

- An analysis of Electric Distribution Company (EDC)-specific residential distribution prices from 1996 through 2016 found that distribution prices for all but one EDC have increased at a rate higher than the rate of inflation, with increases in distribution prices overwhelming generation and transmission savings in some EDC territories.

Commercial and Industrial Pricing Observations

- On a statewide annual average basis, Shopping Customer prices to the commercial and industrial sectors were lower than Default Customer prices during full statewide implementation of restructuring.

| Residential (500 KWh) Default Generation and Transmission Savings From Restructuring | | | |
|--|---|-----------------------------------|----------------------------------|
| | Percent Change (1996 Adjusted to 2016 Actual) | Potential Monthly Savings in 2016 | Potential Annual Savings in 2016 |
| Duquesne | -41% | \$13,979,881 | \$167,758,574 |
| Met-Ed | -2% | \$396,854 | \$4,762,249 |
| PECO | -40% | \$39,919,435 | \$479,033,220 |
| Penelec | -4% | \$784,546 | \$9,414,546 |
| Penn Power | -26% | \$2,203,852 | \$26,446,219 |
| PPL | -20% | \$12,453,265 | \$149,439,180 |
| West Penn Power | 7% | \$(1,518,916) | \$(18,226,988) |
| Totals: | | \$68,218,917.00 | \$818,627,001 |

Table 1 - Summary of Residential Default Generation and Transmission Cost Savings from Restructuring

(Percentage savings compares 1996 pre-restructuring unbundled generation and transmission rates to default service generation and transmission rates as of January 31, 2016. Inflation adjustments are through calendar year 2015, given availability of CPI data. Potential dollar savings assume all PA Electric Distribution Company residential customers are default customers, though many of these customers are shopping.)



- On a statewide annual average basis distribution prices for the commercial and industrial sector have displayed a decreasing trend from 2000 through 2014. Distribution prices to these sectors in 2014 are lower than nominal prices from 2000, an obvious indication that these prices have not kept pace with inflation.

Retail Shopping Statistics

- The industrial sector has the highest and most stable level of Shopping Customer penetration with PA EDC's experiencing 63 percent to 97 percent of industrial customers shopping in 2016. In 2016, most PA EDC have experienced 30 percent to 54 percent of commercial customers shopping, and 22 percent to 45 percent residential customers shopping.

Residential Retail Product Offerings Snapshot

- For the snapshot in time observed (August 25, 2016) for products advertised on the PA PUC's shopping website, residential Shopping Customers had a significant number of retail supply offerings in each PA EDC territory, mostly in the form of fixed and variable rate products.
- Comparatively, there are fewer innovative rate and product offerings available to the residential sector. Renewable energy products are the most widely available innovation, with many other envisioned innovations being offered on a limited basis or are currently not being offered on the PA PUC's website.

Universal Service

- Customer Assistance Program (CAP) and Low Income Usage Reduction Program (LIURP) funding increased significantly as a result of restructuring orders, with most EDC's increasing funding thereafter.

INTRODUCTION

This section focuses primarily on retail pricing outcomes, to determine the performance (i.e. benefits or drawbacks) of retail restructuring. Analysis begins with an examination of statewide annual average data, and then examines more granular data as warranted to determine benefits or drawbacks. This section also explores additional performance metrics related to retail shopping penetration, quantity of product offerings, and universal service program funding.

DATA LIMITATIONS AND RATE CAPS

The following pricing analysis is limited by the quality of available data and implementation of retail restructuring in Pennsylvania.

U.S. EIA Data. Statewide data for all sector and sector-specific prices were supplied by the U.S. Energy Information Administration (EIA). All prices publicly disclosed from the EIA Form 861 are presented on a state-wide, annual average basis, which creates certain limitations, discussed below.

- **Annual Averaging.** Price fluctuations are smoothed by annual averaging, which may apply to variable rate products or fixed rate products with less than a 12-month term. Similarly, sub-annual changes to default service generation rates (i.e. price to compare) from the incumbent utility will be evened out by the effects of annual averaging.

- **Statewide Averaging.** Statewide averages do not account for geographic differences in the price of energy or delivery service. For example, EIA reported the statewide average annual retail price of utility default service to the residential sector for 2014 was 12.83 cents per KWh (EIA, Average retail price of electricity to ultimate consumer, by sector, by state, by provider (back to 1990) 2015). However, average annual prices reported to U.S. EIA from individual Pennsylvania investor-owned utilities for utility default service ranged from a low of 9.04 cents/KWh (West Penn Power) to a high of 14.54 cents/KWh (PECO) (U.S. EIA 2015).

- **Average, Blended Pricing.** Respondents to EIA's form 861 submitted data, including but not limited to, the number of customers, total revenues, and total sales (in MWhs). EIA's Form 861 respondents included electric utilities, all demand-side management program managers, wholesale power marketers, energy service providers (registered with the state), and electric power producers (EIA, Form EIA-861 Annual Electric Power Industry Report Instructions 2016). Average pricing in EIA's form 861 was developed by dividing total reported revenues by total sales, eventually deriving a cents per KWh price. For competitive retail suppliers, total revenues and sales are reported across all product offerings, so the average per KWh price represents a blend of all offerings being purchased by consumers in that state and sector. These data have limits to usefulness on price comparisons. For example, some products may have higher prices because they offer non-standard benefits (such as supply being sourced by renewable energy), while other products are more readily comparable with standard utility service.



Rate Cap Expiration. To allow for recovery of stranded costs (i.e. cost associated with regulated utility investments in generation and related assets that were to be recovered over time through customer rates), Pennsylvania's restructuring law capped generation, transmission, and distribution rates at 1996 levels.

The caps on transmission and distribution rates expired at different times for each EDC, expiring statewide by 2010. The state's restructuring law initially set the following dates for expiration of the generation rate caps:

- As of January 1, 1999 a maximum of 33 percent of the peak load of each customer class shall have the opportunity for direct access.
- As of January 1, 2000 a maximum of 66 percent of the peak load of each customer class shall have the opportunity for direct access.
- As of January 2, 2001 all customers of electric distribution companies in this Commonwealth shall have the opportunity for direct access.

However, generation rate caps were extended for many PA EDCs, through litigation (Pennsylvania Public Utility Commission 2009). Pilot shopping programs for up to 5 percent of EDC peak load may have been in place for some EDC territories before generation rate cap expiration. **Table 2** provides information on the EDC specific generation cap expiration dates.

| PA EDC | Generation Rate Cap Expiration Date |
|-----------------|-------------------------------------|
| Duquesne Light | December 2001 |
| Penn Power | December 2006 |
| PPL | December 31, 2009 |
| MetEd | December 31, 2010 |
| Pennelec | December 31, 2010 |
| PECO | December 31, 2010 |
| West Penn Power | December 31, 2010 |

Table 2 - Generation Rate Caps by PA EDC

As a result, although Pennsylvania's restructuring law was passed in 1996, full statewide implementation was not achieved until 2011. This is because generation rate caps did not expire in many areas of the state until the end of 2010. At the time analysis was performed, U.S. EIA data was available through 2014, leaving only four full years of data for full implementation of retail restructuring.

Pilots and Phase-In Period. Data prior to 2011 for EGS Generation and Shopping Customers therefore does not reflect true statewide implementation of retail restructuring. For example, data before 2011 may reflect loss-leader or pilot pricing for EGS generation, low volumes (phase-in) of EGS Generation and Shopping Customer offerings, and incumbent utility generation pricing reflective of rate caps.

RETAIL PRICING

A National Context for Pennsylvania

Concern about high electricity prices was one of the reasons Pennsylvania policy makers explored deregulation of the electric industry. At the time, it was widely quoted that Pennsylvania's price of electricity was 15 percent higher than the national average.

Pennsylvania's All Sector Electricity Price Moves Closer to National Average. Based on available data from the U.S. EIA, Pennsylvania's average annual price of electricity for all sectors has converged closer to national all sector pricing, see **Figure 1**. (EIA, U.S. EIA Electricity Data Browser 2016) In 2002, Pennsylvania's average annual all sector price was 12 percent higher than the national average. By 2008, the state price was 4 percent below the national average, and in 2015, the state price was 0.1 percent below the national average.

The reader should understand that generation rate caps were in place in certain areas of Pennsylvania through the end of 2010, impacting the overall retail rate.

Figure 2 compares the average annual retail price of electricity for Pennsylvania and the U.S. by customer class (EIA, U.S. EIA Electricity Data Browser 2016).

Average retail price of electricity, annual

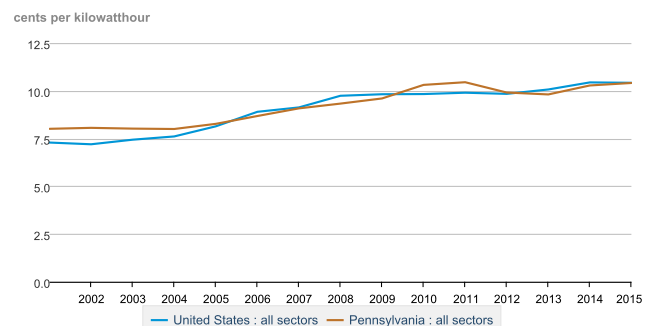


Figure 1 - Average Annual Retail Price of Electricity for All Sector, Pennsylvania and U.S.

Average retail price of electricity, annual

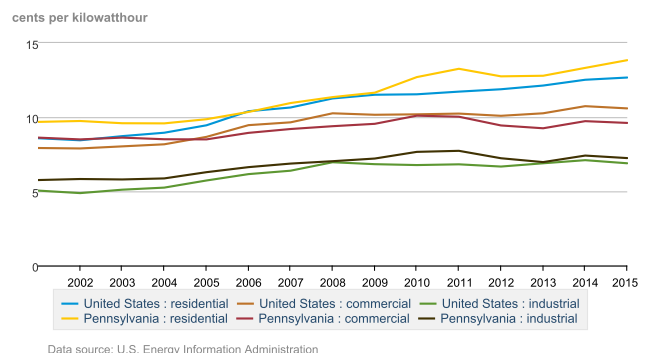


Figure 2 - Average Annual Retail Price of Electricity per Customer Class, PA and U.S.

- **Pennsylvania's Residential Electricity Prices Higher than National Averages.** A sector-specific examination of these average annual prices reveals that with the exception of 2006—when prices were 0.5 percent below the national average—residential retail prices in Pennsylvania have consistently been above national averages. Pennsylvania's average annual price of electricity to the residential sector was 15 percent higher than the national average residential electricity price in 2002, 13 percent higher than the national average in 2011, and 9 percent higher than the national average in 2015.
- **Pennsylvania's Commercial Electricity Prices Lower than National Averages.** On the other hand, Pennsylvania's average annual retail prices to the commercial sector have consistently been lower than the national averages since 2004. In 2001, the state's average annual commercial class price was 9 percent higher than the national average price for the commercial class. By 2005, the average state price was 2 percent below the national average, reaching 10 percent below the national average in 2013. Since both the residential and the industrial sector prices were above the national average, it is presumed that the state-level commercial sector price discount is driving the overall convergence of national and state prices. More research is needed to confirm this presumption.
- **Pennsylvania's Industrial Electricity Prices Higher than National Averages.** Pennsylvania's average annual price to the industrial sector has come closer to, but still consistently exceeds, corresponding national averages. For example, in 2002, Pennsylvania's average annual industrial price was 19 percent above the national average. By 2008, the state's average annual industrial price was within one percent of the national average for the same class. However, by 2010, the state price was 13 percent higher than the national average. By 2013, the state price came within 1 percent of the national average yet again.

The reader should be aware that generation rates were capped in some areas of Pennsylvania through the end of 2010, impacting the overall retail rate.

Average Annual Retail Price of Electricity in Pennsylvania

Information for the graphs in this section were obtained from the U.S. EIA's Form 861 annual electric power industry survey report data (EIA, Average retail price of electricity to ultimate consumer, by sector, by state, by provider (back to 1990) 2015).

"Default Customer" prices represent EIA's "full service provider" category that includes both energy and delivery services. In other words, this is the total price customers pay when they receive both generation and distribution service from their local utility.

"EGS Generation" prices represent EIA's "energy only" category that covers competitive retail generation products offered by electric generation suppliers (EGS) and excludes distribution service.

"Distribution" prices represent EIA's "delivery only" category, which is the incumbent utility's price of distribution service that excludes generation service.

"Shopping Customer" prices represent EIA's "restructured retail service provider" data that combines average annual prices for EGS generation service and utility distribution service for customers who shop. Simply adding the average energy only and delivery only prices will not always equal the average "restructured retail service provider" price data, due to the effects of adding averages. The "restructured retail service provider" data provides an average based from actual energy revenues and KWh sales.

INFLATION ADJUSTMENTS & NATIONAL RETAIL ELECTRICITY PRICING

Throughout this section, historic prices are adjusted for inflation to provide more reasonable comparisons to current prices.

Inflation adjustments used annual Consumer Price Index (CPI) data for all urban consumers (CPI-U) as provided by the U.S. Bureau of Labor and Statistics (U.S. Bureau of Labor and Statistics December 2015). CPI indexes are available for two population groups: a CPI for all urban consumers (CPI-U) covering approximately 89 percent of the population, and a CPI for urban wage earners and clerical workers (CPI-W) covering approximately 28 percent of the population. The CPI-U was chosen as a broader reflection of purchasing power changes.

Appendix A provides an overview of national annual average retail electricity prices, by sector, along with inflation adjustments from a 2001 base year. These data indicate that on a national annual average basis, the "all sector," residential, and industrial sector retail prices have risen at a rate greater than inflation. For the commercial sector, actual prices rose faster than inflation at times, but more recently have closely tracked the rate of inflation. These national data are useful as a benchmark comparison to the Pennsylvania-specific data.

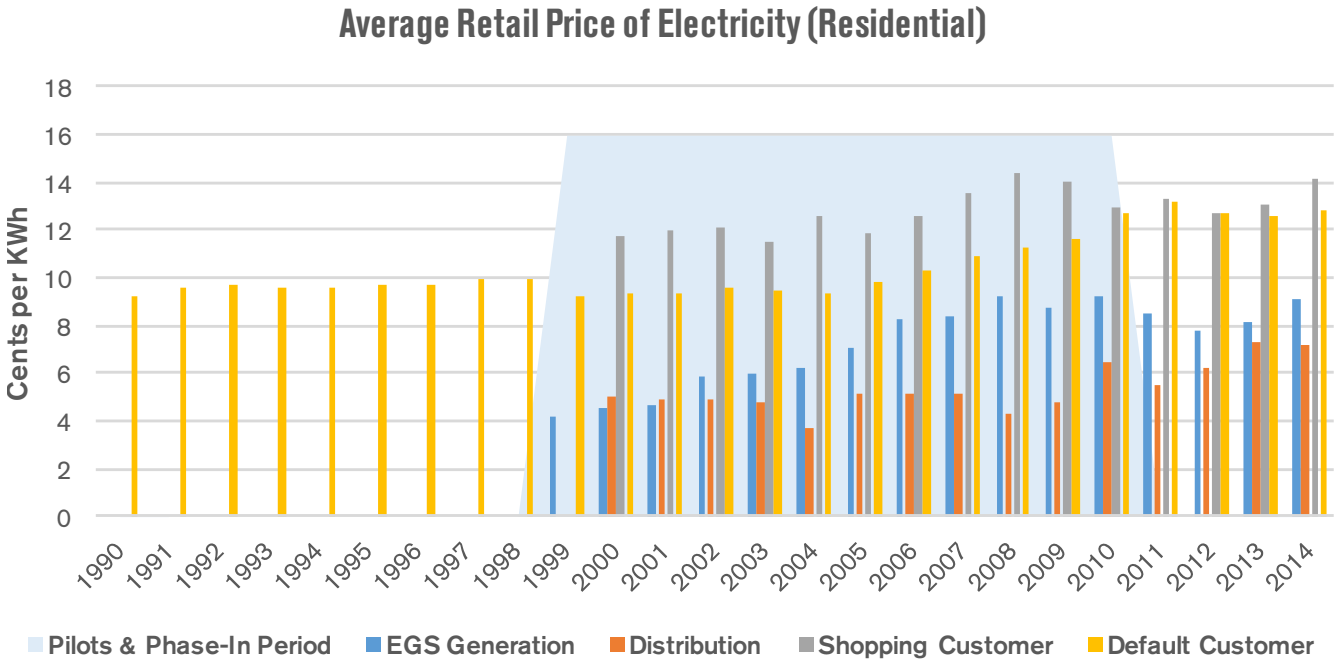


Figure 3- Average Residential Retail Price of Electricity in Pennsylvania

Residential Price Observations

Figure 3 shows average annual retail price data applicable to Pennsylvania's residential customer class. **Figure 4** shows these average values compared to base years indicating how actual prices changed compared to inflation.

Default Customer Prices to Residential Sector Less Expensive than Shopping Customer Prices. During full implementation (2011-2014), Default Customer prices for electricity delivered to the residential sector were less expensive than Shopping Customer prices. This trend was also observed during the pilot and phase-in period.

- Recall these data are presented on a statewide average basis and the results do not necessarily mean residential customers are unable to find a competitive supplier that can offer savings compared to the default utility.
- Competitive retail suppliers' note there is only one standard

type of Default Customer product per EDC, whereas Shopping Customers may be presented with a variety of product types. Some of these product types may create greater value for the customer through beneficial attributes (e.g. renewable energy credits, special discounts, and incentives) and have a commensurately higher price. (More information on the various Shopping Customer product types is available in the Residential Retail Offerings sub-section.)

- On the other hand, some (e.g. consumer advocates) argue that Shopping Customer products are higher priced, because competitive retail suppliers have higher costs, and/or these products have greater exposure to market volatility.
- More research is needed to understand if greater value or other factors (e.g. market volatility, retail supplier costs) are driving observed price differentials.

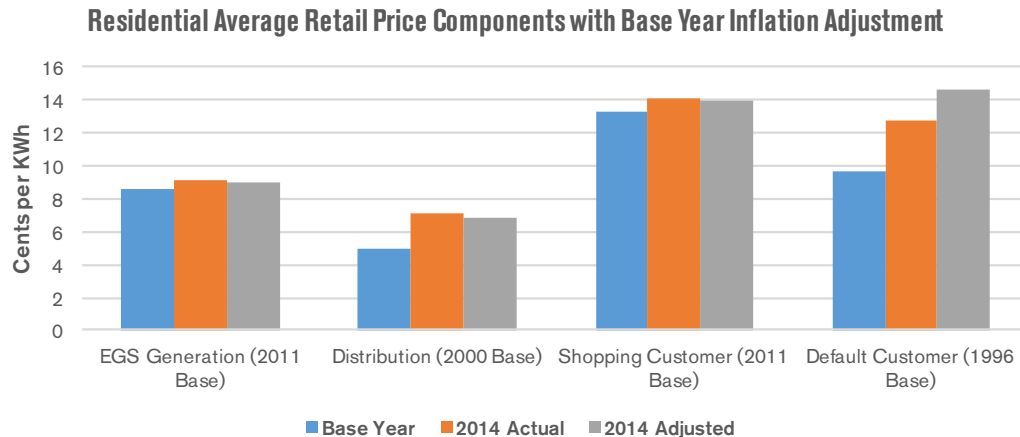


Figure 4- Residential Average Retail Price Components with Base Year Inflation Adjustment

Average Retail Price of Electricity (Commercial)

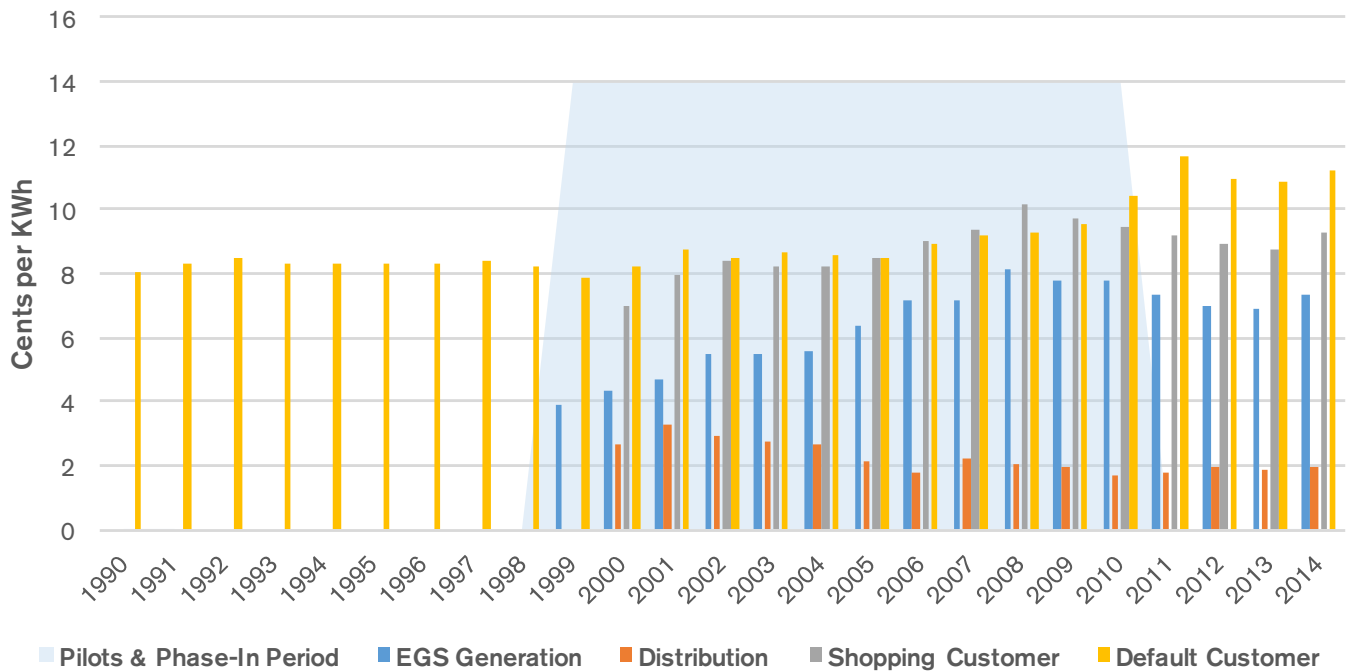


Figure 5 - Average Annual Commercial Retail Price of Electricity in Pennsylvania

Inflation Comparisons

- **EGS Generation and Shopping Customer Prices Increasing Faster than Inflation.** Using 2011 as the full implementation base year, actual prices in 2014 were greater than inflation adjusted prices for 2001.
- **Default Customer Prices Increasing Slower than Inflation.** Over a much longer period, using 1996 as a base year through 2014, Default Customer prices have increased at rates slower than inflation.

Residential Sector Distribution Service is Significant, Increasing Price Driver.

From 2000 to 2014, the average price of distribution service to the residential sector increased above the rate of inflation. In addition, the price of distribution service makes up a larger portion of the total per kWh delivered price of power, compared to the industrial and the commercial classes. The 2000 distribution price to the residential sector was 4.99 cents per kWh. Adjusted for inflation, this price in 2014 would be 6.86 cents per kWh. However, the actual price of distribution service in 2014 was 7.15 cents. In 2000, distribution service made up 43 percent (Shopping Customer) to 53 percent (Default customer) of the total per kWh price of delivered power. By 2014, distribution service price made up 51 percent (Shopping Customer) to 56 percent (non-Shopping Customer) of the total per kWh price of delivered power to the residential sector. Of course, these percentage figures can indicate both an increase in delivery prices and/or a decrease in total bundled price, but a total price decrease was not observed.

Commercial Price Observations

Figure 5 shows average annual retail prices to the commercial class in Pennsylvania. Figure 6 shows average retail price components to the commercial sector compared to a base year that is adjusted for inflation.

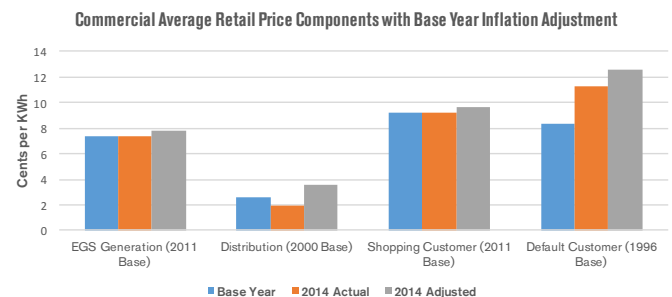


Figure 6 - Commercial Average Retail Price Components with Base Year Inflation Adjustment

- **Commercial Sector Shopping Customer Prices Generally Lower than Default Prices.** During full implementation (2011-2014), prices to Shopping Customers were lower than Default Customer prices. This trend was also observed in the Pilots and Phase-In period, except from 2005 through 2009.
- **Inflation Comparisons**
 - **EGS Generation and Shopping Customer Prices Increasing Slower than Inflation.** Comparing 2011 full implementation

Average Retail Price of Electricity (Industrial)

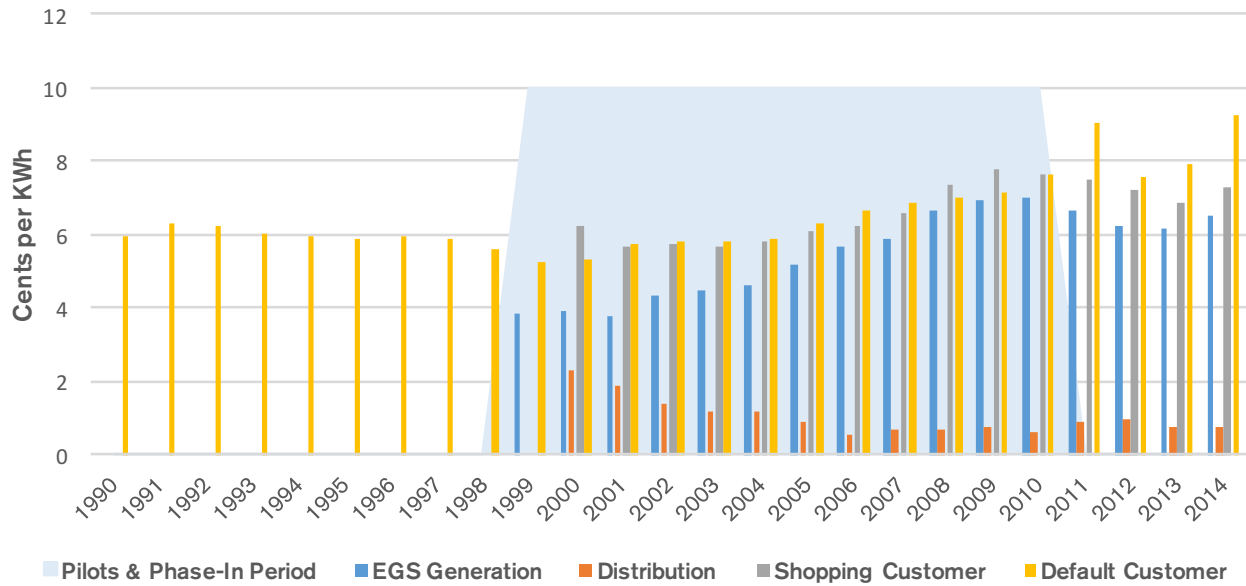


Figure 7 - Average Annual Industrial Retail Price of Electricity in Pennsylvania

base prices for EGS Generation and Shopping Customers to 2014 actual and inflation adjusted levels shows these prices have not kept pace with inflation.

- **Default Customer Prices Increasing Slower than Inflation.** Over a much longer period, using 1996 as the base year, actual Default Customer prices in 2014 have increased at rates slower than inflation.
- **Commercial Sector Distribution Prices Decreasing.** From 2000 through 2014, distribution prices to the commercial sector have trended down both in terms of nominal dollar value and as a percentage of total per kWh delivered power price. In 2000, distribution service price was 2.64 cents per kWh. If the 2.64 cent value from 2000 was adjusted for inflation, the price in 2014 would be 3.63 cents. However, the 2014 price for delivery service was 1.94 cents. This indicates a significant price reduction. In 2000, distribution price made up 38 percent (Shopping Customers) to 32 percent (Default) of the total per kWh delivered price of power. By 2014, distribution service made up 21 percent (Shopping Customer) to 17 percent (Default) of the total per kWh delivered power price. Of course, these percentage figures can indicate both a decrease in distribution prices and/or an increase in total bundled price.

Industrial Price Observations

Figure 7 shows the average annual price of retail electricity to industrial customers in Pennsylvania. Figure 8 shows industrial sector average retail price components with a base year inflation adjustment.

- **Industrial Sector Shopping Customer Prices Lower than Default Customer Prices.** During full implementation (2011 through 2014), Shopping Customer prices were lower than Default Customer prices to this sector. This trend was also observed in the Pilots and Phase-In period, except in 2000, 2008, and 2009. Shopping Customer prices tended to be less volatile in the full implementation period, compared to Default Customer prices.
- **Inflation Comparisons**
 - **EGS Generation and Shopping Customer Prices Increasing Slower than Inflation.** Comparing 2011 full implementation base prices for EGS Generation and Shopping Customers to 2014 actual and inflation adjusted levels shows these prices have not kept pace with inflation.
 - **Default Customer Prices Increasing Faster than Inflation.** Over a much longer period, using 1996 as the base year, actual Default Customer prices in 2014 have increased at rates faster than inflation.

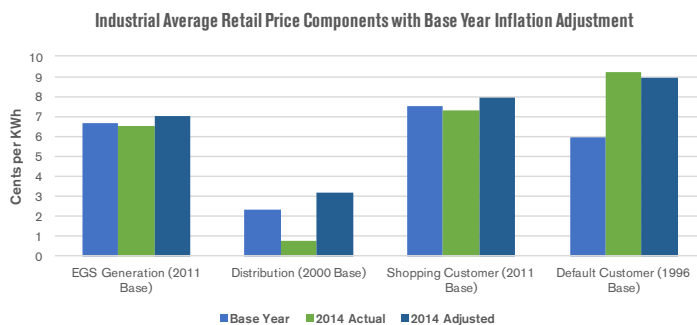


Figure 8 - Industrial Average Retail Price Components with Base Year Inflation Adjustment

• **Distribution Prices to the Industrial Sector have Decreased.**

Distribution prices have decreased in nominal terms, since 2000. In 2000, the average distribution price to the industrial sector was 2.32 cents per KWh. Adjusting this price for inflation, the price would increase to 3.19 cents by 2014. However, the 2014 distribution price was only 0.77 cents. This indicates a significant price reduction. In 2000, distribution prices represented 37 percent (Shopping Customer) to 44 percent (Default Customer) of the total per KWh price of delivered power. By 2014, the price of distribution service dropped to 11 percent (Shopping Customer) to 8 percent (Default Customer) of the total per KWh price of delivered power. Of course, these percentage figures can indicate both a decrease in distribution price and/or an increase in total bundled price.

Residential and Small Commercial Rate and Bill Comparisons

After examining statewide average annual figures, it is clear that retail restructuring has provided an opportunity for cost savings benefits to the commercial and industrial customer classes through retail shopping. However, the same conclusion can't be drawn from these data for the residential sector. **Further analysis was performed to understand the impacts of retail restructuring on lower usage consumers.** This analysis aims to answer that question by 1) comparing generation and transmission rates for the residential and small commercial classes before restructuring to today's rates, and 2) comparing total bills to these customers before restructuring to today's total bills. Of course, to do this, pre-restructured rates and bills must be adjusted for inflation for a reasonable comparison.

Data for PA EDC 2016 bundled and unbundled rates came from the PA PUC's Rate Comparison Report (Pennsylvania Public Utility Commission April 15, 2016). Pennsylvania's restructuring law froze generation rates at December 31, 1996 levels, issued PA EDC-specific restructuring orders, and required PA EDCs to develop restructuring compliance plans no later than September 1997. These restructuring plans required, inter alia, development of unbundled rate schedules that were cost-equivalent to the EDC's 1996 bundled rates. Data for EDC's bundled and unbundled rates, respectively, came from EDC-specific deregulation orders issued by the PA PUC, as amended and included in the following documents, listed here and in the section bibliography for enhanced visibility to the reader:

- PECO's deregulation compliance plan and tariff for residential rate in schedule R and small commercial rate in schedule GS (PECO Energy January 20, 1998).
- GPU Energy's compliance plan and tariff for MetEd for residential rate in schedule R and small commercial rate in schedule GS (GPU Energy MetEd July 24, 1998).
- GPU Energy's compliance plan and tariff for Penelec for residential rate in schedule RS and small commercial rate in

schedule GS (GPU Energy Penelec July 24, 1998).

- FE Penn Power's compliance plan and tariff for Penn Power for residential rate in schedule RS and small commercial rate in schedule GS (First Energy Penn Power October 13, 1998).
- Allegheny Power's compliance plan and tariff for West Penn Power for residential rate in schedule 10 and small commercial rate in schedule 20 (Allegheny Power West Penn Power June 18, 1998).
- PPL's compliance plan and tariff for residential rate in schedule RS and small commercial rate in schedule GS-1 (Pennsylvania Power & Light Company July 17, 1998).
- Duquesne Light's compliance plan and tariff for residential rate in schedule RS and small commercial rate in schedule GS (Duquesne Light September 12, 1998).

Data Limitation. The rates listed in the above referenced orders, compliance plans, and related documents were used to inform the forthcoming analysis. However, it is recognized that the rates listed in these documents may have subsequently changed as a result of litigation, settlements, or other factors. Effort was taken to obtain the best data possible, but the length, historic nature, organization, and availability of docketed information precluded an exhaustive examination.

Once the appropriate rates were located in the above-referenced orders, these rates were applied to usage criteria to derive monthly bill amounts. In order to ensure a consistent approach to customer class criteria, customer class categories followed those listed in the PA PUC's Rate Comparison Report (Pennsylvania Public Utility Commission April 15, 2016).

- For all cases, residential rate R assumes 500 KWh per month for January 31 (i.e. non-summer). The authors note that 500 KWh per month is less than the current average Pennsylvania residential usage of about 855 KWh, but this amount was used to ensure consistency across the analysis. Data for the average number of EDC residential customers for 2015 was supplied by the PA PUC's Customer Service Performance Report (Pennsylvania Public Utility Commission 2015).
- For the small commercial class, all data assumes single phase, 5KW demand, using 1,000 KWh per month in January 31 (i.e. non-summer). However, PECO's unbundled small commercial rate structure included a summer generation rate, which is included as an additional data set in this analysis.¹

Data for the number of small commercial accounts per EDC in Pennsylvania were not available, precluding a long-term, sector-cumulative savings (loss) analysis. These residential and small commercial monthly bills were then compared to monthly bills derived from applying the consistent usage criteria to 2016 rates identified in the PA PUC's 2016 Rate Comparison Report.

¹ Average residential electricity usage for Pennsylvania in 2015 was reported to be 855 KWh per month, according to the U.S. EIA, available at: http://www.eia.gov/electricity/sales_revenue_price/pdf/table5_a.pdf



Comparison of Residential and

Small Commercial Generation and Transmission Prices

Observations from the statewide data presented in **Figures 3 and 4** suggest that on an annual average basis, residential sector customers generally would find utility default service prices more attractive than Shopping Customer prices. The following analysis aims to understand how competition impacted generation and transmission rates for residential and small commercial customers by comparing inflation adjusted pre-deregulation prices to today's actual prices. Understanding from the statewide analysis that energy only prices to all sectors have risen at rates that exceed the rate of inflation, this analysis helps determine if residential and small commercial customers would have benefitted from ongoing cost of service regulation of generation.

Default service generation and transmission charges offered by PA EDCs to the respective customer classes were identified in the PUC's Rate Comparison Report as of January 31, 2016 and compared to the nominal and inflation adjusted generation and transmission charges of these EDCs at the time of deregulation (1996). As part of the restructuring process, PA EDCs were required to break out their 1996 bundled rates into cost equivalent unbundled rates. For this analysis, the unbundled rates based on 1996 costs were used to identify total energy charges, which include the generation rates, transmission rates, and the competitive transition charge (CTC). The non-bypassable CTC charge was established to enable PA EDCs to recover transition and stranded costs plus a rate of return on the cost of capital associated with existing generation assets that would be moving from cost of service regulation and into competitive markets.

The 2016 default service generation rates for residential and small commercial customers offered by PA EDCs reflect the impacts of wholesale competition, and the PA PUC's efforts to align default service generation procurement to more closely reflect electricity market prices through quarterly adjustments.²

Figure 9 and **Table 3** show that for Duquesne, MetEd, PECO, Penelec, Penn Power, and PPL default generation and transmission

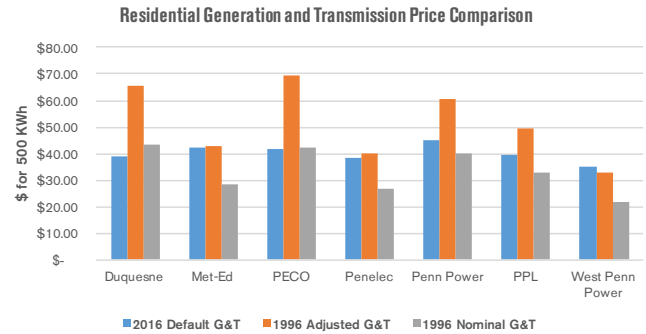


Figure 9- Residential (500 KWh) Generation and Transmission Monthly Price Comparison

prices to residential customers in January 31, 2016 were 2 to 41 percent lower than 1996 inflation adjusted generation and transmission prices. For West Penn Power, the 2016 default service generation and transmission price was 7 percent higher than the 1996 inflation adjusted generation and transmission price. These data indicate that for all but one territory, residential customers on default service in the state paid lower generation and transmission prices under restructuring, as compared to 1996 inflation adjusted generation and transmission prices.

The 1996 adjusted monthly bill, monthly bill for 2016 (using January 1, 2016 price data from the PA PUC's Rate Comparison Report) and 2015 data for the average number of residential customer accounts per EDC, were used to develop estimated values savings (or costs) to the residential sector for each EDC. *These values assume all residential customers are taking default generation and transmission service from their incumbent utility, which we know to be an inaccurate assumption due to the penetration of retail shopping in the residential sector (as discussed in the Retail Shopping Statistics sub-section).* Nonetheless, these values can provide a rough estimation of the potential savings retail restructuring could have provided through the utility-offered default service retail product, by requiring utilities to competitively procure default service in wholesale markets.

| Residential (500 KWh) Generation and Transmission Monthly Price Comparison Data | | | | |
|---|-----------------------------------|-----------------------|--------------|--|
| EDC | 2016 Default G & T (Jan 31, 2016) | 1996 Adjusted to 2015 | 1996 Nominal | Percent Change (1996 Adjusted to 2016) |
| Duquesne | \$38.86 | \$65.45 | \$43.33 | -41% |
| Met-Ed | \$42.04 | \$42.85 | \$28.37 | -2% |
| PECO | \$41.77 | \$69.20 | \$42.25 | -40% |
| Penelec | \$38.52 | \$40.08 | \$26.54 | -4% |
| Penn Power | \$44.98 | \$60.44 | \$40.01 | -26% |
| PPL | \$39.59 | \$49.74 | \$32.93 | -20% |
| West Penn Power | \$35.06 | \$32.62 | \$21.60 | 7% |

Table 3 - Residential (500 KWh) Generation and Transmission Monthly Price Comparison Data

² For MetEd and Penelec, the 2016 (default service) rates for the residential and small commercial class still include a CTC charge

Monthly Residential Savings (Costs) from Restructured Default Generation and Transmission, Compared to 1996 Adjusted Generation and Transmission

| EDC Territory | Average Number of Residential Customers (2015) | 2016 Default Price | 1996 Adjusted to 2015 Price | Monthly Savings (Costs) |
|-------------------------------|--|--------------------|-----------------------------|-------------------------|
| Duquesne | 525,714 | \$20,429,246 | \$34,409,127 | \$13,979,881 |
| Met-Ed | 492,501 | \$20,704,742 | \$21,101,596 | \$396,854 |
| PECO | 1,455,425 | \$60,793,102 | \$100,712,537 | \$39,919,435 |
| Penelec | 502,415 | \$19,353,026 | \$20,137,571 | \$784,546 |
| Penn Power | 142,591 | \$6,413,743 | \$8,617,595 | \$2,203,852 |
| PPL | 1,226,583 | \$48,560,421 | \$61,013,686 | \$12,453,265 |
| West Penn Power | 622,404 | \$21,821,484 | \$20,302,569 | \$(1,518,916) |
| Monthly Total Savings: | | | | \$68,218,917 |

Table 4 - Monthly Residential Savings (Costs) from Restructured Default Generation and Transmission, Compared to 1996 Adjusted Generation and Transmission

Table 4 indicates that residential customers in all PA EDCs, except in West Penn Power, had the potential to enjoy significant savings as a result of restructuring via the utility-offered default service retail product. Restructuring required PA EDC's to procure energy and related services from competitive wholesale markets, rather than from cost-of-service regulated generation. From this analysis, we find the switch to competitive procurement for default service has delivered potential savings for residential customers in the amount of over \$68 million per month in 2016, or over \$818 million for the 2016 year.

Figure 10 and **Table 5** show that small commercial customer 2016 default generation and transmission price in Duquesne, MetEd, PECO, PECO Summer, Penelec, PPL, and West Penn Power were 5 percent to 56 percent lower than the 1996 adjusted generation and transmission prices. For Penn Power, the 2016 default service price to this sector was 9 percent higher than the 1996 adjusted generation and transmission price. Again, these data suggest that most small commercial customers on default service in Pennsylvania paid lower generation and transmission prices under restructuring, compared to the cost-of-service regulated proxy.

As mentioned earlier in this section, the inability to locate the total number of small commercial accounts per EDC precluded a sector-cumulative savings (loss) analysis

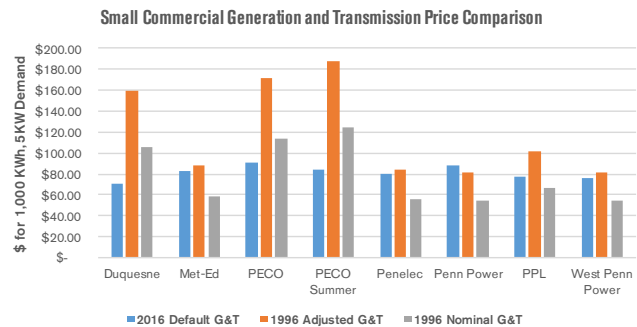


Figure 10 - Small Commercial (1,000 KWh, 5 KW Demand) Generation and Transmission Monthly Price Comparison

Small Commercial (1,000 KWh, 5 KW Demand) Generation and Transmission Monthly Price Comparison Data

| EDC | 2016 Default G & T (Jan 31, 2016) | 1996 Adjusted to 2015 | 1996 Nominal | Percent Change |
|------------------------------------|-----------------------------------|-----------------------|--------------|----------------|
| Duquesne | \$69.94 | \$159.91 | \$105.87 | -56.0% |
| Met-Ed | \$82.52 | \$88.56 | \$58.63 | -6.8% |
| PECO | \$90.59 | \$171.35 | \$113.44 | -47.0% |
| PECO Summer (July 31, 2016) | \$84.64 | \$187.91 | \$124.40 | -55.0% |
| Penelec | \$80.00 | \$84.24 | \$55.77 | -5.0% |
| Penn Power | \$88.67 | \$81.40 | \$53.89 | 9.0% |
| PPL | \$77.41 | \$101.53 | \$67.22 | -24.0% |
| West Penn Power | \$75.47 | \$81.96 | \$54.26 | -8.0% |

Table 5 - Small Commercial (1,000 KWh, 5 KW Demand) Generation and Transmission Monthly Price Comparison



Residential Bundled Bill Comparison

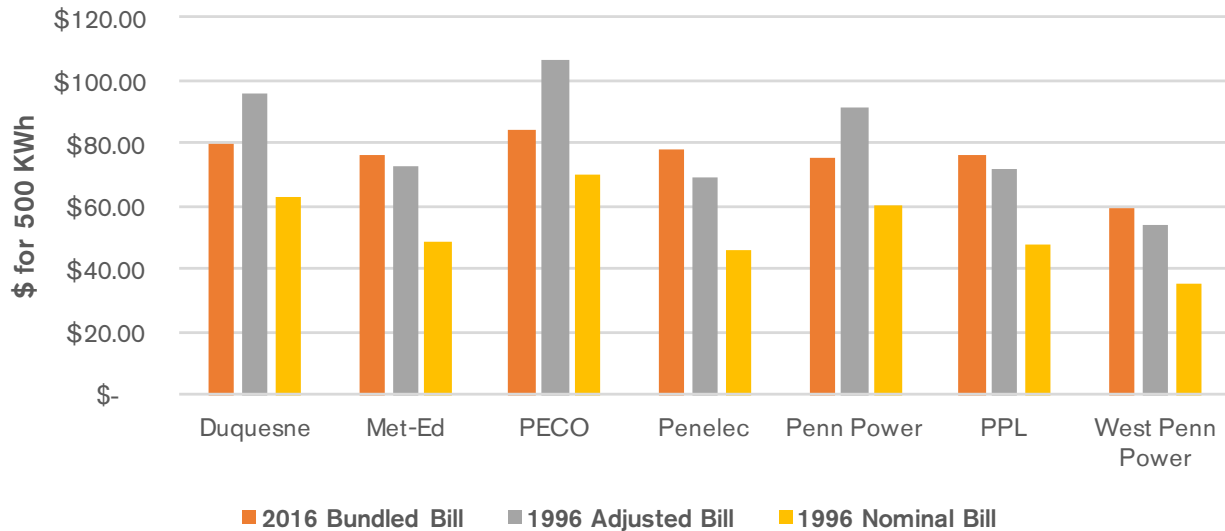


Figure 11 - Residential (500 KWh) Bundled Monthly Bill Comparison

Comparison of Residential and Small Commercial Total Bills

For the bundled bill comparisons, bundled bills from restructuring compliance plans using 1996 costs were compared to bundled bills from the PUC's 2016 Rate Comparison Report using rates as of January 31, 2016 that incorporated default service. The 1996 total bill data for the residential and small commercial classes were then adjusted for inflation and compared to the 2016 bills. Comparing these data presents a broader picture of total delivered electricity price changes, beyond those caused by fluctuations in generation and transmission prices. The other bill components that contribute to prices can include non-generation charges, for example, changes in customer charges, distribution rates, taxes, and other riders and surcharges. These non-generation charges are still regulated by the PA PUC under a cost-of-service model.

Figure 11 and Table 6 show Duquesne, PECO, and Penn Power total bundled bills (which incorporated default service generation and transmission rates) for residential customers in 2016 were 16 to 21 percent lower than the 1996 adjusted bundled bills. Recall, in Figure 9 and Table 3 these three utilities all saw significant generation and transmission price decreases with 2016 default generation and transmission service compared to 1996 inflation-adjusted cost-of-service generation and transmission prices. MetEd, Penelec, PPL, and West Penn Power total bundled bills for residential customers in 2016 were 4 to 12 percent higher than the 1996 adjusted bills.

Recall from Figure 9 and Table 3 that PPL's residential default service generation and transmission price for 2016 was 20 percent lower than the 1996 adjusted generation and transmission price, however, the total bundled bill for 2016 was 6 percent higher than

| Residential (500 KWh) Bundled Bill Comparison | | | | |
|---|---------------------------------|-----------------------|-----------------------------|----------------|
| EDC | Bundled Bill (January 31, 2016) | 1996 Adjusted to 2015 | 1996 Bundled Bill (Nominal) | Percent Change |
| Duquesne | \$80.06 | \$95.63 | \$63.31 | -16% |
| Met-Ed | \$76.06 | \$72.92 | \$48.28 | 4% |
| PECO | \$84.21 | \$106.26 | \$70.35 | -21% |
| Penelec | \$77.89 | \$69.32 | \$45.89 | 12% |
| Penn Power | \$75.72 | \$91.45 | \$60.55 | -17% |
| PPL | \$76.18 | \$72.05 | \$47.70 | 6% |
| West Penn Power | \$59.49 | \$54.04 | \$35.78 | 10% |

Table 6 - Residential (500 KWh) Bundled Bill Comparison

Small Commercial Bundled Bill Comparison

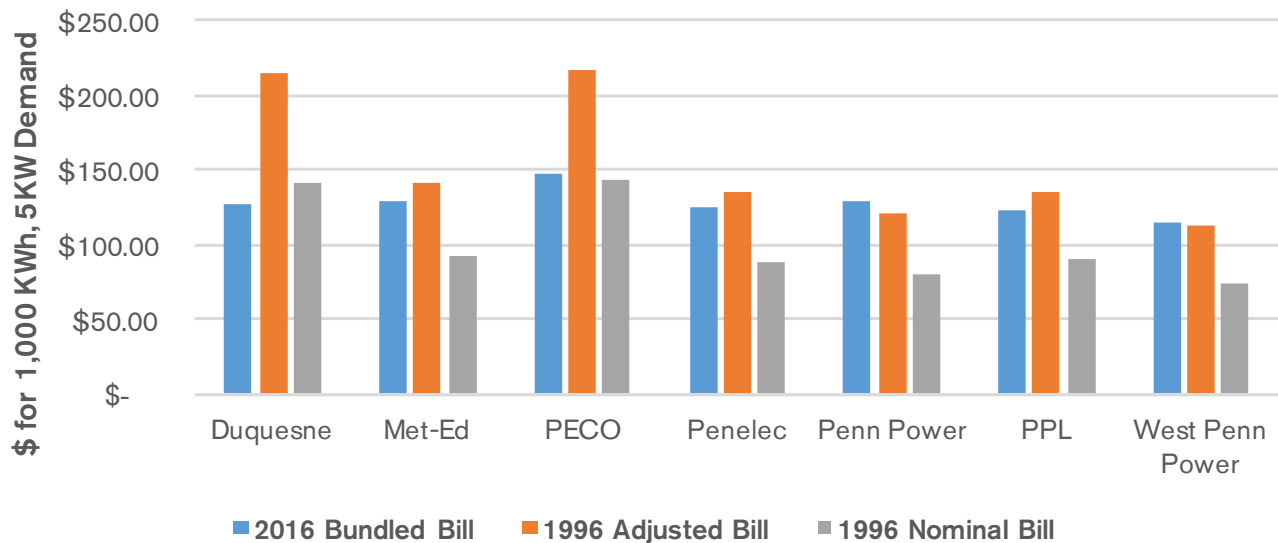


Figure 12 - Small Commercial (1,000 KWh, 5KW Demand) Bundled Bill Comparison

the 1996 adjusted bill. Met-Ed's 2016 default generation and transmission price provided a 2 percent savings compared to the 1996 adjusted generation and transmission price, however, in 2016 the total bill was 4 percent higher than the 1996 adjusted total bill. Penelec's 2016 default generation and transmission price provided a 4 percent savings compared to the 1996 adjusted generation and transmission price, but the total bundled bill in 2016 was 12 percent higher than the 1996 adjusted total bill. *These data indicate that for total bills, increases in distribution prices are outstripping savings realized from generation cost savings.* Observations from the statewide data indicate that delivery prices to the residential sector are increasing both in terms of component cost and as a percentage of total per KWh price of delivered power. This item deserves additional attention and will be explored later in this report.

Figure 12 and Table 7 show that for Duquesne, MetEd, PECO, Penelec, and PPL, the 2016 bundled bill to the small commercial

class was 7 percent to 40 percent lower than the inflation adjusted 1996 bundled bill. Penn Power and West Penn Power's 2016 bundled bill to the small commercial class was 2 percent to 7 percent higher compared to 1996 adjusted bills. Recall in Figure 10 and Table 4, default generation and transmission price in Penn Power was 9 percent higher than the 1996 inflation adjusted generation and transmission price, which likely contributes to the bundled bill price increases. However, for West Penn Power, small commercial customer default generation and transmission prices in 2016 provided an 8 percent savings compared to the 1996 adjusted generation and transmission price, indicating that non-generation prices are likely contributing to total bundled bill price increases. However, data from Figure 5 in the statewide assessment indicated that distribution prices to the commercial class were generally decreasing from 2000 to 2014. More research is needed to understand small commercial distribution price trends for West Penn Power.

| Small Commercial (1,000 KWh, 5 KW Demand) Bundled Monthly Bill Comparison | | | | |
|---|------------------|-----------------------|--------------|----------------|
| EDC | January 31, 2016 | 1996 Adjusted to 2015 | 1996 Nominal | Percent Change |
| Duquesne | \$127.71 | \$214.60 | \$142.07 | -40% |
| Met-Ed | \$130.03 | \$141.20 | \$93.48 | -8% |
| PECO | \$148.68 | \$216.38 | \$143.25 | -31% |
| Penelec | \$125.67 | \$134.86 | \$89.28 | -7% |
| Penn Power | \$130.25 | \$121.30 | \$80.31 | 7% |
| PPL | \$123.44 | \$135.62 | \$89.78 | -9% |
| West Penn Power | \$115.12 | \$113.12 | \$74.89 | 2% |

Table 7 - Small Commercial (1,000 KWh, 5 KW Demand) Bundled Monthly Bill Comparison

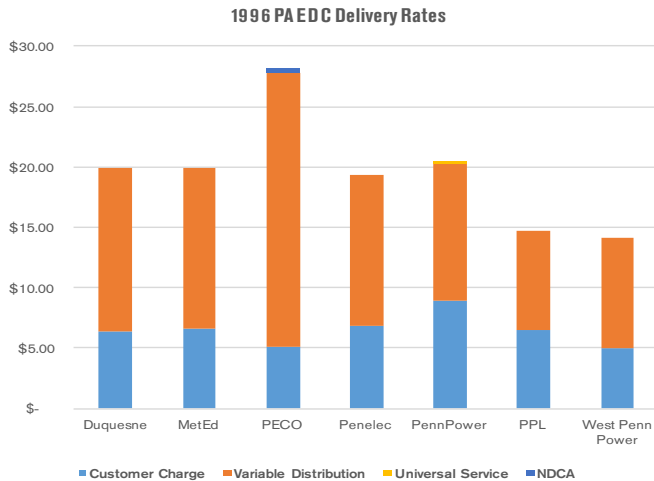


Figure 13: Pre-Restructuring EDC Delivery Rates from 1996, 500 KWh per Month

Distribution Rates to the Residential Sector

Restructuring did not seek to impact distribution rates, other than to freeze these rates for a period of time and unbundle rates into component charges. Distribution rates are still regulated by the PA PUC under a cost-of-service model. Data examined thus far indicates that for the residential sector, distribution rates can significantly impact total bills. Specific to restructuring, it is useful to understand if distribution charge increases are overwhelming potential generation and transmission rate savings.

As examined in **Figures 3 and 4**, distribution service is a significant and increasing cost driver to the residential customer class. **Figure 9** indicated that for most PA EDC's (except for West Penn Power) 2016 default generation and transmission prices provided potential savings to residential consumers, compared to 1996 inflation adjusted generation and transmission prices. However, **Figure 11** and **Table 6** indicate that MetEd, Penelec, PPL, and West Penn Power total bundled bills to the residential sector in 2016 were higher than 1996 adjusted total bills.

The analysis below examines PA EDC distribution rates in 1996 and compares them to distribution rates as of January 31, 2016 using the constant of 500 KWh usage per month. Data for the figures below

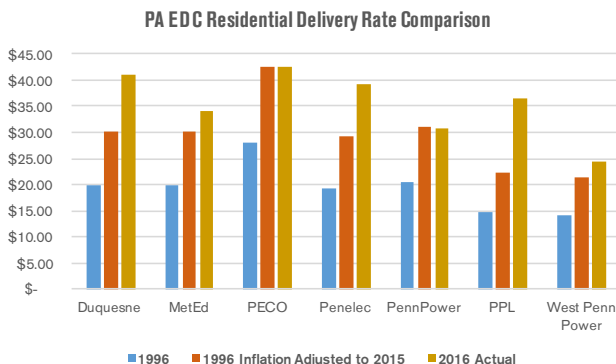


Figure 15 - Comparison of EDC Residential Delivery Rates 1996 and 2016, with Inflation Adjustment

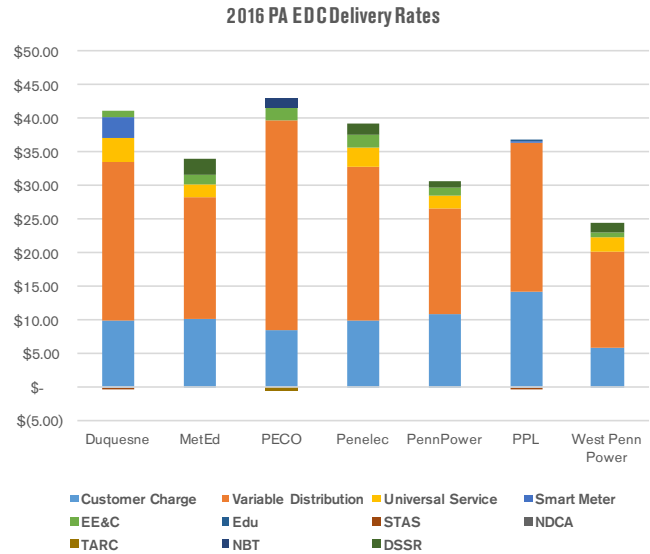


Figure 14 - PA EDC Delivery Rates in January 2016, 500 KWh per Month

are taken from the same sources cited in the residential and small commercial rate and bill comparisons sector, which includes the PA PUC's Rate Comparison Report and EDC-specific restructuring orders and compliance plans.

Figure 13 breaks down the components charges for PA EDC distribution rates prior to restructuring. Typically, distribution charges included a fixed customer charge and variable distribution charge. PECO's delivery rate included a nuclear decommissioning cost adjustment (NDCA) and Penn Power's delivery rate included a universal service charge.

Figure 14 identifies component charges for PA EDC distribution rates as of January 31, 2016, per the PUC's Rate Comparison Report. Negative charges indicate credits against the distribution rate. As with 1996 distribution rates, the bulk of charges come from the fixed customer charge and variable distribution charge. Most EDCs, except for PPL, included a universal service charge or credit. In addition, there were charges or credits for smart meters, energy efficiency and conservation (EE&C), education (Edu), state tax adjustment surcharge (STAS), NDCA, tax accounting repair costs (TARC), non-bypassable transmission charge (NBT), and default service support rider (DSSR).

Figure 15 compares 1996 (pre-restructuring) distribution rates for PA EDCs to distribution rates in January 31, 2016. The 1996 distribution rates are also adjusted for inflation to 2015 levels (as annual CPI data is not yet available for 2016). These data indicate that distribution rates have increased faster than the rate of inflation for Duquesne Light, MetEd, Penelec, PPL, and West Penn Power. Penn Power distribution rates have increased slower than the rate of inflation. For PECO, distribution rate increases have basically kept pace with the rate of inflation, exceeding the inflation adjusted rate by one cent.

The following general conclusions for total residential customer bills were deduced from the data and analysis explored:

- For residential customers in the West Penn Power territory, escalating generation, transmission, and distribution rates are driving total bill increases beyond 1996 inflation adjusted levels.
- For residential customers in MetEd, Penelec, and PPL, increases in distribution prices are likely overwhelming savings from the default generation and transmission price savings that have resulted from restructuring, causing increases to total bundled bills.
- Residential customers in the Duquesne Light and PECO territories are experiencing total bundled bill savings due to default generation and transmission price savings that have overcome distribution price increases.
- Residential customers in the Penn Power territory have experienced total bundled bill savings from both default generation and transmission prices and distribution prices, compared to 1996 inflation adjusted prices.

These data indicate that retail restructuring, through savings from the utility-offered default service (i.e. generation and transmission) product, has the potential to benefit the majority of residential sector customers in Pennsylvania. Price increases related to distribution service have the potential to erode or overwhelm savings related to said generation and transmission service.

RETAIL SHOPPING STATISTICS

Retail electric shopping data from the Pennsylvania Office of the Consumer Advocate (PA OCA) was examined in order to understand retail shopping activity by customer class, by PA EDC service territory (Pennsylvania Office of the Consumer Advocate 2016). The PA OCA publishes quarterly shopping statistics and maintains an archive of this information back through 1999. These data break down the following categories of information about alternative supply on an EDC territory basis, including: number of customers served by an alternative supplier, percentage of customer served, customer load (MW) served, and percent of total load (MW) served. This analysis only uses percentage of customers served by an alternative supplier. In addition, the analysis only captures shopping data sampled from quarterly data reported on January 1 of each year.

To allow for recovery of stranded costs, generation, transmission and distribution rates were capped at 1996 levels. The caps on transmission and distribution rates expired at different times for each EDC, expiring statewide by 2010. However, generation rate caps were extended for many PA EDCs, through litigation (Pennsylvania Public Utility Commission 2009), but expiring statewide at the end

of 2010.

Prior to 2003, data for MetEd and Penelec territories was combined and presented as GPU Energy. Beginning in 2003, data for these two territories continued to be combined but reported as First Energy companies. In 2012, data for these two companies were split into respective service territories of MetEd and Penelec. Prior to 2012, West Penn Power data was presented under the name of Allegheny Power. From 2012 through 2016, PPL and PECO shopping statistics include active and pending shopping customers.

PECO's shopping statistics show unique trends in the early years of restructuring as the result of backstop provisions included in settlement agreements that were meant to reduce PECO's market share and promote electric competition (PECO 1998). The settlement stipulated:

- For residential customers, the settlement agreement stipulated that on January 1, 2001, approximately 20 percent of all PECO's residential customers will be randomly assigned to a non-PECO affiliated Competitive Discount Service (CDS) provider. The CDS provider will be selected through a Commission approved bidding process and customers were allowed to opt out and return to PECO's default service. The settlement agreement included provisions that would require the CDS to be less expensive than PECO's default service, included renewable energy supply requirements, and other stipulations.
- For residential and commercial customers, the settlement agreement set up certain dates by which specific levels of shopping penetration must be achieved, or else the Market Share Threshold (MST) requirements would be triggered. If by January 1, 2001 less than 35 percent of all PECO's residential and commercial customers were receiving service from a competitive supplier, PECO would randomly assign the remaining number of customers needed to achieve 35 percent penetration to the MST program. If by January 1, 2003 less than 50 percent of all PECO's residential and commercial customers were receiving competitive supply, PECO would assign the remainder needed to achieve this threshold to the MST program. The MST program would be a commission-approved process in which PECO affiliates could participate. Customers were allowed to opt out of the program.

The MST and CDS programs were eventually phased out, because competitive suppliers could not meet discount terms while covering costs. Most customers returned to PECO's default service (Federal Energy Regulatory Commission and Electric Energy Market Competition Task Force 2006).



Residential Shopping Statistics

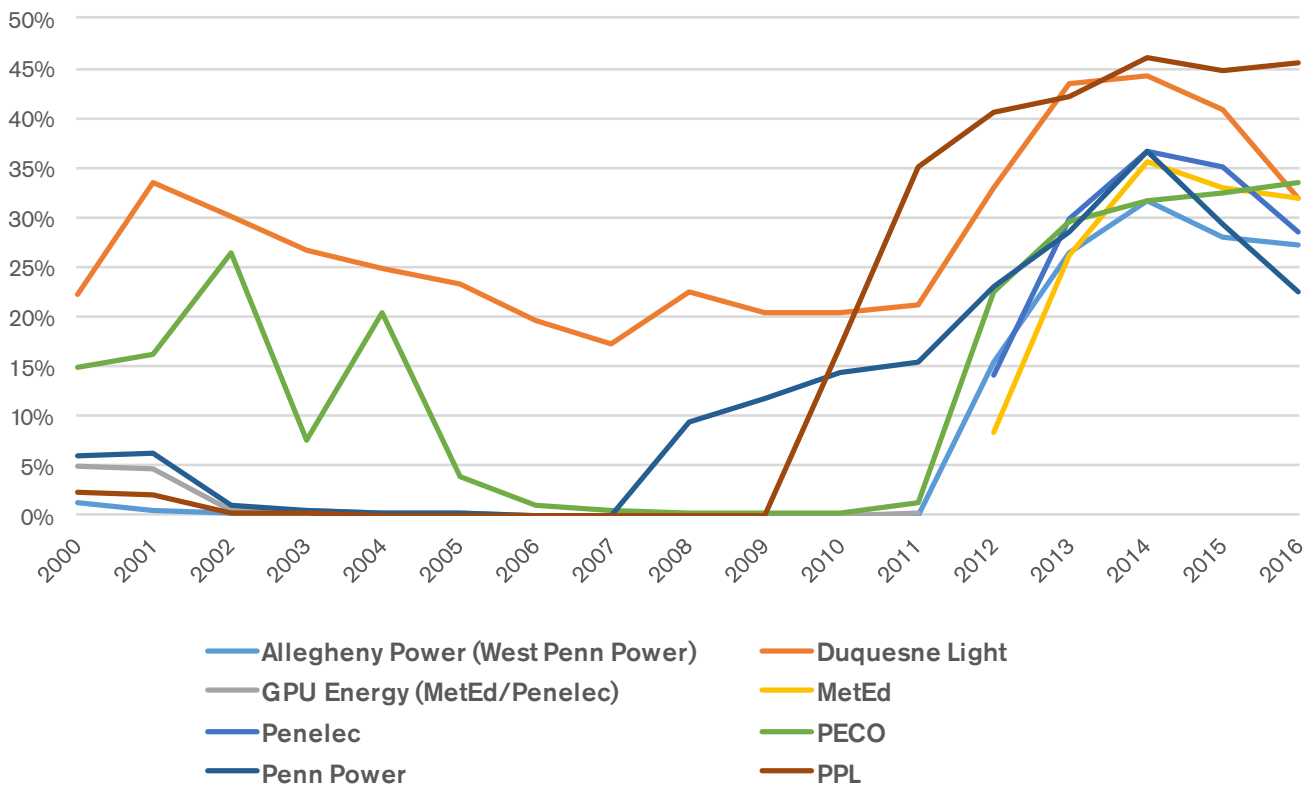


Figure 16 - Residential Shopping Statistics by Percentage of EDC Customers Served by Alternative Supplier (as of January 1)

Residential Shopping Statistics

Figure 16 shows that as measured by percentage of total EDC customers, Duquesne Light has significant penetration of residential shopping customers. This is likely due to the early (December 2001) expiration of generation rate caps in that territory. Penn Power's residential shopping percentages also started to climb after expiration of generation rate caps in December 2006. For the other service territories, the same trend of residential shopping customers appearing upon expiration of generation rate caps was observed.

As noted in the introduction to this section, PECO shopping data in the early years of restructuring is unique due to the settlement agreement provisions that automatically assigned customers to competitive suppliers. For example, by 2002, OCA data shows that the 26.5 percent of residential customers served by alternative suppliers included 16.6 percent residential customers automatically assigned to CDS, leaving about 10 percent of residential customers who actively chose alternative suppliers.

Most PA EDC territories experienced a peak point of residential shopping customer penetration in 2014. After 2014, most territories (except for PECO) saw a reduction in residential customer shopping activity. This is likely the result of the late January 2014 polar vortex, where extreme cold temperatures caused steep increases in power prices. Shopping customers on variable rate plans saw

significant rate increases as a result (see Section III - Policy for more information on electricity rates, policy and the polar vortex). To date, the residential shopping penetration has remained below 46 percent for all service territories.

Commercial Shopping Statistics

Figure 17 shows that in general, the same trend of shopping activity materializing soon after generation rate cap expiration is observed in the commercial sector. Commercial sector shopping reached higher and more stable levels of penetration compared to

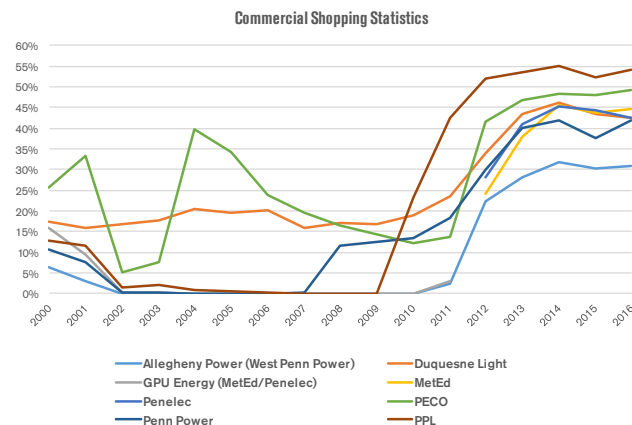


Figure 17 - Commercial Shopping Statistics as Percent of Total EDC Customers Served by an Alternative Supplier (as of January 1)

the residential sector. By 2014, most EDC's territories experienced commercial shopping levels at over 30 percent, with some territories experiencing over 50 percent. Even after the 2014 polar vortex, these levels of penetration remained relatively stable.

Again, PECO's early commercial customer shopping percentages are unique as a result of a percentage of commercial customers automatically assigned to the Market Share Threshold (MST) program.

Industrial Shopping Statistics

Figure 18 indicates the industrial sector has the highest and most stable level of shopping customer penetration. As with the other sectors, shopping activity increases after the expiration of generation rate caps. After 2012, most EDC territories saw sustained shopping levels of over 80 percent of their industrial customers. Even after the polar vortex, industrial customer shopping levels remained high.

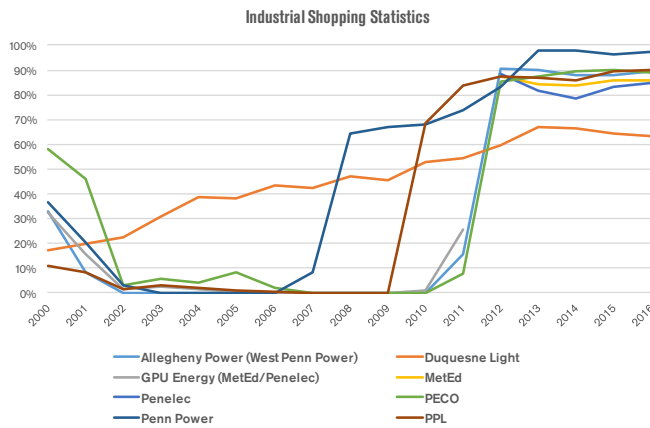


Figure 18 - Industrial Shopping Statistics as Percent of Total EDC Customers Served by an Alternative Supplier (as of January 1)

RETAIL OFFERINGS TO THE RESIDENTIAL SECTOR

One of the proposed benefits of retail competition was the opportunity for competitive suppliers to offer shopping customers new and innovative products and services. The PA PUC's shopping website, www.PaPowerSwitch.com, was reviewed on August 25, 2016 to understand the level of new products, and product and service innovation that has materialized for the residential sector in Pennsylvania (Pennsylvania Public Utility Commission 2016). In previous sub-sections, data showed that on a statewide annual average basis residential customers may not always experience cost savings from retail shopping offerings. This analysis aims to identify some potential non-monetary benefits residential customers may experience as a result of retail shopping.

Prior to restructuring, EDC customers generally did not have choices about generation rates and rate plans. Typically, EDC generation rates would change periodically based on fuel adjustment clauses, rate case proceedings, or other factors. Restructuring allowed competitive electric generation suppliers (EGS) to develop and market new rate plans to customers that offered alternatives to EDC's default generation service. These new plans included, for example, rates that could be locked in for a certain term (i.e. fixed rate plans), rates that vary with market pricing or other factors (i.e. variable rate plans), and plans that had non-standard terms and conditions. Some of these non-standard terms and conditions could include introductory prices, price with pass-through-clauses (where a fixed price is offered, but generation suppliers can pass through certain cost increases), term end date options, cancellation or monthly fees, and deposit requirements. A brief overview of fixed and variable rate plans available to regular (i.e. not heating or other service) residential customers in each EDC, as they appear on the PA PUC's shopping website, is provided in **Table 8**.

Beyond fixed and variable rates plans, EGSs could also develop new innovations that offer customers additional choice. For this analysis, innovative offerings to regular residential service (i.e. not heating

| Residential Customer Fixed and Variable Product Offerings (on August 25, 2016) | | | | | | |
|--|----------------|----------------|-------------|--------------|--------------|--------------|
| EDC | # of offerings | Variable Price | Fixed Price | 3 Year Fixed | 2 Year Fixed | 1 Year Fixed |
| Duquesne | 95 | 15 | 80 | 7 | 15 | 30 |
| PPL | 138 | 24 | 109 | 8 | 19 | 47 |
| MetEd | 102 | 18 | 82 | 7 | 14 | 35 |
| PECO | 134 | 23 | 107 | 9 | 15 | 46 |
| Penelec | 88 | 17 | 68 | 6 | 13 | 31 |
| Penn Power | 57 | 11 | 44 | 4 | 8 | 19 |
| West Penn | 79 | 15 | 62 | 6 | 10 | 25 |

Table 8 - Residential Customer Fixed and Variable Product Offerings (on August 25, 2016)

or other service) customers were grouped into two categories, 1) innovative rates, and 2) innovative products. Innovative rate offerings provide standard electricity service, but offer new approaches to pricing. For example, the PA PUC's website listed the following categories and ability to filter product offerings by these categories, classified in this report as innovative rate offerings:³

- **Unlimited Usage Flat Bill** – This plan advertises a locked-in monthly price that is not based on kWh usage. This provides customers with unlimited electric usage at a fixed rate that cannot change during the contract's term.
- **Time of Use** – Tracking and recording a customer's consumption during specific periods of time that can be tied to a rate reflective of the price of energy.
- **Indexed Pricing** – A variable rate product in which the rate is tied to a specific index, such as the NYMEX, hourly prices in the retail energy market, or a utility's price to compare.
- **Discounts and Incentives** – These offerings provide discounts and incentives that consumers may find attractive, such as rebates, magazine subscriptions, discounts for entertainment, or other enticements.
- **Prepaid Energy Services** – This term is not defined by the PA PUC and there are no competitive offerings in the state.

Innovative products offer specialized electricity service. For innovative products, the PA PUC website listed:

- **Energy Efficiency and Conservation** – These products attempt to reduce or manage energy consumption in a cost effective manner.
- **Net Metering** – Net metering is a policy enabling owners of distributed energy generation to measure the amount of energy generated and used, and provides compensation for the energy generated. In Pennsylvania, only PA EDCs are required to offer net metering, so owners of distributed generation are therefore discouraged from shopping for electricity, unless the competitive supplier voluntarily offers net metering.

- **Renewable Energy** – These products source electricity supplied to the customer from renewable energy projects, typically through use of renewable energy credits.
- **Pennsylvania-Based Renewable Energy** – These products source electricity supplied to customers from renewable energy projects located in Pennsylvania, typically through use of renewable energy credits.

The analysis only examined competitive offerings included on the PA PUC's www.PaPowerSwitch.com website and did not attempt to review the websites of each EGS to determine if additional products and services may be available beyond what is listed on the PA PUC's shopping website. In addition, this analysis did not attempt to verify the claims and attributes of these competitive offerings. For example, offerings listed when toggling the website's net metering filter were assumed to in fact offer net metering service, as indicated on the website.

Table 9 shows the results of this analysis, which indicate that there are a significant number of total competitive offerings in each EDC territory. With respect to innovation, the majority of the "innovative rate" offerings on the PUC website were rates with discounts and incentives. One unlimited usage flat bill offering was available in PECO's service territory, and one in the PPL territory. There were zero time of use, indexed price, or prepaid rate offerings included by the competitive marketers on the PUC shopping website at the time of the analysis. The PA PUC's 2015 Retail Electric Choice Report did confirm that for the residential sector in calendar year 2015, there were zero residential time of use and/or hourly/real-time pricing residential customer accounts being served by EGS's in the EDC territories examined (Pennsylvania Public Utility Commission August 2016).⁴ By far, renewable energy offerings represented the greatest number of "innovative products" advertised, which included a subset of renewable energy products sourced by Pennsylvania-located renewable energy projects. There were also net metering products available in all but one EDC territory. There were zero energy efficiency and conservation products advertised on the PUC website.

| Innovative Rate and Product Offerings to Residential Customers (on August 25, 2016) | | | | | | | | | | |
|---|------------------|---------------------------|-----|---------------|---------------------|---------|---------------------|--------------|----------|-------|
| EDC | Innovative Rates | | | | | | Innovative Products | | | |
| | # of Offerings | Unlimited Usage Flat Bill | TOU | Indexed Price | Discount-Incentives | Prepaid | EE&C | Net Metering | Total RE | PA RE |
| Duquesne | 95 | 0 | 0 | 0 | 2 | 0 | 0 | 3 | 27 | 4 |
| PPL | 138 | 1 | 0 | 0 | 2 | 0 | 0 | 4 | 44 | 9 |
| MetEd | 102 | 0 | 0 | 0 | 2 | 0 | 0 | 3 | 37 | 5 |
| PECO | 134 | 1 | 0 | 0 | 2 | 0 | 0 | 4 | 45 | 10 |
| Penelec | 88 | 0 | 0 | 0 | 2 | 0 | 0 | 3 | 29 | 5 |
| Penn Power | 57 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 21 | 0 |
| West Penn | 79 | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 23 | 2 |

Table 9 - Innovative Rate and Product Offerings to Residential Customers (on August 25, 2016)

³ www.PaPowerSwitch.com only provided definitions for some of these categories. Therefore, some definitions included are approximations based on details gathered from the listed offerings.

⁴ The report notes that EDCs are no longer required to track EGS time of use offerings, which may impact the quality of these data, since information in the report is submitted by PA EDCs.



a subset of renewable energy products sourced by Pennsylvania-located renewable energy projects. There were also net metering products available in all but one EDC territory. There were zero energy efficiency and conservation products advertised on the PUC website.

It is clear that restructuring has yielded new rates and product choices to the residential sector, namely in the form of fixed and variable rate plans. Innovation has certainly been realized through the significant number of available products that provide residential customer choices about renewable energy supply. A limited number of innovative offerings are listed on the PA PUC's shopping website related to unlimited usage, discounts and incentives, and net metering. For many expected innovations—expected in the sense that the PA PUC's website created filters for customers to use specifically to identify these offerings—EGS's are either not offering these products or are not listing these products on the PA PUC's shopping website.

It is also noted that additional risks have been experienced as a result of these new products, for example, exposure to market price spikes for customers on variable rate plans. In addition, an unquantified amount of spending has been borne by ratepayers to provide public education about electricity shopping, revise utility billing systems, and other transition costs. More research is needed to quantify the costs associated with these risks and expenditures.

UNIVERSAL SERVICE

The Pennsylvania's electricity restructuring law maintained that through restructuring, Pennsylvania, “...must, at minimum, continue the protections, policies and services that now assist customers who are low-income to afford electric service.”⁵ Furthermore, the law required the PA PUC to ensure that universal service and energy conservation programs were offered by all PA EDCs, and that these program costs would be appropriately funded by ratepayers.

Universal service and energy conservation is defined in the Act to mean “policies, protections and services that help low-income customers to maintain electric service, including customer assistance programs and policies and services that help low-income customers to reduce or manage energy consumption in a cost-effective manner, such as the low-income usage reduction programs application of renewable resources and consumer education.”⁶

This report examines historical funding for two universal service programs, the Customer Assistance Program (CAP) and Low Income Usage Reduction Program (LIURP).

CAPs are debt forgiveness and payment assistance programs. Qualifying households can have monthly bills adjusted to affordable amounts through various mechanisms, for example, application of reduced per KWh rates, payment of only a percentage of month bill costs, or monthly bills costs calculated as a percentage of household income. CAP debt forgiveness programs can freeze past debt upon entry into the program. Households participating in CAP programs must remain timely and current on their payments to receive program benefits.

LIURP is an energy usage reduction and education program where qualifying low-income households can receive free energy audits and installation of energy saving measures (e.g. insulation, air sealing).

In most cases, prior to restructuring, PA EDCs were offering CAP and LIURP programs or pilot programs, though under different names. For example, LIURP equivalent programs were called WARM (MetEd), WRAP (PPL), or Smart Comfort (Duquesne). CAP equivalent programs may have been called LIPURP (West Penn) or On Track (PPL).

Universal service and energy conservation programs details and cost recovery mechanisms were to be included as part of a utility's proposed restructuring plan. Through the commission's restructuring proceedings, stakeholders and the EDC's debated, inter alia, universal service and energy conservation program details, funding levels, and recovery mechanisms. The PA PUC issued restructuring orders that included required funding levels for these programs for each EDC, from 1999 through 2002. CAP and LIURP funding levels for 1996 through 2002 were taken from PA EDC-specific regulatory filings and the PA PUC's applicable restructuring orders. Data for 2005 through 2014 were taken from the PA PUC's Universal Service Reports (PA Public Utility Commission October 2015). The applicable PA EDC data sources are included below:

- Duquesne Light (Duquesne Light 1998) (PA Public Utility Commission 1998)
- Penn Power (PA Public Utility Commission 1998)
- GPU Energy's MetEd and Penelec (PA Public Utility Commission 1998). Note, these two PA EDC's were owned by GPU Energy and proposed a single, blended CAP program to be uniform over the two service territories, with different levels of funding. LIURP funding for both EDC's was also addressed in the MetEd order.
- PECO (PECO Energy Company 1997) (PA Public Utility Commission 1997)
- PPL (PA Public Utility Commission 1998)
- West Penn Power – (PA Public Utility Commission 1998)

Date Limitations. It is possible that the funding levels identified in the above referenced restructuring orders and compliance plans were subsequently revised as part of ongoing negotiations and settlements between the EDCs, regulators, and stakeholders. Efforts were made to obtain the best data possible, given the length of each docket and access to available historic documentation. However, the reader should understand that these data may not always represent the final negotiated outcomes.

⁵ Electricity Generation Customer Choice and Competition Act, Section 2802 (10)

⁶ Electricity Generation Customer Choice and Competition Act, Section 2803



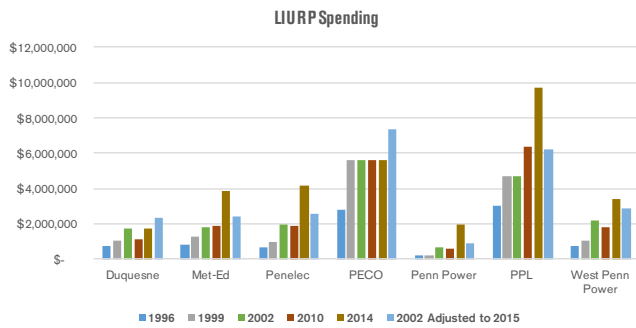


Figure 19 - LIURP Program Spending by PA EDC

Figure 19 shows LIURP funding data for PA EDCs, including actual LIURP program spending in 1996 (pre-restructuring), PA PUC mandated funding levels via restructuring orders for LIURP program funding in 1999 and 2002, and actual LIURP program spending for 2010 and 2014. In addition, 2002 LIURP funding levels prescribed to each EDC through restructuring orders were adjusted for inflation. Comparing 2014 funding levels with 2002 levels adjusted for inflation provides a benchmark for long-term funding growth.

These data indicate LIURP program funding has grown significantly as a result of restructuring orders (comparing 1996 levels to 2002 levels), has increased thereafter (in most EDCs), and program spending increases have kept pace with inflation (in most EDCs).

- Comparing 1996 spending to 2002 funding levels ordered by the commission indicates the following LIURP program budget increases: Duquesne (150%), Met-Ed (137%), Penelec (201%), PECO (102%), Penn Power (258%), PPL (55%) and West Penn Power (187%).
- Comparing 1996 actual spending to 2014 actual spending on LIURP programs—spending increased by the following percentage for each PA EDC: Duquesne (142%), Met-Ed (397%), Penelec (540%), PECO (102%), Penn Power (998%), PPL (220%) and West Penn Power (345%). However, comparing 1996 funding to 2014 funding levels will not only reflect how restructuring impacted LIURP funding—namely through the mandate to offer, fully fund, and recover costs from these programs—but can also reflect changes in program spending levels resulting from other factors, such as stakeholder settlements in other commission proceedings, or changes in program eligibility.
- Comparing 2014 funding levels to 2002 levels (adjusted for inflation), this analysis indicates that LIURP funding levels having increased at rates above the rate of inflation since 2002, for Met-Ed, Penelec, PennPower, PPL, and West Penn. For Duquesne Light and PECO, LIURP program funding level increases since 2002 have not kept pace with inflation.

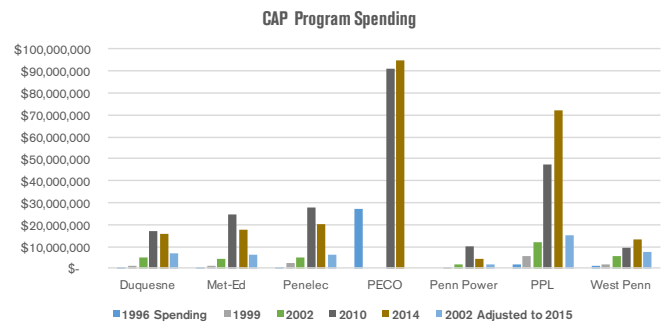


Figure 20 - Annual CAP Program Spending by PA EDC

Figure 20 shows EDC-specific CAP program funding levels. As with the LIURP data, 1996 is actual spending, 1999 and 2002 are funding levels ordered by the commission during restructuring, and 2010 and 2014 are actual spending. In addition, 2002 levels were adjusted for inflation to provide a benchmark for long-term CAP funding growth. These data show CAP program funding increased significantly as a result of restructuring, spending generally increased thereafter (though some spending dropped between 2010 and 2014), and spending increases generally exceeded the rate of inflation.

Data for PECO was not available for 1999 through 2002. In 1996, PECO offered both a CAP (\$27.5 million) and a CAP rate (\$1.6 million) program. At the time of restructuring, PECO was in the process of expanding its CAP rate program and phasing out its CAP program through a separate evaluation proceeding under review by the Commission. In the PA PUC's December 11, 1997 restructuring order for PECO, the Commission agreed to wait until the evaluation was complete before ordering any program changes. Efforts were made to locate the aforementioned evaluation and subsequent Universal Service Plan filing, but these data could not be located.

- Comparing 1996 pre-restructuring spending to 2002 ordered levels show the following CAP funding increases: Duquesne (859%), Met-Ed (910%), Penelec (690%), Penn Power (not available, as Penn Power did not have a CAP or CAP equivalent program in 1996), PPL (485%) and West Penn Power (511%).
- Comparing 1996 actual spending to 2014 actual spending, CAP funding increased by the following percentages: Duquesne (2789%), Met-Ed (3777%), Penelec (3164%), Penn Power (not available), PPL (3501%) and West Penn Power (1290%).
- Comparing 2014 funding levels to 2002 levels (adjusted for inflation), this comparison indicates that CAP funding levels from 2002 to 2014 grew faster than the rate of inflation for all PA EDCs.

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SECTION III: POLICY CHOICES AHEAD

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SECTION HIGHLIGHTS

- Good policymaking will ensure wholesale markets are competitive, electricity becomes cleaner, and power remains affordable and reliable.
- There are opportunities to develop solutions that synergistically address multiple challenges, but these solutions will take creativity, cooperation, and coordination across traditional jurisdictional boundaries.
- Key policy choices impacting retail markets include creating a sustainable utility business model for the future, developing a modern, resilient and secure grid that can accommodate the next generation of electricity service, leveraging new market opportunities such as transportation electrification, and making choices about utility default service.
- Key policy choices impacting wholesale markets include maintaining market efficacy in the face of state policy interventions, making decisions about the ever-evolving capacity market in light of an increasingly complex set of resources and stakeholder needs, and integrating and optimizing the value of distributed energy resources for wholesale power markets.

INTRODUCTION

Public policy continues to play a major role in the performance of the electricity market. Policy choices have shaped the markets we have today and policy choices will substantially shape markets in the future. There are numerous policy options now being debated at the state, regional, and federal levels. This section highlights just seven of these choices. It is necessarily an incomplete discussion.

Good policymaking will ensure the wholesale markets are competitive; electricity becomes increasing cleaner; and our power remains affordable and reliable.

RETAIL POLICY

As the electricity sector and the preferences of its customers evolve, business as usual will become more challenging for regulated

distribution utilities. Thankfully, there are many opportunities for growth that can offer real value to customers. A new business paradigm may be needed to realize solutions to contemporary challenges.

1. Sustainable Business Model for the Future

Many distribution utilities across the country are experiencing disruptive changes, forcing conversations about the sustainability of the current utility business model. Factors like low load growth, aging infrastructure, grid modernization and cybersecurity needs, increased penetration of distributed energy resources (e.g. demand response, solar), evolving consumer expectations, and increased exposure to public policy priorities (e.g. environmental regulations, energy efficiency mandates) are creating a host of economic and technical challenges. In theory, these challenges also present opportunities.¹ For example, new service offerings or rate designs could be created to allow enhanced value and growth in low sales environments, while grid modernization investments could appease shareholders, improve resiliency, and facilitate distributed energy resource integration. However, unlike wholesale restructuring—where the federal government envisioned a framework, passed enabling law, and gave states the option to accept, tailor, or reject restructuring—no clear or proven vision for a new sustainable distribution business model exists. States like New York, California and Hawaii - where high retail electricity prices and transformative public policies (e.g. ≥50% renewable portfolio standards) have heightened challenges and opportunities - are pioneering potential solutions. There will not be a single one-size-fits-all solution, and each jurisdiction will need to develop approaches that fit its specific needs.

While transformative answers are being developed, many states have taken incremental approaches to meeting regulatory demands, attempting to balance the needs of the public, policymakers, and investors in a changing environment. To date, Pennsylvania fits into this latter category, employing incremental strategies—such as modestly increasing fixed monthly customer charges, adding bill riders or automatic adjustment clauses, pursuing adjustments to net metering policy and proposing fees on distributed generation systems—to tackle contemporary challenges.² The PA PUC

¹ For more information about electric utility challenges and opportunities is available at "PA Future Utility Part II: Electric Utility Challenges and Opportunities," July 14, 2015, at the Kleinman Center for Energy Policy's website at <http://www.kleinmanenergy.upenn.edu/policy-digests/pa-future-utility-part-ii-electric-utility-challenges-and-opportunities>

² For example, the PA PUC has: approved the automatic adjustment Distribution System Improvement Charge (DSIC) for EDCs to facilitate infrastructure improvements between rate cases, allowed modest increases to fixed monthly customer charges in recent rate cases, and in 2014 the PUC proposed tightening the state's net metering rules and allowing fees to be placed on distributed energy systems (Docket L-2014-2404361).



hosted an en banc hearing and took public comment on alternative ratemaking, with a specific focus on rate decoupling, but no additional action has been taken.³ In addition, some Pennsylvania EDCs have proposed plans to develop microgrid projects.⁴ Now is an opportune time to consider a broader state strategy, precisely because of plummeting costs for distributed energy resources and low power prices.

2. Secure and Modernized Distribution Grid

Ensuring a modern, resilient, and secure grid is a challenge with embedded growth opportunities. As electricity system resources evolve, the electricity grid must also keep pace with change. As older equipment is replaced, opportunities arise to modernize infrastructure to allow for better integration of distributed energy resources, more seamless interaction with the wholesale power system, enhanced communication with customers, improved monitoring of grid conditions, and opening up new opportunities through the use of data.

The U.S. Department of Energy's energy sector risk profile for Pennsylvania notes that from 1992 to 2009 Pennsylvania experienced 34 electric transmission outages affecting almost 2.3 million customers (U.S. Department of Energy 2015). The majority of these outages were related to severe weather events such as high winds, thunderstorms, hurricanes/tropical storms, and winter storms. At the distribution level, from 2008 through 2013, the leading cause of Pennsylvania outages were related to weather and falling trees, impacting almost 840,000 people (U.S. Department of Energy 2015). As extreme weather continues, electric utilities will increasingly be challenged to maintain or enhance system resiliency.

As energy companies, consumers, and the grid become more dependent on technology and the internet of things, the risks of cyber threats have increased. Although cyberattacks on energy systems—such as the 2015 Ukrainian system outages—are looming threats, cyber espionage into energy company operations, through spear phishing and ransomware schemes pose more immediate and related pressures.⁵ The U.S. North American Electric Reliability Corporation (NERC) has developed cybersecurity standards for the bulk power system, and has administered exercises (e.g. GridEx) to prepare and educate distribution utilities for cyberattacks. Pennsylvania has also taken a number of steps to increase cybersecurity preparedness.⁶ Cybersecurity continues to be an issue of international, national, and local importance, where much work remains. Recent physical attacks on energy infrastructure have also highlighted opportunities for hardening physical system security.⁷

3. Electrification of Transportation Sector

Electrification of the transportation sector is a major growth opportunity for retail and wholesale markets. The electric vehicle (EV) market saw a downturn in 2014, but EV sales are up 34 percent from January through September year-on-year compared to 2015, with much growth owing to improved design and desirability of the cars (Pyper 2016). In September 2016, EV's represented 1.2 percent of all U.S. automotive sales (Cole 2016) and the U.S. DOE forecasts that EVs will make up 6 percent of all automotive sales by 2025 (U.S. Department of Energy 2016). The transportation sector is now the largest U.S. contributor to greenhouse gas emissions, and emission reduction standards are expected to drive increased EV penetration (U.S. Department of Energy 2016).⁸ Since 2014, average annual household expenditures on gasoline have ranged from about \$1,500 to \$2,700 per year (U.S. Energy Information Administration 2014). For states with the right policies in place, a portion of these expenditures can be transitioned into the electricity sector.

4. Default Service

Controversy has swirled around the existence and form of default service in Pennsylvania. Some argue that reforming or ending EDC default service is needed to bring about improvements in retail competition, while others maintain retail market participation levels are appropriate and hedged EDC default service is a critical consumer protection tool. As shown in Section II, shopping participation in commercial and industrial sectors is high, but lower in the residential sector. Many retail market businesses argue that residential customers will reap more benefits (such as greater savings or more product innovation) if EDCs no longer offer default service. DEFG, a consulting group supported by companies with business interests in competitive markets, annually publishes a baseline assessment of retail choice covering Canada and the United States (DEFG July 2015).⁹ For residential sector metrics, the report puts significant value on default service in its scoring metrics, noting that "The design and implementation of default service is the single most significant issue affecting the success of competitive retail markets," and further recommends the phasing out of default service (DEFG July 2015).

In 2011, the PA PUC initiated a multi-phase investigation of Pennsylvania's retail electricity market.¹⁰ In February 2013, the PA PUC concluded its retail markets investigation by adopting a Final Order on the end state of default service (Pennsylvania

³ More information on the PA PUC's alternative ratemaking en banc hearing and comments can be found on the PA PUC website at http://www.puc.state.pa.us/filing_resources/issues_laws_regulations/alt_ratemaking_methodologies.aspx

⁴ See PECO's petition for approval of a microgrid plan and cost recovery for Concord Township (P-2016-2546452, A-2016-2546450) and Duquesne Light's Wood Run microgrid proposal in the company's most recent Long Term Infrastructure Improvement Plan (Docket No. P-2016-2540046).

⁵ More information on cyberattacks on energy infrastructure can be found at the Kleinman Center's website at <http://www.kleinmanenergy.upenn.edu/blog/2016/06/10/cyber-attacks-energy-infrastructure>

⁶ For example, the PA PUC audits utility physical and cyber security plans, released and updates cybersecurity best practices for small and medium Pennsylvania utilities, and promote dialogue and coordinate between utilities, among states, and with national experts. Pennsylvania's Governor declared October as cybersecurity awareness month.

⁷ For example, the September 2016 sniper attack on Garkane Energy Cooperative's Buckskin substation in Utah, and 2013 attack on PG&E's Metcalf substation near San Jose, California.

⁸ For more information on transportation sector emissions, please review U.S. EIA's Monthly Energy Review for September 2016, available at <http://www.eia.gov/totalenergy/data/monthly/pdf/mer.pdf>

⁹ The 2015 DEFG report ranked Pennsylvania's competitive residential electricity market as the third best (of eighteen jurisdictions examined), and its commercial and industrial market as the second best (tied with Illinois).

¹⁰ The first phase examined the status of the markets concluding the state's current retail market requires changes to bring about the markets envisioned by the General Assembly when the restructuring law was passed (Pennsylvania Public Utilities Commission 2011). The second phase explored potential changes to improve the markets. While the second phase was underway, the PA PUC issued a final rule in December 2011 meant to guide EDC default service plan procurement (many of which were scheduled to be filed while the retail markets investigation was pending) (Pennsylvania Public Utilities Commission 2011). The PA PUC also issued an intermediate work plan final rule in March 2012 meant to provide additional tools and details to retail market improvements (Pennsylvania Public Utilities Commission 2012).



Public Utilities Commission 2013). Among other measures aimed at promoting retail competition, the order envisioned a new model for default service where the EDC price to compare would more closely reflect current market conditions. Later that year, a bill was introduced into Pennsylvania's General Assembly seeking to end the EDC's role in providing default service, and allowing competitive suppliers to fill this role.¹¹ In January 2014, events related to the polar vortex created price spikes that were passed along to retail shopping customers on variable rate plans. Many customers saw significant bill increases, prompting a large volume of complaints to regulators. The PUC took actions to respond to the 2014 polar vortex experience—which led to unexpected price increases for shopping customers on variable rate plans—but efforts to promote competition through default service reforms have since slowed and the prime sponsor of the bill to eliminate utility default service ended his support for the legislation.¹²

Supporters of EDC default service may welcome this change in pace, believing that EDC-offered default service is a critical component to retail choice. For example, the Office of the Consumer Advocate (OCA) objected to the legislative proposal to end EDC-offered default service, citing the strong performance of Pennsylvania's retail markets and maintaining that being forced to shop is not a choice (McCloskey 2014). OCA also raised objections to the PA PUC's efforts to align EDC default service rates with market prices, arguing this would subject customers to increased price volatility, and advocating that EDC default service remain a type of hedged product (Beatty 2012).

The policy choice boils down to staying the course with default service in the current form, or modifying default service (e.g. to increase hedging or to further align with the market) in small or big ways.

Policy choices impacting retail markets can help address challenges by enabling real opportunities presented. There are synergistic opportunities to address multiple issues by developing planned and strategic approaches, as well as more narrowly focused policy choices.

WHOLESALE POLICY

Policy choices have the ability to improve or distort markets.

The transformation occurring in the energy sector is pressuring current market rules, market participants, and policymakers. Future policy choices will require effectively balancing the needs of an increasingly complex set of resources and stakeholders.

5. State Policy Intervention into Markets

States have the ability to distort PJM's competitive market outcomes through imposition of subsidies. For example, if a state-based subsidy allows a resource to offer into the market at a price that is below its actual cost, that resource could artificially lower wholesale market prices. Over time, this has the potential to distort price signals needed to attract new resource investment.

5a. Power Market Trends

Persistently low natural gas prices, relatively flat demand, and growth of zero-cost offer resources (i.e. renewables) have lowered energy market clearing prices, reducing revenues to all supply resources. While lower energy market prices are good for consumers, they present challenges for companies in the business of generating power. Concurrent with these trends, some existing generation sources have faced increasing costs.¹³ Faced with reduced revenues and increasing costs, many plant owners/operators have chosen to retire units that cannot continue to compete. Over 72 percent of the capacity retirements from 2011 through 2020 are fueled by coal, 10.7 percent by natural gas, 8.6 percent from nuclear, and 4 percent from light oil (Monitoring Analytics 2016), see **Table 1**, as reproduced from Monitoring Analytics Second Quarter 2016 State of the Market Report for PJM. On a megawatt basis, the majority of these retirements have or are expected to occur in Ohio (5,812 MW) and Pennsylvania (5,724 MW), New Jersey (4,487 MW) and Illinois (3,959 MW) (Monitoring Analytics 2016).

In May 2016, PJM issued a report, "Resource Investment in Competitive Markets," concluding that PJM's markets are adapting

| | Coal | Diesel | Heavy Oil | Kerosene | Landfill Gas | Light Oil | Natural Gas | Nuclear | Wind | Wood Waste | Total |
|-------------------------------|----------|--------|-----------|----------|-----------------|-----------|----------------|---------|------|---------------|----------|
| Retirements 2011 | 543.0 | 0.0 | 0.0 | 0.0 | 0.0 | 63.7 | 522.5 | 0.0 | 0.0 | 0.0 | 1,129.2 |
| Retirements 2012 | 5,907.9 | 0.0 | 0.0 | 0.0 | 0.0 | 788.0 | 250.0 | 0.0 | 0.0 | 16.0 | 6,961.9 |
| Retirements 2013 | 2,589.9 | 2.9 | 166.0 | 0.0 | 3.8 | 85.0 | 0.0 | 0.0 | 0.0 | 8.0 | 2,855.6 |
| Retirements 2014 | 2,427.0 | 50.0 | 0.0 | 184.0 | 15.3 | 0.0 | 294.0 | 0.0 | 0.0 | 0.0 | 2,970.3 |
| Retirements 2015 | 7,661.8 | 10.3 | 0.0 | 644.2 | 2.0 | 212.0 | 1,319.0 | 0.0 | 10.4 | 0.0 | 9,859.7 |
| Retirements 2016 | 243.0 | 59.0 | 74.0 | 0.0 | 5.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 381.0 |
| Planned Retirements 2016 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Planned Retirements Post-2016 | 1,109.0 | 0.0 | 34.0 | 0.0 | 0.0 | 0.0 | 661.8 | 2,433.5 | 0.0 | 0.0 | 4,238.3 |
| Total | 20,481.6 | 122.2 | 274.0 | 828.2 | 26.1 | 1,148.7 | 3,047.3 | 2,433.5 | 10.4 | 24.0 | 28,396.0 |

Table 1 - Summary of PJM Unit Retirement by Fuel and MWs, 2011 - 2020 (Monitoring Analytics 2016)

¹¹ See PA General Assembly Senate Bill 1121 of Regular Session 2013-2014, sponsored by Senator Mensch, available at <http://www.legis.state.pa.us/cfdocs/billinfo/billinfo.cfm?Year=2013&Ind=0&body=S&type=B&bn=1121>

¹² PA PUC's actions to respond to polar vortex related price spikes included, for example, seeking legal settlements for deceptive or unclear practices by suppliers, requiring greater disclosure of contract terms, and hastening the time it takes for customers to switch suppliers.

¹³ For example, coal-fired generation must invest to comply with more stringent environmental air quality regulations (e.g. Mercury and Air Toxics Standards) in order to continue to operate. Nuclear plants must invest in post-Fukushima plant safety and resiliency requirements to continue operations, and some units may require additional capital expenditures to secure operating license extension.



to these changing market trends, effectively managing the entry of new resources and retirement of uncompetitive resources, and maintaining reliability (PJM Interconnection 2016). This report was published in response to concerns that wholesale markets were forcing resources to retire prematurely, as well as concerns about the ability of these markets to attract new resource capacity in light of these retirements.

Actions at the state-level reflect these concerns. Some states within PJM have promoted policies to provide out-of-market subsidies aimed at keeping economically at-risk units in operation and/or incenting construction of new generation. For example, Maryland and New Jersey attempted to enact policies to subsidize construction of new generation.^{14,15} However, these efforts were unsuccessful because the specific subsidy methods used were determined by the courts to illegally infringe on federal jurisdiction. Ohio proposed plans to subsidize existing, economically at-risk nuclear and coal generation.¹⁶ Ohio's early strategies were rejected by FERC, but the state continues to explore alternative strategies to support these generation units that could avoid federal preemption. Owing to concerns about nuclear plant retirements, Illinois' legislature is considering legislation that would provide new revenue streams to in-state nuclear units to compensate for zero-carbon power production.¹⁷ Outside of PJM, other states are considering subsidies for economically challenged units. Most notably, New York's newly passed Clean Energy Standard aims to provide new revenue streams for zero-carbon power to certain existing in-state nuclear power plants.¹⁸

5b. Clean Power Plan Implementation

In October 2015, the U.S. Environmental Protection Agency officially published the Clean Power Plan rule to limit carbon emissions from the power sector. Each state was given a specific carbon reduction target and a significant degree of flexibility to craft a tailored plan to meet that target or be required to implement a federal plan template. The flexibility provided to the states was hailed by some as a positive feature of the rule. On the other hand, a state-by-state patchwork

of compliance strategies impacting the power sector raises challenges for a regionally integrated, competitive market system. State choices with respect to trading or no trading of emissions credits, mass or rate based compliance, multi-state cooperation or single state compliance, and many other factors can complicate functioning of competitive regional markets. Run-time limitations on specific generators are another potential outcome of the rule that could provide operational challenges for PJM.

PJM's own analysis indicates that Clean Power Plan goals can be achieved over a variety of compliance pathways, at an incremental cost (1.1 to 3.3 percent of average total wholesale cost of electricity), while maintaining reliability (PJM Interconnection 2016). In addition, PJM has experience working with states that do and do not participate in RGGI, a regional carbon emissions trading program. Notwithstanding this analysis and experience, the potential for Clean Power Plan implementation has contributed to significant dialogue and concerns about state policy choices and market implications.

6. Capacity Market Evolutions

The capacity market has recently experienced major rule changes, yet numerous challenges remain—prompting suggestions for further revisions to adjust for a transforming sector.

6a. Background on Capacity Performance Requirement Redesign

The polar vortex of January 2014 raised PJM's awareness of potential reliability issues related to increased natural gas dependency during winter peak conditions, as well as operational issues for generation units.¹⁹ In August 2014, PJM issued a draft problem statement outlining reliability concerns highlighted from the polar vortex and significant capacity retirements.²⁰ Later in August 2014, PJM presented their proposal to reform the capacity market, called the Capacity Performance Proposal, to better address performance issues. The Capacity Performance Proposal was a "pay-for-performance" approach that set higher year-round

¹⁴ After expressing concerns about in-state resource adequacy, the Maryland Public Service Commission (MD PSC) solicited proposals to build new gas-fired generation at a particular in-state location. MD PSC planned to require the local utility to enter into a 20-year contract for differences with the winning bidder, CPV Maryland LLC. The contract essentially guaranteed CPV a certain level of capacity market revenues, independent of what price the market clears. In April 2016, the Supreme Court of the United States determined that Maryland's subsidy program is preempted by the Federal Power Act as it intrudes on the wholesale electricity market which is exclusively under FERC's jurisdiction (Supreme Court of the United States 2016).

¹⁵ In 2011, New Jersey Governor Christie signed into law the Long-Term Capacity Agreement Pilot Program (LCAPP) to promote construction of in- or near-state electricity generation capacity. The New Jersey Board of Public Utilities solicited new generation bids that would be supported by 15-year, fixed price contracts with NJ distribution utilities that essentially guaranteed pre-established capacity payment rates. In September 2014, the U.S. Court of Appeals for the Third District affirmed a lower-court decision that the LCAPP was preempted by the Federal Power Act (U.S. Court of Appeals for the Third Circuit 2014).

¹⁶ In March 2016, the Public Utilities Commission of Ohio (PUCO) approved proposals from American Electric Power (AEP) and First Energy (FE) providing a guarantee of ratepayer-supported income to several coal and nuclear units via eight-year power purchase agreements with regulated distribution affiliates (Public Utilities Commission of Ohio 2016). In April 2016, FERC rescinded the underlying 2008 waivers allowing affiliated generator PPAs for AEP and FE (Federal Energy Regulatory Commission 2016). At the time of this report, AEP, FE, and Dayton Power and Light (DPL) have each proposed bill riders aiming to protect at-risk generation while avoiding federal oversight (Walton 2016). On October 12, 2016, PUCO approved a bill rider for First Energy that did not include support for at-risk generation.

¹⁷ In June 2016, Exelon announced plans to move forward with retiring the Clinton and Quad Cities nuclear plants, citing lack of progress with Illinois-based legislation aimed to support these economically challenged plants. Exelon reported the two plants had lost a combined \$800 million over the past seven years, in spite of being some of the company's best performing plants (Exelon 2016). The legislation would have established, inter alia, a zero-carbon emissions standard that would provide an additional revenue stream to these nuclear units.

¹⁸ In August 2016, the New York Public Service Commission (NY PSC) approved a Clean Energy Standard (CES) that requires 50 percent of the state's electricity to come from renewables and other zero emissions sources by 2030. The CES would provide approximately \$965 million to compensate certain nuclear plants (Ginna, Nine Mile Units 1&2, and FitzPatrick) for their zero-carbon emissions (New York Public Service Commission 2016).

¹⁹ For example, many natural gas generators with interruptible gas supply could not access fuel to operate, and PJM experienced a 22 percent forced outage rate as certain coal, gas, and nuclear generation units failed under intensely cold temperatures (PJM Interconnection May 2014). Although PJM was able to maintain reliability in light of increased demand and failing supply, wholesale power prices sharply increased, and PJM forecasted greater reliability concerns for future delivery years (PJM Interconnection August 2014). PJM also highlighted concerns about significant (over \$597 million) uplift costs – when energy market payments do not cover generator costs, requiring additional out-of-market remuneration by PJM – that are not included in price signals and therefore not transparent to market participants (PJM Interconnection May 2014).

²⁰ The document noted the current capacity market successfully attracts investment in demand resources and new gas generation, achieves planning criteria, and meets installed reserve margins. The current construct was found to be less successful in addressing generation performance issues, winter peak operations issues, and other operational characteristics needed for a transforming industry to maintain reliability (PJM Interconnection August 2014).



standards of performance, imposed penalties on resources that could not perform, and rewarded resources that over performed. The expectation was that these changes would both improve the reliability of capacity resources and increase capacity market compensation for these higher performers.

The Capacity Performance Proposal was approved at PJM through an expedited process, and submitted to FERC in December 2014.²¹ After requesting additional information from PJM in April, FERC approved PJM proposal in June 2015. PJM began the transition to the Capacity Performance Requirement (CPR) during the base residual auction (BRA) for the 2018-2019 delivery year, where 80 percent of the market resource would have to meet the more stringent CPR performance requirements. PJM also held transition auctions for the 2016-2017 and 2017-2018 delivery years to provide additional revenues for resources that could meet the CPR requirements. As intended, the CPR requirement raised capacity prices for eligible resources. The PJM expects to only clear resources that meet the CPR requirement, starting with the 2020-2021 delivery year BRA and going forward.

6b. Seasonal Resources Problem Statement

In January 2016, PJM's governance committee approved a seasonal resources problem statement identifying barriers for certain types of resources with varying levels of annual availability (i.e. seasonal) to participate as capacity resources once the capacity market is fully transitioned to the CPR. A task force of stakeholders was also established to evaluate the issue and consider alternative solutions.²² Resources that have limits on availability—for example, non-annual demand response, energy efficiency measures that impact only summer load, and intermittent renewables—had historically qualified as capacity resources. Once fully transitioned to the annual performance requirements of the CPR in 2020-2021 delivery year, these resources would no longer qualify unless they aggregated with complementary resources (e.g. wind resources with higher winter output paired with summer demand response) to offer an annual product. Early efforts to enable resource aggregation did not produce meaningful results, leading to the problem statement.

The task force continues to explore solutions to this challenge. Meanwhile, a coalition of environmental groups initiated a lawsuit challenging FERC's approval of the CPR, claiming the rules are unnecessarily costly, discriminate against seasonally available resources that can provide capacity, and have not provided proof the rules benefit grid reliability.²³

6c. Role of Demand Side Resources

PJM's treatment of demand reduction as a supply-side resource in the capacity market is controversial. For example, PJM's

independent market monitor, Monitoring Analytics, argues that demand response should not be treated as a form of supply. Instead, Monitoring Analytics suggests it should be fully accounted for on the demand-side of the market. Monitoring Analytics has argued for reform of PJM's Price Responsive Demand (PRD) rule to promote demand response, rather than supply-side reforms in the capacity market (Monitoring Analytics 2015).

Many stakeholders disagree with this position, arguing that demand response can provide meaningful, reliable capacity (e.g. on-site generation) or avoided capacity (e.g. load curtailment) that deserves capacity payment. In the energy market, FERC Order 745 requires PJM to pay locational marginal pricing for demand response resources that can provide service in a cost effective manner, compensating these demand-side resources like supply-side generators in the energy market.²⁴ Monitoring Analytics has unsuccessfully raised complaints with FERC arguing that demand response resources should be required to play by the same rules (i.e. must offer requirements in the day ahead energy market, offer cap on all energy offers) as generation resources in the energy market (Federal Energy Regulatory Commission 2016). It is likely that the treatment of demand-side resources as supply-side resources in the capacity market will continue to be controversial.

6d. Accounting for State Policy Interventions

PJM and the states across which it operates have important choices ahead that will require creativity, coordination, and leadership that balances state's legal rights with efficient market outcomes. To this end, PJM proposed a white paper in August 2016 outlining ideas for how to balance these goals (Bresler 2016). The white paper outlined three options:

Maintain the "status quo." This option allows state subsidies to enter the markets with no adjustment to market rules, resulting in uncompetitive subsidized resources clearing the market and suppressing capacity prices—which may negatively impact unsubsidized resources and/or reduce investment into new resources.

Expand the Minimum Offer Price Rule (MOPR) to existing resources. This option uses the MOPR screening process to prevent certain new capacity resources from submitting below-cost, uncompetitive offers that suppress market prices. PJM notes that expanding the MOPR to existing resources could result in procuring more capacity than is needed for reliability, while load would pay twice (once through capacity market, once through the subsidy).

Create a two-stage auction as an alternative to expanding MOPR. PJM proposed a two-stage auction process where the first stage determines capacity commitments and the second stage determines the price that cleared capacity resource from the first auction are paid. The first auction would remove subsidized capacity and associated load, then runs the auction to secure capacity

²¹ More information about the expedited "Enhanced Liaison Committee for Capacity Performance" can be found at PJM's website at <http://www.pjm.com/committees-and-groups/committees/elc.aspx>

²² More information about the problem statement and "Seasonal Capacity Resources Senior Task Force" can be found at PJM's website at <http://www.pjm.com/committees-and-groups/task-forces/scrstf.aspx>

²³ More information about the environmental coalition's petition for review at the D.C. Circuit Court of Appeals can be found at <https://www.nrdc.org/experts/jennifer-chen/enviros-look-court-undo-costly-electricity-market-rule>

²⁴ In January 2016, the Supreme Court of the United States affirmed FERC's authority to regulate demand response programs in wholesale markets (Supreme Court of the United States 2016)



commitments. The second auction would reinsert subsidized capacity (at an unsubsidized proxy price) and associated load, and then runs the second auction to establish the market clearing price. Capacity cleared in the first auction would be paid the price established by the second auction. Subsidized capacity resources would not be paid by PJM, but would still be obligated to provide capacity under PJM's performance criteria. PJM believes this system would yield market-based prices corresponding to all system load and supply, while avoiding over procurement or overpayment. However, marginal units would be disadvantaged and there are many issues to be resolved, such as: What constitutes a subsidy? What is the appropriate proxy price for subsidized resources? And how much of a greater subsidy will states have to offer to protect at-risk generation?²⁵

It is unclear if or when PJM intends to formally move forward with alternatives to the status quo to address policy interventions into the markets.

6e. Draft Problem Statement on Capacity Market

On August 25 and September 29, 2016, PJM's Markets & Reliability Committee (MRC)—a stakeholder committee that works with PJM and other PJM committees on matters related to efficacy of markets and reliability of operations and planning—explored a draft problem statement on the capacity market (PJM Interconnection 2016).²⁶

The draft problem statement and issue charge was proposed by a group of predominantly public and cooperative power interests (PJM Interconnection 2016). The draft problem statement notes that the capacity market (also called the Reliability Pricing Model) was established in 2007 under contentious negotiations, has continually changed (noting 24 significant filings made to modify the RPM since 2010), is again facing potential adjustments to deal with out-of-market subsidies, faces the potential of Clean Power Plan implementation, and lists additional issues to consider. The draft concludes by advocating for a comprehensive and holistic assessment of the RPM and consideration of alternative resource adequacy constructs that would provide greater certainty.

Many MRC members did not support the idea of a holistic redesign of the capacity market. For example, advocating that more time was needed to implement the CPR to determine its efficacy, that embarking on widespread changes would create greater uncertainty, and suggesting more targeted changes might be needed to address state policy intervention (Sweeney 2016). Ultimately, the proposers of the draft problem statement decided to revise the document before seeking approval from the MRC.

7. Integration of Distributed Energy Resources in Wholesale Markets

At a recent symposium, Norman Bay, chair of the Federal Energy Regulatory Commission, highlighted the transformative changes happening in the electric power industry, further focusing on the opportunity to integrate distributed energy resources into the wholesale market (California ISO Stakeholder Symposium 2016). Bay identifies future expectations of DERs growth, cost reduction trends for renewables and energy storage, and changing individual and corporate preferences for clean, distributed energy resources. Given these trends, Bay states the question for FERC and others will be how to optimize the value of DERs for the wholesale market, for example, by developing market rules and addressing jurisdictional issues. Bay cites the model of state, RTO/ISO, and federal coordination used by California to promote DERs and storage market rules.²⁷ As DER's grow in PJM states, similar opportunities to optimize value will arise.

As with policy choices impacting retail markets, there are opportunities to synergistically address multiple challenges in the wholesale market with integrated policy solutions, as well as more narrowly targeted answers.

²⁵ More information about PJM's Markets and Reliability Committee can be found at PJM's website at <http://www.pjm.com/committees-and-groups/committees/mrc.aspx>

²⁶ More information about PJM's Markets and Reliability Committee can be found at PJM's website at <http://www.pjm.com/committees-and-groups/committees/mrc.aspx>

²⁷ Bay specifically points to two California ISO filings as helpful examples, including the Distributed Energy Resource Provider (DERP) proposal to allow for owner/operators of DER to aggregate resources for wholesale market participation (Federal Energy Regulatory Commission 2016), and a proposal to better integrate non-generator resources



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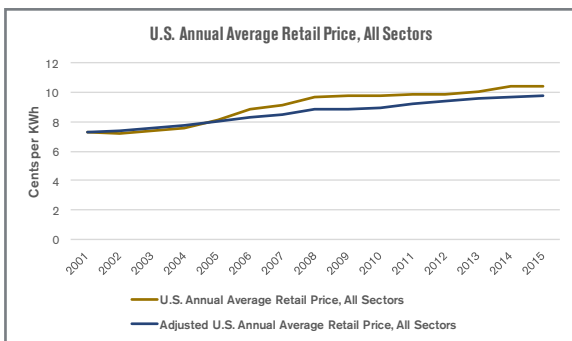
APPENDIX A

National Annual Average Retail Electricity Prices and Inflation

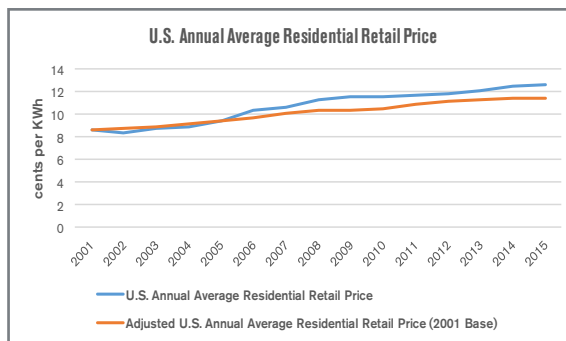
This report compares recent state and regional electricity prices to historic electricity prices adjusted for inflation using the CPI-U. This appendix provides national benchmarks for such inflation adjustments using U.S. EIA data for annual average retail electricity prices by sector from 2001 through 2015 (EIA 2016) annually adjusted for inflation using 2001 price data as the base year and CPI-U annual inflation data (U.S. Bureau of Labor and Statistics December 2015). These benchmarks are useful in comparing and providing context for sub-national inflation-adjusted electricity price data.

These national benchmarks indicate that on an average annual basis:

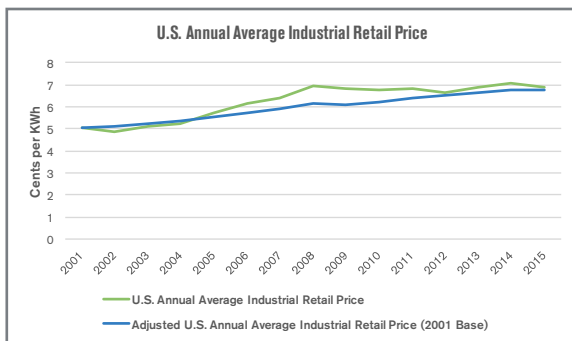
- Retail electricity prices blended for all sectors, the residential sector, and the industrial sector have risen at a rate greater than inflation.
- Retail electricity prices for the commercial sector have at times during the period of examination risen at a rate greater than inflation. More recently, in 2012, 2013, and 2015, inflation adjusted prices were greater than actual prices.



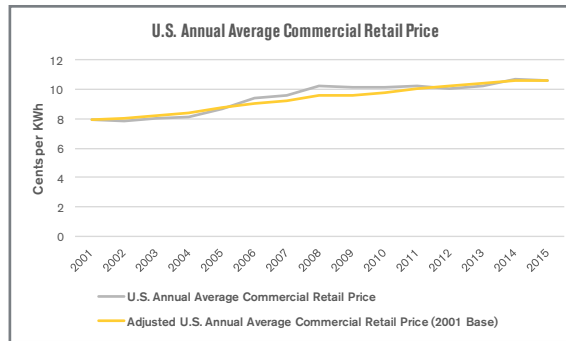
Appendix A Figure 1 - U.S. Annual Average Retail Prices, All Sectors



Appendix A Figure 2 - U.S. Annual Average Residential Retail Prices



Appendix A Figure 3 - U.S. Annual Average Industrial Retail Prices



Appendix A Figure 4 - U.S. Annual Average Commercial Retail Prices