DAYMARK® ENERGY ADVISORS

CONFIDENTIAL

ANALYSIS REGARDING PENNSYLVANIA NUCLEAR POWER PLANT CASH FLOWS

JUNE 14, 2017

PREPARED FOR

Citizens Against Nuclear Bailouts

PREPARED BY

Daymark Energy Advisors

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EXECUTIVE SUMMARY

There has been a lot press recently about the perceived struggles of nuclear generation. This report considers the financial condition of the nuclear generation in Pennsylvania in light of the stranded cost payments and market revenues made over the past 15-plus years. Deregulation in the late 1990s and early 2000s led to billions of dollars of stranded costs being collected in market transition charges from ratepayers across multiple states to owners of nuclear facilities. A large portion of the utilities' stranded costs was associated with nuclear power generation plants, including plants in Pennsylvania, New Jersey and Ohio. A summary of the total stranded costs for Pennsylvania, including the portion associated with nuclear generation are presented in Figure ES-1 below.

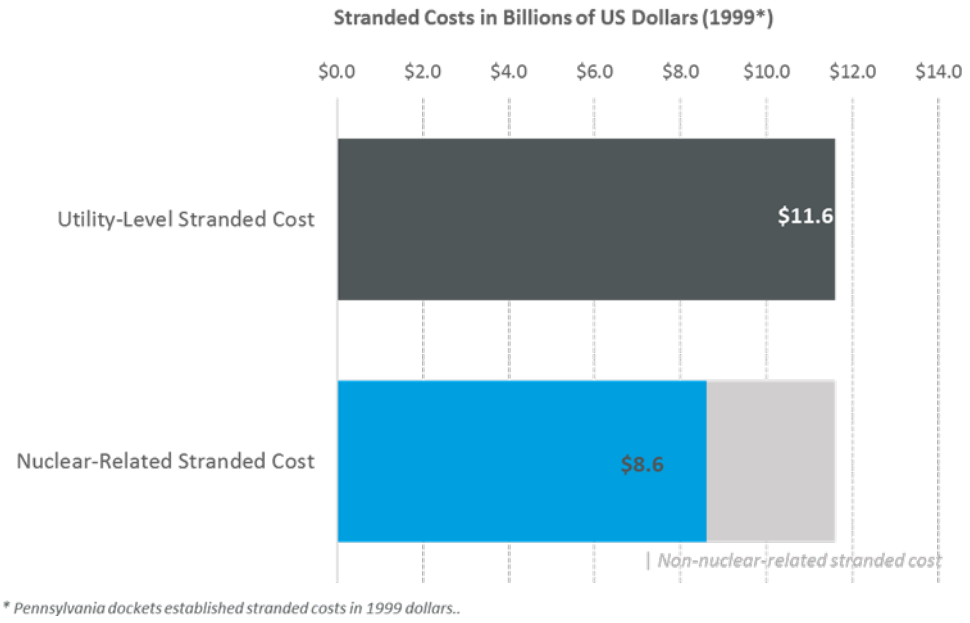

Figure ES-1: Total Stranded Costs of Utilities Analyzed

The stranded costs were negotiated amounts, determined based on settlement discussions and finalized in orders at each utility's utility commission. Each utility's stranded costs related to nuclear generating capacity reflected the remaining cost on the utility's books (Book Value, or BV) less a forecast of the plants' market value (MV), plus costs associated with nuclear decommissioning funding and other nuclear-related regulatory assets.

Table ES-1 presents the utility level stranded cost data of those utilities that filed in Pennsylvania.

Utility	Utility Level Stranded Costs ($ Millions)	Nuclear Related Stranded Costs ($ Millions)
Pennsylvania Electric Company	$858	$135
Metropolitan Edison	$975	$250
PPL	$2,970	$2,351
PECO[1]	$5,260	$4,914
Penn Power	$234	$92
Duquesne	$1,332	$884
Total	**$11,628**	**$8,626**

Table ES-1: Utility level PA stranded costs

While there was some disagreement and negotiation regarding BV and decommissioning costs, by far the more contentious element of the calculation of stranded costs was the determination of MV. Energy markets were just being developed and for many of the plants, capacity markets did not yet exist when stranded costs were being settled. Nearly twenty years later, these power plants have been operating in the energy and capacity markets so have actual market revenues to compare against the original forecasted revenues. In all cases the data shows that actual revenues exceeded forecasted revenues, in many cases by material amounts. Figure ES-2 presents the present value of the forecasted and actual revenue by utility for each PA plant roughly as of the time that the stranded costs were determined.

[1] Includes the main stranded costs docket plus the separately calculated nuclear decommissioning costs

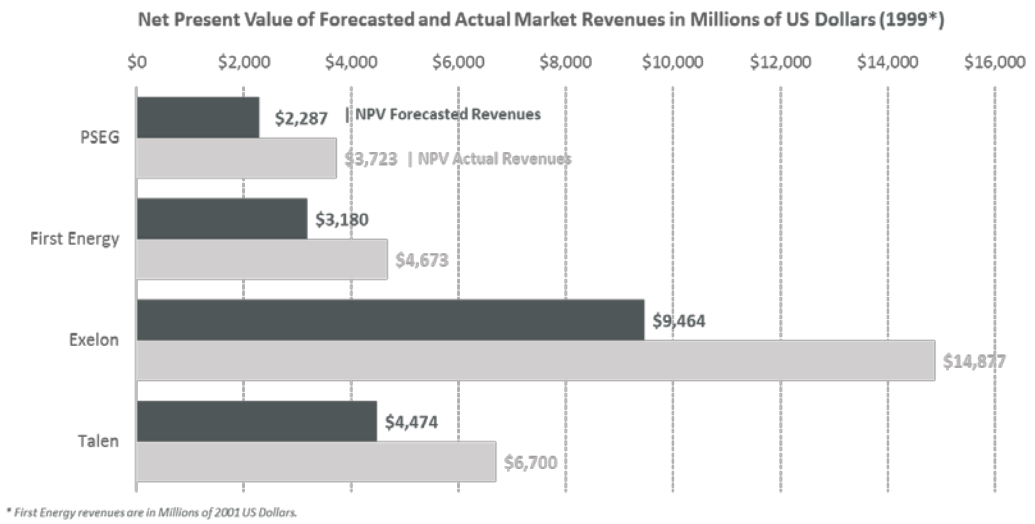

Figure ES-2: Present Value of Forecasted and Actual Market Revenues for PA Plants by Current Owners (Millions of US Dollars)

Since the time stranded costs were settled, the original owner utilities have either sold generating assets or merged and/or been acquired; we do not adjust for any changes in market value associated with these transactions. Additionally, to maximize market opportunities the owners have made investments to increase availability and rated capacity (uprates), reduce refueling outage times, and decrease refueling cycles. These investments have allowed plant owners to realize more revenue on increased sales and to reduce costs. These investments were likely generally not forecast at the time stranded costs were determined and thus were not reflected in the MV, nor were the costs associated with these additional revenues quantified in this analysis.

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I. INTRODUCTION

Daymark Energy Advisors ("Daymark") assessed the financial condition of the five nuclear plants in Pennsylvania in light of the stranded cost payments and market revenues made from the time of the initial stranded cost determinations through 2015. The five plants are:

- Susquehanna Steam Electric Station ("Susquehanna")
- Limerick Generating Station ("Limerick")
- Three Mile Island Nuclear Generation Station ("Three Mile Island" or "TMI")
- Beaver Valley Nuclear Generating Station ("Beaver Valley")
- Peach Bottom Nuclear Generating Station ("Peach Bottom")

Daymark identified the utilities that held ownership stakes in the five nuclear power plants when the stranded costs were originally calculated and reviewed the restructuring application and the final order from each docket, as well as other information as needed to determine forecasted market value data and stranded cost values for each utility. We also used data services and PJM records to estimate actual energy and capacity prices for each plant. These data were used to establish forecasted and actual market prices (energy and capacity) and to calculate forecasted and actual market revenues from the date of stranded cost determination through 2015. We then compare the projected and actual market prices and revenues for each utility to estimate the difference between realized market revenues and the estimates used to set stranded costs.

II. NUCLEAR PLANT OWNERSHIP CHANGES OVER TIME

All five nuclear plants have gone through various ownership changes during the last twenty years that have affected their revenues since stranded costs were established. Most of the ownership changes are due to mergers, acquisitions, or consolidation of the utilities that owned them. Appendix A has a brief description of the changes.

Figure 1 below shows the ownership of the five Pennsylvania-based plants. The top half of the figure shows the utilities that owned the plants during the stranded cost calculations as well as the state where the stranded costs were determined. The boxes underneath each plant detail the ownership percentages when stranded cost were calculated and at the ownership percentages today.

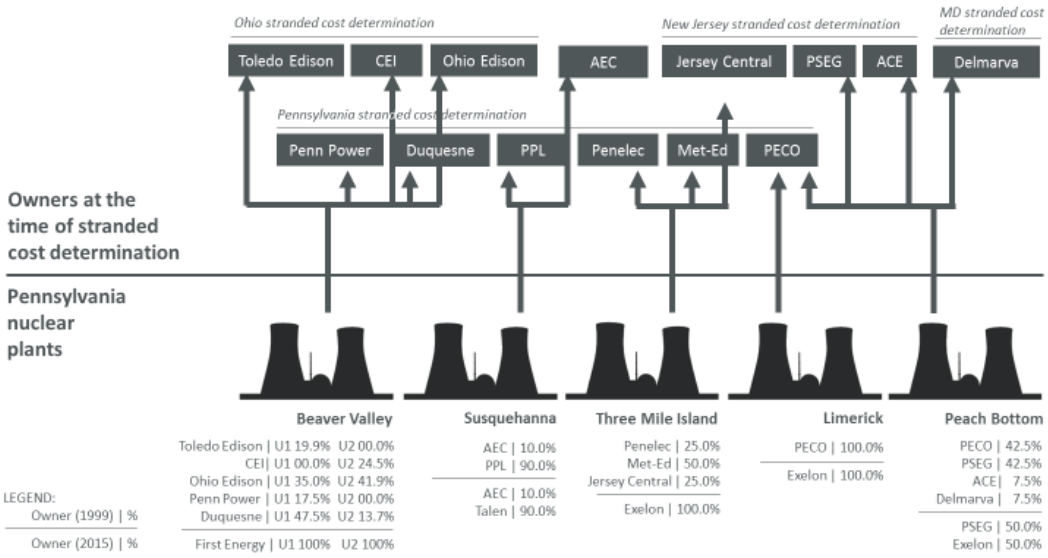

Figure 1: Ownership Structures of Beaver Valley, Susquehanna, Three Mile Island, Limerick, and Peach Bottom Nuclear Plants

III. DATA GATHERING

A. Data Collection

At the time of restructuring, fourteen utilities owned shares in Pennsylvania's five nuclear power plants. Six of these utilities filed restructuring applications with the Pennsylvania Public Utilities Commission (PA PUC). Each restructuring application addressed all owned generating assets, including the nuclear plants in which the utility had ownership interest.[2] Daymark examined the payments to these five PA nuclear power plants from the time of the initial stranded cost determination through 2015.

The data collected for this study were primarily drawn from three sources: the restructuring applications submitted by each electric utility, the final orders granted by the state public utility commissions, and the SNL Energy online database. The restructuring applications contained forward revenue forecasts developed by the utilities from which we took projected annual generation values. These applications also contained initial stranded costs calculations. The final orders handed down by the public utility commission at the end of each utility's restructuring case included the final stranded cost values.

For Pennsylvania, Daymark's (then La Capra Associates') market price forecast prepared on behalf of the Pennsylvania Office of the Consumer Advocate was used as a proxy for the negotiated market line. This forecast of annual market prices was referenced in most settlement talks and accepted by the Pennsylvania commission in their final orders. These market prices were multiplied by the forecasted annual plant generation to estimate the yearly forecasted revenues that formed the basis of the market valuation used in settlement discussions for each utility.

In order to estimate actual annual energy revenues, Daymark used historical annual generation values and day-ahead locational marginal prices for each plant.[3] The capacity prices for the years 1999 – 2006, prior to the creation of Reliability Pricing Model (RPM) market, are the weighted average prices for the capacity credit market and are collected from Monitoring Analytics' State of the Market Report for PJM.[4] The nuclear plant's capacity prices after the creation of the RPM market are the annual PJM capacity prices for the Locational Deliverability Area (LDA) associated with each plant's location and

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[2] The Pennsylvania restructuring case docket numbers for the six utilities are listed in the Appendix.

[3] The actual generation, energy and capacity prices were collected via SNL Energy online database.

[4] Page 272, 2015 State of the Market Report for PJM, Monitoring Analytics, LLC: http://www.monitoringanalytics.com/reports/PJM_State_of_the_Market/2015/2015-som-pjm-volume2.pdf

were collected from the website of the independent market monitor for PJM, Monitoring Analytics. The LDA's used are summarized in the Table 1.

Table 1: Locational Deliverability Area (LDA) by Nuclear Plant

Plant	LDA Zone
Susquehanna	MAAC
Limerick	EMAAC
Peach Bottom	EMAAC
Three Mile Island	MAAC
Beaver Valley	RTO

B. Data Manipulation

Ownership of each nuclear plant studied was divided among several utilities. The utility stranded cost applications, including projected stranded costs and forecasted revenue-related information, were specific to each utility and its ownership share. Therefore, the analysis considers projected revenues, actual revenues, and market prices (projected and actual) for each individual utility and the ownership stake it had in the Pennsylvania nuclear plants.

The annual forecasted market revenue values were calculated using the annual forecasted generation figures in megawatt hours (MWh), taken from the forecasts the companies typically included in their initial restructuring applications. Each generation value was assumed proportional to the utility's ownership stake in each plant. The annual generation values were multiplied by the annual all-in market prices from the appropriate market forecast to calculate the annual forecasted revenue share for a specific plant, where all-in is the sum of energy and capacity prices converted to an average $/MWh value. Once the annual forecasted generation and revenue values were calculated for a utility's share of a plant, the Net Present Value (NPV) was calculated using the final order discount rate for each plant in the utility's Pennsylvania nuclear fleet. This process was repeated for each utility with interest in any of the five nuclear power plants analyzed.

The calculation of actual revenues closely followed the methodology described above. For each plant, annual historical generation and capacity factors were gathered from the SNL Energy database for the same time period in which revenues had been estimated

for stranded cost calculation.[5] The generation value and capacity factor were used to calculate the annual capacity (MW) for each plant. Locational marginal prices applicable to each plant were collected from SNL and used to compute the annual generation revenue for each plant. Annual capacity prices for the LDAs associated with a plant's location were used to calculate yearly capacity revenues. Once annual energy and capacity revenues were computed, they were combined to create total annual plant revenue. The total annual plant revenue and annual plant generation were then adjusted by the ownership share percentage of the associated utility. The NPV and all-in market prices were then calculated using the same discount rate as applied to the forecasted values.

The stranded cost values featured in this report were drawn from the final orders or decisions issued by the state utility commissions for each of the restructuring cases. These values were the commission-approved stranded costs amounts to be recovered by the utilities. These final orders primarily highlighted only the utility-level stranded cost and the utility-level generation stranded cost values.

Breaking down the utility-level generation stranded cost amounts into utility-level nuclear generation stranded cost required using the estimated net book value for the nuclear plants typically found in the initial utility application filing. By finding the proportion of the estimated total nuclear generation net book value to the estimated utility-level generation net book value, this proportion could then be applied to the commission-approved utility-level generation net book value to calculate the utility-level nuclear generation stranded cost. This book value could then be applied against the market value attributed to the nuclear plant to estimate final stranded costs from nuclear power plants. Finally, the numbers in this report were presented to the state's consumer advocate for a high-level review of the reasonableness of the results. Figure 2, provides a visual summary of these stranded cost components.

C. Increased Efficiency of Pennsylvania Nuclear Power Plants

Since restructuring, the owners of the nuclear plants have had the economic incentive to optimize the operations of the plants in order to maximize revenues.[6] Nuclear plants

[5] PECO, PPL, Pennsylvania Power, and Duquesne stranded cost calculation used a MV forecast time frame of 1999 to 2015; Penelec and Met-Ed, had a time frames of 1999-2014.

[6] This was documented in Davis, Lucas W., and Catherine Wolfram. 2012. "Deregulation, Consolidation, and Efficiency: Evidence from US Nuclear Power." American Economic Journal: Applied Economics, 4(4): 194-225.

performed various uprates to increase rated capacity and the capacity factors of the units significantly improved.

Table 2 contains a summary of the uprates performed during two different time periods. The number of uprates along with the total capacity in post-2000 period is almost double than during 1980-1999 period. There was a total of 14 unit-level uprates approved by NRC after 2000, adding 872.7 MW of new capacity. NRC approved three different uprate applications to each of the two unit of Susquehanna increasing its capacity by almost 20%. Similarly, both Peach Bottom and Beaver Valley increased their capacity by at least ten percent.

Table 2: Summary of Approved Power Uprates at the Nuclear-plant level[7]

Current Owner	Nuclear Plant Name	1980 - 1999		2000 - Present	
		Uprates Count	Capacity (MWe)	Uprates Count	Capacity (MWe)
Exelon	Limerick	2	110	2	38
	TMI	1	11		
Exelon/PSEG	Peach Bottom	2	110	4	328.7
FirstEnergy	Beaver Valley			4	165.3
Talen/AEC	Susquehanna	2	98.7	4	340.7
Total		*7*	*329.7*	*14*	*872.7*

Additionally, the owners had clear market incentives to increase availability, minimize reduce refueling outage times, and increase time between refueling. Over time, each of the nuclear plants has had increases in output and other improvements that have allowed their owners to realize more revenue than could have been forecasted assuming status quo utility operations at the time stranded costs were determined. The uprates and higher capacity factors are reflected in the higher actual generation numbers, which contribute to the higher revenues.

IV. ANALYSIS

Daymark's analysis of nuclear plant cash flows uses the data and methods discussed in Section III. First, we present final agreed stranded costs for utilities that owned the five nuclear plants during the stranded cost calculation period. Then, we aggregate the plant-level actual and forecasted values based on the ownership shares to derive current

[7] Approved Applications for Power Uprates, United States Nuclear Regulatory Commission: https://www.nrc.gov/reactors/operating/licensing/power-uprates/status-power-apps/approved-applications.html Accessed April 6, 2017

owner level values. We present both stranded costs and revenues number at the current owner level.

A. Stranded Costs

Each utility applied for stranded costs based on their estimated of the fair market value of the plant and its book value. The final stranded costs levels were ultimately determined by PA PUC orders. These final stranded costs were often lower than what had been requested due to the settlement process.

Figure 2 shows the total final stranded costs for all utilities that owned a portion of any of the five PA nuclear plants analyzed. The total utility-level stranded costs for the utilities listed in Table 3 are $11.6 billion. Over $8.6 billion of the stranded costs are related to nuclear generation.

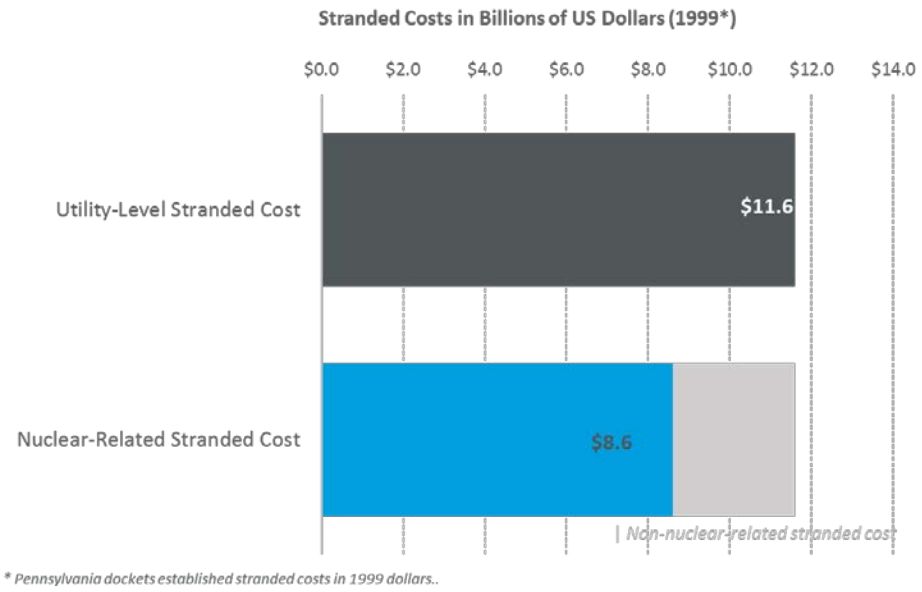

Figure 2: Total Stranded Costs of Utilities that Owned Five PA Nuclear Plants Analyzed

Table 3 shows the stranded costs for the utilities that had some ownership of the five Pennsylvania nuclear plants analyzed.

Table 3: Pennsylvania Stranded Costs at the Utility Level

Utility	Utility Level Stranded Costs ($ Millions)	Nuclear Related Stranded Costs ($ Millions)
Pennsylvania Electric Company	$858	$135
Metropolitan Edison	$975	$250
PPL	$2,970	$2,351
PECO[8]	$5,260	$4,914
Penn Power	$234	$92
Duquesne	$1,332	$884
Total	**$11,628**	**$8,626**

B. Market Value

The market values were first determined at the original plant ownership percentage level, and then aggregated to reflect current ownership information. The annual actual and forecasted numbers were calculated by aggregating plant-level revenue information by appropriately applying ownership share percentages.

[8] Includes the main stranded costs docket plus the separately calculated nuclear decommissioning costs

Figure 3 compares the net present value of actual and forecasted revenues for the current owners of the five nuclear plants. In all cases, the net present value of actual revenue exceeds the net present value of the forecasted revenues used to calculate stranded costs. PSEG's actual revenue during the analysis period is $3.7 billion, whereas the forecasted revenue was $2.3 billion. Similarly, the actual and forecasted revenues for FirstEnergy is $4.7 billion versus $3.2 billion. There is a considerable gap between Exelon's actual ($14.9 billion) and forecasted ($9.5 billion) revenues. The difference between Talen Energy's actual and forecasted revenues is around $2.2 billion.

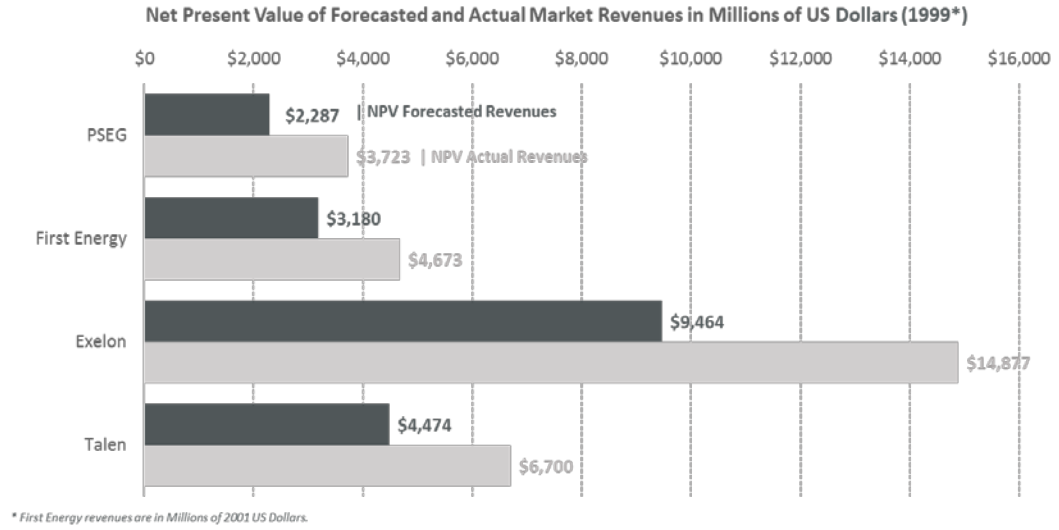

Figure 3: Net Present Value of Forecasted and Actual Market Revenues of PA Plants by Current Owners (Millions of US Dollars)

Figure 4 presents the annual forecasted and actual market revenues for PSEG from the period of restructuring to 2015. These revenues represent the combined revenues from the different Pennsylvania nuclear plants that PSEG owns. The timeline below the graph shows the timing of various power uprates performed on these plants. The graph shows that from 1999 to 2015, PSEG actual market revenues were higher than the forecasted revenues.

The shape of the revenue curves also differs with the forecasted revenues increasing gradually to adjust for inflation while the actual revenue curve has several peaks and troughs. This difference in shape is reasonable since the forecasted revenues would not be able to capture market unpredictability. The peak seen in actual market revenue in 2014 coincides with the year where a power uprate was carried out on Peach Bottom. Uprates, higher than forecasted energy prices, capacity prices, and higher capacity factors than those originally forecasted, combine to explain the year-to-year difference between actual and forecasted market revenues.

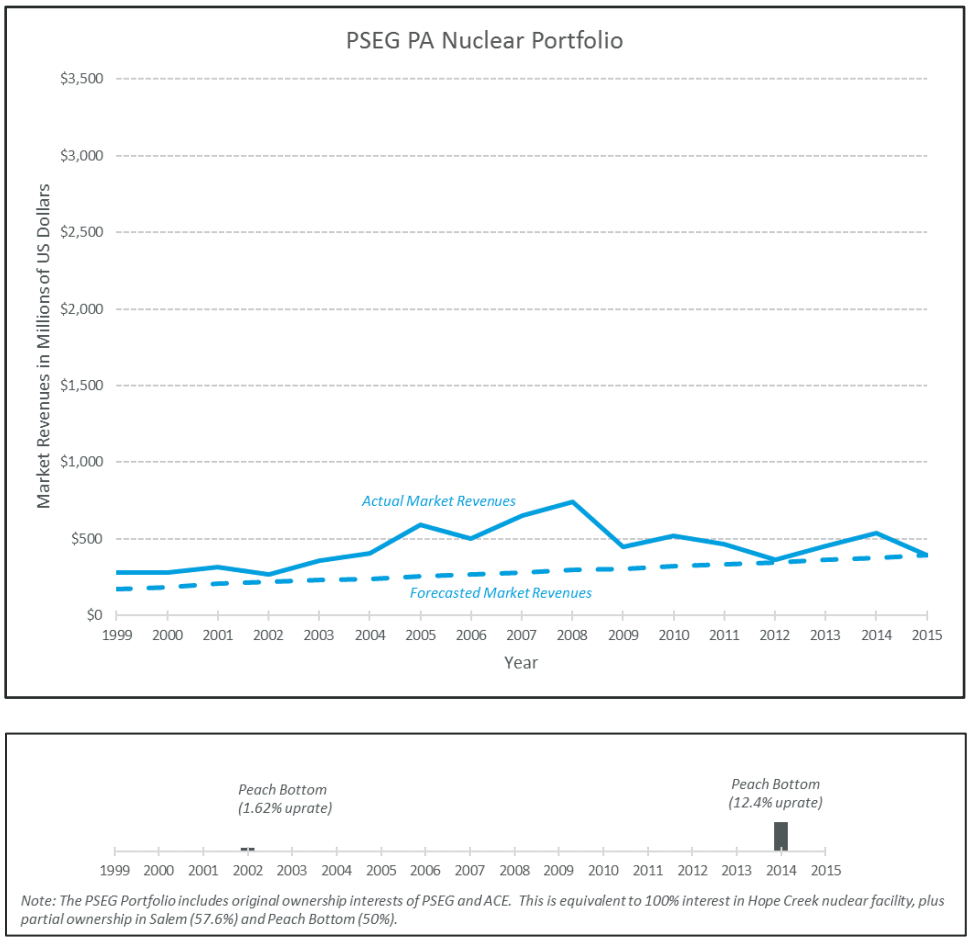

Figure 4: Annual Forecasted and Actual Revenues and Uprates of PSEG Plants

Figure 5 presents the annual revenues for Exelon's portfolio and shows the sizeable difference between the forecasted and actual revenues. As with the preceding PSEG graph, the peaks shown here generally occur at the same time as the implementation of power uprates at different plants. However, the largest peak in actual revenue occurring in 2008 does not coincide with a power uprate.

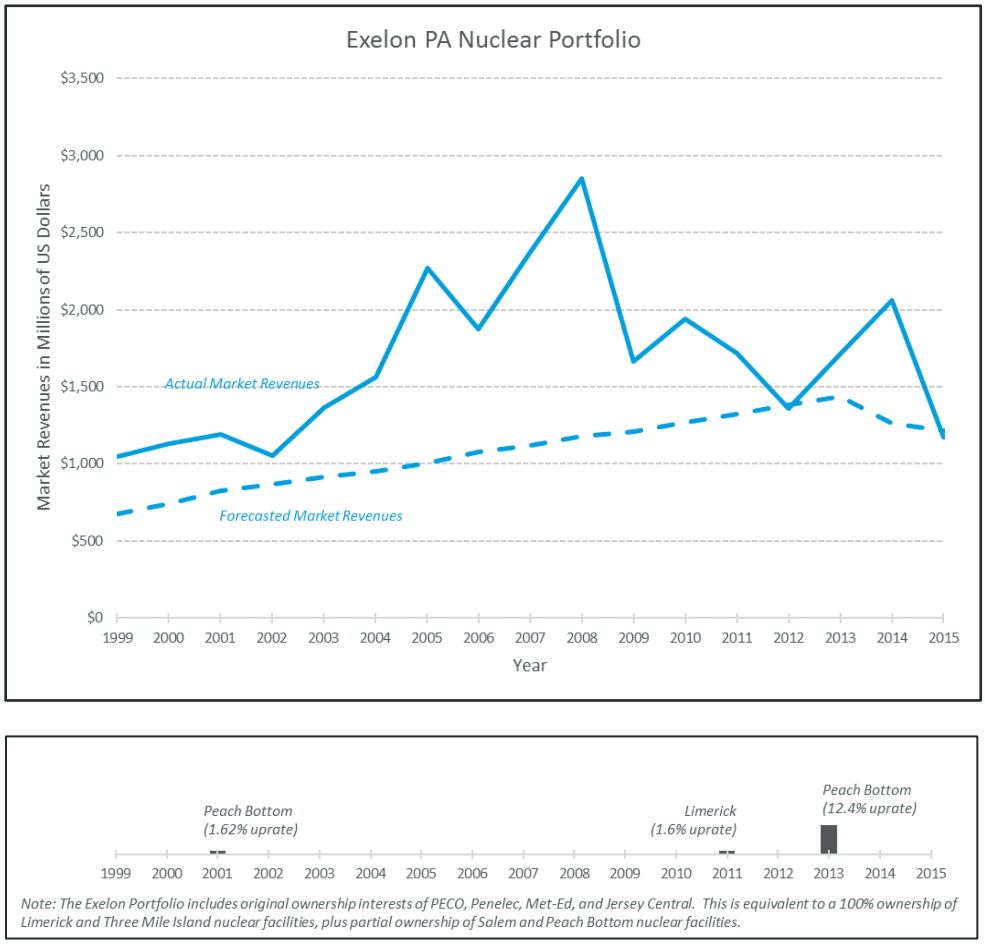

Figure 5: Annual Forecasted and Actual Revenues and Uprates of Exelon owned Plants

FirstEnergy's annual actual and forecasted revenues are included in Figure 6. The story is similar to that for PSEG and Exelon shown above in terms of shape and the disparity between the forecasted market revenues and the actual market revenues earned by the utility. The years when uprates were performed also appear to match several of the spikes in actual revenues, particularly in 2001. Interestingly, the power uprate that was performed on Beaver Valley occurred during a year (2006) in which actual revenues appeared to dip. This demonstrates that the nature of the actual market revenues generated can be tied to a variety of factors, not just uprates.

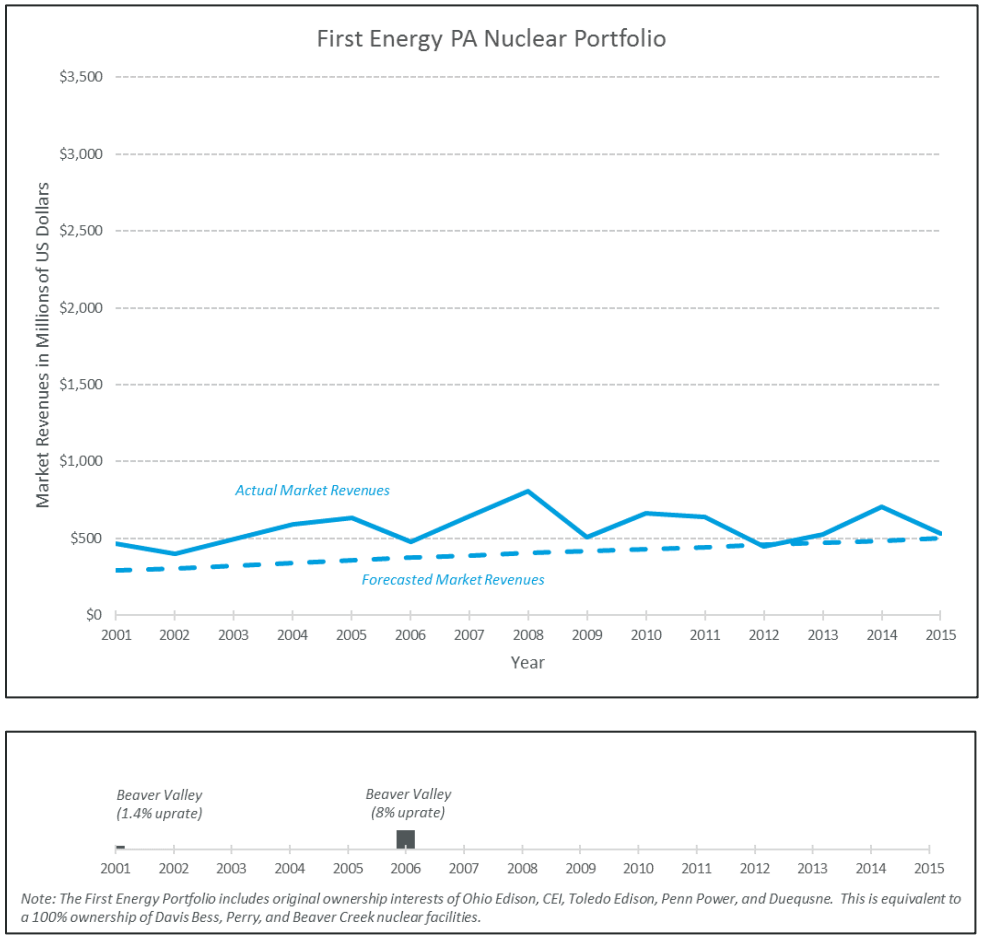

Figure 6: Annual Forecasted and Actual Revenues and Uprates of FirstEnergy Plants

Figure 7 shows the actual versus forecasted revenues for Susquehanna plant. Talen Energy owns 90% of the Susquehanna. The annual actual and forecasted revenues have a similar trend to other current owners shown in earlier figures.

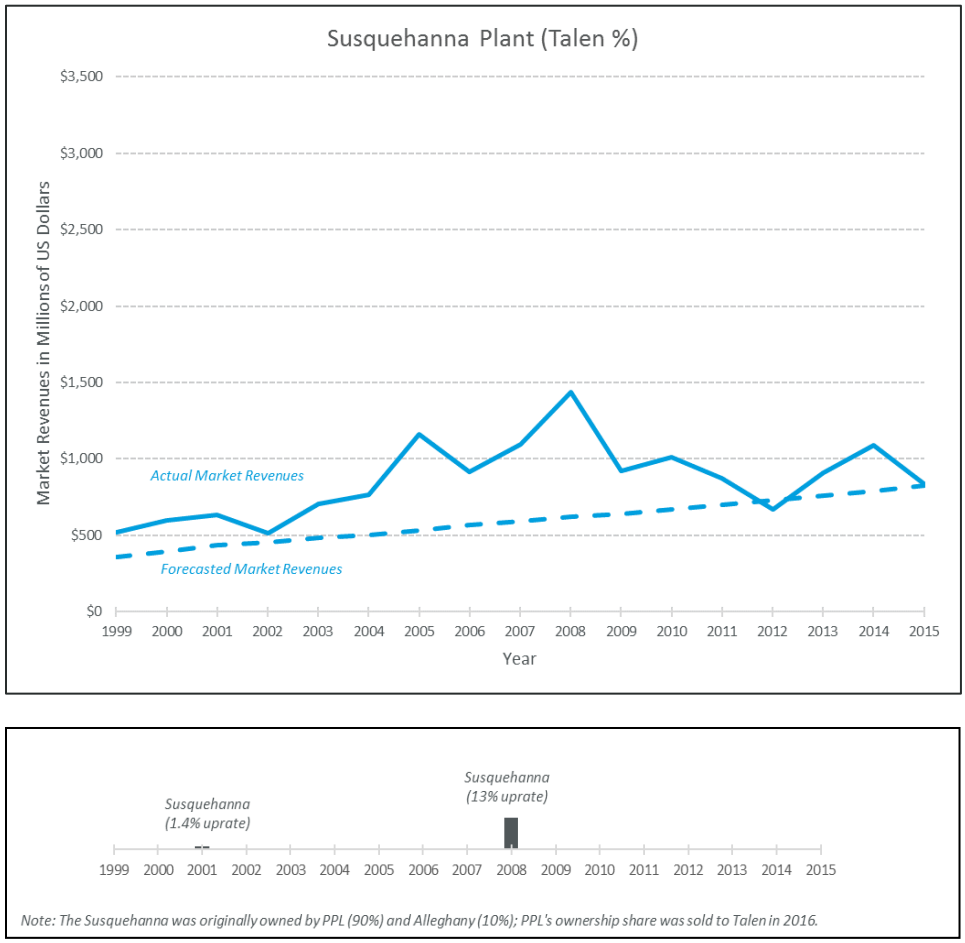

Figure 7: Annual Forecasted and Actual Revenues and Uprates of Susquehanna plant

V. APPENDIX A: OWNERSHIP CHANGES

This section contains a brief description on ownership changes in five Pennsylvania based nuclear plants. Most of the ownership changes have happened due to mergers and acquisitions of the utilities owning them. There are few plants with all or portion of their shares being bought at then market value resulting in actual change in ownership.

The background information on utility-level merger and acquisition, especially the formation of Exelon and FirstEnergy, is helpful before we discuss the plant-level ownership changes. Exelon was formed by the merger of Philadelphia-based PECO with Chicago-based Unicom Corporation in 2000. Exelon later acquired Pepco Holdings Incorporated (PEPCO) in 2016. PEPCO was formed in 2002 when Potomac Electric Power Company acquired Conectiv Power Delivery. Conectiv was formed in March 1998 when Delmarva Power & Light Company merged with Atlantic Energy, Incorporated, which was the parent company of Atlantic City Electric Company (ACE).

Similarly, FirstEnergy Corp. was formed in 1997 when Ohio Edison Company merged with Centerior Energy Corporation and became the holding company of Ohio Edison, Penn Power, Cleveland Electric Illuminating Inc. (CEI), and Toledo Edison Company. In 2001, FirstEnergy merged with GPU Inc. which at the time had three operating companies: Metropolitan Edison Company (Met-Ed), Pennsylvania Electric Company (Penelec) and Jersey Central Power & Light.

Peach Bottom's shares of Atlantic City Energy's (ACE) and Delmarva was bought equally by PSEG Nuclear and Exelon in October 2001. With this transaction, PSEG and Exelon currently own 50% of Peach Bottom.

Similarly, PECO's full ownership of Limerick was transferred to Exelon due to the PECO-Unicom merger.

Susquehanna's 90% ownership was transferred from PPL to Talen Energy due to PPL spin off. Susquehanna's remaining 10% ownership was, and is still, held by Allegheny Electric Cooperative (AEC).

The ownership of Three Mile Island Unit 1 (TMI1) switched from GPU, Incorporated via its subsidiaries: Metropolitan Edison Company (Met-Ed), Pennsylvania Electric Company (Penelec) and Jersey Central Power & Light, to AmerGen. AmerGen, which was then equally owned by Exelon and British Energy, purchased TMI1 in 1998 from GPU Inc. Exelon then again purchased British Energy's 50%, shares from TMI1 in 2003 obtaining the full ownership of the unit.

FirstEnergy Corp acquired Duquesne's partial ownership of Beaver Valley via its subsidiaries. The U.S. Nuclear Regulatory Commission approved the transfer of Duquesne's 47.5% ownership share of Beaver Valley Unit 1 and its 13.7% share of Beaver Valley Unit 2 to Penn Power in October 1999.

VI. APPENDIX B: ADDITIONAL DATA

Table 1: Restructuring Docket Lists by Utilities

Utilities	**Dockets**
Penelec	PA PUC: R-00974009
Penn Power	PA PUC: R-00974149
Met-Ed	PA PUC: R-00974008
PECO	PA PUC: R-00973953
Duquesne	PA PUC: R-00974104
PPL	PA PUC: R-00973954

Table 2: Annual Forecasted and Actual Estimated Revenues by Current Owners of five Pennsylvania Nuclear Plants.

Year	Exelon		PSEG		Talen		First Energy	
	Forecasted	Actual	Forecasted	Actual	Forecasted	Actual	Forecasted	Actual
1999	679.2	1,050.2	171.5	280.2	359.1	520.2		
2000	742.2	1,130.3	187.4	283.0	392.2	598.6		
2001	825.1	1,193.7	208.4	314.7	435.7	631.8	291.3	466.2
2002	865.6	1,051.0	218.7	269.9	457.0	511.8	306.6	399.2
2003	915.1	1,364.9	231.2	357.8	482.8	707.0	323.8	497.0
2004	953.2	1,561.1	240.9	404.0	502.7	764.7	340.1	590.2
2005	1,004.8	2,273.0	253.9	595.2	530.1	1,159.6	359.1	635.8
2006	1,074.8	1,872.0	271.5	499.7	567.5	913.8	375.7	479.7
2007	1,121.1	2,369.5	283.2	652.3	592.2	1,096.8	389.4	647.3
2008	1,180.2	2,852.9	298.1	744.8	623.9	1,436.9	404.3	807.1
2009	1,212.5	1,664.4	306.2	447.4	641.2	922.2	416.6	511.4
2010	1,271.3	1,940.7	321.0	520.0	672.4	1,010.8	432.0	663.3
2011	1,325.3	1,721.9	334.7	467.8	700.8	875.7	444.8	638.2
2012	1,380.8	1,360.2	348.7	367.6	730.3	672.2	457.8	446.6
2013	1,439.6	1,711.3	363.5	454.4	761.3	911.5	471.9	525.0
2014	1,264.3	2,061.9	378.1	541.1	792.0	1,086.9	485.9	705.5
2015	1,215.1	1,171.2	394.7	397.1	826.5	839.1	500.4	534.6
Note: Forecasted and Actual revenues are nominal and expressed in Million US$.								