Pennsylvania State Report

July 2017

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Executive Summary

(July 2017)

- **Existing Capacity:** Nuclear represents approximately 24 percent of the total installed capacity in Pennsylvania while natural gas represents approximately 29 percent and coal represents approximately 31 percent. This differs from PJM where nuclear is 19 percent and natural gas and coal are relatively even at 35 and 34 percent respectively.
- **Interconnection Requests:** Natural gas represents 96 percent of new interconnection requests in Pennsylvania.
- **Deactivations**: Approximately 14 MW of capacity in Pennsylvania retired in 2016. This represents only 3.6 percent of the 392 MW that retired RTO-wide in 2016.
- **RTEP 2016:** Pennsylvania RTEP 2016 projects total nearly $656 million of investment. Over 35 percent represents baseline-type projects.
- **Load Forecast:** Pennsylvania load growth is nearly flat, averaging less than 1 percent per year over the next 10 years. This aligns with PJM RTO load growth projections.

Executive Summary

(July 2017)

- **2020/21 Capacity Market:** Compared to the PJM footprint, Pennsylvania's distribution of generation, demand response and energy efficiency in capacity performance is similar.
- **6/1/14 – 5/31/17 Market Performance:** Pennsylvania's average daily locational marginal prices were consistently at or below PJM average daily LMPs. Nuclear resources represented 38 percent of generation used in Pennsylvania while natural gas and coal each averaged 28 percent.
- **Emissions:** 2016 carbon dioxide, nitrogen oxides, and sulfur dioxide emissions are slightly down from 2015.

PJM Service Area – Pennsylvania

(December 31, 2016)

Planning

Generation Portfolio Analysis

Pennsylvania – Existing Installed Capacity

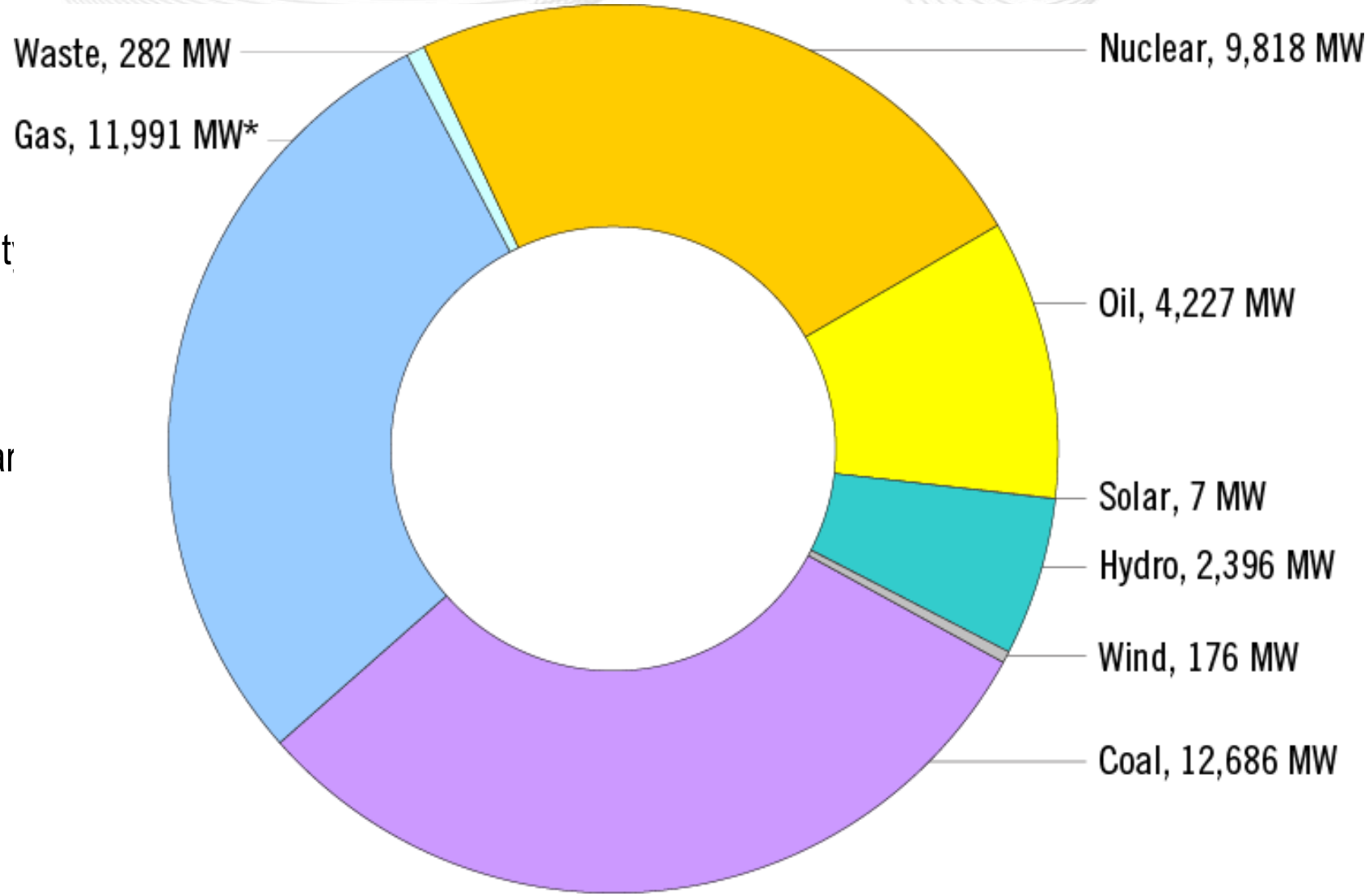
(Capacity Rights, December 31, 2016)

Summary:

Natural gas represents approximately 29 percent of the total installed capacit in Pennsylvania while coal represents approximately 30 percent.

Overall in PJM, natural gas and coal ar relatively even at 35 percent and 34 percent respectively.

* Gas Contains	
Natural Gas	11,853 MW
Other Gas	138 MW

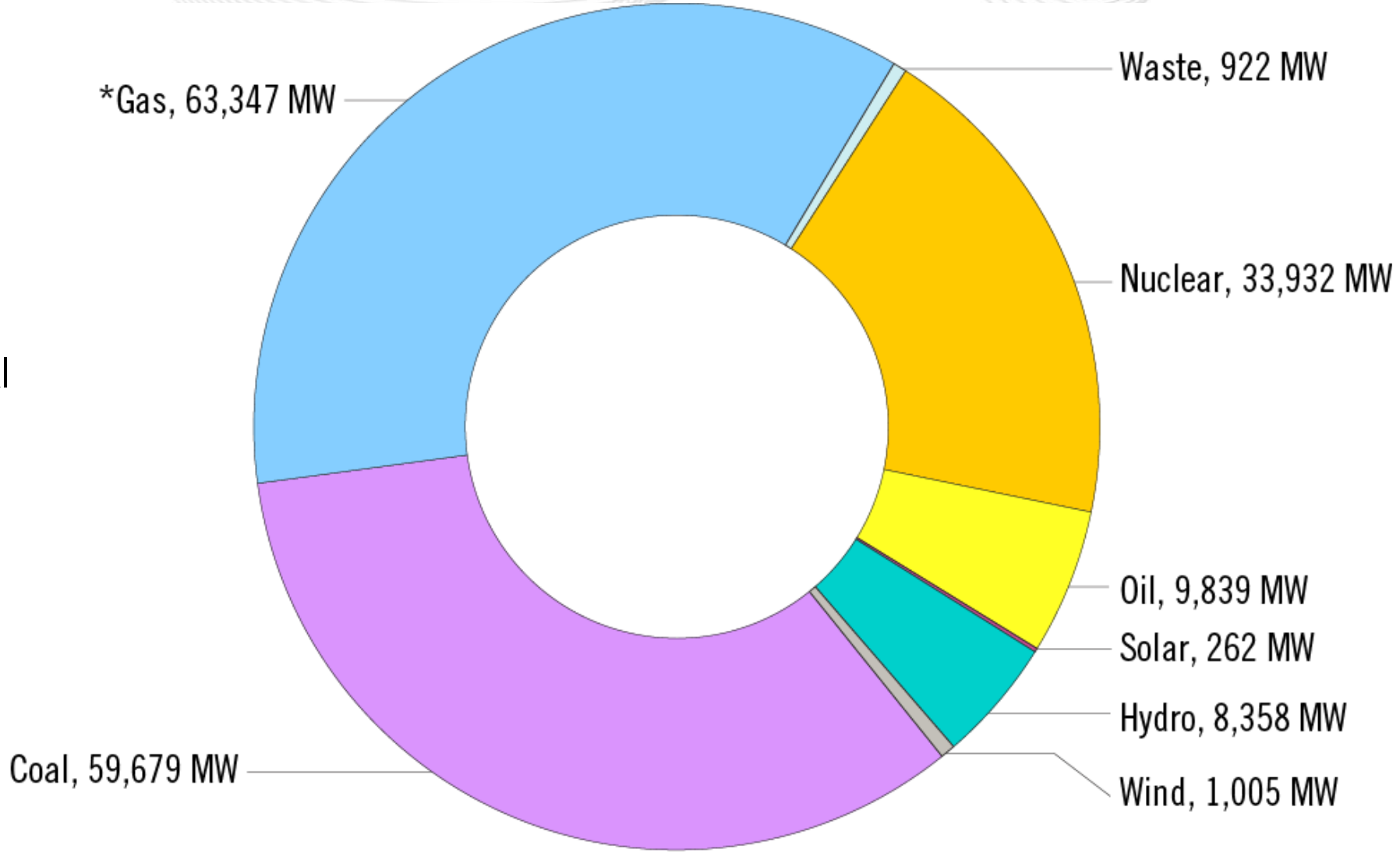


PJM – Existing Installed Capacity

(Capacity Rights, December 31, 2016)

In PJM, natural gas and coal make up nearly 70 percent total installed capacity.

* Gas Contains	
Natural Gas	62,941 MW
Other Gas	405 MW



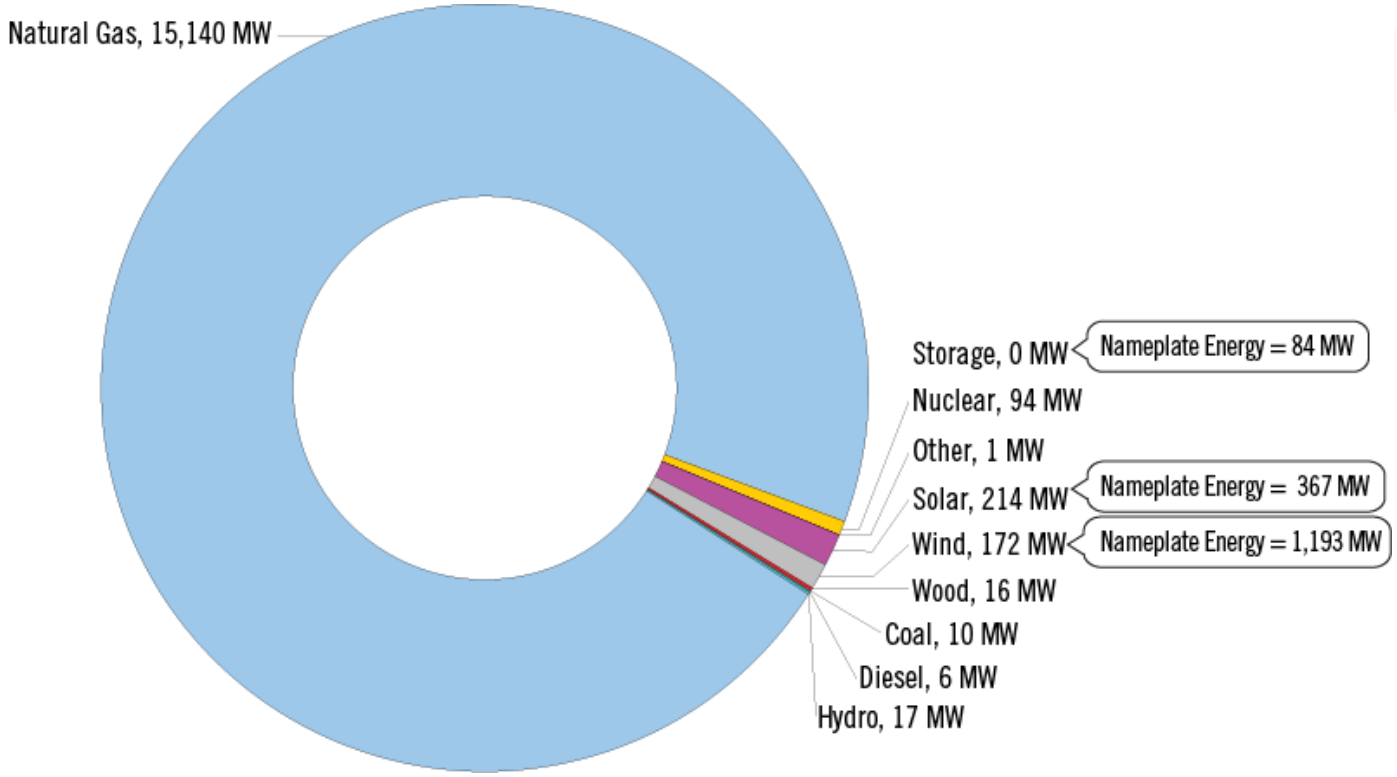
Pennsylvania – Interconnection Requests

(Requested Capacity Rights, December 31, 2016)

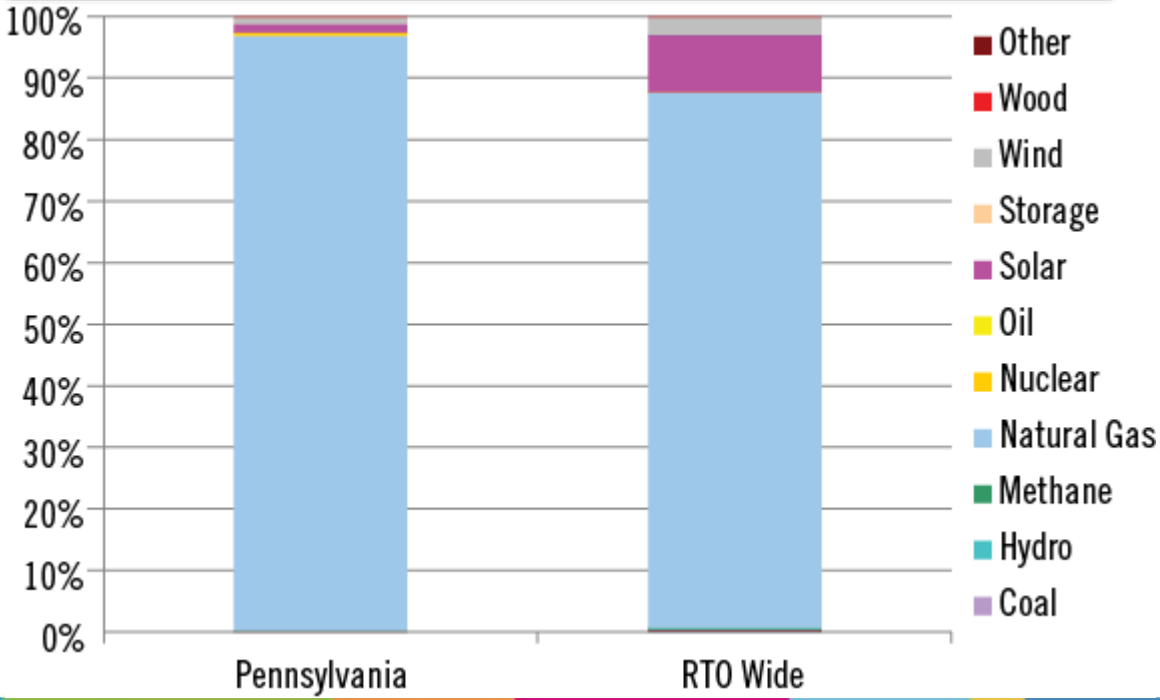
	MW	# of Projects
Active	8,296	62
Under Construction	7,142	29
Suspended	232	17
Total	**15,670**	**108**

Natural gas represents more than 96 percent of new interconnection requests in Pennsylvania.

Total MW Capacity by Fuel Type



Fuel as a Percentage of Projects in Queue



PA – Interconnection Requests

	Active		In Service		Suspended		Under Construction		Withdrawn		Total Sum	
	MW	# of Projects	MW	# of Projects	MW	# of Projects	MW	# of Projects	MW	# of Projects	MW	# of Projects
Biomass			31.4	3					36.5	4	67.9	7
Coal	10.0	1	229.0	17					14,354.6	28	14,593.6	46
Diesel	6.1	1	33.3	3					51.5	12	90.9	16
Hydro			463.8	11			17.0	1	188.6	15	669.4	27
Methane			134.6	26					197.2	36	331.8	62
Natural Gas	7,920.4	36	11,621.7	57	154.4	9	7,064.8	22	82,687.3	208	109,448.6	332
Nuclear	94.0	5	2,581.8	15					1,681.0	8	4,356.8	28
Oil			9.4	3					1,307.0	9	1,316.4	12
Solar	192.3	7	6.8	3	21.4	4			504.7	85	725.2	99
Storage	0.0	4	0.1	6			0.0	2	0.1	13	0.2	25
Other	1.1	1	326.5	3					344.0	6	671.6	10
Wind	71.8	7	240.4	37	40.0	3	60.4	4	1,568.3	122	1,980.9	173
Wood					16.0	1					16.0	1
Total	**8,295.7**	**62**	**15,678.8**	**184**	**231.8**	**17**	**7,142.2**	**29**	**102,920.8**	**546**	**134,269.3**	**838**

Pennsylvania – Progression History Interconnection Requests (Requested Capacity Rights, 1999 - 2016)

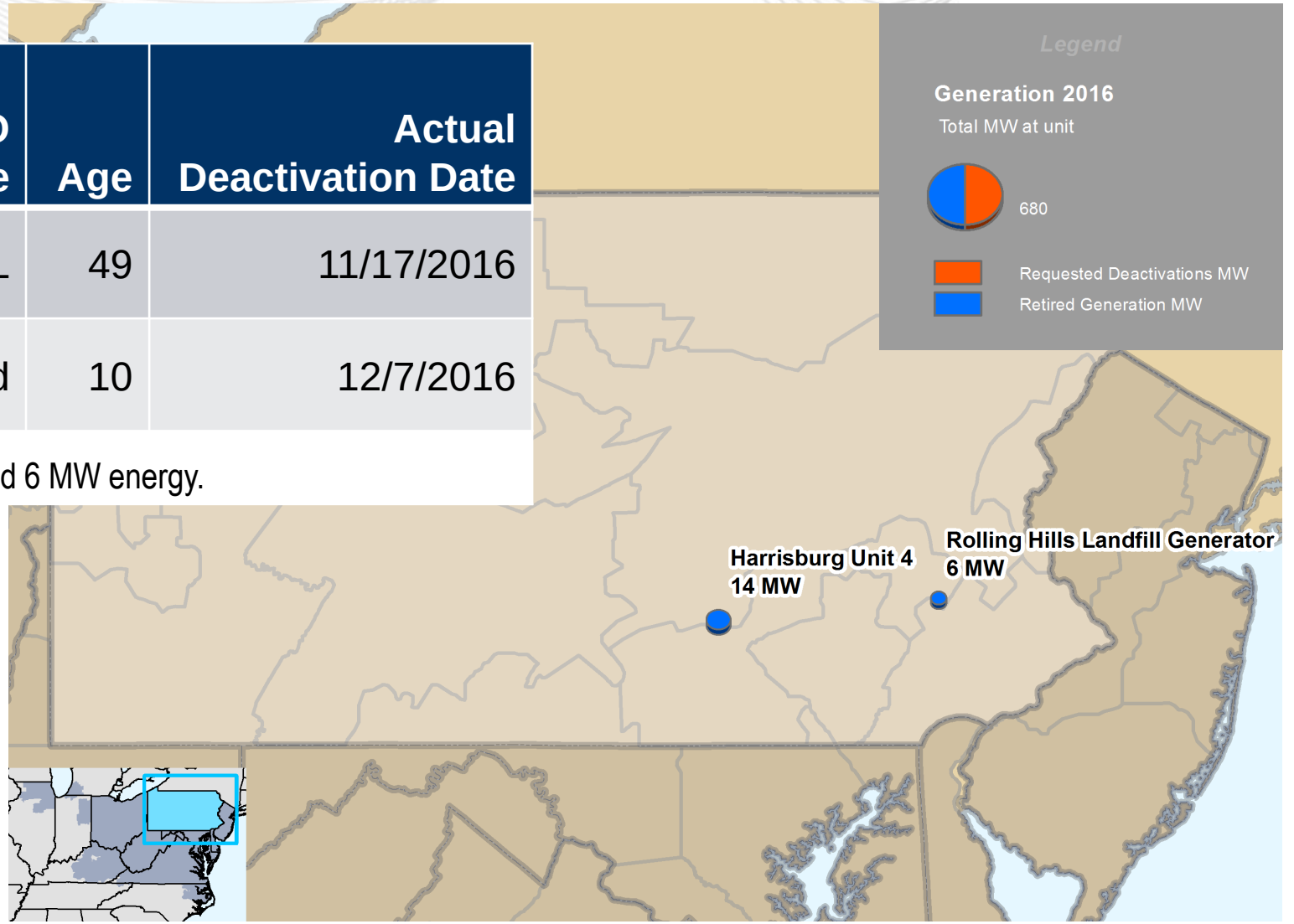
Following Final Agreement execution 3,481 MW of capacity with ISAs withdrew from PJM's interconnection process. Another 6,664 MW have executed agreements but were not in service as of December 31, 2016. Overall, 10% of requested capacity MW reaches commercial operation.

Pennsylvania – 2016 Actual Generation Deactivations

(Capacity, As of December 31, 2016)

Unit	MW Capacity	TO Zone	Age	Actual Deactivation Date
Harrisburg 4 CT	14	PPL	49	11/17/2016
Rolling Hills Landfill Generator*	0	MetEd	10	12/7/2016

*Note: Rolling Hills landfill generator was 0 MW capacity and 6 MW energy.



Summary:

- Two units in PA deactivated in 2016
- 11 generating units totaling 392 MW of capacity deactivated in PJM in 2016

Pennsylvania – 2016 Announced Generation Deactivations

(Capacity, As of December 31, 2016)

Summary:

- There were no additional generators that announced their intent to deactivate in 2016 or beyond.
- In 2016 there were a total of 23 PJM generating units that announced their intent to deactivate, ranging in date from 2016 - 2020.

Planning

Transmission Infrastructure Analysis

PA – RTEP Baseline Projects

PA – RTEP Baseline Projects

Map ID	Project ID	Project	PA Baseline Project Driver: Baseline Load Growth/ Deliverability & Reliability	PA Baseline Project Driver: Congestion Relief - Economic	PA Baseline Project Driver: Operational Performance	PA Baseline Project Driver: Generator Deactivation	PA Baseline Project Driver: TO Criteria Violation	Required Date	Cost ($M)	Designated Entity*	2016 TEAC Review
1	b2716	Add a 200 MVAR shunt reactor at Lackawanna 500 kV substation			•			12/1/2018	$10.00	PPL	12/3/2015
2	b2743.1	Tap the Conemaugh - Hunterstown 500 kV line & create new Rice 500 kV & 230 kV stations. Install two 500/230 kV transformers, operated together.		•				6/1/2020	$117.29	Transource	6/9/2016

Note: Baseline upgrades are those that resolve a system reliability criteria violation.

PA – RTEP Baseline Projects

Map ID	Project ID	Project	PA Baseline Project Driver: Baseline Load Growth/ Deliverability & Reliability	PA Baseline Project Driver: Congestion Relief - Economic	PA Baseline Project Driver: Operational Performance	PA Baseline Project Driver: Generator Deactivation	PA Baseline Project Driver: TO Criteria Violation	Required Date	Cost ($M)	Designated Entity*	2016 TEAC Review
2	b2743.2	Tie in new Rice substation to Conemaugh-Hunterstown 500 kV		•				6/1/2020		PENELEC	6/9/2016
	b2743.3	Upgrade terminal equipment at Conemaugh 500 kV: on the Conemaugh - Hunterstown 500 kV circuit		•				6/1/2020		PENELEC	6/9/2016

Note: Baseline upgrades are those that resolve a system reliability criteria violation.

PA – RTEP Baseline Projects

Map ID	Project ID	Project	PA Baseline Project Driver: Baseline Load Growth/ Deliverability & Reliability	PA Baseline Project Driver: Congestion Relief - Economic	PA Baseline Project Driver: Operational Performance	PA Baseline Project Driver: Generator Deactivation	PA Baseline Project Driver: TO Criteria Violation	Required Date	Cost ($M)	Designated Entity*	2016 TEAC Review
2	b2743.4	Upgrade terminal equipment at Hunterstown 500 kV: on the Conemaugh - Hunterstown 500 kV circuit		•				6/1/2020		ME	6/9/2016
	b2743.5	Build new 230 kV double circuit line between Rice and Ringgold 230 kV, operated as a single circuit.		•				6/1/2020		Transource	6/9/2016

Note: Baseline upgrades are those that resolve a system reliability criteria violation.

PA – RTEP Baseline Projects

Map ID	Project ID	Project	PA Baseline Project Driver: Baseline Load Growth/ Deliverability & Reliability	PA Baseline Project Driver: Congestion Relief - Economic	PA Baseline Project Driver: Operational Performance	PA Baseline Project Driver: Generator Deactivation	PA Baseline Project Driver: TO Criteria Violation	Required Date	Cost ($M)	Designated Entity*	2016 TEAC Review
3	b2752.1	Tap the Peach Bottom – TMI 500 kV line & create new Furnace Run 500 kV & 230 kV stations. Install two 500/230 kV transformers, operated together.		•				6/1/2020	$93.88	Transource	6/9/2016
	b2752.2	Tie in new Furnace Run substation to Peach Bottom-TMI 500 kV		•				6/1/2020		PECO	6/9/2016

Note: Baseline upgrades are those that resolve a system reliability criteria violation.

PA – RTEP Baseline Projects

Map ID	Project ID	Project	PA Baseline Project Driver: Baseline Load Growth/ Deliverability & Reliability	PA Baseline Project Driver: Congestion Relief - Economic	PA Baseline Project Driver: Operational Performance	PA Baseline Project Driver: Generator Deactivation	PA Baseline Project Driver: TO Criteria Violation	Required Date	Cost ($M)	Designated Entity*	2016 TEAC Review
3	b2752.3	Upgrade terminal equipment and required relay communication at Peach Bottom 500 kV: on the Peach Bottom - TMI 500 kV circuit		•				6/1/2020		PECO	6/9/2016
	b2752.4	Upgrade terminal equipment and required relay communication at TMI 500 kV: on the Peach Bottom - TMI 500 kV circuit		•				6/1/2020		ME	6/9/2016

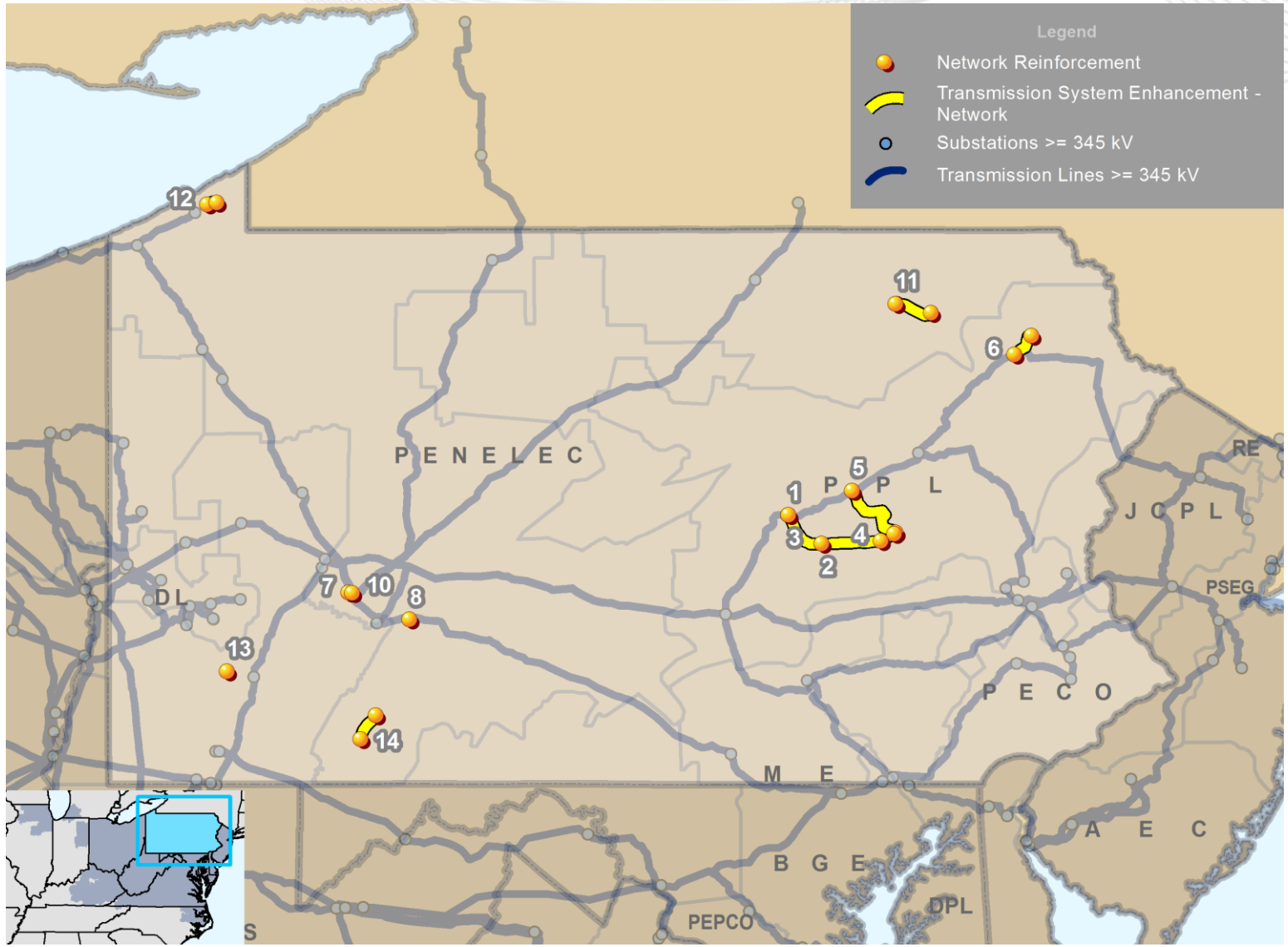
Note: Baseline upgrades are those that resolve a system reliability criteria violation.

PA – RTEP Baseline Projects

Map ID	Project ID	Project	PA Baseline Project Driver: Baseline Load Growth/ Deliverability & Reliability	PA Baseline Project Driver: Congestion Relief - Economic	PA Baseline Project Driver: Operational Performance	PA Baseline Project Driver: Generator Deactivation	PA Baseline Project Driver: TO Criteria Violation	Required Date	Cost ($M)	Designated Entity*	2016 TEAC Review
3	b2752.5	Build new 230 kV double circuit line between Furnace Run and Conastone 230 kV, operated as a single circuit.		•				6/1/2020		Transource	6/9/2016
4	b2756	Install 2% reactors at Martins Creek 230 kV	•					6/1/2018	$10.00	PPL	8/11/2016

Note: Baseline upgrades are those that resolve a system reliability criteria violation.

PA – RTEP Network Projects



PA - RTEP Network Projects

Map ID	Project ID	Project	PA Network Project Drivers: Generation Interconnection	PA Network Project Drivers: Merchant Transmission Interconnection	PA Network Project Drivers: Long-term Firm Transmission Service	Required Date	Cost ($M)	TO Zone(s)	2016 TEAC Review
1	n3907	Install a second 900MVA 500-230kV transformer and associated equipment.	Y2-015			7/4/2015	$25.00	PPL	10/6/2016
2	n3908	Rebuild the Eldred-Frackville 230kV line using double 1590 ACSR conductor (12 miles)	Y2-015			7/4/2015	$34.62	PPL	10/6/2016
3	n3911	Replace the substation conductors with 1590 ACSR. Replace two breakers, 4 switches and associated equipment with 3000amp rated equipment.	Y2-015			7/4/2015	$71.77	PPL	10/6/2016
4	n4356	Install new 500/230kV substation on of Y2-015	Y2-015			7/1/2017	$102.90	PPL	10/6/2016

Note: Network upgrades are new or upgraded facilities required primarily to eliminate reliability criteria violations caused by proposed generation, merchant transmission or long term firm transmission service requests.

PA – RTEP Network Projects

Map ID	Project ID	Project	PA Network Project Drivers: Generation Interconnection	PA Network Project Drivers: Merchant Transmission Interconnection	PA Network Project Drivers: Long-term Firm Transmission Service	Required Date	Cost ($M)	TO Zone(s)	2016 TEAC Review
5	n4358	Tie in W3-022 230kV switchyard to Catawissa/Frackville 230kV line	Y2-015			7/1/2017	$10.42	PPL	10/6/2016
6	n4393	Rebuild 4.5 miles of the conductor using 556 ACSR, remove 110 structures, install 55 new conductors, remove 24,000ft of (3) 336 MCM 30/7 ACSR.	Z2-107			12/31/2017	$13.50	PPL	10/6/2016
7	n4660	Adding a new 500/345 kV transformer and constructing a 500 kV yard in breaker and a half layout is required. The proposed 500 kV yard will tap into the existing Keystone – Conemaugh 500 kV line.	AA1-082			12/1/2015	$40.49	PENELEC	10/6/2016

Note: Network upgrades are new or upgraded facilities required primarily to eliminate reliability criteria violations caused by proposed generation, merchant transmission or long term firm transmission service requests.

PA – RTEP Network Projects

Map ID	Project ID	Project	PA Network Project Drivers: Generation Interconnection	PA Network Project Drivers: Merchant Transmission Interconnection	PA Network Project Drivers: Long-term Firm Transmission Service	Required Date	Cost ($M)	TO Zone(s)	2016 TEAC Review
7	n4660.1	Replace Keystone 500 kV breaker NO.14 CABOT from 40 kA to 63 kA breaker	AA1-144			12/29/2017		APS	10/6/2016
	n4660.2	Replace Keystone 500 kV breaker NO.16 CABOT from 40 kA to 63 kA breaker	AA1-144			12/29/2017		APS	10/6/2016
	n4660.3	Replace Keystone 500 kV breaker #1 from 40 kA to 63 kA breaker	AA1-144			12/29/2017		APS	10/6/2016
	n4660.4	Replace Keystone 500 kV breaker Juniata from 40 kA to 63 kA breaker	AA1-144			12/29/2017		APS	10/6/2016
	n4660.5	Replace Keystone 500 kV breaker NO.3 TRANSFO from 40 kA to 63 kA breaker	AA1-144			12/29/2017		APS	10/6/2016

Note: Network upgrades are new or upgraded facilities required primarily to eliminate reliability criteria violations caused by proposed generation, merchant transmission or long term firm transmission service requests.

PA – RTEP Network Projects

Map ID	Project ID	Project	PA Network Project Drivers: Generation Interconnection	PA Network Project Drivers: Merchant Transmission Interconnection	PA Network Project Drivers: Long-term Firm Transmission Service	Required Date	Cost ($M)	TO Zone(s)	2016 TEAC Review
8	n4682	Construct new 500kV 3 breaker ring bus substation to connect the AA1-076 project.	AA1-076			3/1/2021	$15.24	PENELEC	10/6/2016
9	n4924	Rebuilding the line with 1590 ACSS	AA1-111			12/31/2019	$30.48	PENELEC	10/6/2016
10	n4926	Reconductoring line with 1033 ACSS conductor and replacing the line drops at the Moshannon 230 kV substation	AA1-111			12/31/2019	$30.77	PENELEC	10/6/2016
11	n4927	Rebuilding the line with 1590 ACSS, replacing the disconnect switch at the Canyon 230 kV substation, and replacing the wave trap at the N. Meshhoppen 230 kV	AA1-111			12/31/2019	$21.15	PENELEC	10/6/2016

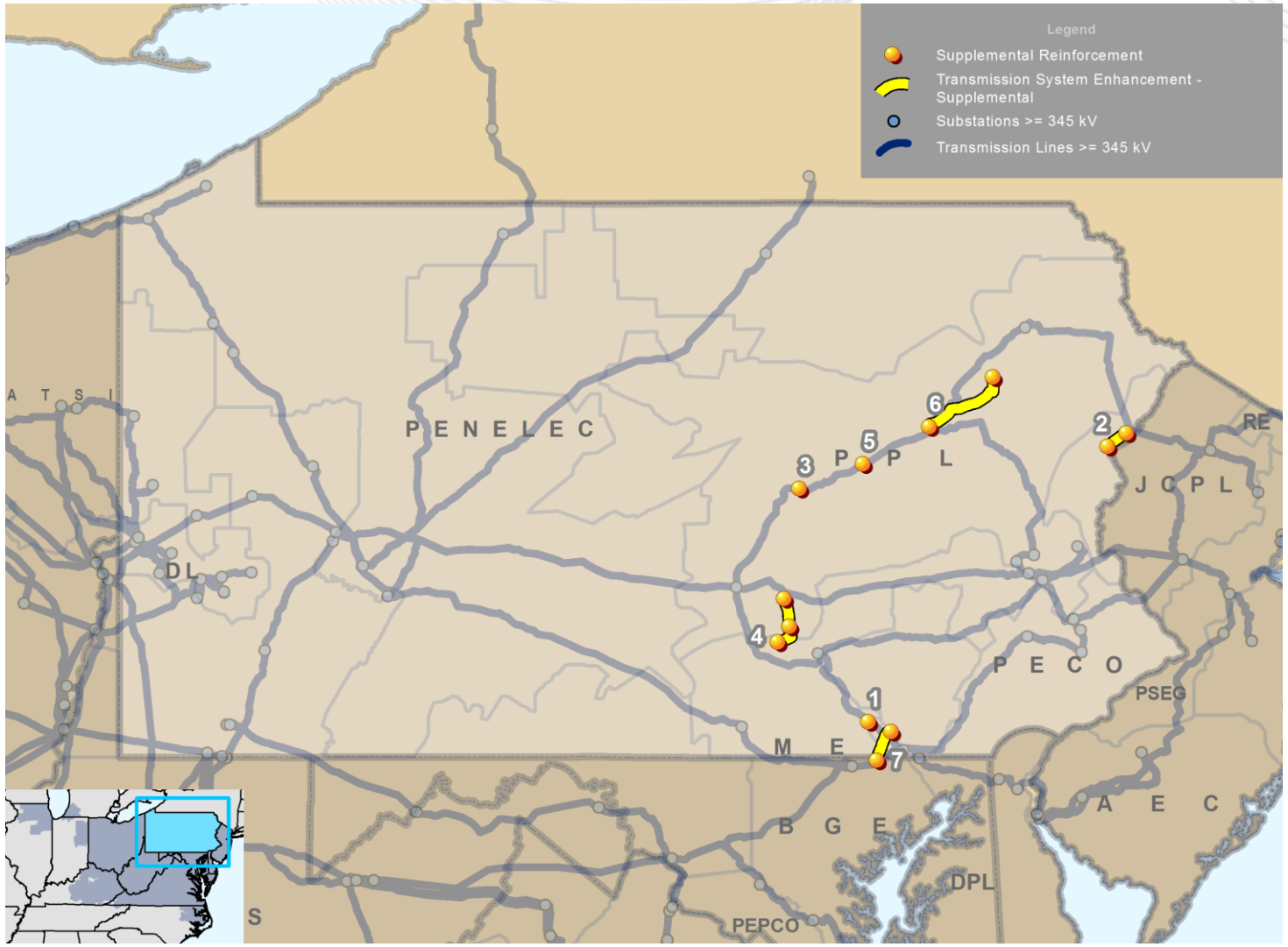
Note: Network upgrades are new or upgraded facilities required primarily to eliminate reliability criteria violations caused by proposed generation, merchant transmission or long term firm transmission service requests.

PA – RTEP Network Projects

Map ID	Project ID	Project	PA Network Project Drivers: Generation Interconnection	PA Network Project Drivers: Merchant Transmission Interconnection	PA Network Project Drivers: Long-term Firm Transmission Service	Required Date	Cost ($M)	TO Zone(s)	2016 TEAC Review
12	n4931	Reconductoring 230 kV line from Four Mile Junction to the W3-099 Tap point with 1033 ACSS high temperature conductor, and replacing the line drops at the Four Mile Junction substation	AA1-111			12/31/2019	$10.46	PENELEC	10/6/2016
13	n5027	Buena Vista SS – Construct 6-breaker ring bus substation	AA2-161			6/1/2020	$7.10	APS	10/6/2016
14	n4656	Reconductor the Rockwood – Somerset 115 kV line and upgrade terminal equipment at Rockwood and Somerset.	AA1-062			9/25/2017	$10.89	APS	10/6/2016

Note: Network upgrades are new or upgraded facilities required primarily to eliminate reliability criteria violations caused by proposed generation, merchant transmission or long term firm transmission service requests.

PA – Supplemental Projects



PA – TO Supplemental Projects

			PA Supplemental Project Driver			
Map ID	Project ID	Project	Required Date	Cost ($M)	TO Zone(s)	2016 TEAC Review
1	s1097	Upgrade the Otter Creek 230kV Yard to three bays breaker and a half arrangement, and replace relays.	12/31/2026	$10.70	PPL	1/7/2016
2	s1100	Rebuild the existing Foxhill-Shawnee 230 kV line (Approximately 8.25 Miles).	12/31/2020	$24.80	PPL	1/7/2016
3	s1102	Construct a new 230 kV GIS yard at Sunbury Substation.	4/30/2018	$25.00	PPL	1/7/2016
4	s1105.1	Build new 230 kV Line from Dauphin to New Harrisburg kV Substation.	5/31/2026	$88.00	PPL	1/7/2016
4	s1105.2	Build new UG 230 kV Line from West Shore to New Harrisburg Substation.	5/31/2026		PPL	1/7/2016
5	s1106	Build new 500-230 kV Substation and associated transmission work (tap Sunbury - Susquehanna 500 kV and Colombia - Frackville 230 kV).	12/31/2020	$95.00	PPL	1/7/2016

Note: Supplemental projects are transmission expansions or enhancements that are used as inputs to RTEP models, but are not required for reliability, economic efficiency or operational performance criteria, as determined by PJM.

PA – TO Supplemental Projects

			PA Supplemental Project Driver			
Map ID	Project ID	Project	Required Date	Cost ($M)	TO Zone(s)	2016 TEAC Review
6	s1143	Add second circuit to approximately 23.7 miles of the Susquehanna-Jenkins 230 kV line using 1590 ACSR conductor	5/31/2018	$12.50	PPL	6/9/2016
7	s1154	Reconductor the PPL portion (8.5 miles) of the Face Rock - Five Forks 115 kV tie-line as a 3-conductor line with a modern high capacity conductor. Evaluate all lattice steel towers for condition and determine structure member repair and remediation	12/31/2019	$10.80	PPL	7/26/2016

Note: Supplemental projects are transmission expansions or enhancements that are used as inputs to RTEP models, but are not required for reliability, economic efficiency or operational performance criteria, as determined by PJM.

PA - Merchant Transmission Project Requests

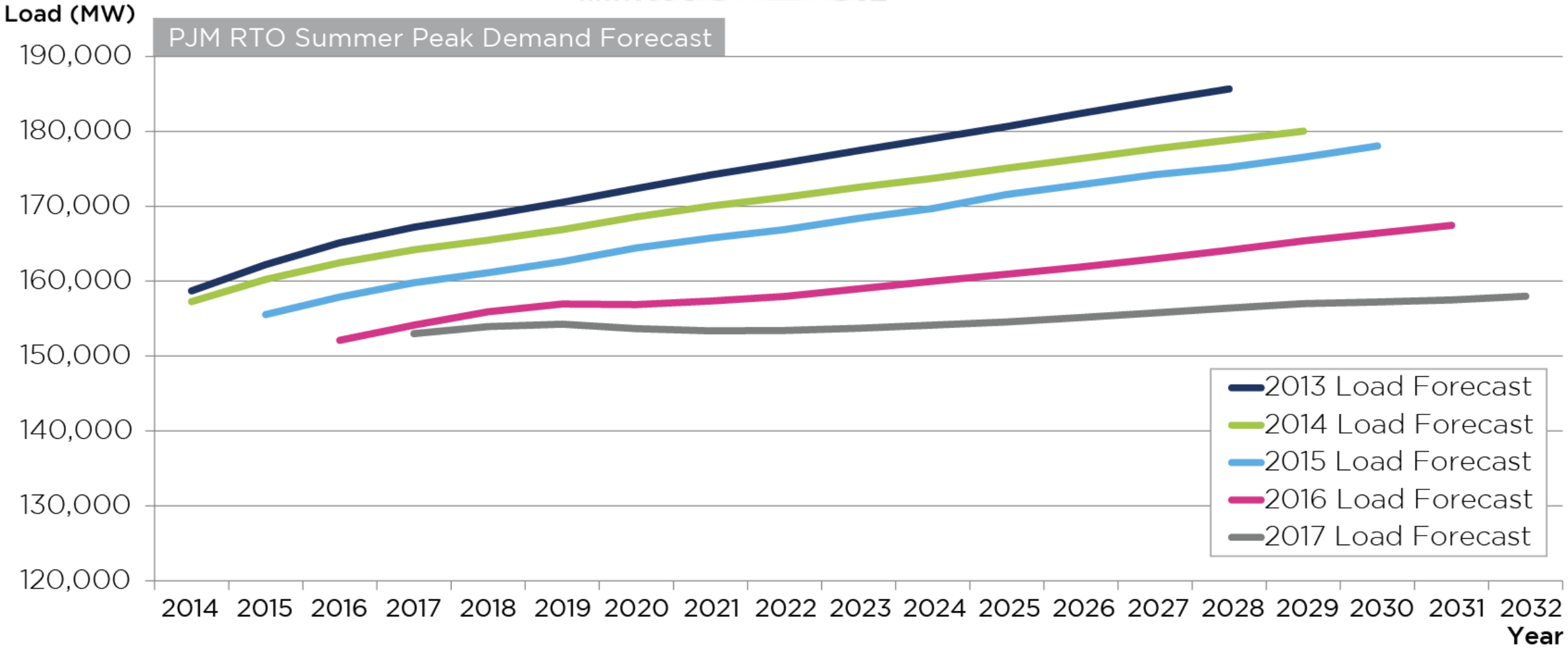
Queue	Project Name	MFO	Status	In Service Date	TO
Y3-092	Erie West 345kV	1,000	Active	01/01/17	PENELEC
AB1-019	Cochranville	100	Active	06/01/18	PECO
AB2-019	Erie West 345kV	28	Active	12/01/19	PENELEC

Planning

Load Forecast

PJM Annual Load Forecasts

(January 9, 2017)



PA – 2017 Load Forecast Report

	Summer Peak (MW)			Winter Peak (MW)		
Transmission Owner	2017	2027	Growth Rate (%)	2016/17	2026/27	Growth Rate (%)
Allegheny Power *	3,996	4,094	0.3%	3,691	3,875	0.5%
American Transmission Systems, Inc. *	896	909	0.1%	849	865	0.2%
Duquesne Light Company	2,884	2,882	0.0%	2,171	2,179	0.0%
Metropolitan Edison Company	2,940	3,028	0.3%	2,615	2,670	0.2%
PECO Energy Company	8,547	8,693	0.2%	6,694	6,741	0.1%
Pennsylvania Electric Company	2,891	2,847	-0.2%	2,821	2,807	0.0%
PPL Electric Utilities Corporation	7,132	7,186	0.1%	7,177	7,218	0.1%
UGI	191	185	-0.3%	195	188	-0.4%
PJM RTO	152,999	155,773	0.2%	131,391	134,915	0.3%

*Allegheny Power and ATSI serve load other than in Pennsylvania. The Summer peak and Winter Peak MW values in this table each reflect the estimated amount of forecasted load to be served by each of those transmission owners solely in Pennsylvania. Estimated amounts were calculated based on the average share of each transmission owner's real-time summer and winter peak load located in Pennsylvania over the past five years.

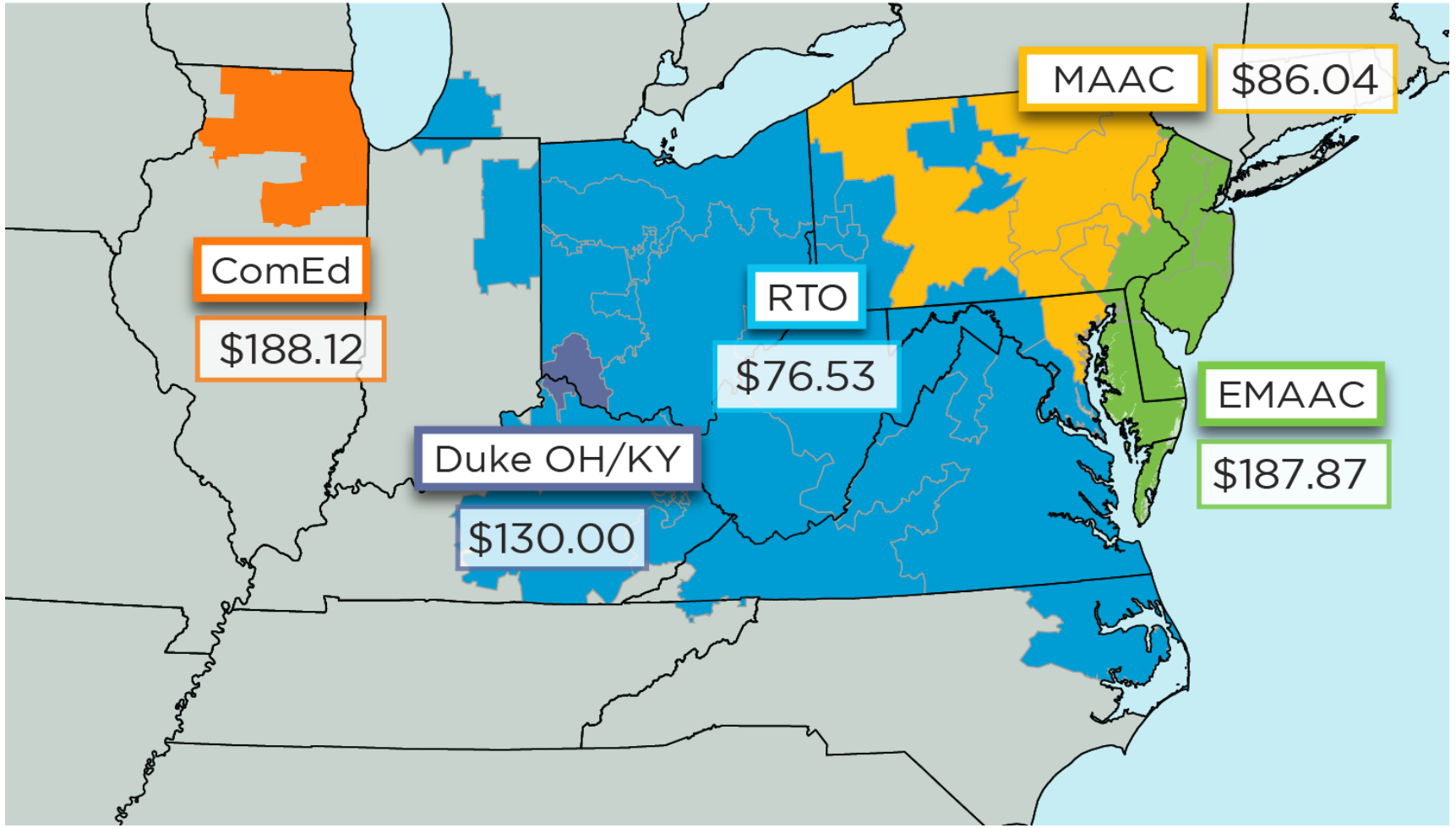
*PJM's 2017 forecast reflects methodology improvements implemented in 2016: variables to account for equipment and appliance saturation and efficiency, distributed solar generation adjustments and more refined treatment of weather data.

Markets

Capacity Market Results

PJM 2020/21 Auction Clearing Prices

(May 23, 2017)



Pennsylvania - Cleared Resources in 2020/21 Auction

(May 23, 2017)

	Cleared MW (Unforced Capacity)	Change from 2019/20 Auction
Generation	42,388	3,951
Demand Response	2,251	(341)
Energy Efficiency	234	80
Total	44,8723	3,690

RTO Clearing Prices	EMAAC Clearing Prices	MAAC Clearing Prices
$76.53	$187.87	$86.04

NOTE: Demand Response and Energy Efficiency are reported to PJM by Transmission Zone. The numbers above reflect the state's pro-rata share of cross-state zones for illustrative purposes.

PJM - Cleared Resources in 2020/21 Auction

(May 23, 2017)

	Cleared MW (Unforced Capacity)	Change from 2019/20 Auction
Generation	155,976	882
Demand Response	7,820	(2,528)
Energy Efficiency	1,710	195
Total	165,506	(1,450)

Pennsylvania – Offered and Cleared Resources in 2020/21 Auction

(May 23, 2017)

		Unforced Capacity
Generation	Offered MW	46,914
	Cleared MW	42,388
Demand Response	Offered MW	2,365
	Cleared MW	2,251
Energy Efficiency	Offered MW	259
	Cleared MW	234
Total Offered MW		49,538
Total Cleared MW		44,873

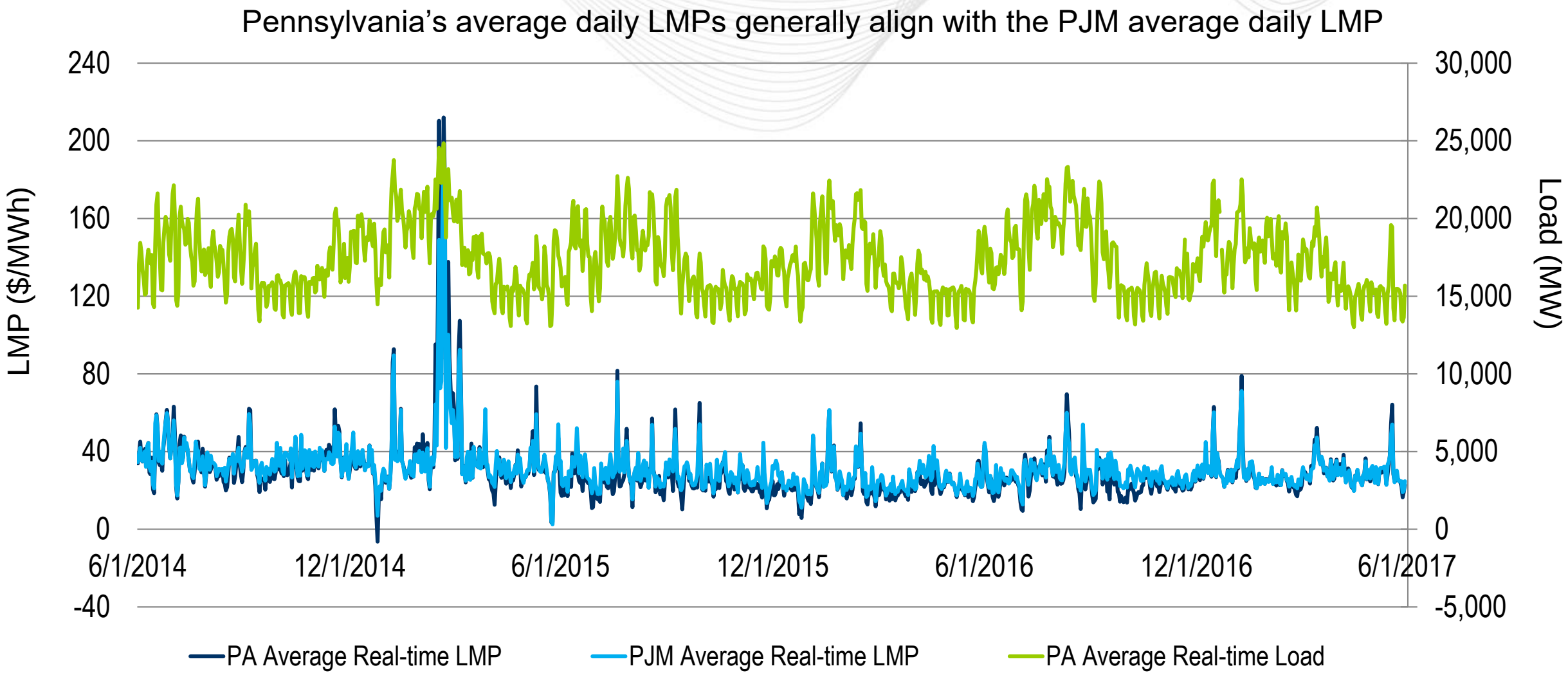
NOTE: Demand Response and Energy Efficiency are reported to PJM by Transmission Zone. The numbers above reflect the state's pro-rata share of cross-state zones for illustrative purposes.

Markets

Market Analysis

Pennsylvania - Average Daily Load and LMP

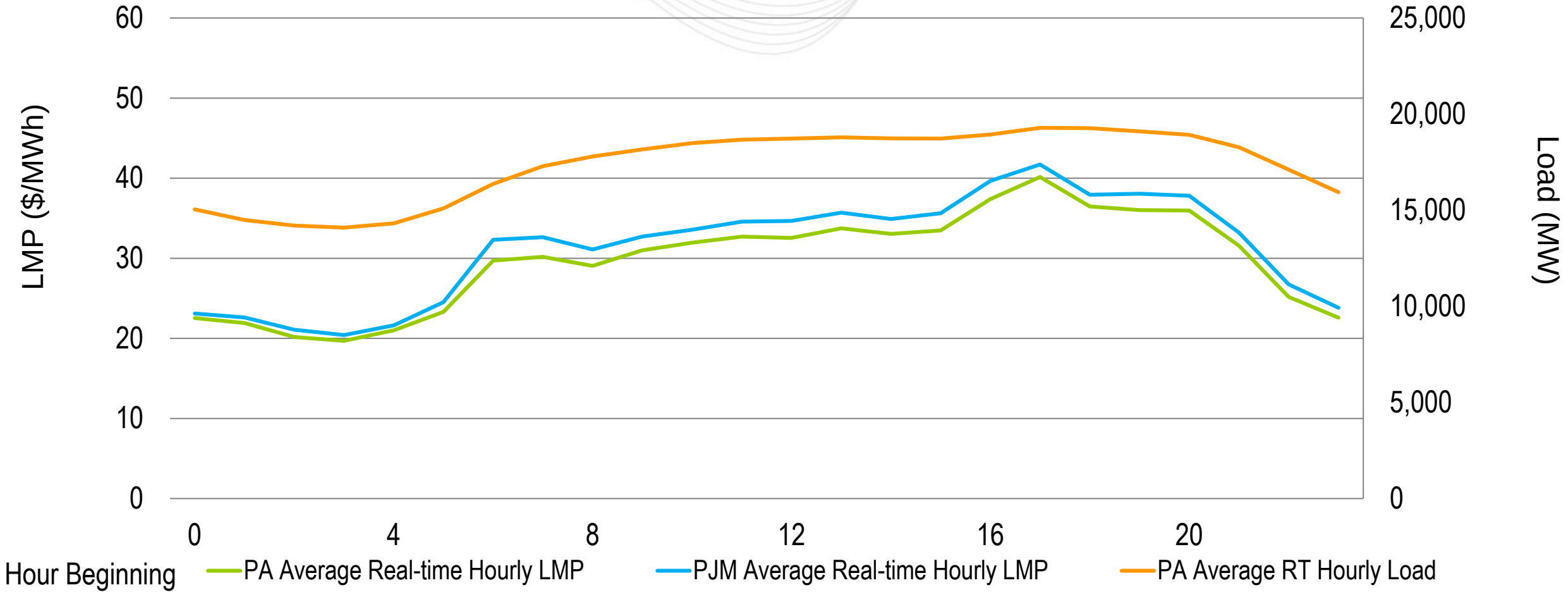
(June 1, 2014 - May 31, 2017)



Pennsylvania – Hourly Average LMP and Load

(June 1, 2014 – May 31, 2017)

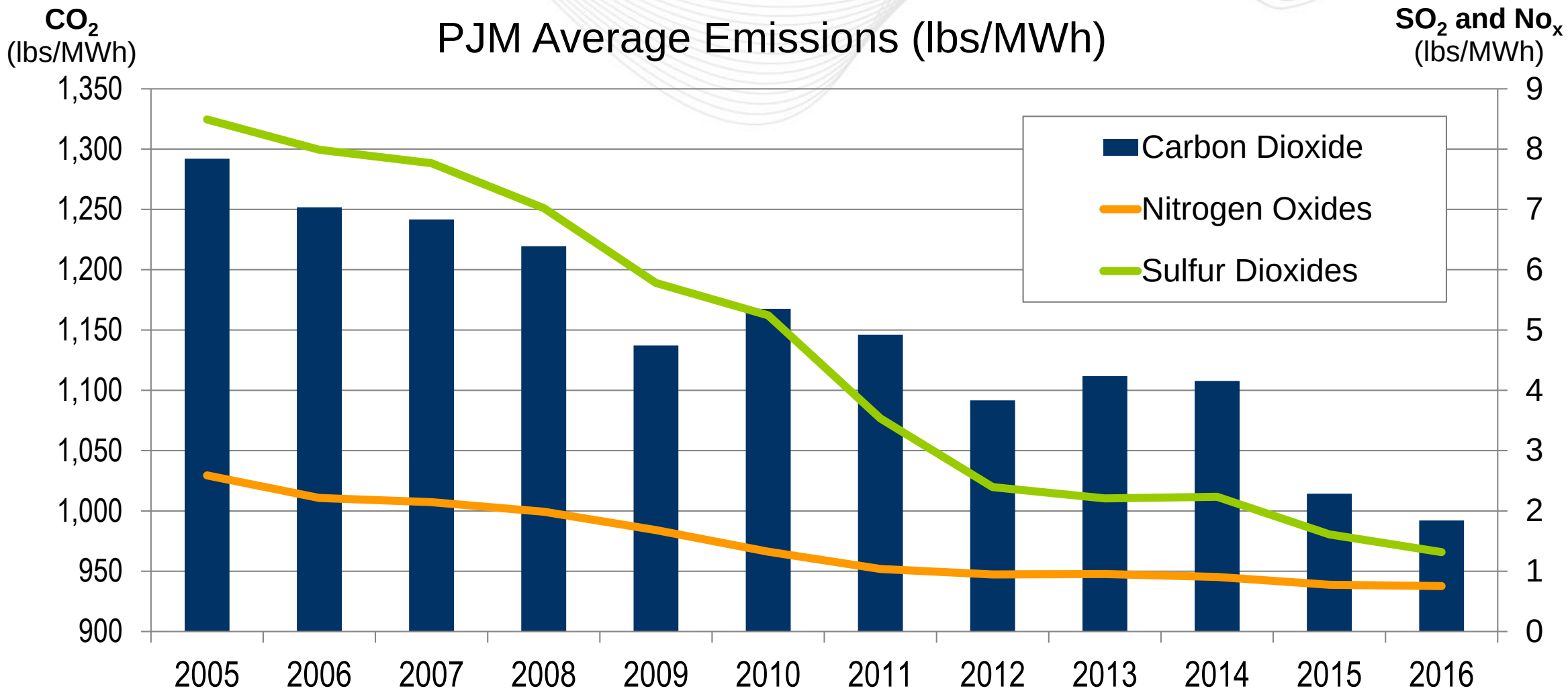
Pennsylvania's hourly LMPs were below the PJM average.



Operations
Emissions Data

PJM - Average Emissions (lbs/MWh)

(December 31, 2016)



Pennsylvania - Average Emissions (lbs/MWh)

(December 31, 2016)