



2017 West Virginia State Infrastructure Report

(January 1, 2017 – December 31, 2017)

May 2018

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- Generation Portfolio Analysis
- Transmission Analysis
- Load Forecast

2. Markets

- Capacity Market Results
- Market Analysis

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- Emissions Data

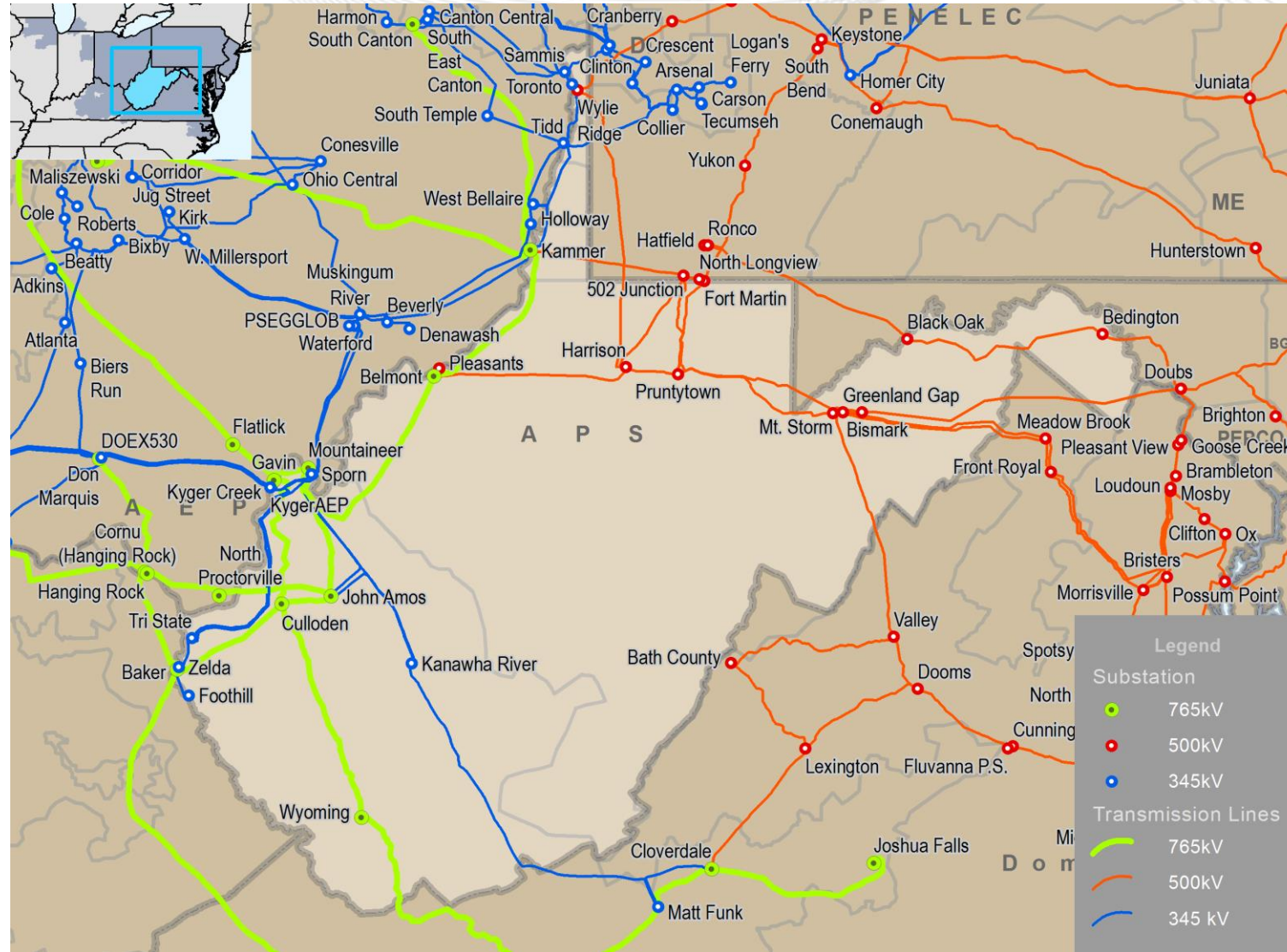
- **Existing Capacity:** Natural gas represents approximately 7.6 percent of the total installed capacity in West Virginia while coal represents approximately 89.8 percent. This differs from PJM where natural gas and coal are at 37 and 32 percent of total installed capacity.
- **Interconnection Requests:** Natural gas represents approximately 90 percent of new interconnection requests in West Virginia.
- **Deactivations:** West Virginia did not have any generation deactivations in 2017.
- **RTEP 2017:** West Virginia RTEP 2017 projects total nearly \$215 million in investment. Approximately 70.5 percent of that represents supplemental projects.
- **Load Forecast:** West Virginia load growth is nearly flat, averaging between .5 and .8 percent per year over the next 10 years. This aligns with PJM RTO load growth projections.

- **2020/21 Capacity Market:** West Virginia cleared 178 MW more Demand Response and Energy Efficient resources than in the prior auction.
- **6/1/15 – 12/31/17 Performance:** West Virginia's average locational marginal prices were consistent with PJM average LMPs. Coal resources represented 94.7 percent of generation produced in West Virginia while natural gas averaged 1.9 percent. West Virginia exports 51.9 percent of the energy produced in the state.
- **Emissions:** 2017 carbon dioxide emissions are slightly up from 2016; sulfur dioxides and nitrogen oxides continue to hold flat from 2015.



PJM Service Area – West Virginia

(December 31, 2017)



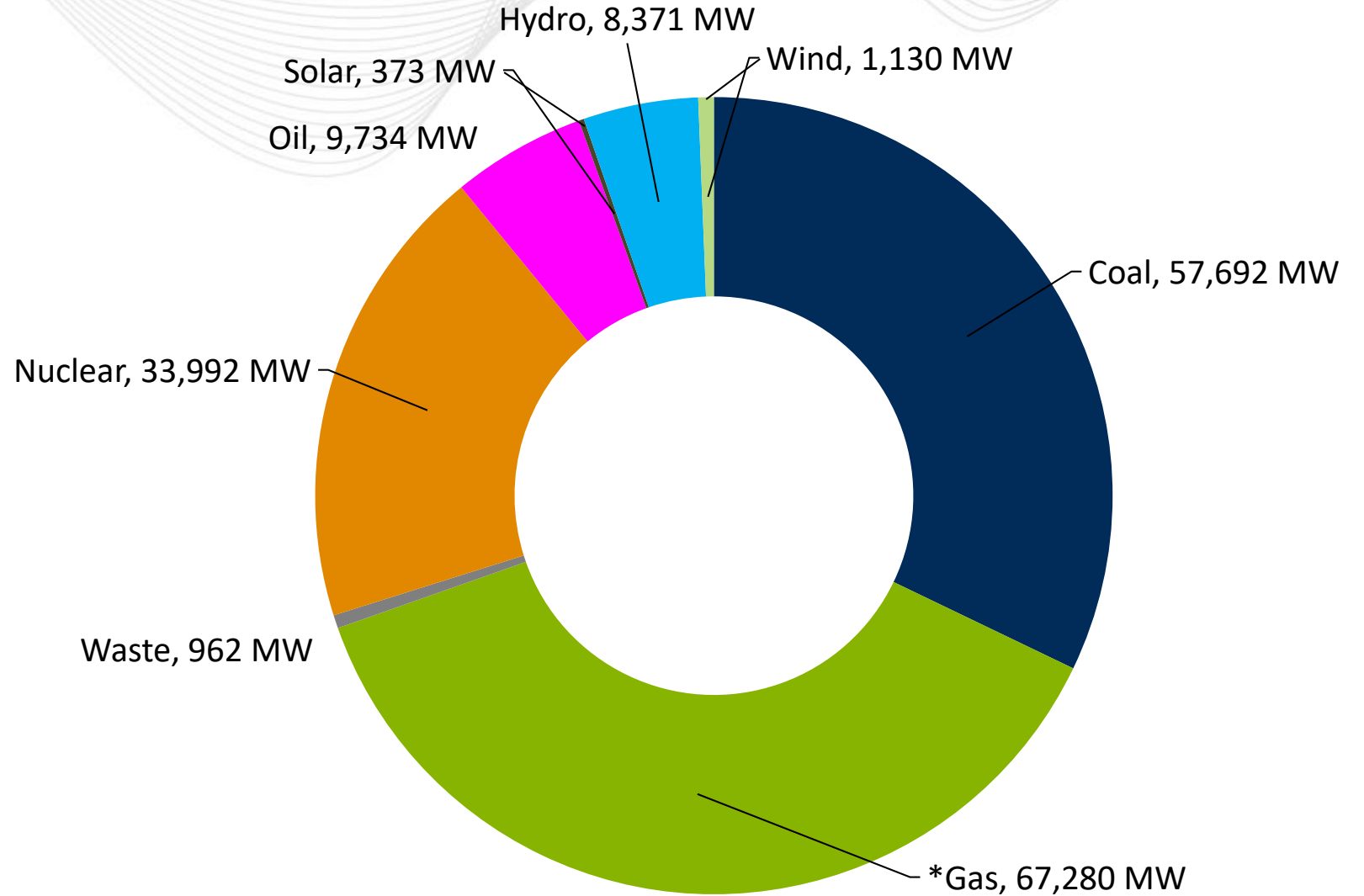
Planning

Generation Portfolio Analysis

PJM – Existing Installed Capacity

(MW submitted to PJM, December 31, 2017)

In PJM, natural gas and coal make up nearly 70 percent total installed capacity. Nuclear represents another 18.9 percent.

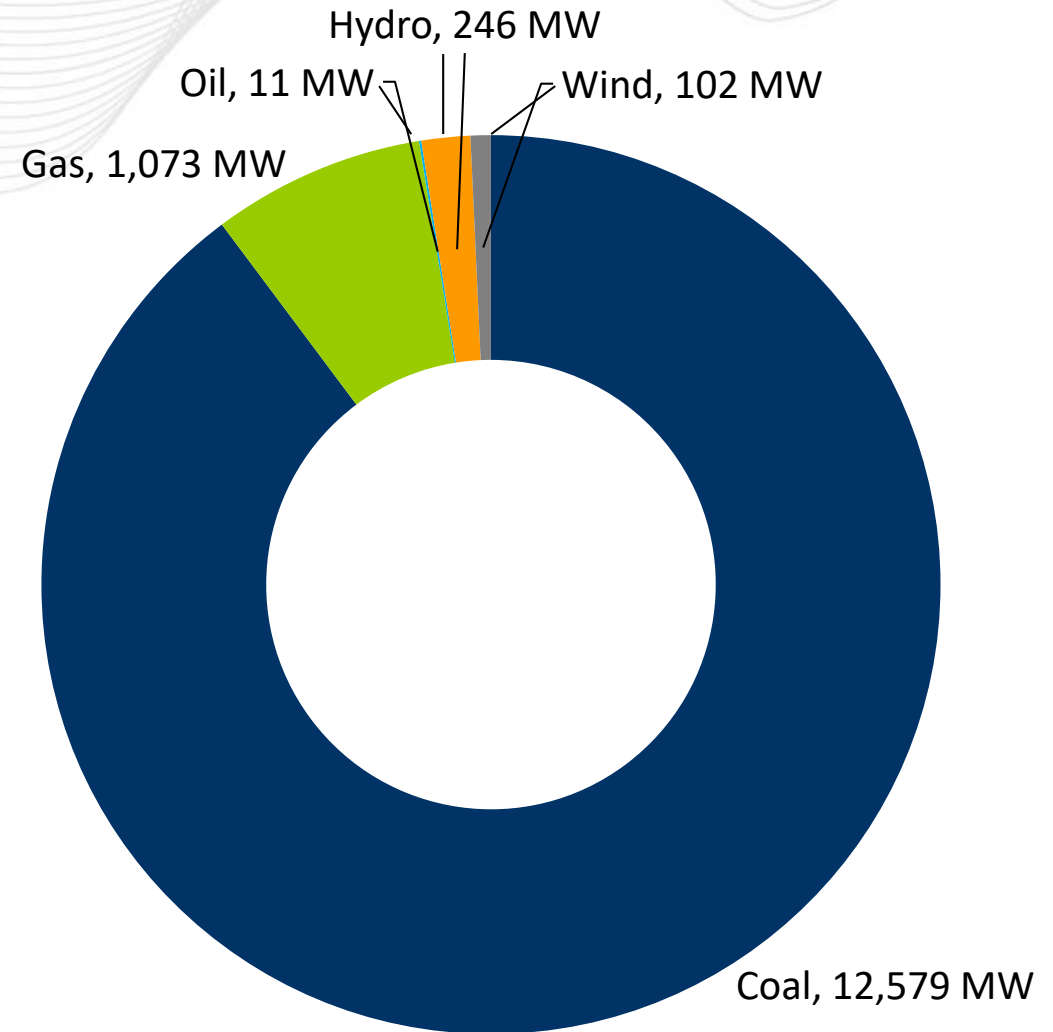


* Gas Contains	
Natural Gas	66,836.3 MW
Other Gas	443.8 MW

Summary:

Natural gas represents approximately 7.6 percent of the total installed capacity in the West Virginia territory while coal represents approximately 89.8 percent.

Overall in PJM, natural gas represents approximately 37 percent of installed capacity while coal represents 32 percent.



* Gas Contains

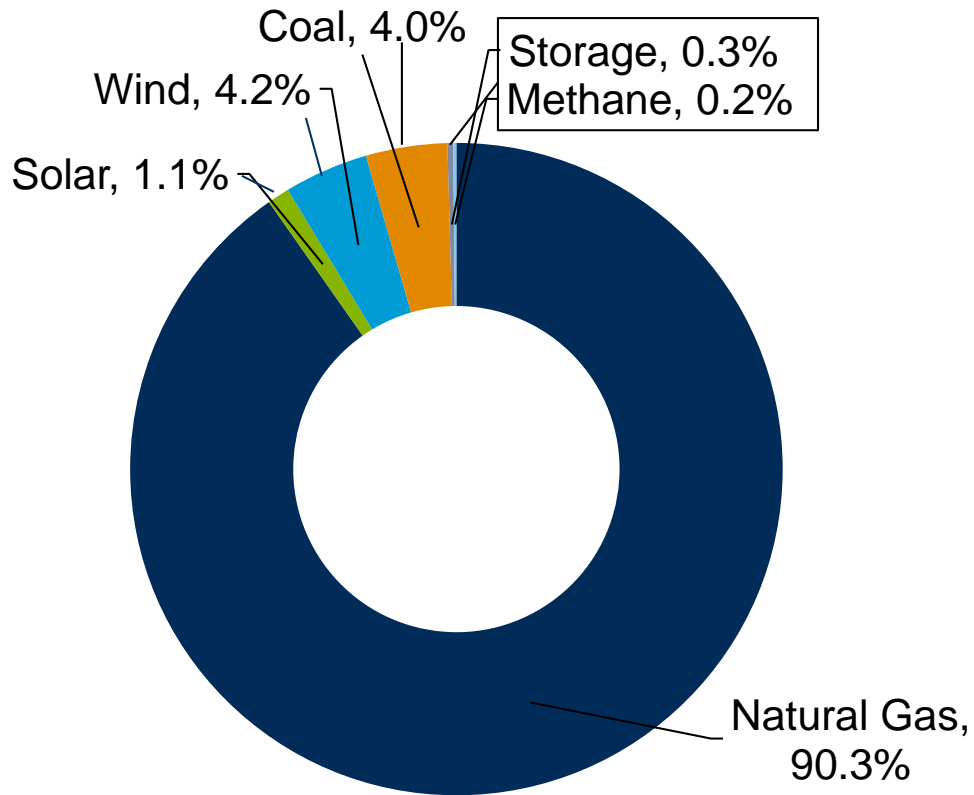
Natural Gas	1,071.3 MW
Other Gas	1.2 MW

West Virginia – Interconnection Requests

(Requested Capacity Rights, December 31, 2017)

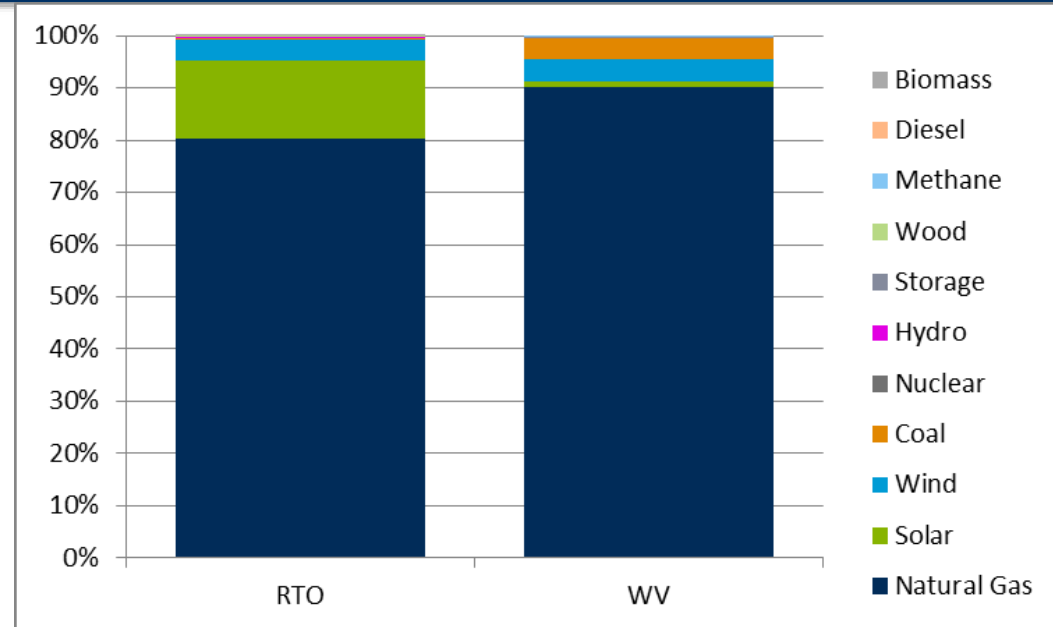
Natural gas represents approximately 90 percent of new interconnection requests in West Virginia.

Total MW Capacity by Fuel Type



Fuel Source	Capacity, MW	Nameplate Capability, MW
Natural Gas	1,835.6	1,823.0
Wind	84.7	562.6
Coal	82.0	82.0
Solar	22.4	54.9
Storage	5.8	68.3
Methane	3.2	3.2
Total	2,033.7	2,594.0

Fuel as a Percentage of Projects in Queue





West Virginia – Interconnection Requests

(As of December 31, 2017)

	Complete				In Queue						Grand Total	
	In Service		Withdrawn*		Active		Suspended**		Under Construction**			
	MW	# of Projects	MW	# of Projects	MW	# of Projects	MW	# of Projects	MW	# of Projects	MW	# of Projects
Non-Renewable	1,189	14	14,656	44	1,119	8	750	3	54	3	17,768	72
Coal	815	8	2,023	7	46	2			36	1	2,920	18
Natural Gas	374	4	12,567	35	1,068	5	750	2	18	1	14,777	47
Other			66	2							66	2
Storage	-	2			6	1	-	1	-	1	6	5
Renewable	326	14	681	42	46	5			64	4	1,117	65
Biomass			48	2							48	2
Hydro	154	5	209	11							363	16
Methane	2	2	14	3					3	1	19	6
Solar			18	1	22	3					40	4
Wind	170	7	393	25	24	2			61	3	647	37
Grand Total	1,515	28	15,337	86	1,165	13	750	3	118	7	18,885	137

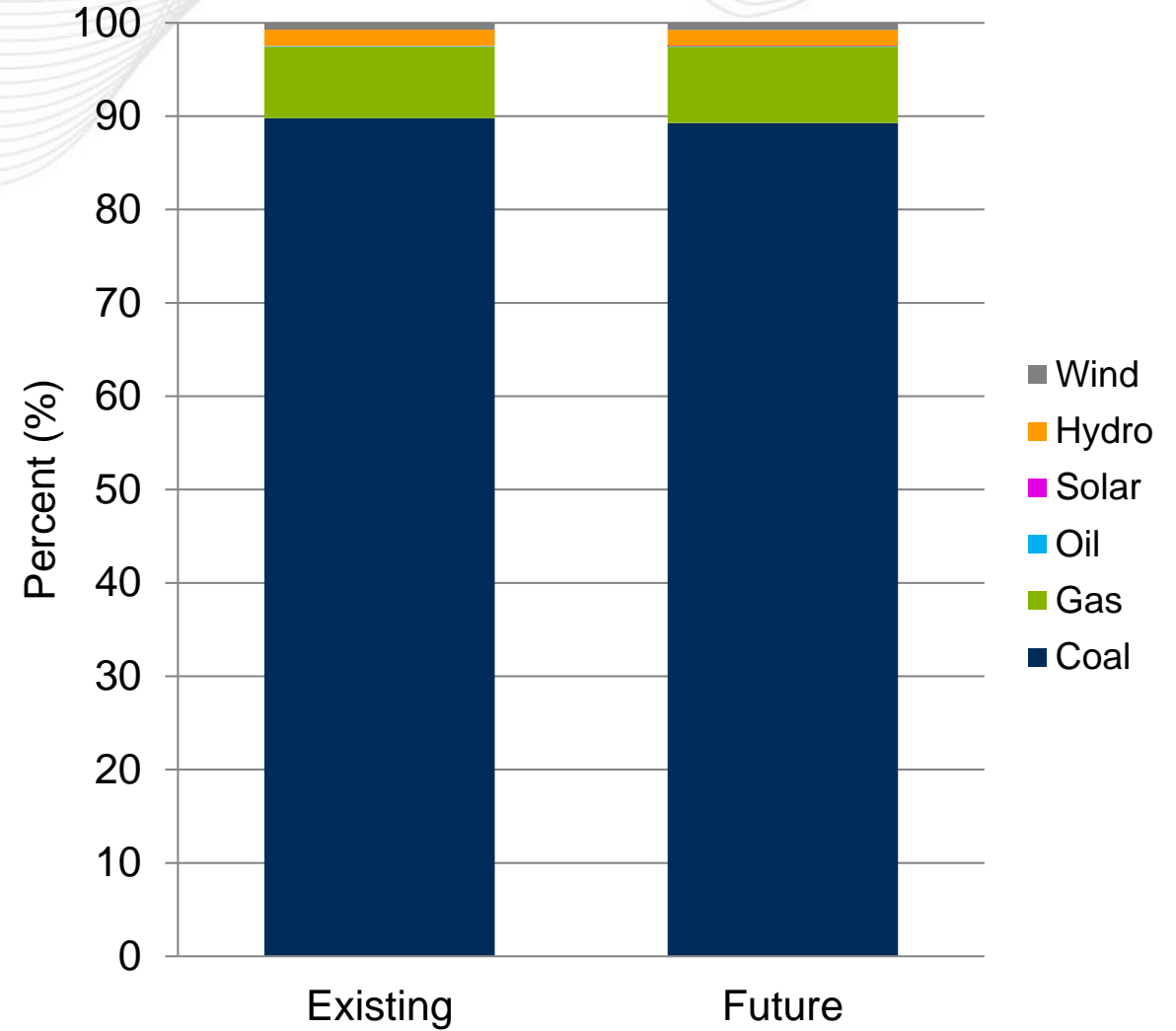
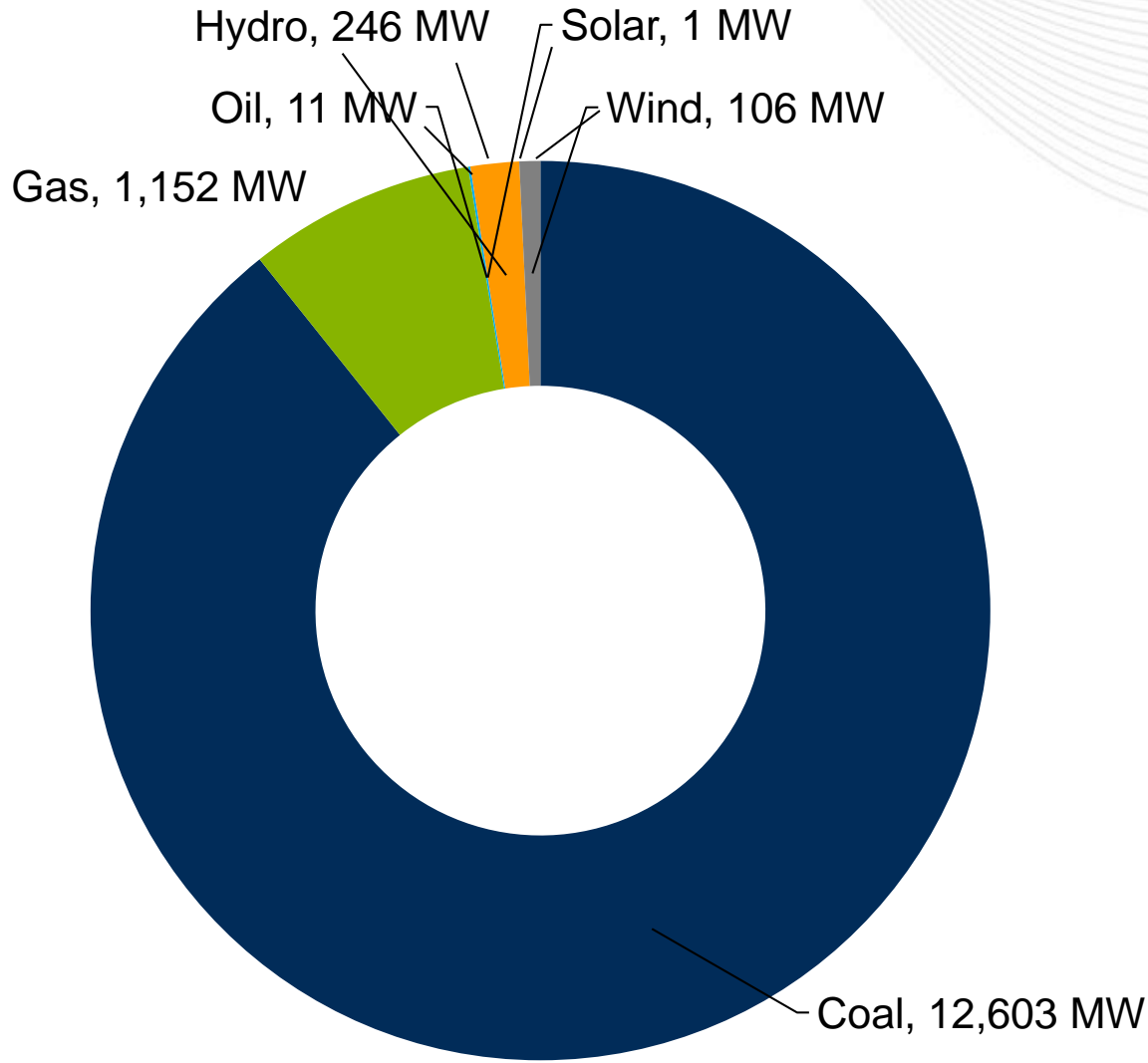
*May have executed final agreement

** Executed final agreement (ISA / WMPA)



West Virginia – Future Capacity Mix

Based on known queued interconnection requests and deactivation notices through December 31, 2022, adjusted to reflect the probability of commercialization as indicated by historical trends specific to an interconnection request's state/zonal location and fuel type.





West Virginia – Progression History Interconnection Requests

Projects under construction, suspended, in service, or withdrawn – As of December 31, 2017

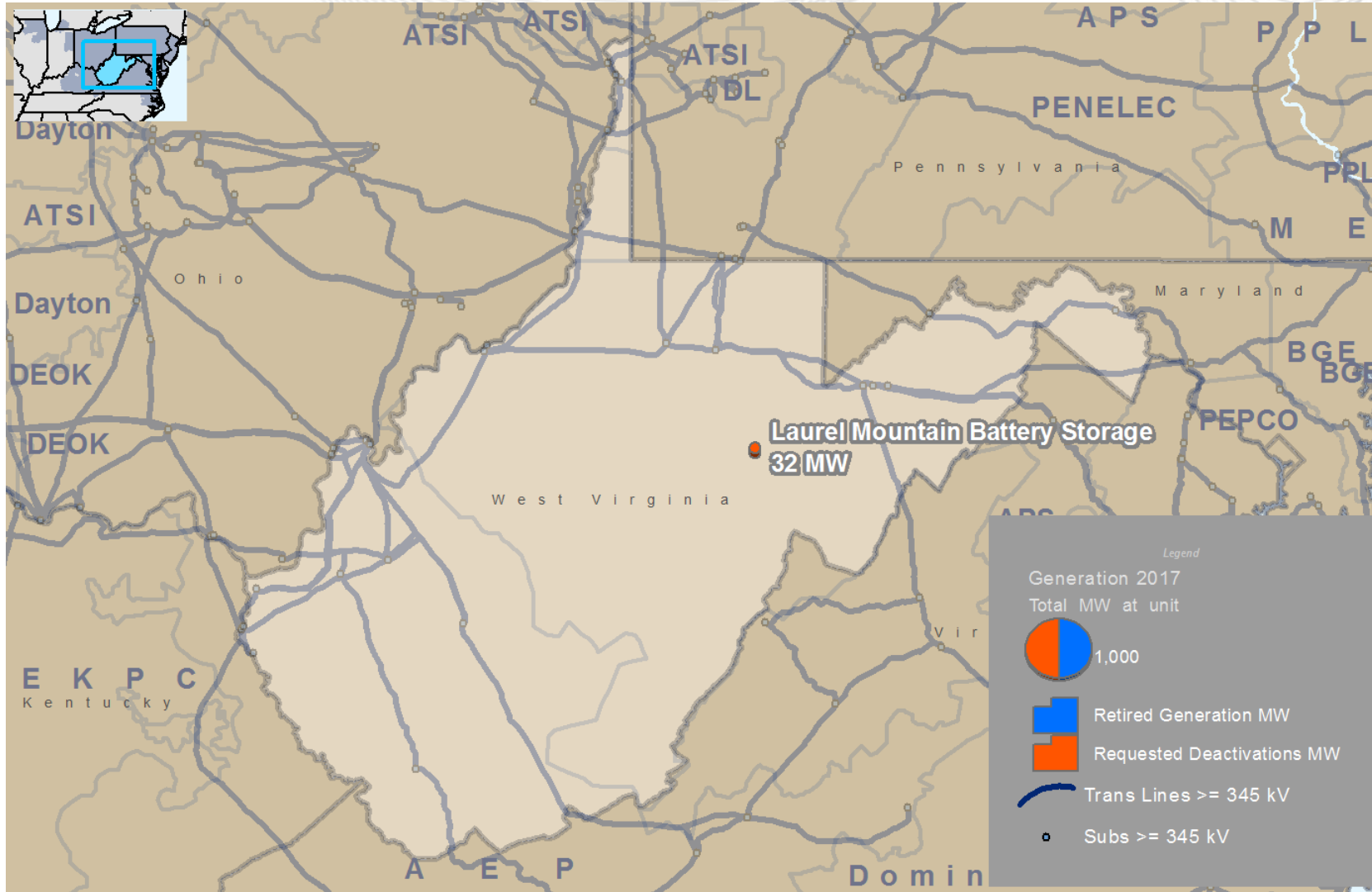


Projects that withdrew after a final agreement

	Number of Projects	Capacity, MW	Nameplate Capability, MW
ISA	7.0	647.0	939.0
WMPA	1.0	6.0	6.0

8.9% of requested capacity megawatt and 24.2% of projects reaches commercial operation

West Virginia – Deactivation Notifications Received in 2017





West Virginia – Deactivation Notifications Received in 2017

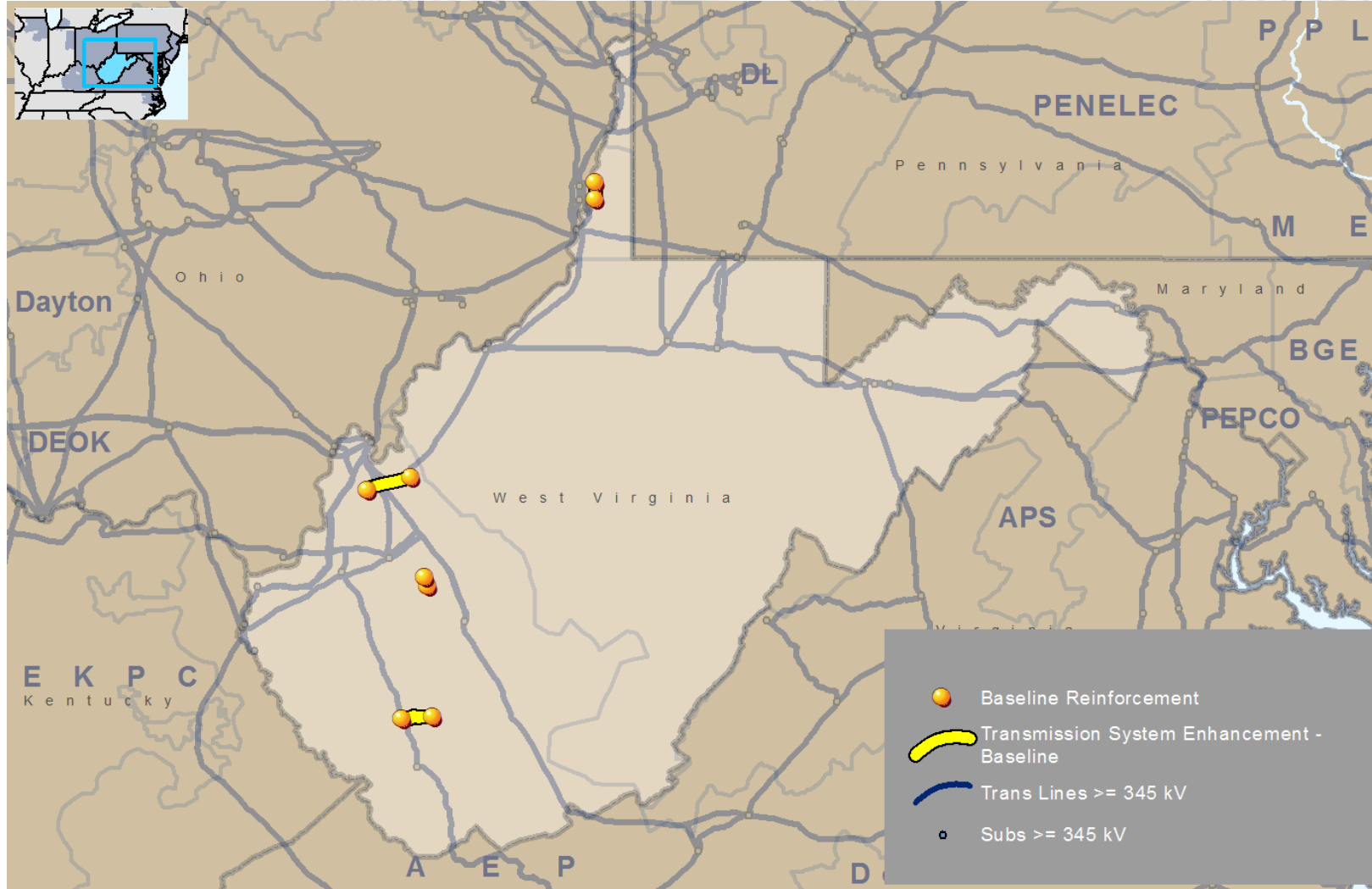
Unit	MW Capacity	TO Zone	Age	Actual Deactivation Date
Laurel Mountain Battery Storage	0	APS	6	6/6/2018

Summary:

- In 2017, one generating unit in West Virginia announced its intention to deactivate
- In 2017, a total of 12 PJM generating units announced their intent to deactivate, ranging in dates from 2018 - 2020.
- West Virginia did not have any actual generation deactivations in 2017.

Planning

Transmission Infrastructure Analysis



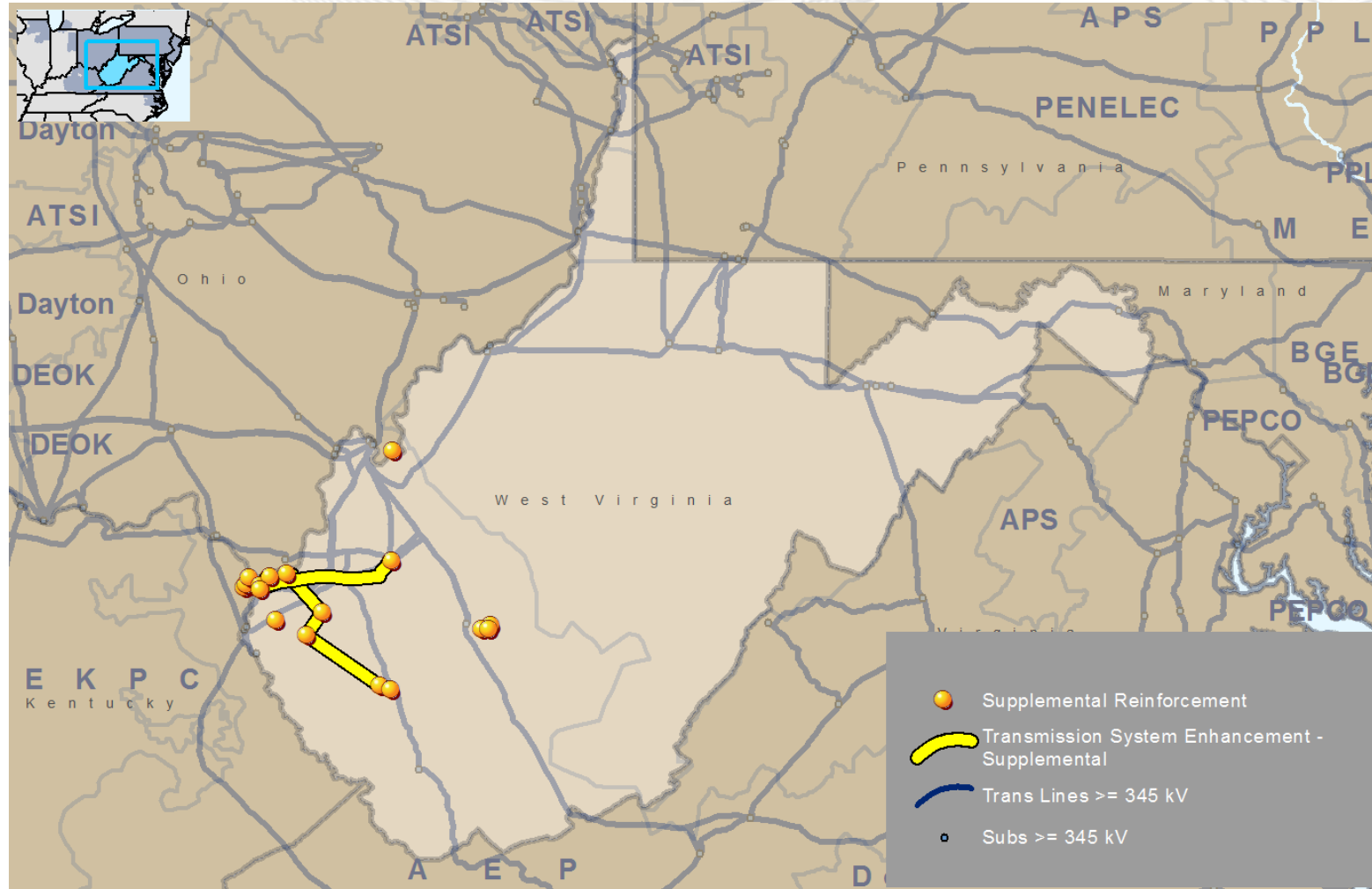
Note: Baseline upgrades are those that resolve a system reliability criteria violation.



West Virginia – RTEP Baseline Projects

(Greater than \$5 million)

Project ID	Project	Project Driver	Required In Service Date	Project Cost (\$M)	TO Zone(s)	2017 TEAC Review
b2834	Reconductor and string open position and sixwire 6.2 miles of the Chemical - Capitol Hill 138 kV circuit	Baseline Load Growth Deliverability & Reliability	12/1/2021	\$ 7.3	AEP	1/12/2017
b2883	Rebuild the Craneco – Pardee – Three Forks – Skin Fork 46kV line section (approximately 7.2 miles) utilizing 795 26/7 ACSR conductor (108 MVA rating, 43%)	TO Criteria Violation	6/1/2021	\$ 12.2	AEP	5/31/2017
b2892	Install new 138/12kV transformer with high side circuit switcher at Leon and a new 138 kV line exit towards Ripley. Establish 138kV at the Ripley station with a new 138/69 kV 130MVA transformer and move the distribution load to 138 kV service. Rebuild the	TO Criteria Violation	6/1/2021	\$ 27.1	AEP	5/31/2017
b2789	Rebuild the Brues-Glendale Heights 69kV line section (5 miles) with 795 ACSR (128 MVA rating, 43% loading)	TO Criteria Violation	6/1/2021	\$ 16.7	AEP	5/31/2017



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.



West Virginia – TO Supplemental Projects

(Greater than \$5 million)

Project ID	Description	Required Date	Project Cost (\$M)	TO Zone(s)	2017 TEAC Date
s1301	Replace circuit breakers at Chadwick, Leach, England Hill and Keonva	6/7/2017	\$ 9.8	AEP	5/31/2017
s1192	Construct new Marriett 138/12kV Station, which is tapped into the Twelve Pole Creek – Tri-State 138 kV line.	7/1/2017	\$ 7.2	AEP	1/5/2017
s1290	Retire the Smithers Switch structure. Smithers load will be served out of Carbondale station via a new transformer. Replace existing Dunn Hollow Switching Structure with new 3-way phase over phase Structure	6/1/2021	\$ 9.4	AEP	5/31/2017
	Rebuild Carbondale-Dunn Hollow 46kV line and retire Smither Swith				
	Rebuild ~3.5 miles of the Carbondale – Dunn Hollow 46kV line section with 795 ACSR conductor. This section of line is currently comprised of a mix of 2/0, 3/0, and 4/0 Copper conductor. The line portion to Montgomery station is of newer construction wit				
s1301	At Kenova, replace 69 kV circuit breaker C with a 3000 A 40 kA breaker.	6/7/2017	\$ 9.8	AEP	5/31/2017
s1319	Purchase Transmission lines owned by Century Aluminum, which has shut down. Century Aluminum has retired and planned to scrap the lines.	3/31/2018	\$ 5.2	AEP	5/31/2017
s1416	Construct a new 138-34.5 kV Station. Install a 138/34.5 kV 30 MVA transformer, high side circuit switcher and two 138kV 40 kA CBs.	12/1/2017	\$ 12.1	AEP	12/18/2017
	Tap the Amos - West Huntington 138kV line utilizing 1033.5 ACSR conductor (167 MVA rating) and extend 3.6 miles in and out of the new Balls Gap Station.				
s1449	At Tri State station, replace circuit breaker “H” with a 345 kV 63kA breaker. Install 4 new 345 kV 63kA breakers in a new breaker and a half string configuration. Replace transformers 1 & 2 with 345-138 450 MVA units.	12/1/2018	\$ 9.0	AEP	12/14/2017



West Virginia – TO Supplemental Projects

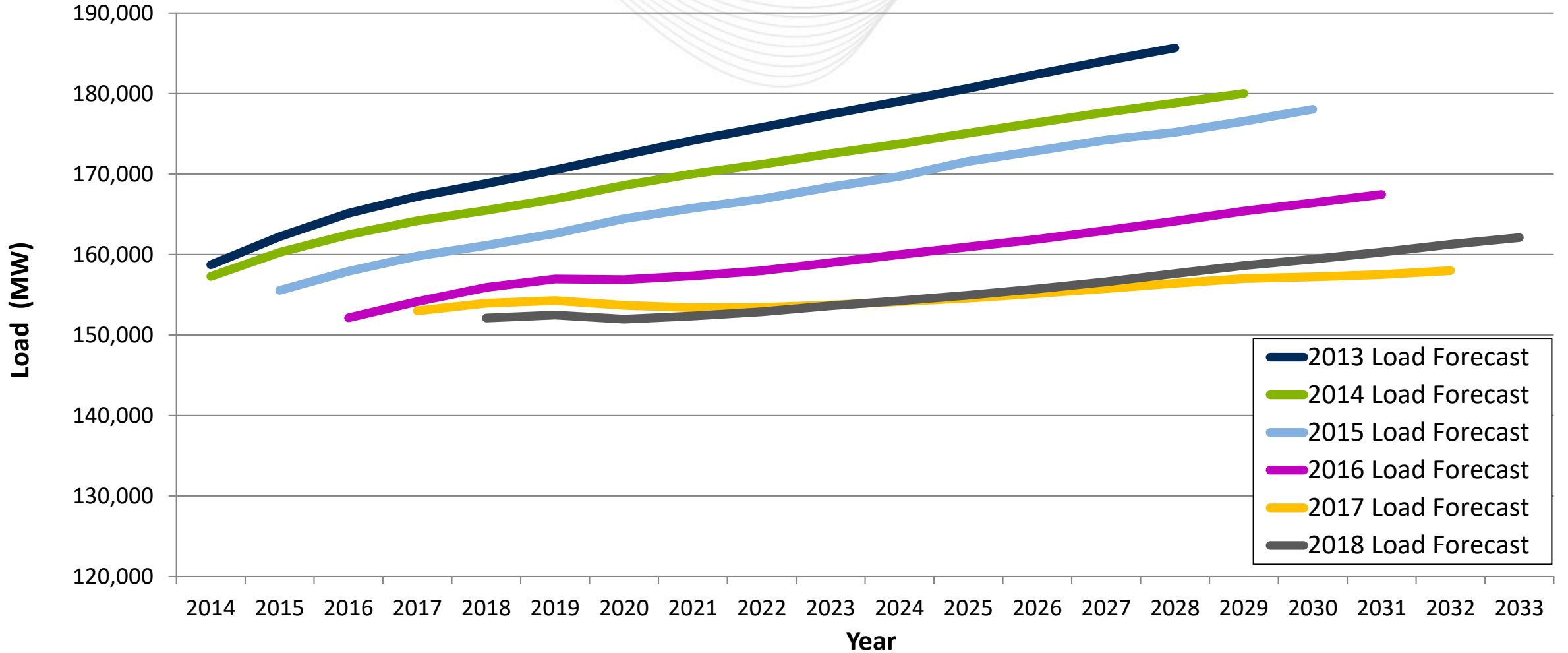
(Greater than \$5 million)

Project ID	Description	Required Date	Project Cost (\$M)	TO Zone(s)	2017 TEAC Date
s1377	Midkiff: Install a motorized phase-over-phase switch outside Midkiff Station to maintain 138kV service.	12/1/2020	\$ 8.7	AEP	12/18/2017
	Lavalette: Install 138kV MOAB facing West Huntington. Replace high-speed ground switch/MOAB combo on XFR #1 with a circuit switcher.				
	Stone Branch: Replace high-speed ground switch/MOAB combo on XFRs #1 and #2 with circuit switchers. Install 138kV MOABs facing Midkiff and Chapman.				
	Retire 69/12kV Sheridan station. Rebuild on property near existing station as 138/34.5kV station. Install two 138kV line circuit breakers, one 138/34.5kV XFR, one 138kV circuit switcher, one 138kV cap bank, and distribution line exits with breakers				
	Chapman: Retire Trace Fork S.S. and 4-way switch and replace with Chapman Switching Station located ~1 mile away. Install 4 138kV 3000 A 40 kA CB ring bus at new Chapman.				
	Construct 138kV double circuit line from Chapman to existing 138kV Logan – Hopkins line utilizing 1590 ACSR (493/624 MVA winter ratings) to match the existing Logan-Hopkins line capabilities. Install OPGW on new line sections.				
	Construct an 8 mile 138kV double circuit line between Sheridan and Midkiff utilizing 1033.5 ACSR (375/464 MVA winter ratings) and OPGW.				
	Construct a 17 mile 138kV line between Midkiff and Stone Branch utilizing 1033.5 ACSR (375/464 MVA winter ratings) and OPGW.				
	Construct 138kV double circuit line from Chapman to existing 138kV Stone Branch – Trace Fork line utilizing 1033.5 ACSR (375/464 MVA winter ratings). Install OPGW on new line sections.				
	Darraha: Retire 69kV CBs H and M.				
Retire Darraha – Sheridan 69kV line.					

Planning

Load Forecast

PJM RTO Summer Peak Demand Forecast





West Virginia – 2018 Load Forecast Report

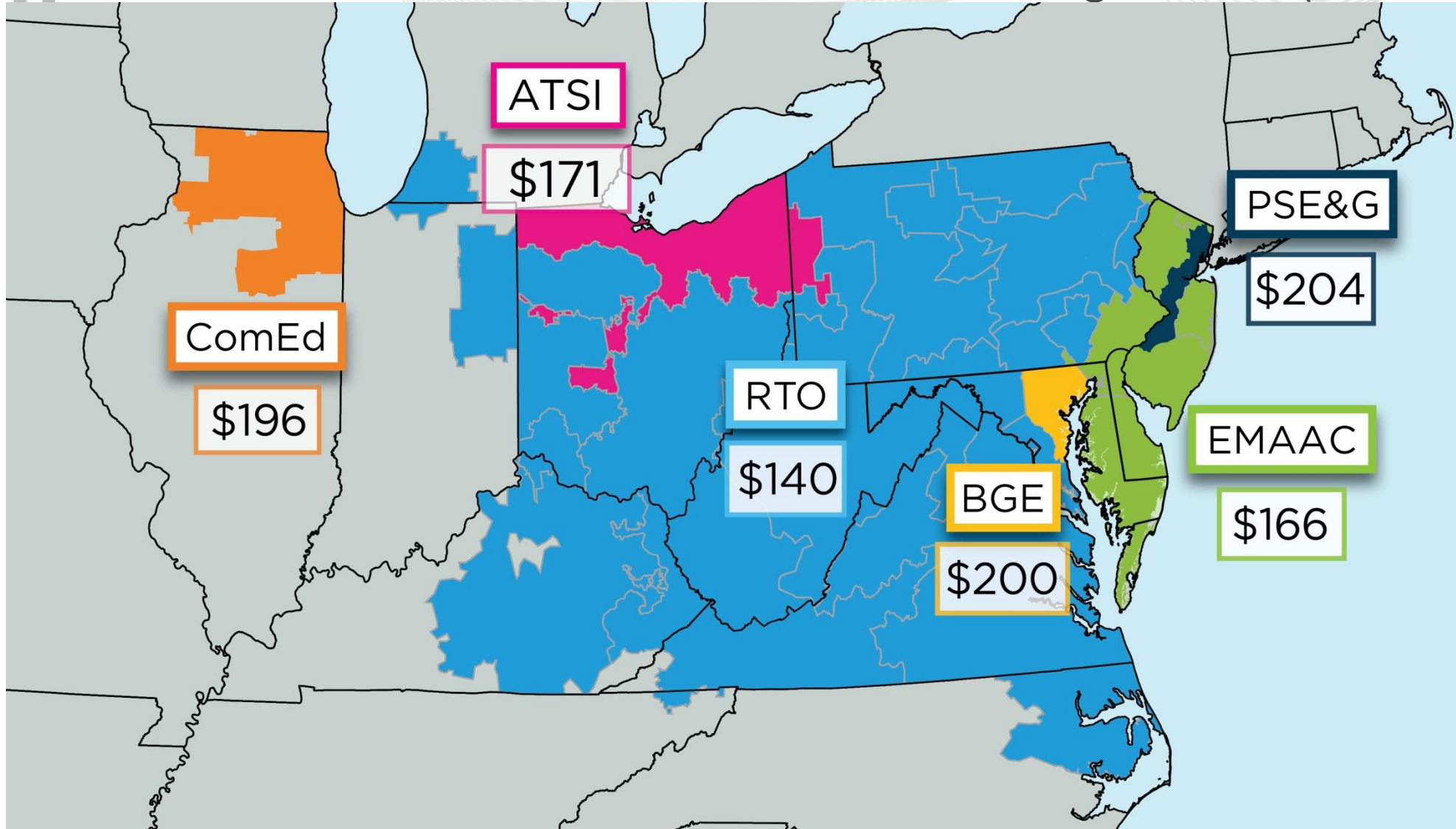
Transmission Owner	Summer Peak (MW)			Winter Peak (MW)		
	2018	2028	Growth Rate (%)	2017/18	2027/28	Growth Rate (%)
American Electric Power Company *	3,076	3,229	0.5%	3,632	3,819	0.5%
Allegheny Power *	2,875	3,078	0.7%	2,979	3,232	0.8%
PJM RTO	152,108	157,635	0.4%	131,463	136,702	0.4%

* PJM notes that American Electric Power Company and Allegheny Power serve load other than in West Virginia. 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 West Virginia. Estimated amounts were calculated based on the average share of each transmission owner's real-time summer and winter peak load located in West Virginia over the past five years.

Markets

Capacity Market Results

2021/22 Base Residual Auction Clearing Prices (\$/MW-Day)





West Virginia - Cleared Resources in 2021/22 Auction

(May 23, 2018)

	Cleared MW (Unforced Capacity)	Change from 2020/21 Auction
Generation	7,270	195
Demand Response	567	165
Energy Efficiency	43	13
Total	7,880	373

RTO Locational Clearing Price

\$140

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 - 2021/2022 Cleared MW (UCAP) by Resource Type

	Annual	Summer	Winter	Total
Generation	149,616 MW	54 MW	716 MW	150,385 MW
DR	10,674 MW	452 MW	- MW	11,126 MW
EE	2,623 MW	209 MW	- MW	2,832 MW
Total	162,912 MW	716 MW	716 MW	164,343 MW



West Virginia – Offered and Cleared Resources in 2021/22 Auction

(May 23, 2018)

		Unforced Capacity
Generation	Offered MW	7,347
	Cleared MW	7,270
Demand Response	Offered MW	597
	Cleared MW	567
Energy Efficiency	Offered MW	48
	Cleared MW	43
Total Offered MW		7,992
Total Cleared MW		7,880

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

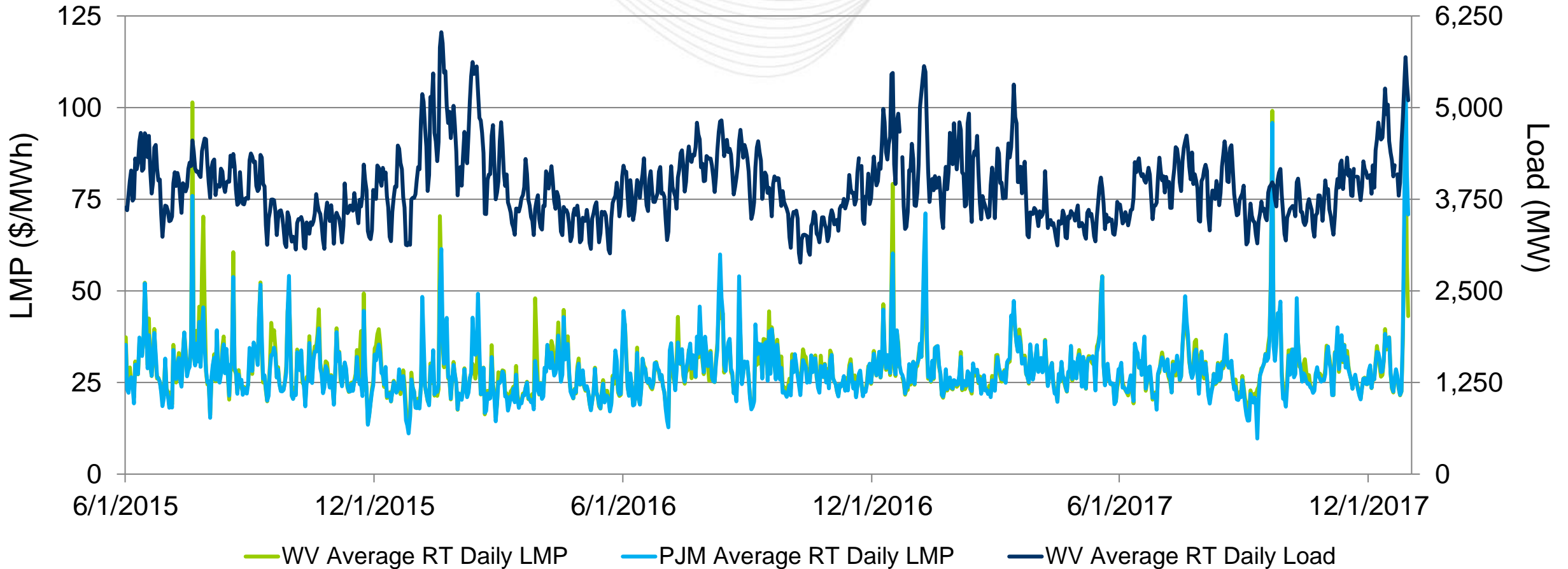
Market Analysis



West Virginia - Average Daily Load and LMP

(June 1, 2015 - December 31, 2017)

West Virginia's average daily LMPs generally align with the PJM average daily LMP



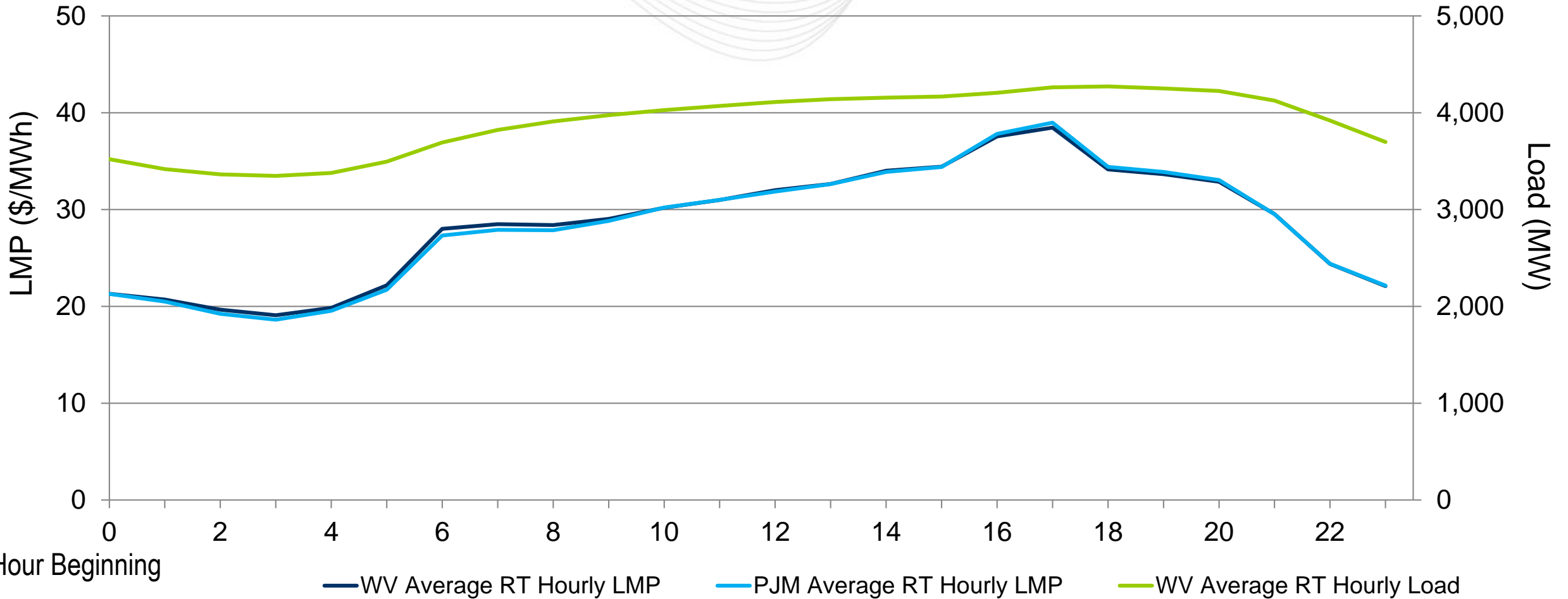
Note: The price spike on 9/21/2017 reflects the PJM shortage pricing event. The price spike starting 12/28/2017 reflects the beginning of the Cold Snap.



West Virginia – Hourly Average LMP and Load

(June 1, 2015 – December 31, 2017)

West Virginia's average hourly LMPs generally aligned with the PJM average.

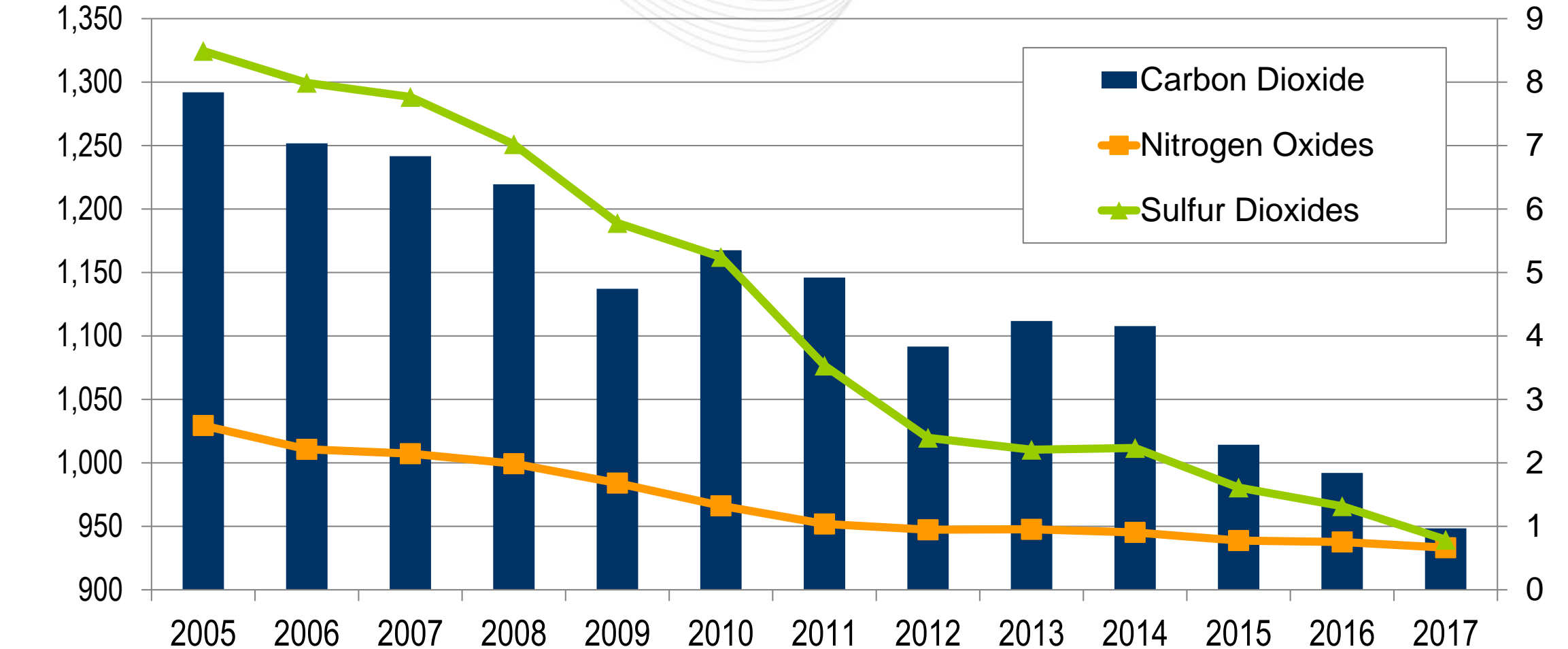


Operations Emissions Data

CO₂
(lbs/MWh)

PJM Average Emissions (lbs/MWh)

SO₂ and No_x
(lbs/MWh)



CO₂
(lbs/MWh)

West Virginia Average Emissions (lbs/MWh)

SO₂ and No_x
(lbs/MWh)

