



2018 West Virginia State Infrastructure Report

(January 1, 2018 – December 31, 2018)

May 2019

1. Planning

- Generation Portfolio Analysis
- Transmission Analysis
- Load Forecast

2. Markets

- Capacity Market Results
- Market Analysis

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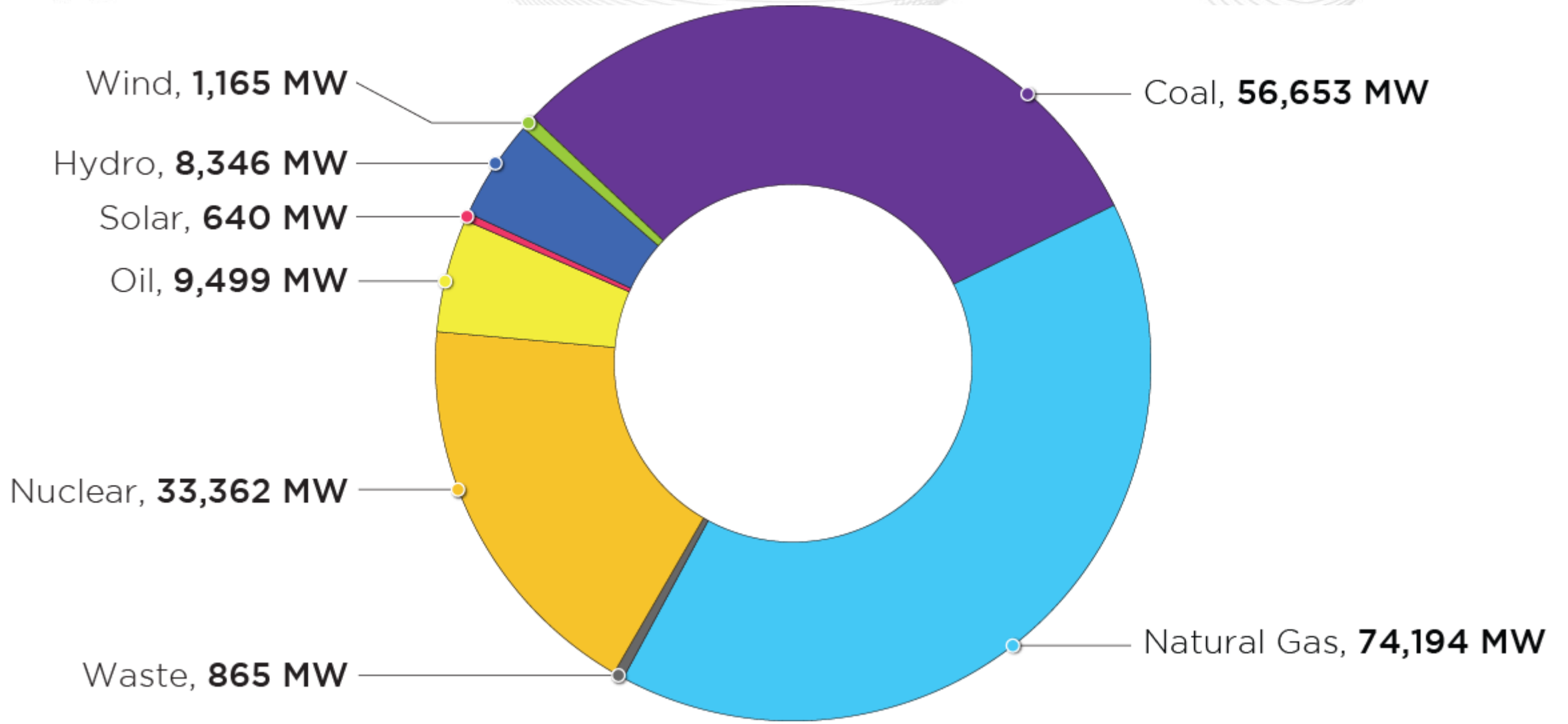
- Emissions Data

- **Existing Capacity:** Natural gas represents approximately 7.8 percent of the total installed capacity in West Virginia while coal represents approximately 89.6 percent. This differs from PJM where natural gas and coal are at 40.2 and 30.7 percent of total installed capacity.
- **Interconnection Requests:** Natural gas represents approximately 89.9 percent of new interconnection requests in West Virginia.
- **Deactivations:** 1,278 MW of generation in West Virginia gave a notification of deactivation in 2018.
- **RTEP 2018:** West Virginia RTEP 2018 projects total nearly \$587.7 million in investment. Approximately 78.7 percent of that represents supplemental projects. These investment figures only represent RTEP projects that cost at least \$5 million.
- **Load Forecast:** West Virginia load growth is nearly flat, averaging between 0.5 and 0.8 percent per year over the next 10 years. This aligns with PJM RTO load growth projections.

- **2021/22 Capacity Market:** West Virginia cleared 178 MW more Demand Response and Energy Efficient resources than in the prior auction.
- **1/1/18 – 12/31/18 Performance:** West Virginia's average locational marginal prices were consistent with PJM average LMPs. Coal resources represented 94 percent of generation produced in West Virginia while natural gas averaged 2.1 percent. West Virginia exports 43.7 percent of the energy produced in the state.
- **Emissions:** 2018 carbon dioxide emissions remained flat from 2017; sulfur dioxide and nitrogen oxide levels slightly decreased from 2017.

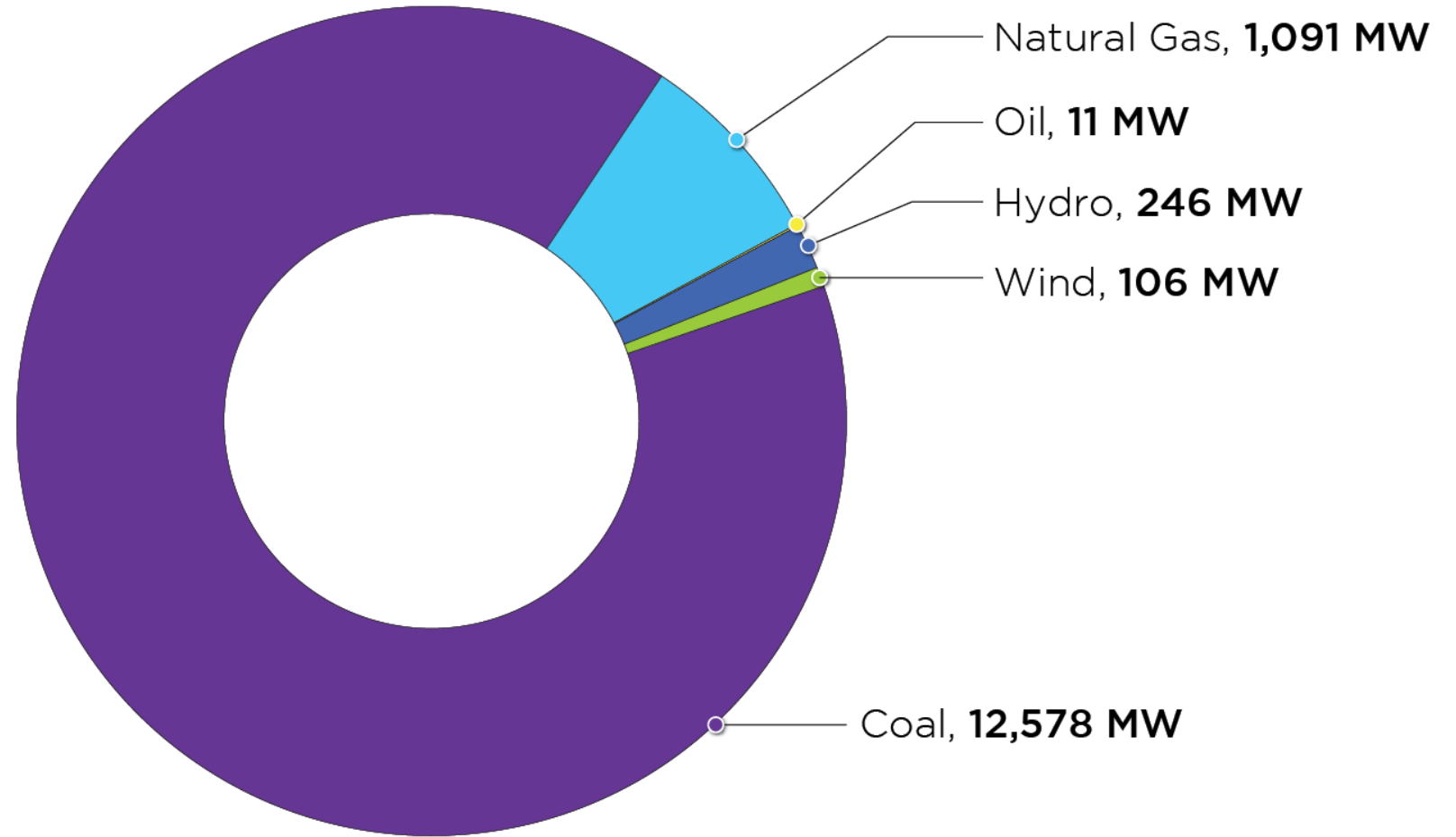
Planning

Generation Portfolio Analysis



West Virginia – Existing Installed Capacity

(MW submitted to PJM, December 31, 2018)



Summary:

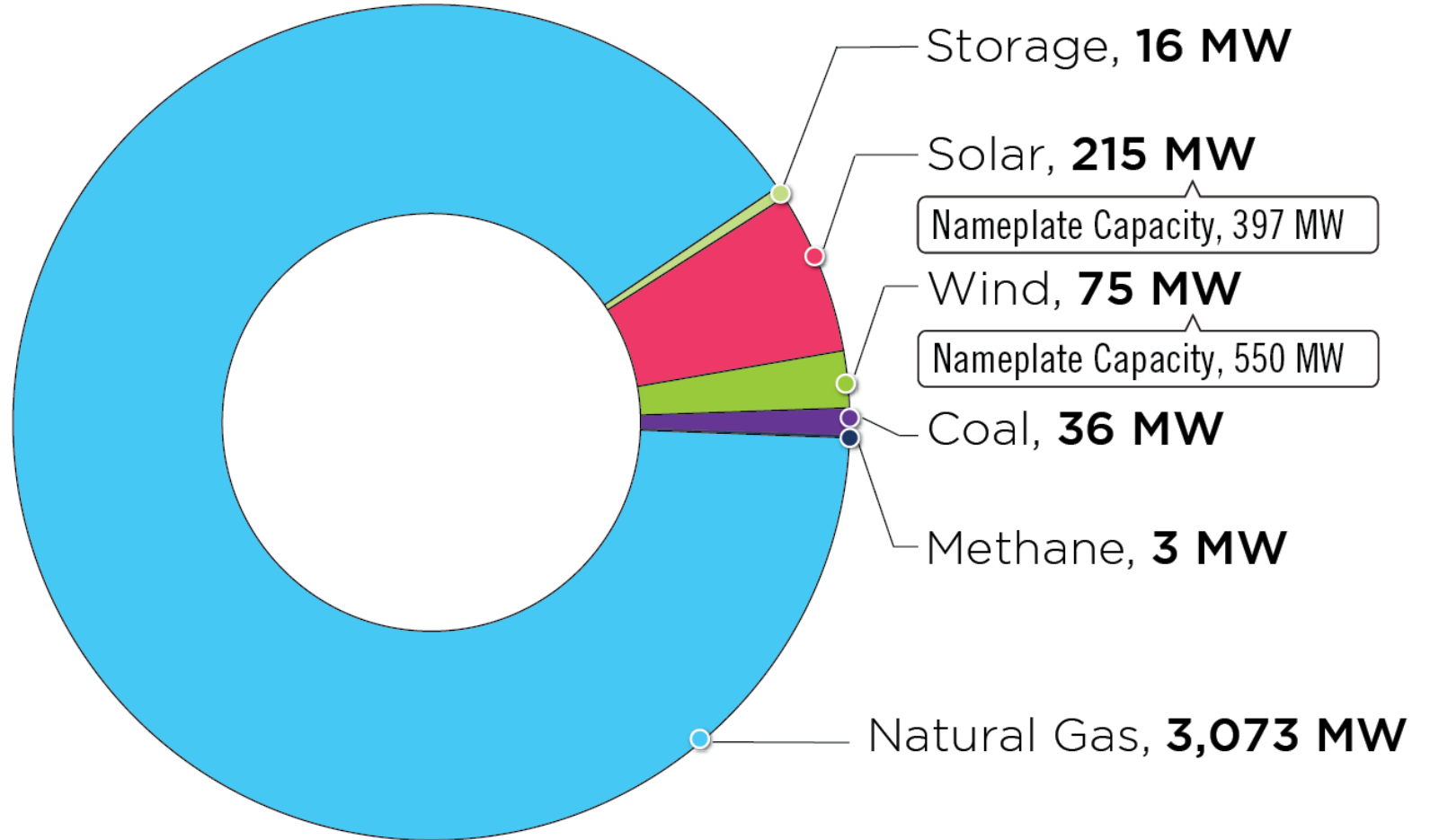
Natural gas represents approximately 7.8 percent of the total installed capacity in the West Virginia territory while coal represents approximately 89.6 percent.

Overall in PJM, natural gas represents approximately 40.2 percent of installed capacity while coal represents 30.7 percent.

West Virginia – Queued Capacity (MW) by Fuel Type

(as of December 31, 2018)

Natural gas represents approximately 89.9 percent of new interconnection requests in West Virginia.

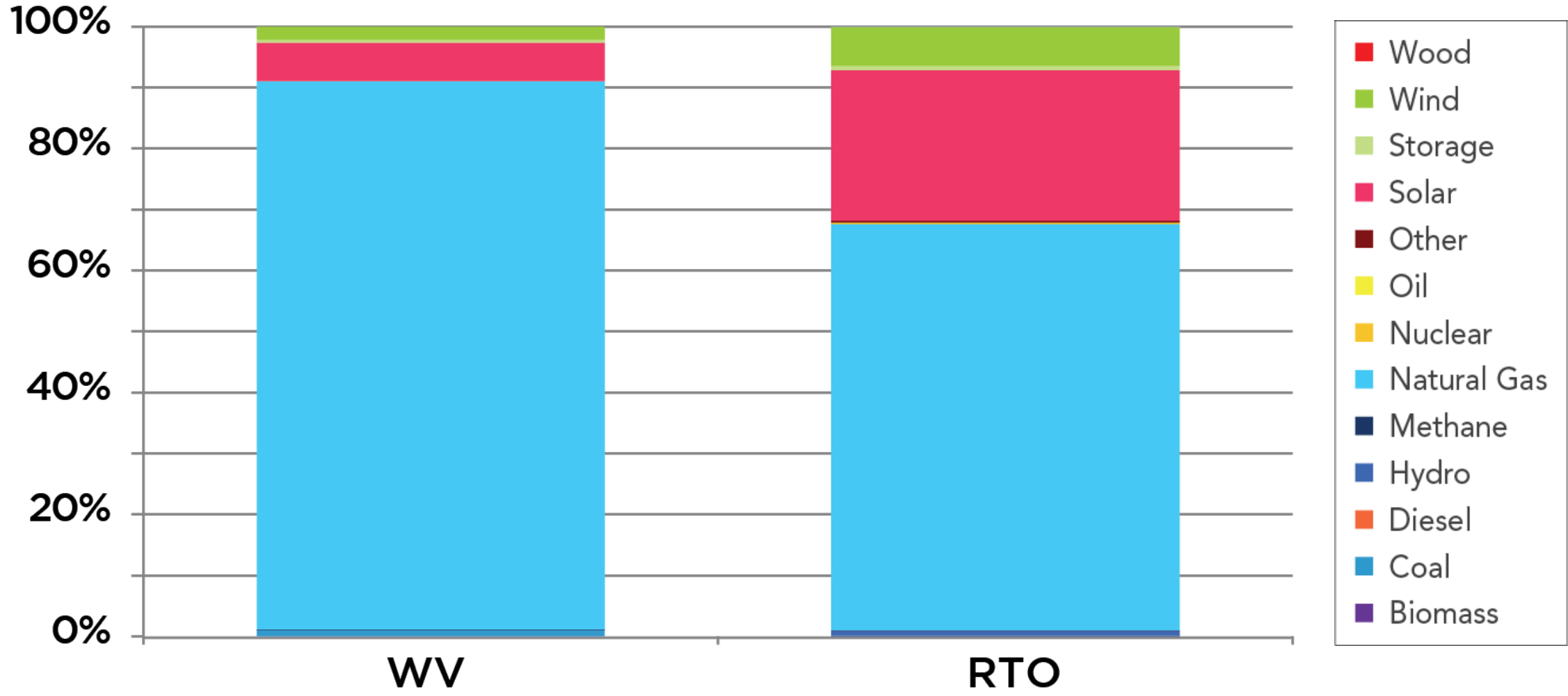


* **Note:** Nameplate Capacity represents a generator's rated full power output capability.



West Virginia – Percentage of Projects in Queue by Fuel Type

(as of December 31, 2018)





West Virginia – Interconnection Requests

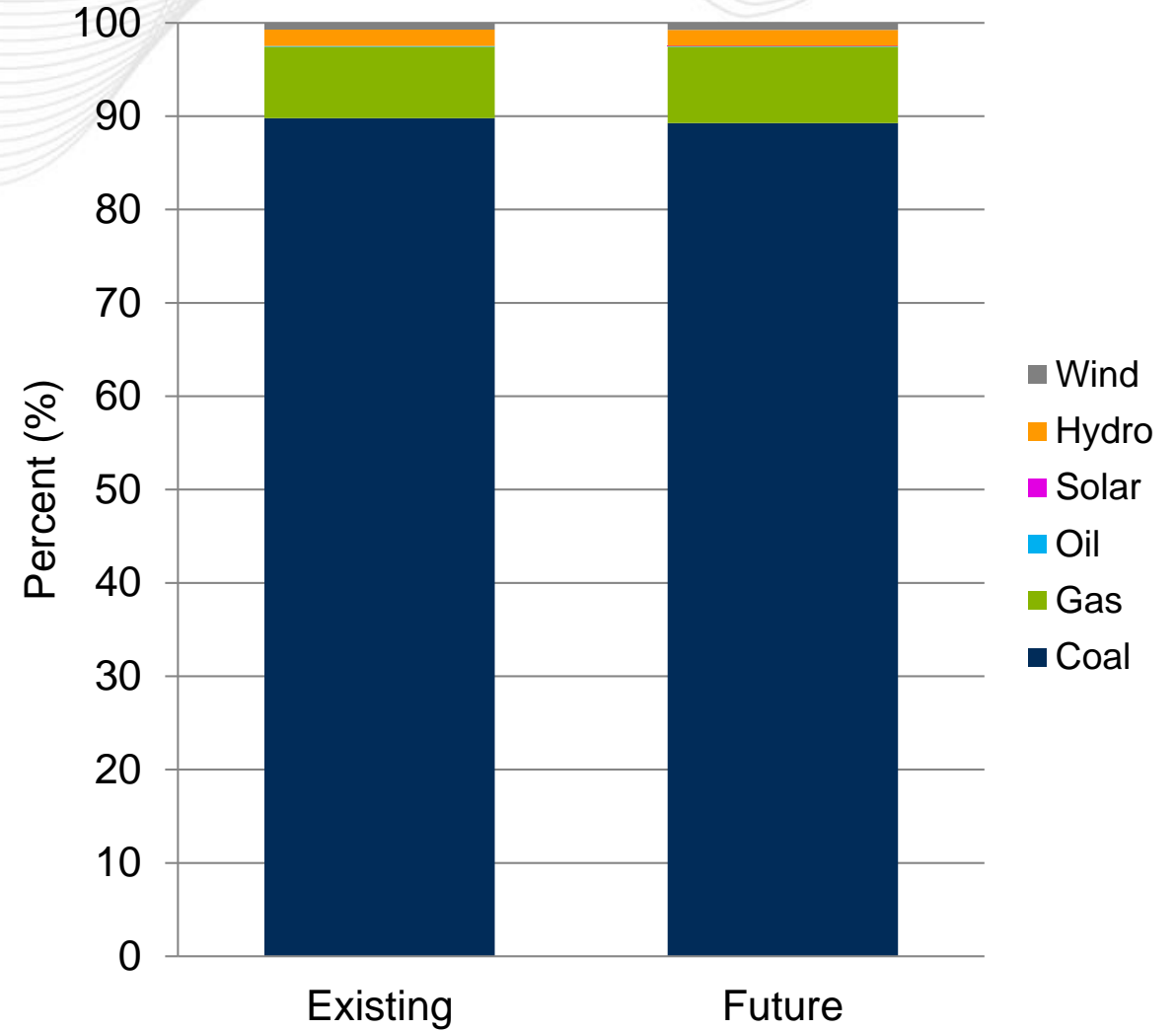
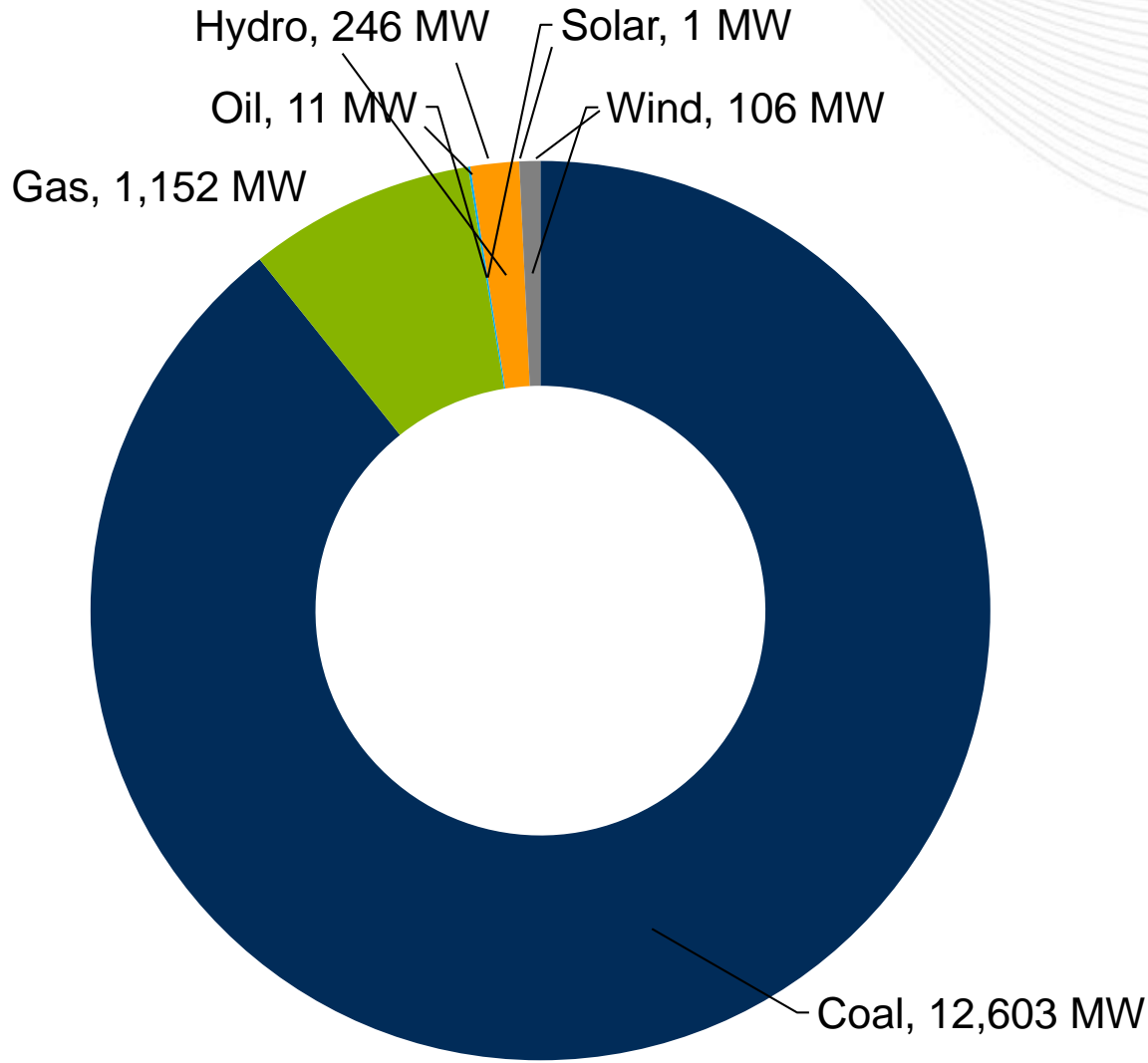
(Unforced Capacity, As of December 31, 2018)

	Complete				In Queue						Grand Total	
	In Service		Withdrawn		Active		Suspended		Under Construction			
	No. of Projects	Capacity, MW	No. of Projects	Capacity, MW	No. of Projects	Capacity, MW	No. of Projects	Capacity, MW	No. of Projects	Capacity, MW	No. of Projects	Capacity, MW
Non-Renewable	17	1,252.7	46	15,054.2	6	1,672.6	2	5.8	7	1,446.0	78	19,431.3
Coal	10	861.0	7	2,023.0	0	0.0	0	0.0	1	36.0	18	2,920.0
Natural Gas	5	391.7	36	12,947.2	4	1,662.6	0	0.0	5	1,410.0	50	16,411.5
Other	0	0.0	2	66.0	0	0.0	0	0.0	0	0.0	2	66.0
Storage	2	0.0	1	18.0	2	10.0	2	5.8	1	0.0	8	33.8
Renewable	3	361.0	391	753	1,123	263.0	256	38.0	37	4.0	1,085	1,419.0
Biomass	0	0.0	2	48.0	0	0.0	0	0.0	0	0.0	2	48.0
Hydro	5	153.7	11	208.8	0	0.0	0	0.0	0	0.0	16	362.5
Methane	2	2.4	3	13.8	0	0.0	0	0.0	1	3.2	6	19.4
Solar	0	0.0	4	44.2	5	215.2	0	0.0	0	0.0	9	259.4
Wind	8	190.2	25	392.7	4	39.2	2	35.7	0	0.0	39	657.8
Grand Total	32	1,599.0	91	15,761.7	15	1,927.0	4	41.5	8	1,449.2	150	20,778.4



West Virginia – Future Capacity Mix

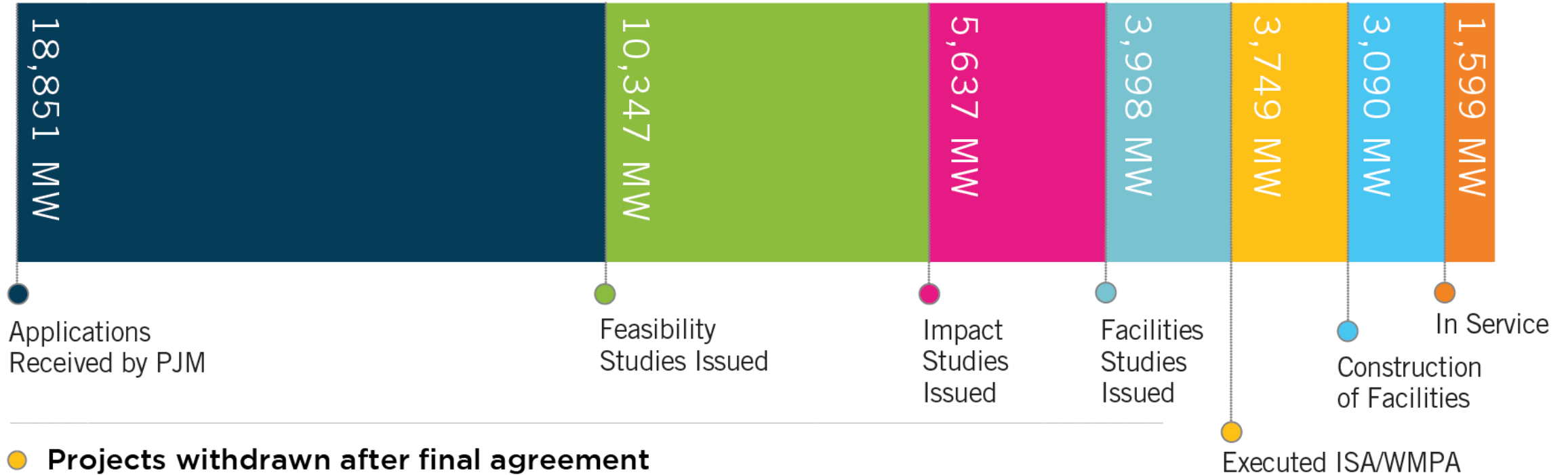
Based on known queued interconnection requests and deactivation notices through December 31, 2022, adjusted to reflect the probability of commercialization as indicated by historical trends specific to an interconnection request's state/zonal location and fuel type.





West Virginia – Progression History Interconnection Requests

Projects under construction, suspended, in service, or withdrawn (as of December 31, 2018)



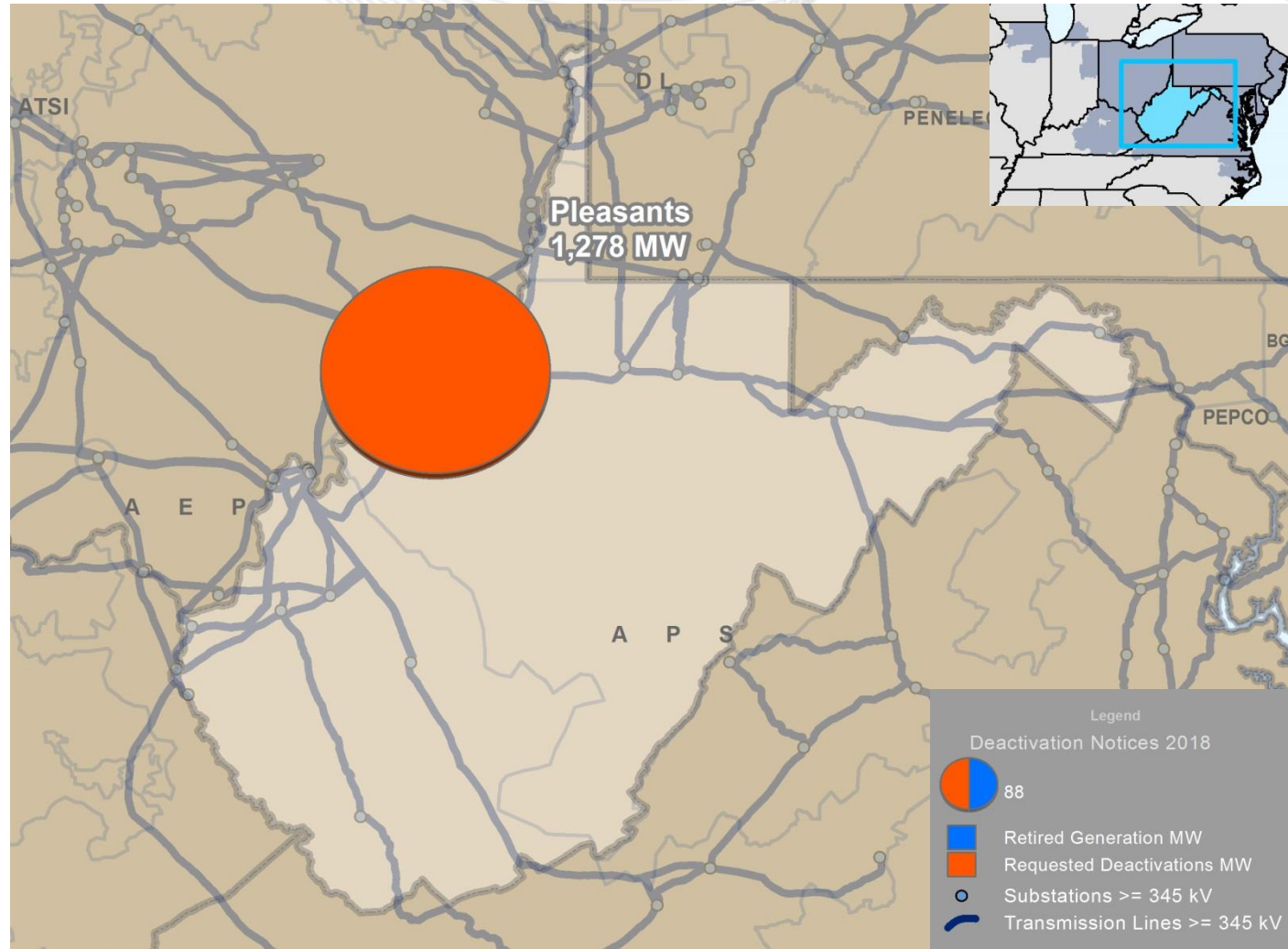
● Projects withdrawn after final agreement

- 7 Interconnection Service Agreements – 647 MW (Nameplate Capacity, 939 MW)
- 2 Wholesale Market Participation Agreements – 6 MW (Nameplate Capacity, 11 MW)

● Percentage of planned capacity and projects reached commercial operation

- 8.5 % requested capacity megawatt
- 24.4 % requested projects

West Virginia – Actual Generation Deactivations and Deactivation Notifications Received in 2018



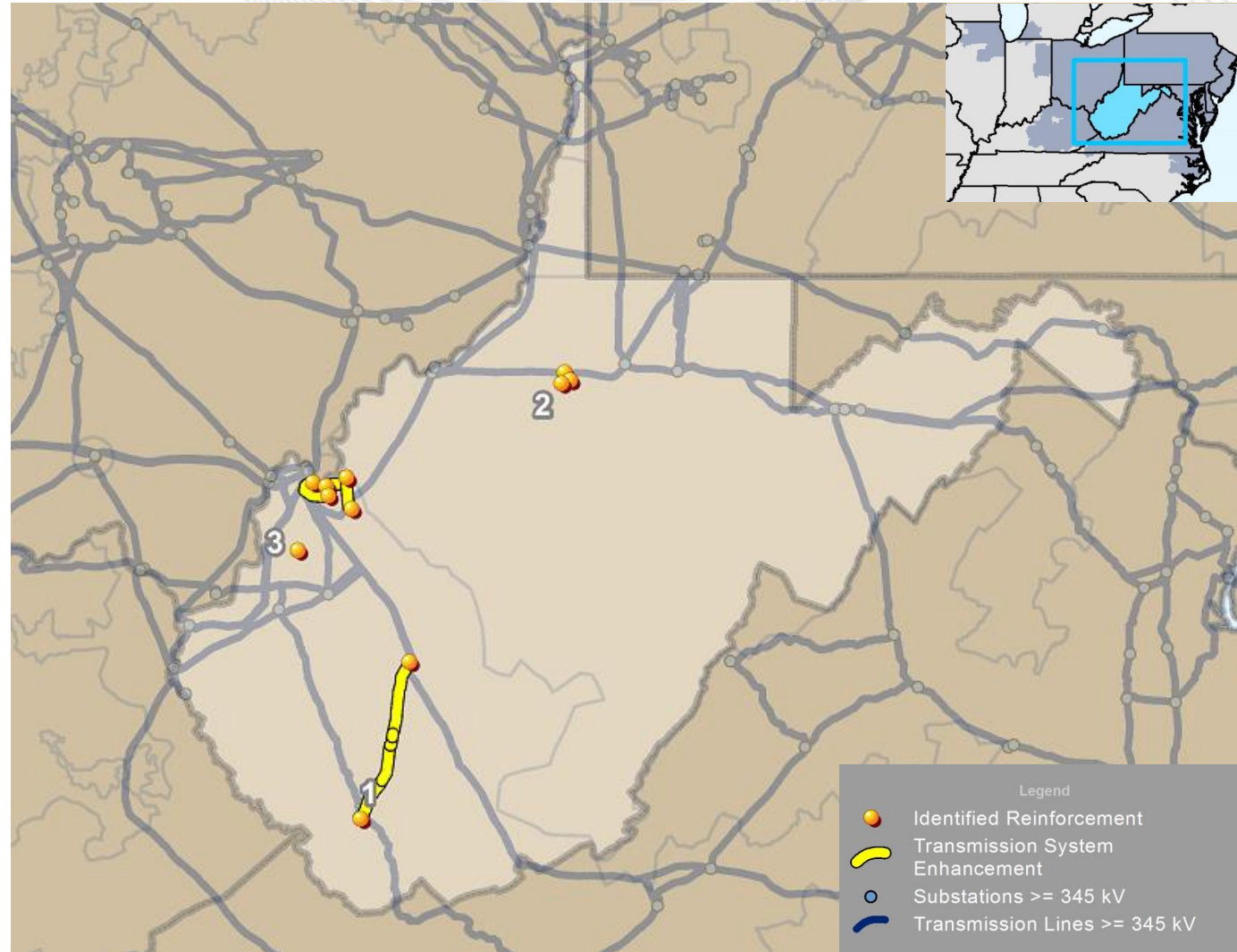


West Virginia – Actual Generation Deactivations and Deactivation Notifications Received in 2018

Unit	Capacity (MW)	TO Zone	Age (Years)	Projected/Actual Deactivation Date
Pleasants 1	639	APS	38	6/1/2022
Pleasants 2	639	APS	38	6/1/2022

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)

Map ID	Project	Sub ID	Description	Required In-Service Date	Project Cost (\$M)	TO Zone	2018 TEAC Review	Generator Deactivation	TO Criteria Violation
1	b2611	0.1	Build a new 138 kV double circuit off the Kanawha-Baileysville No. 2 138 kV circuit to Skin Fork station	6/1/2015	\$17.1	AEP	10/29/2010		X
		0.2	Install a new 138/46 kV transformer at Skin Fork	6/1/2015		AEP	10/28/2010		
2	b2996		Construct a new 500/138 kV substation as a four-breaker ring bus with expansion plans for double-breaker-double-bus on the 500 kV bus and breaker-and-a-half on the 138 kV bus to provide extra high voltage source to the Marcellus shale load growth area. Projected load growth of additional 160 MVA to current plan of 280 MVA, for a total load of 440 MVA served from Waldo Run substation. Replace primary relaying and carrier sets on Belmont and Harrison 500 kV remote end substations. Construct additional three-breaker string at Waldo Run 138 kV bus. Relocate the Sherwood No. 2 line terminal to the new string. Construct two single circuit Flint Run - Waldo Run 138 kV lines using 795 ACSR (approximately 3 miles). After terminal relocation on new three-breaker string at Waldo Run, terminate new Flint Run 138 kV lines onto the two open terminals.	6/1/2019	\$40.1	APS	5/3/2018	X	
3	b3040	0.1	Rebuild 15 miles Ravenswood-Racine Tap 69 kV line section to 69 kV standards, utilizing 795 26/7 ACSR conductor.	6/1/2022	\$68.1	AEP	8/31/2018		X
		0.2	Rebuild nine miles existing Ripley - Ravenswood 69 kV circuit to 69 kV standards, utilizing 795 26/7 ACSR conductor.	6/1/2022		AEP	8/31/2018		X
		0.3	Install new three-way phase over phase switch at Sarah Lane station to replace the retired switch at Cottageville.	6/1/2022		AEP	8/31/2018		X
		0.5	Retire Mill Run station.	6/1/2022		AEP	8/31/2018		X
		0.6	Install 28.8 MVar cap bank at South Buffalo station.	6/1/2022		AEP	8/31/2018		X
		0.6	Upgrade remote end relays for Yukon-Allenport-Iron Bridge 138 kV line	6/1/2021		APS	6/7/2018		X

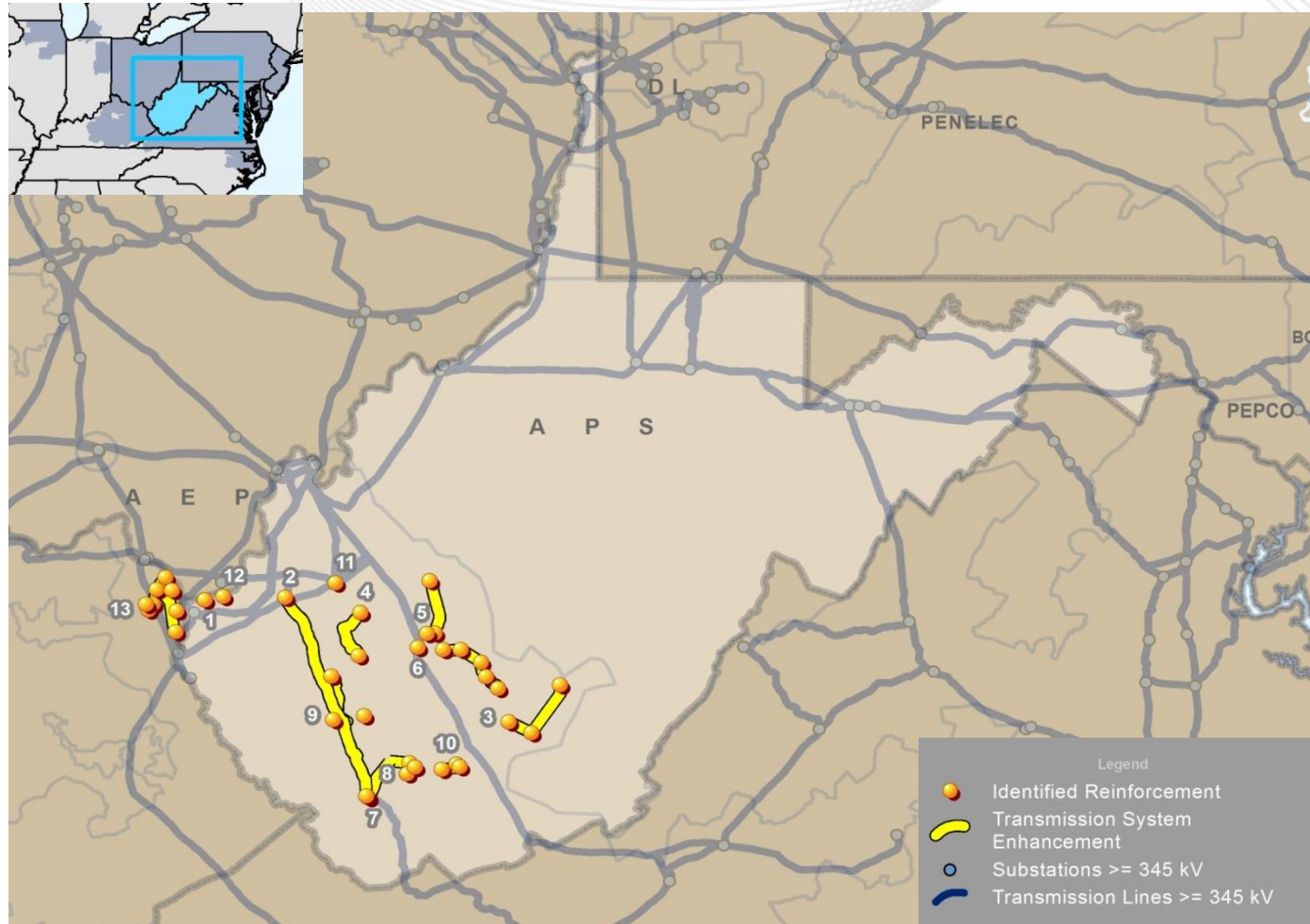


West Virginia – RTEP Network Projects

(Greater than \$5 million)

West Virginia had no network project upgrades in 2018.

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.



Note: Supplemental projects are transmission expansions or enhancements that are not required for compliance with the following PJM criteria: system reliability, operational performance or economic criteria, pursuant to a determination by the Office of the Interconnection and is not a state public policy project.



West Virginia – TO Supplemental Projects

(Greater than \$5 million)

Map ID	Project	Description	Projected In-Service Date	Project Cost (\$M)	TO Zone	2018 TEAC Review
1	s1377	Sheridan Area improvements including terminal equipment updates at Midkiff, Lavalette, Chapman and Darrah 138 kV substation and construction of new 138 kV circuits in the Midkiff, Stone Branch, Chapman, Logan and Hopkins 138 kV substations.	5/1/2018	\$88.7	AEP	2/14/2018
2	s1580	At Wyoming 765 kV yard, replace existing Transformer No. 1 with a new 765/138 kV 750 MVA transformer. Replace existing transformer No. 2 with a new 765/138 kV 750 MVA transformer. Install a new switchable spare 250 MVA transformer. Replace existing 300 MVAR reactor bank on the Wyoming-Culloden 765 kV line and 40 kA switcher with a new 300 MVAR reactor bank and 50 kA switcher. Make the spare reactor switchable.	12/31/2020	\$53	AEP	3/8/2018
3	s1566	At Meadow Bridge station, replace the two-way phase-over-phase switch with a new two-way phase-over-phase switch (motorized)	12/4/2020	\$35	AEP	2/14/2018
		Rebuild approximately 20 miles of the Layland-McClung 69 kV line with aluminum conductor steel cable	12/4/2020		AEP	2/14/2018
4	s1501	Rebuild approximately 17.5 miles of the Boone-Ward Hollow circuit utilizing aluminum conductor steel cable (86 MVA rating) at 69 kV standards (operated at 46 kV). Switching structures at Mikes Run, Emmons, and Alum Creek will be replaced with a standard three-way phase-over-phase switch. Retire Timberland switching station.	11/18/2020	\$32.7	AEP	1/30/2018
5	s1560	Rebuild approximately 17.5 miles of the Clendenin-Kelly Creek 46 kV line to 69 kV standards (energized at 46 kV) utilizing aluminum conductor steel cable (68 MVA rating). Retire Kendalia switch.	12/4/2020	\$30.7	AEP	2/14/2018
		At Kelly Creek retire the switching structure and replace it with a 1200 A three-way-phase-over-phase (POP) motorized switching structure.	12/4/2020		AEP	2/14/2018
		At Mammoth station, install a three-way phase-over-phase motorized switching structure.	12/4/2020		AEP	2/14/2018
6	s1461	Replace three existing 50 kA 345 kV circuit breakers with new 63 kA circuit breakers. Replace the three sections of the existing Kanawha River Series Capacitor with a single series capacitor. Replace existing 400 MVA 345/138/13.8 kV transformer with a new 450 MVA 345/138/13.8 kV transformer.	10/25/2019	\$30	AEP	1/11/2018



West Virginia – TO Supplemental Projects (cont.)

(Greater than \$5 million)

Map ID	Project	Description	Projected In-Service Date	Project Cost (\$M)	TO Zone	2018 TEAC Review
7	s1497	Rebuild about 16.6 miles of the Baileysville-Bolt line with aluminum conductor steel cable to 138 kV standards (energized at 46 kV, 86 MVA rating). Existing right-of-way will be used when possible but supplemental may be needed in order to build to 138 kV standards.	5/2/2019	\$29.11	AEP	1/30/2018
		At Baileysville station, replace 46 kV bus, risers and switches on circuit breaker	12/6/2019		AEP	1/30/2018
		At Marianna station, replace the existing switches with a phase-over-phase switch and replace the bus/risers	8/13/2019		AEP	1/30/2018
		At Rock View station, replace the existing switches with a phase-over-phase switch	9/26/2019		AEP	1/30/2018
		At Poplar Gap station, replace the existing switches with a phase-over-phase switch	6/26/2019		AEP	1/30/2018
		Retire Milam Tap station	12/1/2019		AEP	1/30/2018
		Retire Penn Hollow Tap station	12/20/2019		AEP	1/30/2018
		Install a circuit breaker at McGraws station towards Baileysville	12/20/2019		AEP	1/30/2018
8	s1509	Rebuild ~4 miles of the Carbondale-Brownsville 69 kV line utilizing 795 ACSR conductor (125 MVA rating) at 69 kV standards with steel equivalent H frame structures. Rebuild ~5.6 miles of the Brownsville-Gauley Mountain 69 kV line utilizing 795 ACSR conductor at 69 kV standards with steel equivalent H frame structures. Rebuild 0.1 miles of the Elmo-Tower 117 69 kV line over route 19 with 795 ACSR conductor at 69 kV standards.	10/1/2019	\$26	AEP	2/14/2018
		Replace Gauley Mountain switches with a new three-way motorized phase-over-phase structure	12/14/2018		AEP	2/14/2018
9	s1431	Rebuild approximately 11 miles of the Hopkins-Sharples circuit including 2.6 miles of the Hopkins-Bim line that is double circuited with Hopkins-Sharples. Replace switches at Hewett station with three-way phase-over-phase switch. On all lines, install optical ground wire.	12/1/2019	\$23.7	AEP	1/8/2018
10	s1667	At Tams Mtn. Station, replace all 46 kV circuit breakers with 3000 A 40 kA breakers designed to 138 kV standards in ring bus operated at 46 kV. Replace an existing motor-operated air breaker with a new circuit switcher. Retire 138 kV bus tie breaker and establish one 138 kV bus. Install two new 3000 A 40 kA 138 kV circuit breakers on Pierpont 138 kV line and Pemberton 138 kV lines. Replace existing 138/69/46 kV 40 MVA transformer with a new 138/69/46 130 MVA transformer. Reconfigure transmission lines entering the station to accommodate new ring configuration.	6/1/2021	\$21.2	AEP	6/26/2018
		Pemberton 138 kV Station remote-end relay work detail	6/1/2021		AEP	6/26/2018



West Virginia – TO Supplemental Projects (cont.)

(Greater than \$5 million)

Map ID	Project	Description	Projected In-Service Date	Project Cost (\$M)	TO Zone	2018 TEAC Review
11	s1463	Replace three existing 29 kA 765 kV circuit breakers at Amos 765 kV with new 50 kA 765 kV circuit breakers	12/13/2018	\$11.78	AEP	1/11/2018
12	s1595	At Darrah station, replace the existing 1600 A 42 kA 138 kV circuit breaker “T” with a new 3000 A 40 kA 138 kV circuit breaker. Replace the existing 1200 A 17 kA 34.5 kV circuit breakers “C”, “D”, “F”, and “I” with new 3000 A 40 kA 34.5 kV. Replace the existing 1800 A 27 kA 34.5 kV circuit breakers “J”, “G”, and “N” with new 3000 A 40 kA 34.5 kV circuit breakers. 138 kV circuit switchers will be added to the high side of Darrah transformers No. 1, 2, 3, and 4. The existing 45 MVA 138/34.5 kV transformer No. 1 will be replaced by 138/69/34.5 kV transformer with a 50 MVA tertiary.	6/1/2020	\$11.5	AEP	3/27/2018
13	s1687	Construct a new greenfield station, named Ramey, tapping the Bellefonte-Grangston 138 kV circuit. Four 138 kV circuit breakers (3000 A 40 kA) will be installed as well as a 138/19 kV transformer (25 MVA). AEP already owns the land at the proposed Ramey station site.	6/30/2021	\$53.9	AEP	8/31/2018
		Construct 3.4 mile 138 kV line between Princess and Moore Hollow stations.	12/31/2021		AEP	8/31/2018
		Convert Princess station to 138 kV by installing five 138 kV circuit breakers (3000 A 40 kA), a 138/69 kV transformer (to Coalton), and a 138/34.5 kV transformer.	12/31/2020		AEP	8/31/2018
		Convert Hoods Creek station to 138 kV by rebuilding the station in the adjacent lot with a 138/12 kV transformer.	12/1/2021		AEP	8/31/2018
		Convert the existing Bellefonte to Coalton 69 kV line between Bellefonte and Princess to 138 kV (line is built to 138 kV standards).	12/31/2021		AEP	8/31/2018
		Construct a new 2.8 mile 138 kV extension from Ramey to the existing Bellefonte-Coalton line.	6/30/2021		AEP	8/31/2018
		At Chadwick Station, remote end relaying work will be required.	2/1/2021		AEP	8/31/2018
		Construct a 2.7 mile 138 kV line extension between Moore Hollow and Kentucky Electric Steel (KES). At this time the existing KES metering structure will be retired due to the announced closure of the KES plant.	2/1/2021		AEP	8/31/2018
Construct a new greenfield station named Moore Hollow. Six 138 kV circuit breakers (3000 A 40 kA) will be installed as well as a 138/34.5 kV transformer (30 MVA) and a 57.6 MVAR capacitor at the station.	2/1/2021	AEP	8/31/2018			



West Virginia – TO Supplemental Projects (cont.)

(Greater than \$5 million)

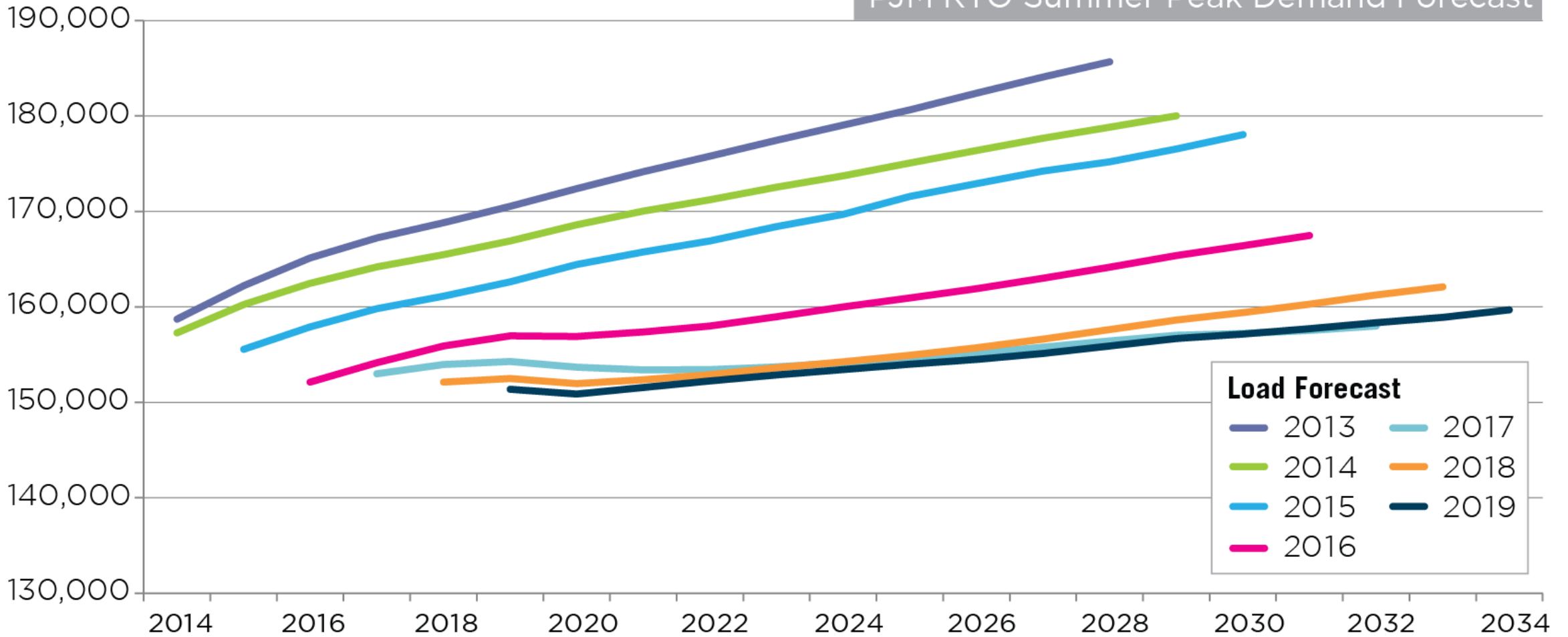
Map ID	Project	Description	Projected In-Service Date	Project Cost (\$M)	TO Zone	2018 TEAC Review
	s1506	Kammer Station: Construct a new 69 kV breaker-and-a-half station with eight breakers (3000 A, 40kA); four 69 kV circuit exits and one 138-69 kV transformer position; install a 28.8 MVAR, 69 kV cap bank; install a new 138-69 kV transformer (130 MVA) to facilitate construction in-the-clear	6/8/2019	\$7.7	AEP	1/30/2018
	s1565	At Johns Creek Station, replace existing 69 kV circuit breaker 'A' with a new 3000 A 40 kA circuit breaker. Replace the existing 138/69/34.5 kV 90 MVA transformer No. 1 with a new 90 MVA 138/69/34.5 kV transformer. Install a new 20 MVA 138/34.5 kV transformer to remove the distribution load from the tertiary of transformer No. 1. Install a new 2000 A 40 kA high side circuit switcher on the 138/34.5 kV Transformer. Replace existing capacitor switcher 'AA' with a new 3000 A 40 kA switcher and existing capacitor switcher 'BB' with new 3000 A 40 kA switcher.	6/18/2020	\$7.4	AEP	2/14/2018

Planning

Load Forecast

PJM RTO Summer Peak Demand Forecast

Load (MW)



Load Forecast

- 2013
- 2014
- 2015
- 2016
- 2017
- 2018
- 2019



West Virginia – 2019 Load Forecast Report

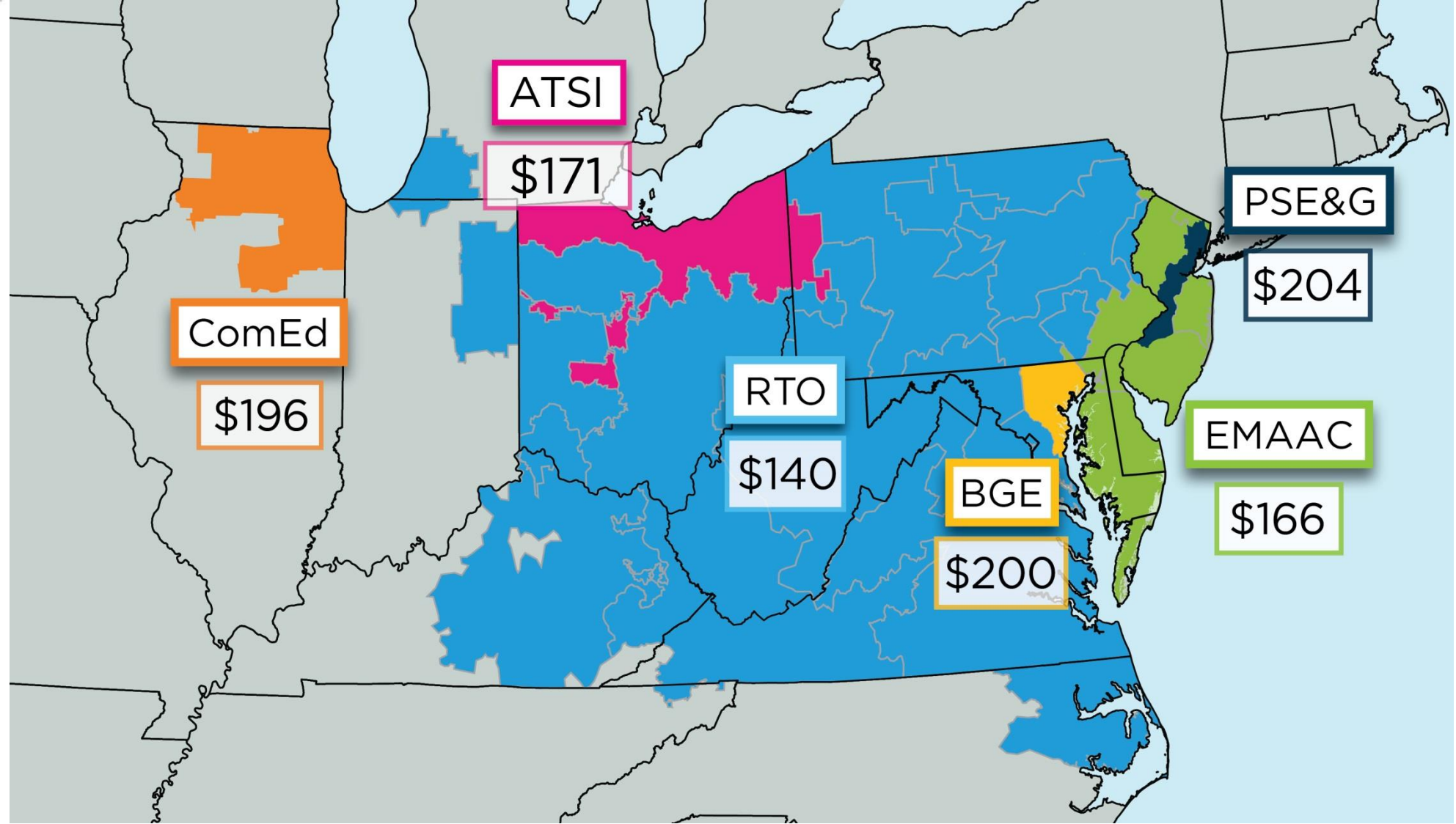
Transmission Owner	Summer Peak (MW)			Winter Peak (MW)		
	2019	2029	Growth Rate (%)	2018/19	2028/29	Growth Rate (%)
American Electric Power Company *	3,108	3,261	0.5%	3,653	3,824	0.5%
Allegheny Power *	2,870	3,067	0.7%	2,974	3,210	0.8%
PJM RTO	151,358	156,689	0.3%	131,082	136,178	0.4%

* 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

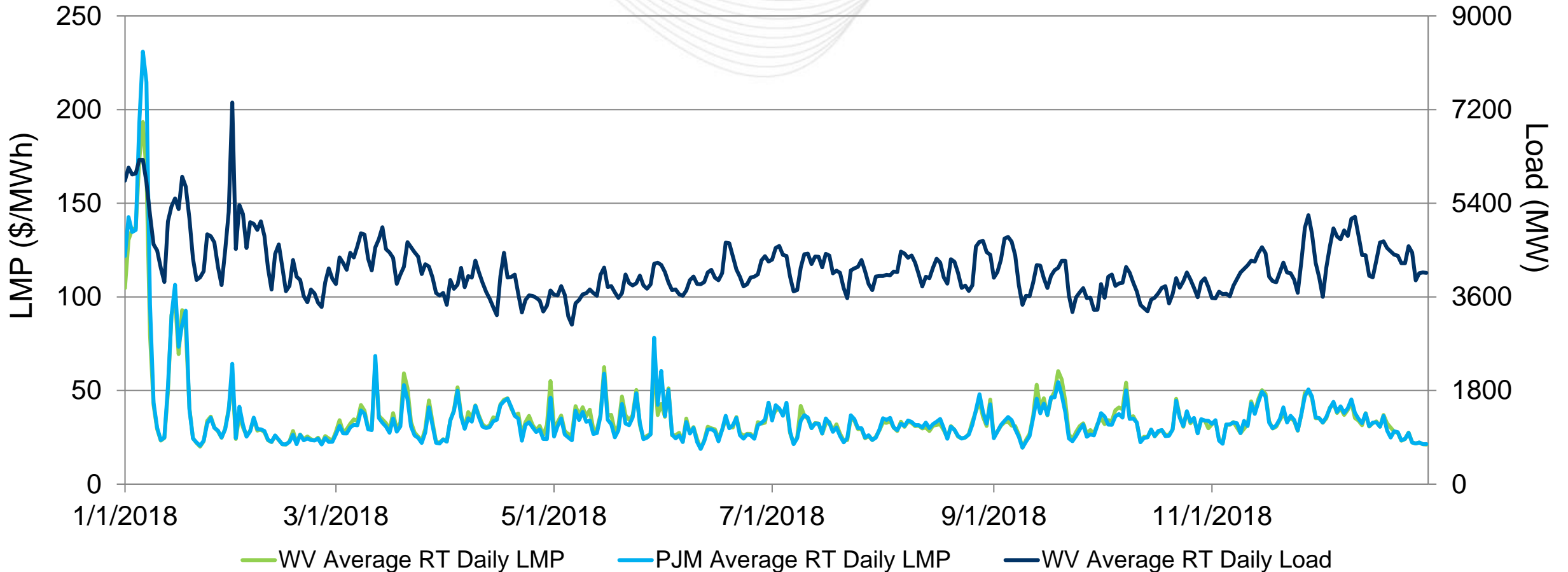
Market Analysis



West Virginia – Average Daily LMP and Load

(January 1, 2018 – December 31, 2018)

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



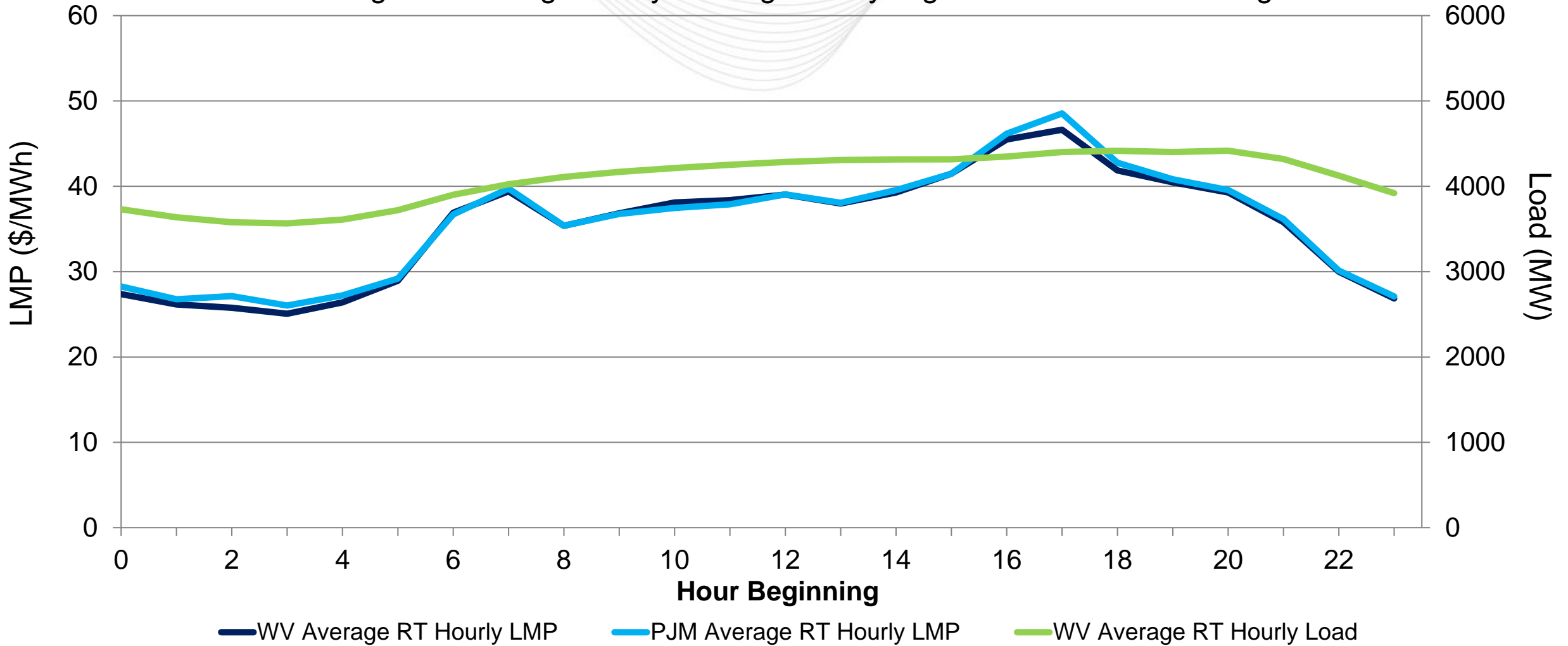
Note: The price spike in January reflects the Cold Snap that lasted from 12/28/17 to 1/7/2018.



West Virginia – Average Hourly LMP and Load

(January 1, 2018 – December 31, 2018)

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

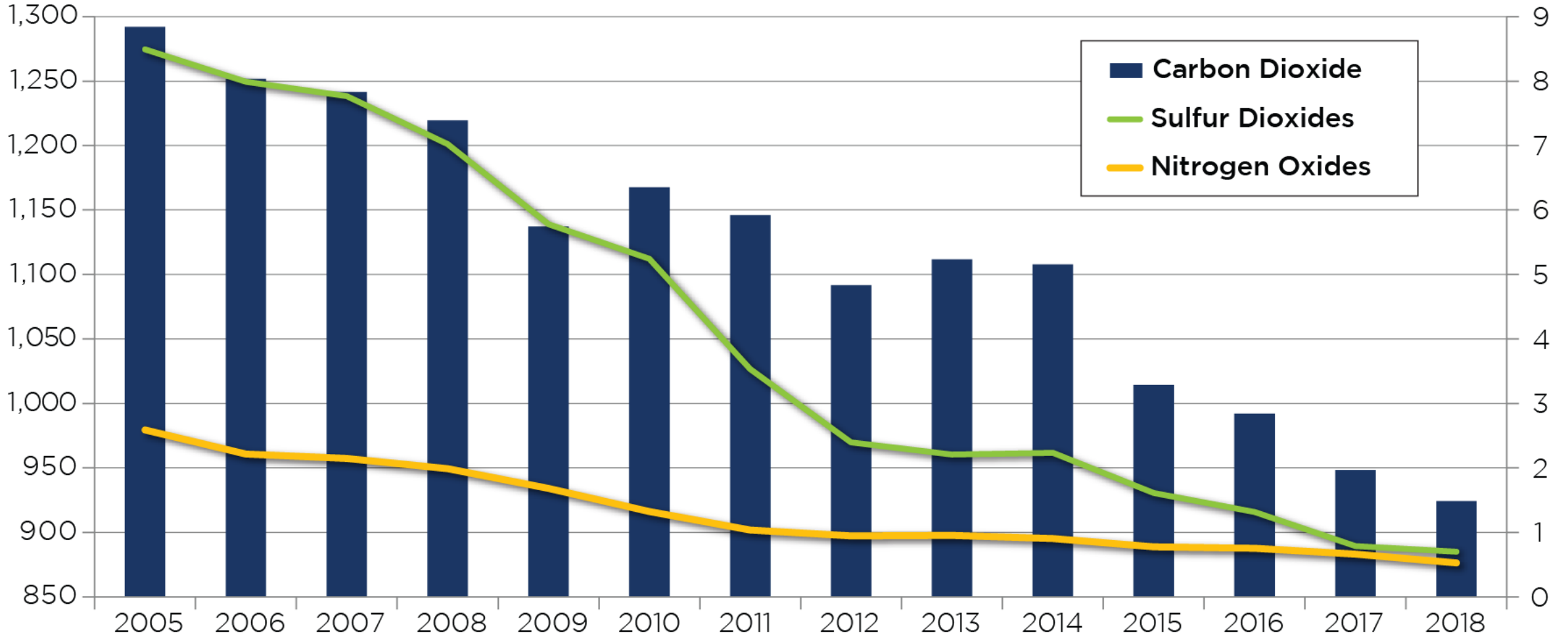


Operations Emissions Data

2005-2018 PJM Average Emissions

CO₂
lbs/MWh

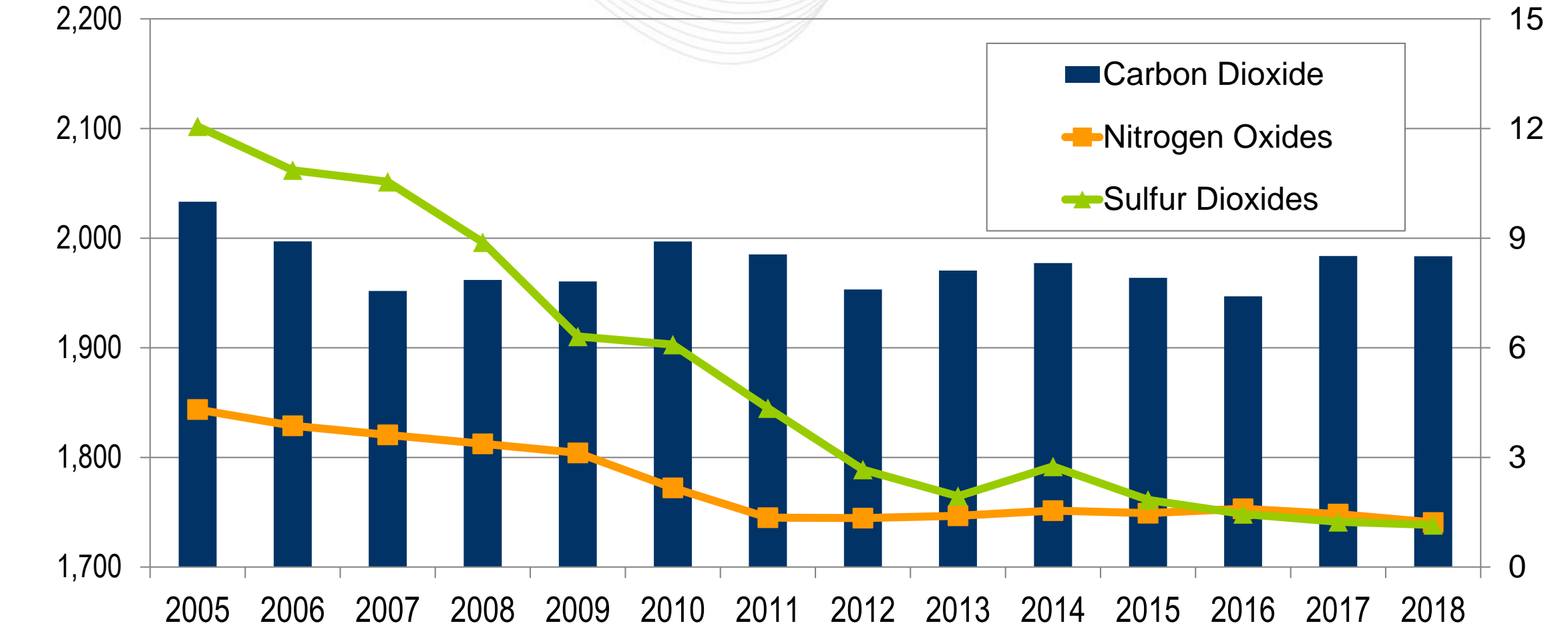
SO₂ and NO_x
lbs/MWh



CO₂
(lbs/MWh)

West Virginia Average Emissions (lbs/MWh)

SO₂ and NO_x
(lbs/MWh)



Please note that PJM has historically used \$5 million as the threshold for listing projects in the RTEP report. Beginning in 2018, it was decided to increase this cutoff to \$10 million. All RTEP projects with costs totaling at least \$5 million are still included in this state report.

For a complete list of all RTEP projects, including those below the RTEP threshold of \$10 million, please visit the “RTEP Upgrades & Status – Transmission Construction Status” page on [pjm.com](https://www.pjm.com).

<https://www.pjm.com/planning/rtep-upgrades-status/construct-status.aspx>