



2018 Ohio State Infrastructure Report

(January 1, 2018 – December 31, 2018)

May 2019

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- Generation Portfolio Analysis
- Transmission Analysis
- Load Forecast

2. Markets

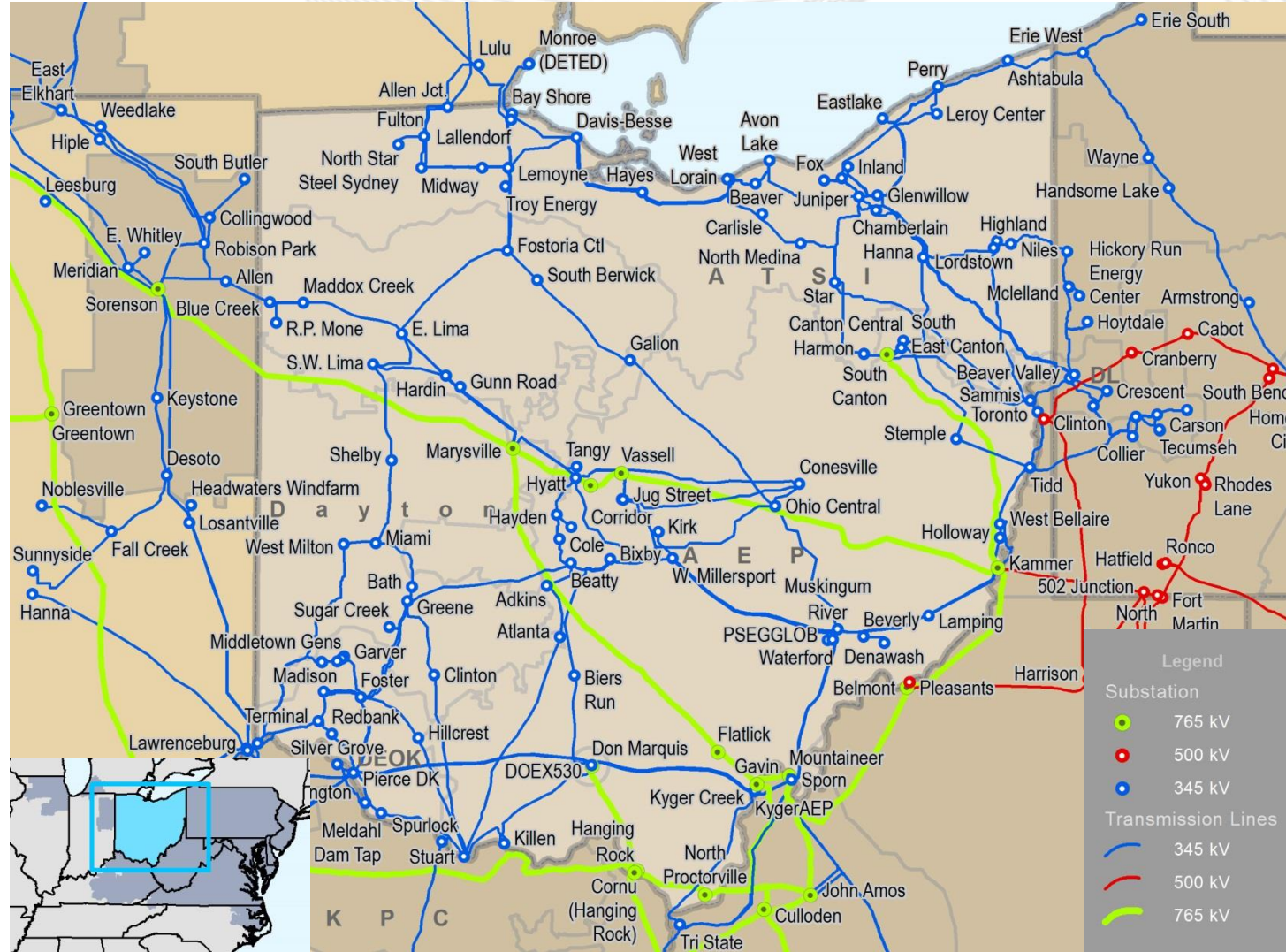
- Capacity Market Results
- Market Analysis

3. Operations

- Emissions Data

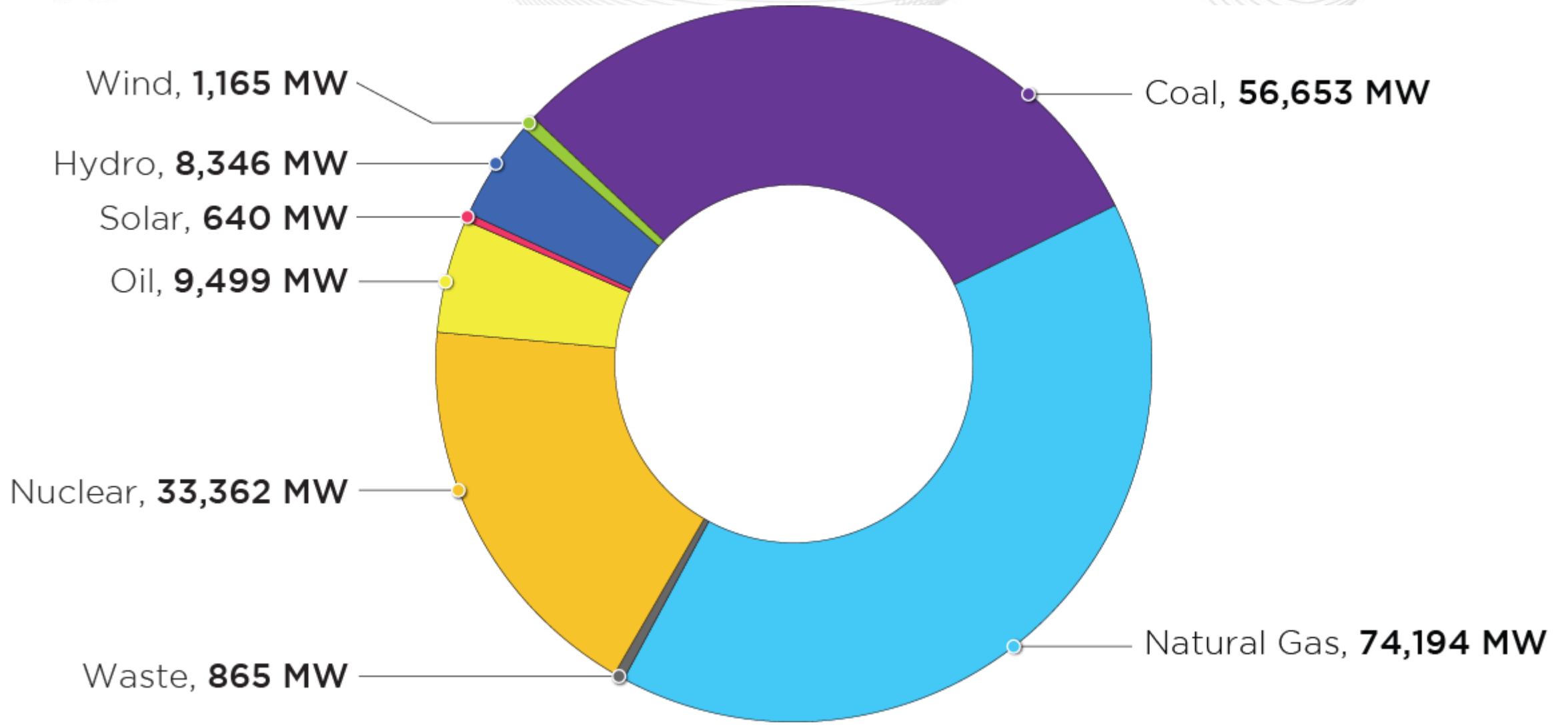
- **Existing Capacity:** Natural gas represents approximately 43.5 percent of the total installed capacity in Ohio while coal represents approximately 46.3 percent. In PJM natural gas and coal account respectively for 40.2 and 30.7 percent of the total installed capacity.
- **Interconnection Requests:** Natural gas represents approximately 68.2 percent of new interconnection requests in Ohio.
- **Deactivations:** 4,481 MW of capacity within Ohio gave a notification of deactivation in 2018.
- **RTEP 2018:** Ohio RTEP 2018 projects total more than \$1.6 billion in investment. Approximately 91.5 percent of that represents supplemental projects. These investment figures only represent RTEP projects that cost at least \$5 million.
- **Load Forecast:** Ohio load growth is nearly flat, averaging between 0.1 and 0.5 percent per year over the next 10 years. This aligns with PJM RTO load growth projections.

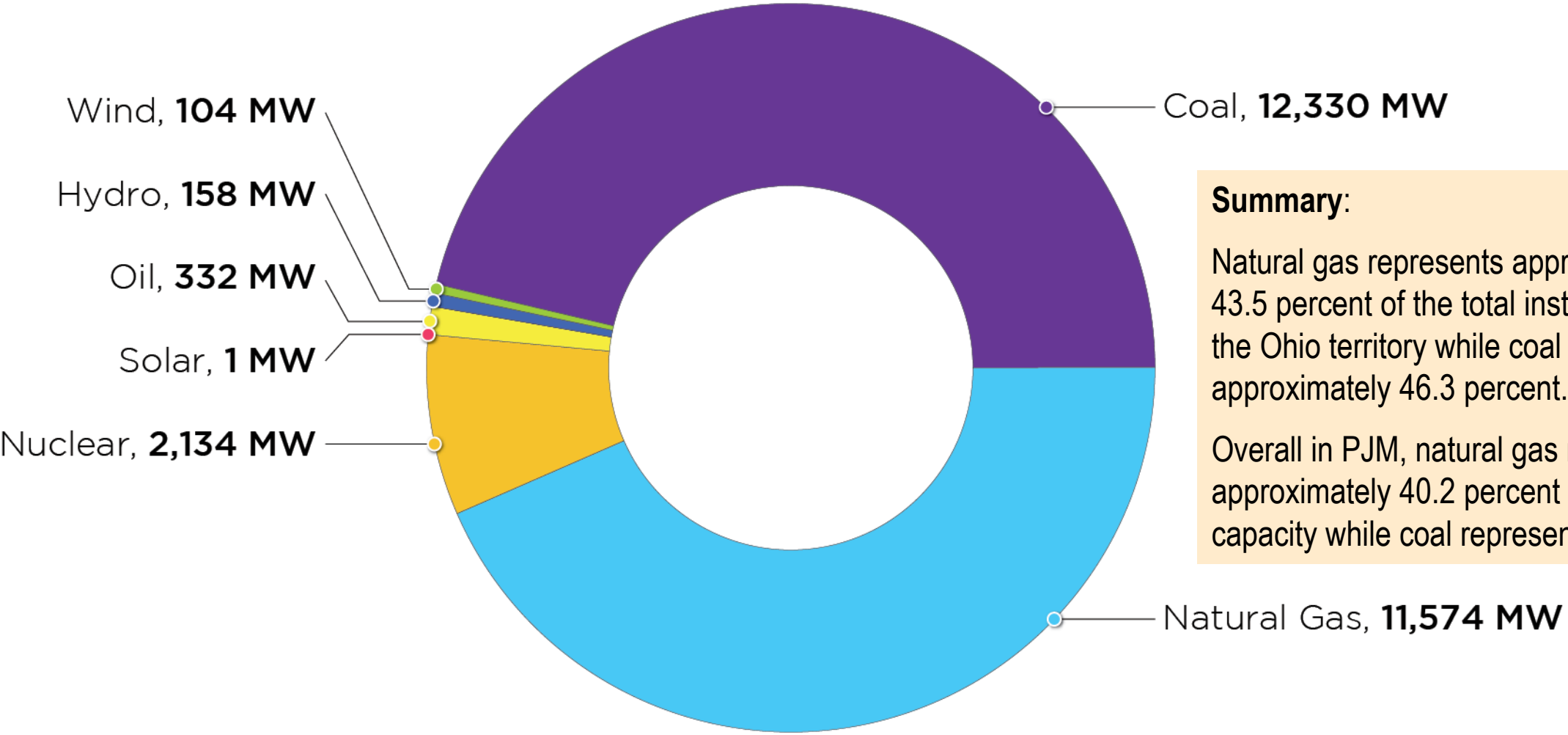
- **2021/22 Capacity Market:** Ohio cleared 615 MW more Demand Response and Energy Efficiency resources than in the prior auction.
- **1/1/18 – 12/31/18 Market Performance:** Ohio's average daily locational marginal prices were slightly above PJM average LMPs during daytime hours in 2018. Coal accounted for 32.7 percent of the generation produced in Ohio.
- **Emissions:** 2018 carbon dioxide, sulfur dioxide and nitrogen oxide emissions decreased from 2017.



Planning

Generation Portfolio Analysis





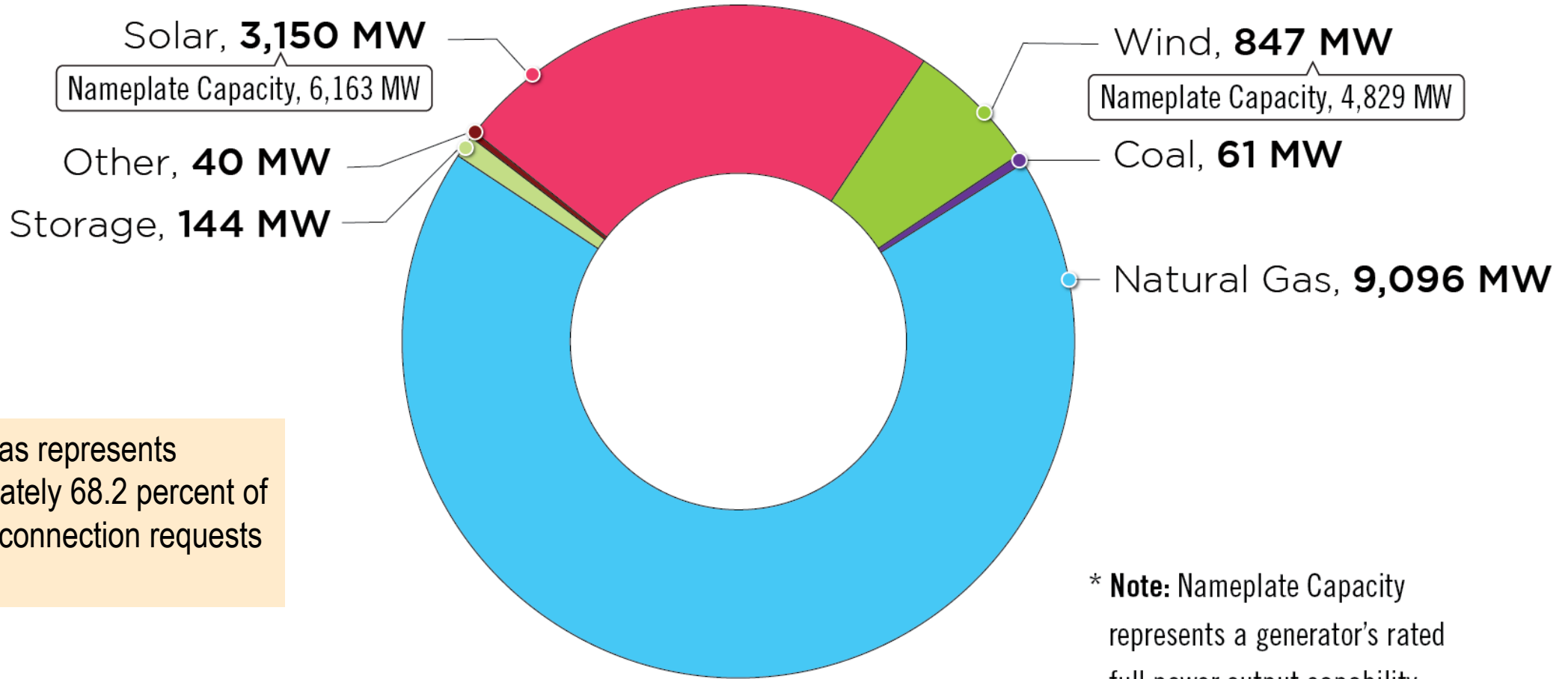
Summary:

Natural gas represents approximately 43.5 percent of the total installed capacity in the Ohio territory while coal represents approximately 46.3 percent.

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

Ohio – Queued Capacity (MW) by Fuel Type

(as of December 31, 2018)

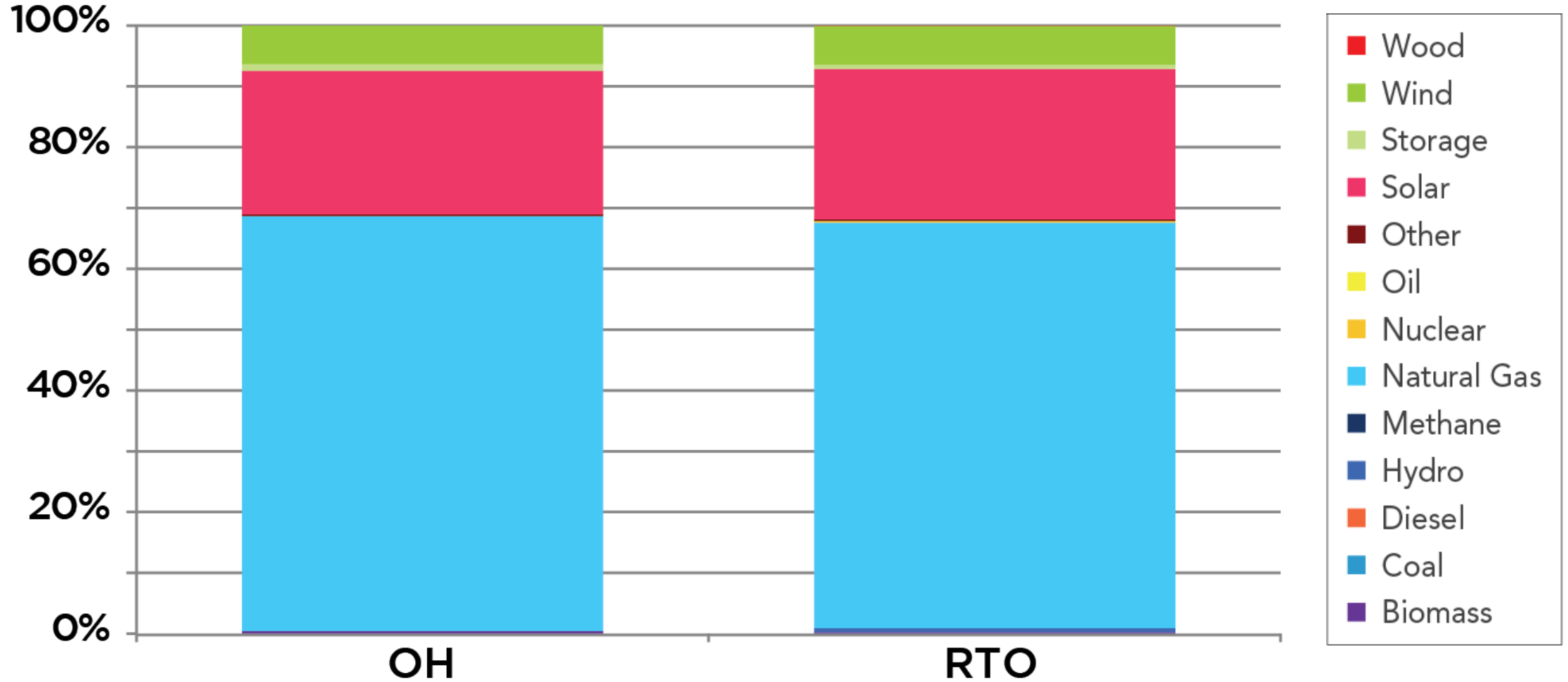


Natural gas represents approximately 68.2 percent of new interconnection requests in Ohio.

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

Ohio – Percentage of Projects in Queue by Fuel Type

(as of December 31, 2018)





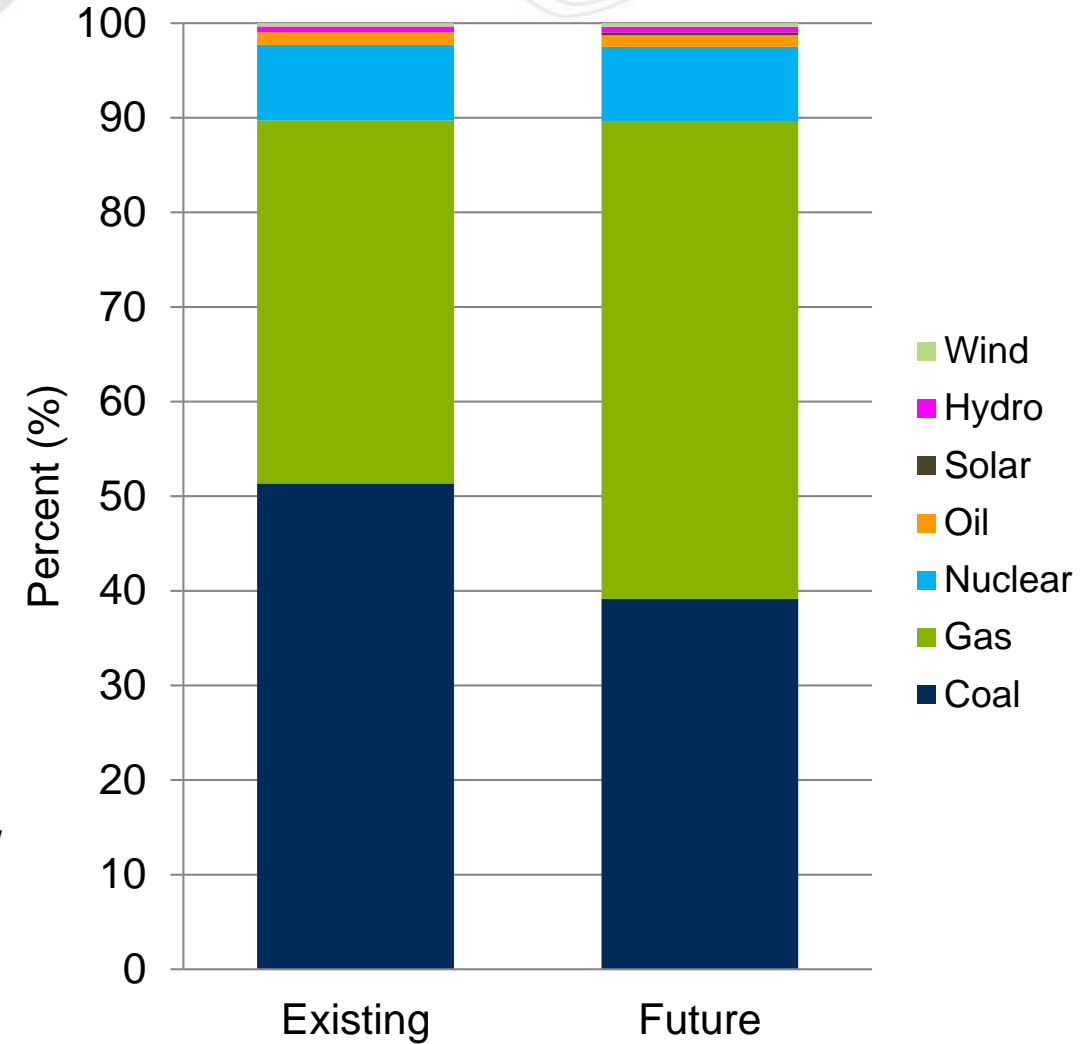
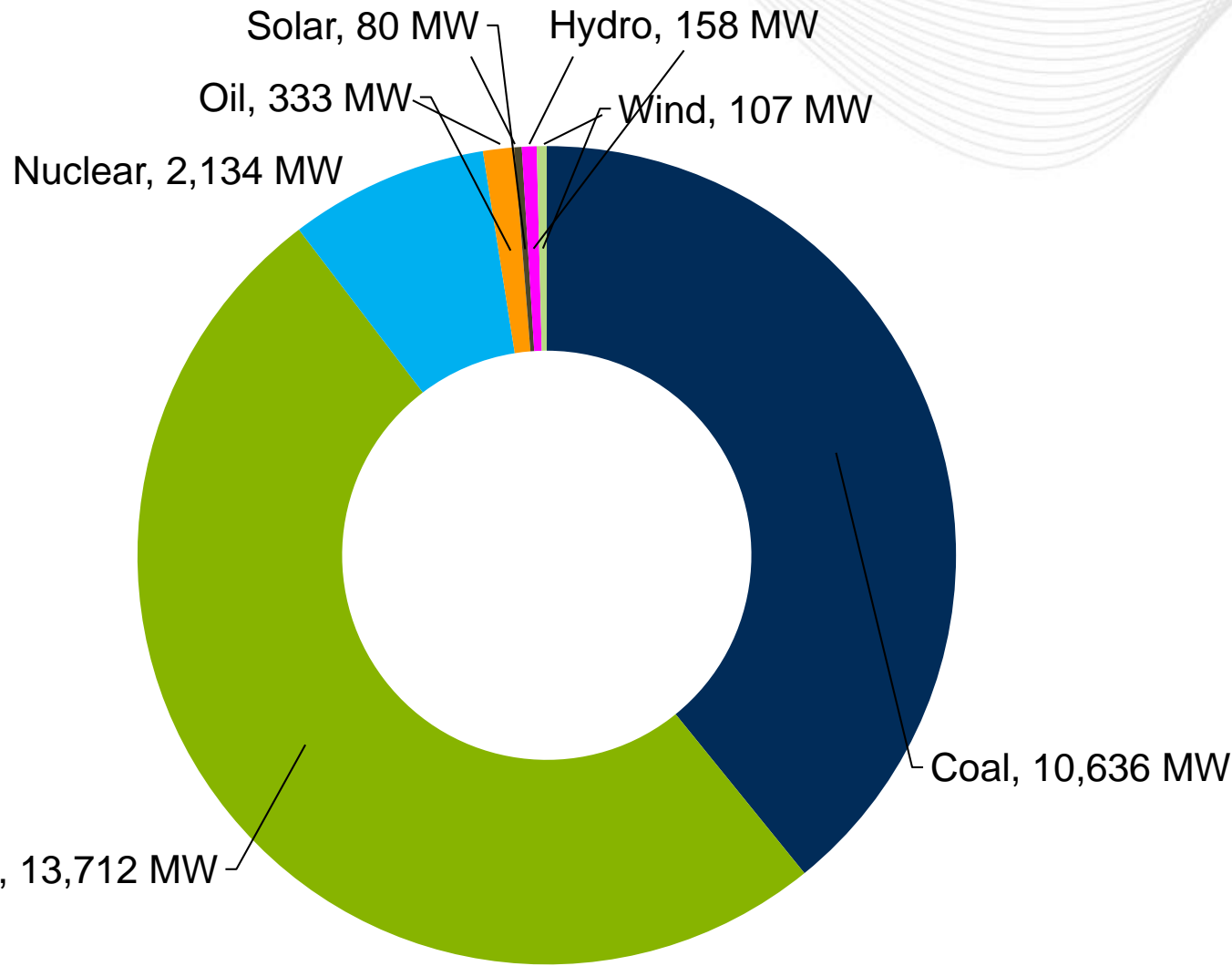
Ohio – Interconnection Requests

(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	51	4,166	64	19,909	21	8,202	1	0.0	4	1,139	141	33,416
Coal	17	299.5	15	8,883.0	2	29.0	0	0.0	2	32.0	36	9,243.5
Diesel	1	7.0	0	0.0	0	0.0	0	0.0	0	0.0	1	7.0
Natural Gas	24	3,843.5	28	10,701.4	15	7,990.7	0	0.0	1	1,105.0	68	23,640.6
Nuclear	1	16.0	0	0.0	0	0.0	0	0.0	0	0.0	1	16.0
Oil	0	0.0	1	5.0	0	0.0	0	0.0	0	0.0	1	5.0
Other	0	0.0	4	320.0	1	40.0	0	0.0	0	0.0	5	360.0
Storage	8	0.0	16	0.0	3	142.0	1	0.0	1	1.9	29	143.9
Renewable	17	289	169	3,750	80	3,676	6	104	8	217	280	8,036
Biomass	1	0.0	1	0.0	0	0.0	0	0	0	0.0	2	0.0
Hydro	1	112.0	8	76.2	0	0.0	0	0	0	0.0	9	188.2
Methane	9	50.9	10	26.1	0	0.0	0	0	0	0.0	19	77.0
Solar	1	1.0	89	2,143.9	66	3,054.9	3	19.0	2	76.0	161	5,294.7
Wind	5	125.0	61	1,503.5	14	621.5	3	84.5	6	141.0	89	2,475.6
Grand Total	68	4,454.8	233	23,659.1	101	11,878.1	7	103.5	12	1,355.9	421	41,451.5

Ohio – Future Capacity Mix

Based on known queued interconnection requests and deactivation notices through December 31, 2022 as of December 31, 2017, adjusted to reflect the probability of commercialization as indicated by historical trends specific to an interconnection request's state/zonal location and fuel type.



Ohio – Progression History Interconnection Requests

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



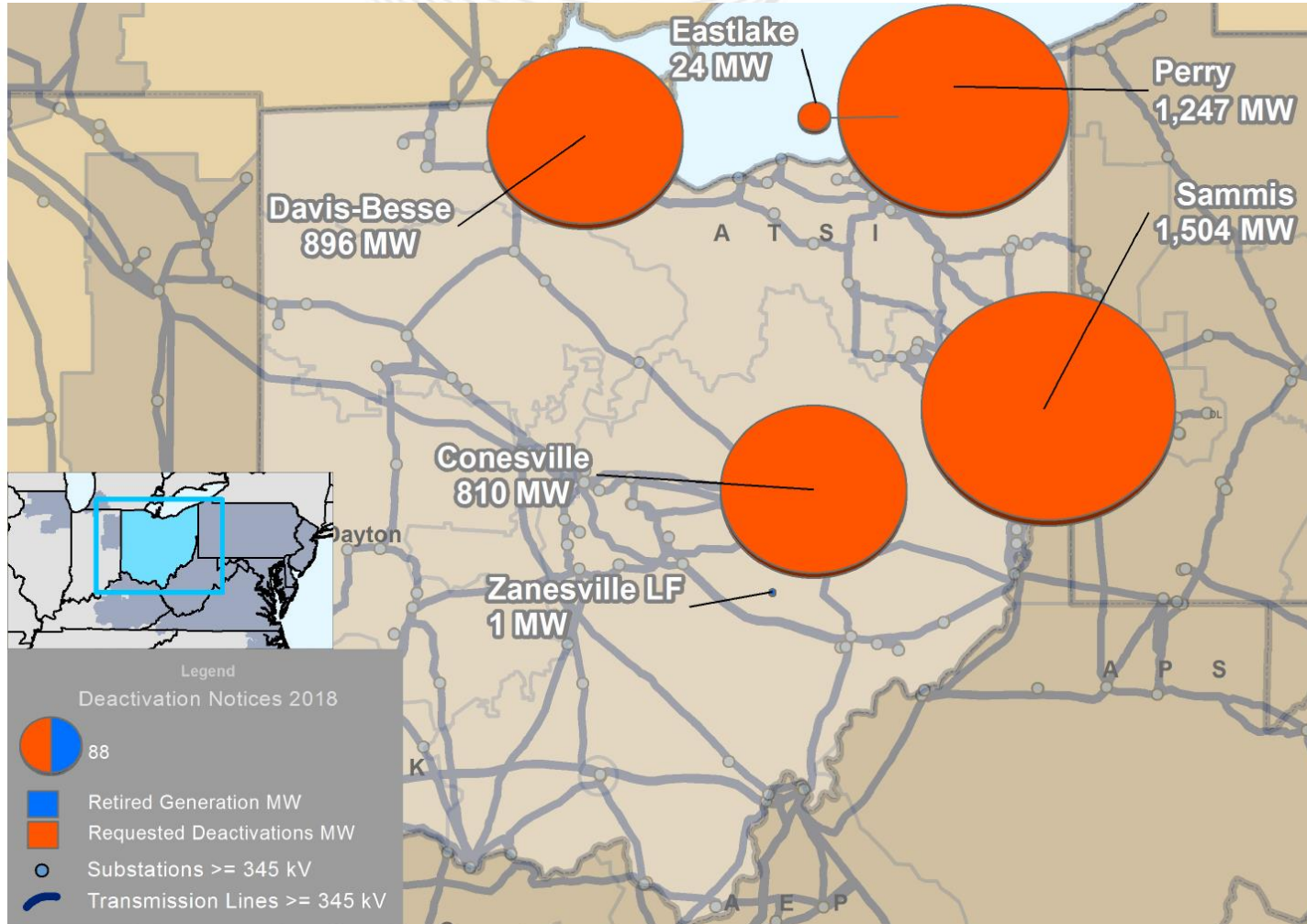
Projects withdrawn after final agreement

- 16 Interconnection Service Agreements – 3,462 MW (Nameplate Capacity, 4,743 MW)
- 11 Wholesale Market Participation Agreements – 16 MW (Nameplate Capacity, 53 MW)

Percentage of planned capacity and projects reached commercial operation

- 15.2 % requested capacity megawatt
- 21.6 % requested projects

Ohio – Actual Generation Deactivations and Deactivation Notifications Received in 2018





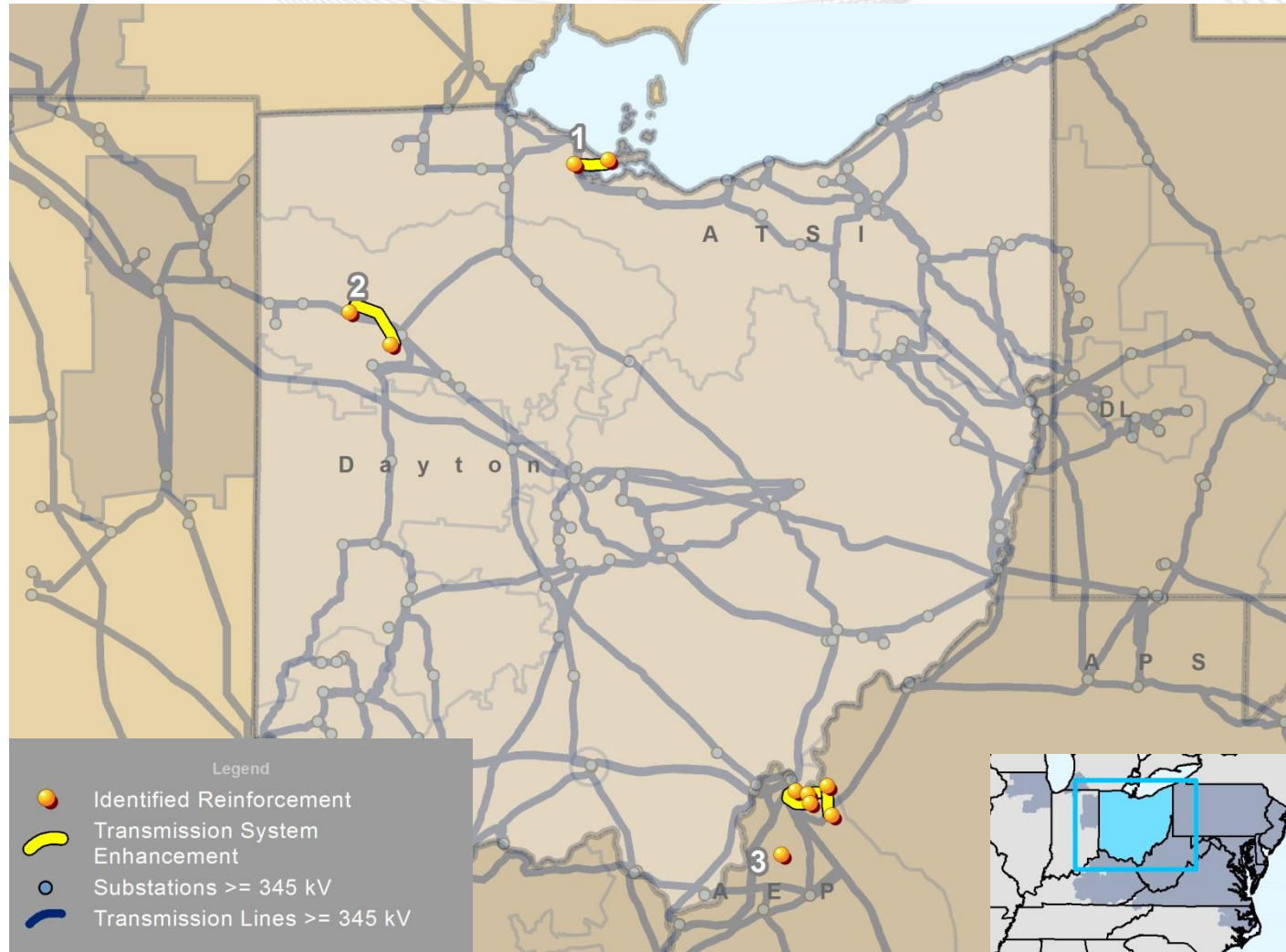
Ohio – Actual Generation Deactivations and Deactivation Notifications Received in 2018

Unit	Capacity (MW)	TO Zone	Age (Years)	Projected/Actual Deactivation Date
Perry	1,247	ATSI	31	5/31/2021
Davis Besse 1	896	ATSI	41	5/31/2020
Sammis 6	600	ATSI	49	6/1/2022
Sammis 7	600	ATSI	47	6/1/2022
Conesville 5	405	AEP	42	6/1/2019
Conesville 6	405	AEP	40	6/1/2019

Unit	Capacity (MW)	TO Zone	Age (Years)	Projected/Actual Deactivation Date
Sammis 5	291	ATSI	51	6/1/2022
Eastlake 6	24	ATSI	45	6/1/2021
Sammis Diesel	13	ATSI	46	6/1/2021
Zanesville Landfill	1	AEP	8	9/8/2018

Planning

Transmission Infrastructure Analysis



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



Ohio – 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	Baseline Load Growth Deliverability & Reliability	TO Criteria Violation
1	b3033	.0	Ottawa-Lakeview 138 kV reconductor and substation upgrades	12/1/2023	\$20	ATSI	8/31/2018	X	
2	b3036	.0	Rebuild 15.4 miles of double circuit North Delphos-Rockhill 138 kV line	12/1/2023	\$24.5	AEP	8/31/2018	X	
3	b3040	.1	Rebuild 15 miles of Ravenswood-Racine Tap 69 kV line to 69 kV standards, utilizing 795 26/7 ACSR conductor	6/1/2022	\$68.1	AEP	8/31/2018		X
		.4	Install new 138/12 kV 20 MVA transformer at Polymer station to transfer load from Mill Run station to help address overload on the 69 kV network	6/1/2022		AEP	8/31/2018		X
	b3079		Replace the Wylie Ridge 500/345 kV transformer No. 7	6/1/2022	\$6.37	APS	11/8/2018		X

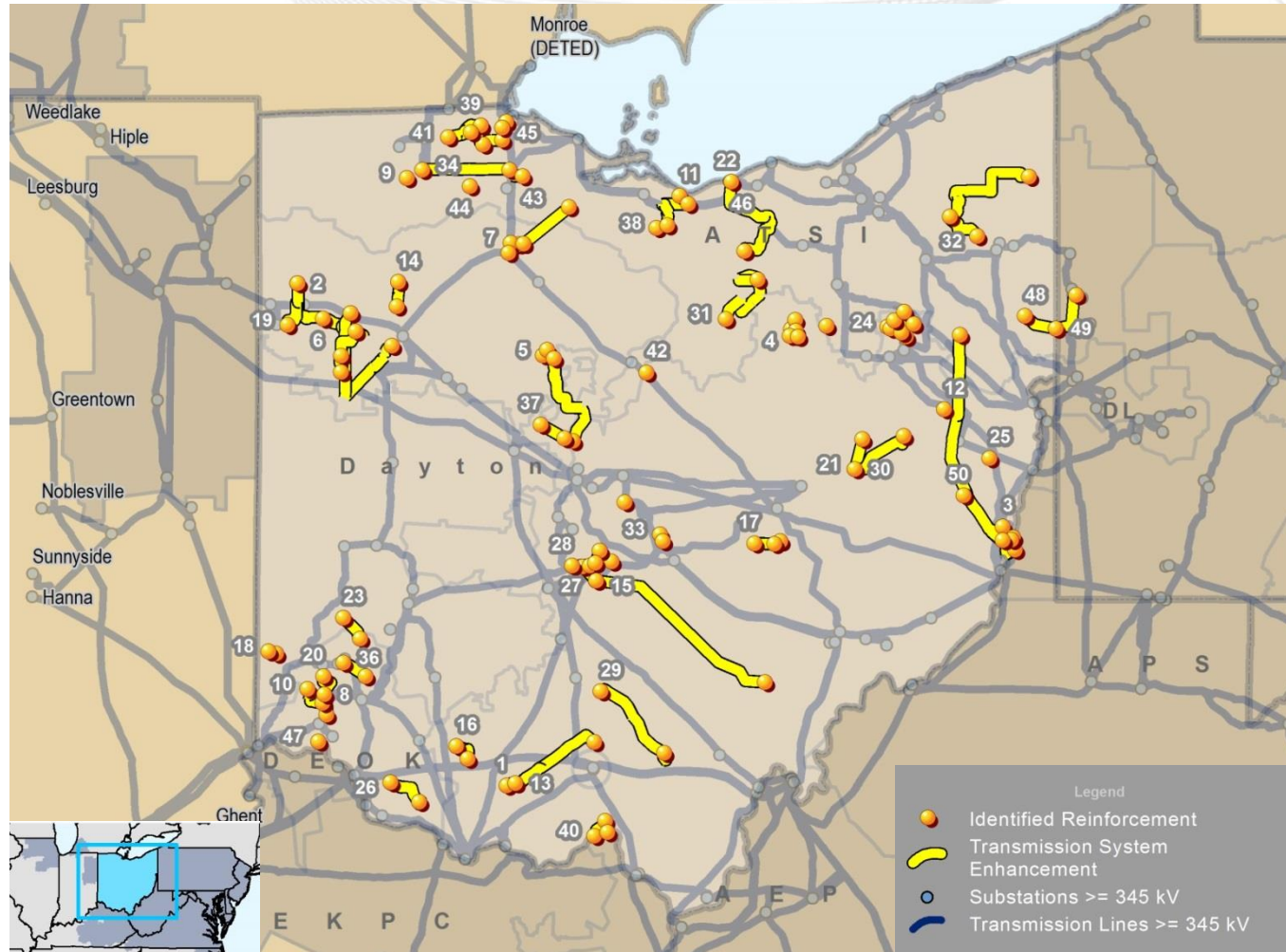


Ohio – RTEP Network Projects

(Greater than \$5 million)

Map ID	Project	Description	Project Driver	Queue	Required In-Service Date	Project Cost (\$M)	TO Zone	2018 TEAC Review
	n5699	Build a new 138 kV Switching Station with required Protection and Controls	Generation	AC2-015 (Solar)	12/31/2019	\$5.95	AEP	9/13/2018
	n5730	Build a new 138 kV Switching Station	Generation	AC2-043 (Solar)	12/15/2018	\$5.95	AEP	9/13/2018
	n5896	Install new 3 breaker ring interconnection switchyard for the AC1-085 project	Generation	AC1-085c(Solar)	1/31/2018	\$6.05	Dayton	9/13/2018

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.



Ohio – TO Supplemental Projects

(Greater than \$5 million)

Map ID	Project	Description	Projected In-Service Date	Project Cost (\$M)	TO Zone	2018 TEAC Review
1	s1621	Rebuild the 138 kV line from Waverly to Adams utilizing aluminum conductor steel cable (296 MVA). Remove old line after rebuild complete.	5/29/2020	\$66	AEP	4/17/2018
		Rebuild two independent lines, less than 0.5 mile apart, between Seaman and Adams, one 138 kV and one 69 kV, as a double circuit for approximately 8.5 miles using aluminum conductor steel cable. Remove old lines after rebuild complete. There will also need to be a short single circuit tap for Lawshe 69 kV.	3/19/2021		AEP	4/17/2018
		A three-way switch structure will be constructed outside Lawshe 69 kV substation.	3/19/2021		AEP	4/17/2018
2	s1563	Rebuild 15.6 miles of double-circuit 138 kV line utilizing aluminum conductor steel cable conductor (296 MVA rating) at Haviland-North Delphos 138 kV.	12/18/2020	\$48.8	AEP	2/14/2018
3	s1623	Rebuild the West Bellaire - Moundsville 69 kV circuit. Utilize aluminum conductor steel cable conductor (128 MVA rating). The extension into Monroe Street will be rebuilt as a double-circuit loop. The extension into Shadyside will be mostly rebuilt as a double-circuit loop.	3/1/2023	\$42.3	AEP	4/17/2018
		Convert Monroe Street to in-and-out with two 69 kV breakers. Replace 12 kV breakers and regulators. Install 69 kV circuit switcher. Remove inoperable line switches at West Monroe Street and West Shadyside. Install new three-way motor-operated air breaker switch.	6/1/2022		AEP	4/17/2018



Ohio – TO Supplemental Projects (cont.)

(Greater than \$5 million)

Map ID	Project	Description	Projected In-Service Date	Project Cost (\$M)	TO Zone	2018 TEAC Review
4	s1511	Construct double-circuit line extension to Clutch switch (0.5 miles).	6/14/2018	\$35.6	AEP	2/14/2018
		Construct a single-circuit line to close the loop between Schafrath and Madisonburg (2 miles).	6/14/2018		AEP	2/14/2018
		Rebuild Clutch Switch to Tigers as single circuit (1.5 miles).	6/14/2018		AEP	2/14/2018
		Rebuild from Schafrath to Oakhills switch (3.0 miles single circuit) and from Oakhills to Highland (0.4 miles double circuit).	5/24/2018		AEP	2/14/2018
		Establish a new station to serve customer (Clutch).	6/14/2018		AEP	2/14/2018
		Establish a new station at Schafrath to eliminate hard tap and loop lines.	5/31/2018		AEP	2/14/2018
		Expand Madisonburg station to establish new line exit to Schafrath.	5/24/2018		AEP	2/14/2018
		Construct new station at Tigers to eliminate hard tap and replace Smithville station.	6/30/2020		AEP	2/14/2018
		Install new phase-over-phase switch at Geyer.	12/6/2019		AEP	2/14/2018
		Retire Oakhills switch and establish a new box bay at Highland Avenue for the double-circuit line.	6/30/2020		AEP	2/14/2018
		Retire Orrville Road switch.	1/15/2020		AEP	2/14/2018
		Upgrade relaying at West Wooster.	6/14/2018		AEP	2/14/2018
		Upgrade relaying at East Wooster.	6/14/2018		AEP	2/14/2018
		Retire Smithville station.	12/6/2019		AEP	2/14/2018
5	s1564	Rebuild approximately 27.7 miles from Harpster 69 kV Station-Waldo 69 kV station utilizing aluminum conductor steel cable conductor.	6/4/2021	\$31.16	AEP	2/14/2018
		Replace existing two-way switch at Harpster Pump station with three-way switch.	6/4/2021		AEP	2/14/2018
		Install a one-way phase-over-phase switch just north of Ridgedale (Marion Rural Co-op).	6/4/2021		AEP	2/14/2018
		Remove station West Marion switch.	6/4/2021		AEP	2/14/2018



Ohio – TO Supplemental Projects (cont.)

(Greater than \$5 million)

Map ID	Project	Description	Projected In-Service Date	Project Cost (\$M)	TO Zone	2018 TEAC Review
6	s1617	Rebuild North Spencerville station. Install two 69 kV circuit breakers.	12/20/2018	\$30.1	AEP	4/17/2018
		At North Middlepoint station, construct new high-side switching facilities. Install one motor-operated air breaker, switch and circuit switcher.	7/11/2019		AEP	4/17/2018
		At South Kossuth station, install a new one-way switch toward North Spencerville, retire the existing one-way switch and build a section of line in the clear on the north side of the highway.	2/14/2019		AEP	4/17/2018
		Rebuild existing Delphos–Van Wert 69 kV line with aluminum conductor steel cable (128 MVA rating), including partial line reroute.	11/30/2020		AEP	4/17/2018
		Rebuild existing East Delphos–Kossuth 69 kV line with aluminum conductor steel cable, including partial reroute.	6/30/2020		AEP	4/17/2018
7	s1614	At Buckley Road Station, replace two 69 kV breakers with 40 kA breakers and associated equipment. Add a 138 kV circuit breaker for high-side protection of transformer No. 1. This will replace the existing ground switching protection currently at the station.	12/7/2018	\$25.31	AEP	4/17/2018
		At Softail switch, replace the hard tap for the Rising Sun delivery point, on the Buckley Road–Fostoria Central 138 kV line, with a three-way phase-over-phase switch.	5/18/2018		AEP	4/17/2018
		Rebuild approximately 15.2 miles of the Allendale–Fremont Center 69 kV line with 138 kV line construction operated at 69 kV. The new line will be double circuit 138 kV construction for 0.6 miles at the Allendale end so that the customer served at Weaver switch can remain served at 69 kV even after a future 138 kV conversion of the rebuilt line. The remaining 14.6 miles of line rebuild will be single-circuit 138 kV construction.	12/31/2020		AEP	4/17/2018
8	s1537	Rebuild 9.5 miles of feeder between Evendale and Port Union 69 kV substations with new structures, hardware, switches and conductor.	4/1/2019	\$25	DEO&K	3/9/2018
9	s1525	Rebuild 16.3 miles of the Van Buren – Liberty Center line utilizing aluminum conductor steel cable (129 MVA rating).	6/5/2019	\$22.4	AEP	2/14/2018
		Install a new three-way phase-over-phase steel switching structure at the Buckeye Tap switch.	6/5/2019		AEP	2/14/2018



Ohio – TO Supplemental Projects (cont.)

(Greater than \$5 million)

Map ID	Project	Description	Projected In-Service Date	Project Cost (\$M)	TO Zone	2018 TEAC Review
10	s1657	Rebuild 10.5 miles of 69 kV feeder between Symmes and Northgreen substations including the tap to Port Union with 298 new structures, hardware and conductor. Capacity of the line will increase from 97 MVA to 150 MVA.	12/31/2022	\$21.3	DEO&K	5/21/2018
11	s1552	Expand Glidden substation from a straight bus to a ring bus. Install seven 138 kV breakers to create a ring bus. Install four transformer high side breakers.	12/31/2020	\$21	ComEd	2/14/2018
12	s1559	Rebuild approximately 18.7 miles of the Ross–Highland 69 kV Line using aluminum conductor steel cable conductor (128 MVA rating) and 69 kV self-supporting steel with partial reroute around Hillsboro.	12/1/2019	\$21	AEP	2/14/2018
		Replace Petersburg switch.	12/1/2019		AEP	2/14/2018
13	s1612	Rebuild the 69 kV Adams-Rarden line. The new line will be rebuilt adjacent to the existing one, leaving the old line in service until the work is completed. The new 69 kV line will be built with aluminum conductor steel cable (125 MVA).	6/1/2020	\$20.3	AEP	4/17/2018
		The switch at the Peebles Tap will be replaced with a three-way motor-operated air breaker switch. A new three-way motor-operated air breaker switch will be installed at the Davon Tap.	6/1/2020		AEP	4/17/2018
14	s1616	Rebuild 6.91 miles on Columbus Grove-Ottawa 69kV line with 795 aluminum conductor steel cable (128 MVA rating) in existing ROW. Remove taps to Ottawa station. Build 69kV line extensions to serve Glandorf station using 795 aluminum conductor steel cable. Retire Pratt Extension 69kV Line. Reconfigure 69kV connections at Agner switch. Remove line sections and de-energized conductor that will no longer be needed.	4/8/2019	\$19.1	AEP	4/17/2018
		Replace 69/12 kV Ottawa station with 69/12 kV Glandorf station at a new station site. Upgrade existing three-way switch at North Columbus Grove to three-way switch with a motor-operated air breaker. Replace three 69 kV circuit breakers and a 69 kV cap switcher at East Ottawa.	4/8/2019		AEP	4/17/2018



Ohio – TO Supplemental Projects (cont.)

(Greater than \$5 million)

Map ID	Project	Description	Projected In-Service Date	Project Cost (\$M)	TO Zone	2018 TEAC Review
16	s1609	Build a 4.5-mile 138 kV double circuit line from Sardinia Station to tap point on the Kenton–Wildcat 138 kV circuit, capable of 200 MVA. Once complete, remove the 11.9-mile 69 kV Seaman-Sardinia transmission line and associated 69 kV equipment at the Seaman and Sardinia substations.	12/1/2021	\$17	AEP	3/27/2018
		Install 138 kV bus and two 138 kV circuit breakers at Sardinia station.	12/1/2021		AEP	3/27/2018
17	s1514	Build a new 5.7-mile 69 kV line from Mount Sterling to Zanesville station with aluminum conductor steel cable (102 MVA rating) to close the radial loop.	12/7/2018	\$16.5	AEP	2/14/2018
		Zanesville–Linden Avenue 69 kV structure removal.	6/29/2018		AEP	2/14/2018
		Mount Sterling–Zanesville 69 kV fiber cable.	12/7/2018		AEP	2/14/2018
		At Zanesville station, install a 69 kV 40 kA circuit breaker. Replace three 69 kV breakers. Install a 138 kV high-side circuit breaker and a 69 kV low-side circuit breaker for the 138/69 kV transformer.	11/9/2018		AEP	2/14/2018
		At Mount Sterling station, install two 69 kV 40 kA circuit breakers in a box-bay configuration.	11/16/2018		AEP	2/14/2018
18	s1539	Rebuild 6.4 miles of 69 kV feeder between Locust and Todd substations with 54 new structures, hardware and conductor.	12/1/2018	\$16	DEO&K	3/9/2018
19	s1608	Retire existing Cavett two-way line switch. Replace with three-way line switch on new route with motor-operated air breaker facing West Van Wert.	12/31/2020	\$16	AEP	3/27/2018
		Rebuild existing Haviland–West Van Wert 69 kV line asset (14.6 miles) with aluminum conductor steel cable conductor (68 MVA rating, non-conductor limited), including partial line reroute. Remove old aluminum conductor steel cable, copper and aluminum conductor steel cable conductor.	12/31/2020		AEP	3/27/2018
20	s1587	Rebuild 5.8 miles of feeder between Princeton and Port Union substations with one 161 new structures, hardware and conductor.	12/31/2019	\$15.2	DEO&K	3/27/2018



Ohio – TO Supplemental Projects (cont.)

(Greater than \$5 million)

Map ID	Project	Description	Projected In-Service Date	Project Cost (\$M)	TO Zone	2018 TEAC Review
21	s1567	Relocate the Newcomerstown-Ray line to the 69 kV bay at Newcomerstown station.	12/21/2018	\$14.02	AEP	2/14/2018
		At Newcomerstown station, install a new 69 kV 40 kA circuit breaker for the Sundergroundarcreek terminal line exit. Remove the 34.5 kV circuit breaker. Replace the 50 MVA transformer with a 90 MVA transformer and install a high-side and low-side circuit breaker.	12/21/2018		AEP	2/14/2018
		At Ray station, install a 69 kV 40 kA bus tie circuit breaker and transformer circuit switchers. Install a 69/34.5 kV transformer to serve the existing customers.	12/16/2018		AEP	2/14/2018
		At Bakersville switch, remove existing and install new transformers due to the 34.5 kV to 69 kV conversion.	12/26/2018		AEP	2/14/2018
		At Sundergroundarcreek terminal station, install a 69 kV 40 kA circuit breaker for the Newcomerstown line exit. Remove 34.5 kV breaker.	12/21/2018		AEP	2/14/2018
		Relocate Ray-Sundergroundarcreek 69 kV line to 69 kV bay at Sundergroundarcreek terminal.	12/21/2018		AEP	2/14/2018
22	s1757	Replace two 345/138 kV transformers at Beaver and replace other equipment at station accordingly.	12/31/2021	\$12.7	ATSI	10/26/2018
23	s1599	Rebuild two 138 kV transmission lines between Hillsboro and Hutchings Tap as double circuit construction. Construct the 19-mile AEP segment from Middleboro to Hutchings Tap as a single circuit line using aluminum conductor steel cable conductor.	12/1/2021	\$114.6	AEP	3/27/2018
		The 1200 A switch at Middleboro will be upgraded to 2000 A. The new switch will have SCADA control, auto sectionalizing and loop opening/line dropping capability.	12/1/2021		AEP	3/27/2018
24	s1620	Rebuild the Northeast Canton 138/69/12 kV station on the existing property. Install a 138 kV four-breaker ring bus, 138-12 kV distribution transformer, 138-69 kV, 90 MVA transformer, 69 kV six-breaker ring bus, 69 kV capacitor bank (14 MVAR).	12/1/2020	\$11.9	AEP	4/17/2018
		At West Canton 138 kV station, replace 138 kV breaker, disconnects and relays.	12/1/2020		AEP	4/17/2018
		At Wagenhals 138 kV station, change relay settings to coordinate with Northeast Canton.	11/1/2019		AEP	4/17/2018
		At Packard 138 kV station, convert two manual line switches to auto-sectionalizing motor-operated air breakers.	12/6/2019		AEP	4/17/2018
		At Stanley Court, upgrade relays to coordinate with Northeast Canton.	5/31/2019		AEP	4/17/2018
		At Oakwood Road 69 kV station, replace 69 kV breaker and relays.	12/20/2019		AEP	4/17/2018
		At Diamond Street 69 kV station, remove two 69 kV breakers and replace with sectionalizing motor-operated air breakers.	12/1/2020		AEP	4/17/2018
		At California 69 kV station, relocate two breakers from Diamond Street and install new relays.	11/1/2019		AEP	4/17/2018



Ohio – TO Supplemental Projects (cont.)

(Greater than \$5 million)

Map ID	Project	Description	Projected In-Service Date	Project Cost (\$M)	TO Zone	2018 TEAC Review
25	s1517	Construct 138 kV-rated four-breaker ring bus, with a 14.4 MVAR capacitor bank.	10/28/2018	\$10.17	AEP	2/14/2018
		Reroute the three 69 kV lines to enter Parlett station.	10/28/2018		AEP	2/14/2018
		Retire Parlett 69 kV switch	11/15/2018		AEP	2/14/2018
26	s1669	Rebuild 9.8 miles of feeder between South Bethel and Brown substations with new structures, hardware and conductor. Replace one 69 kV switch.	12/31/2019	\$10	DEO&K	6/26/2018
27	s1487	Rebuild 54.4 miles of line between Harrison and Poston 138 kV stations with aluminum conductor steel cable (296 MVA rating) and steel poles.	6/27/2019	\$61.9	AEP	1/8/2018
28	s1493	Build a new Beatty-Madison 69 kV line utilizing 795 aluminum conductor steel cable (129MVA rating) in new right-of-way. Acquire existing aluminum conductor steel cable and aluminum conductor steel cable (73 MVA rating) in existing right-of-way.	12/1/2019	\$50.6	AEP	1/30/2018
		Rebuild single circuit 69 kV line from Harrison to Madison with aluminum conductor steel cable (129 MVA rating), mostly in existing right-of-way.	12/1/2019		AEP	1/30/2018
		Rebuild tap to Darbyville as double-circuit aluminum conductor steel cable (129 MVA rating).	10/18/2019		AEP	1/30/2018
		At Harrison station, replace the 138/69 kV transformer with a 90 MVA model. Install three 69 kV circuit breakers with 40 kA breakers. Install a 138 kV circuit breaker with a 63 kA breaker. Install a 69 kV capacitor.	2/1/2020		AEP	1/30/2018
		At Madison station, install two new 69kV 2,000A 40kA circuit breaker's and 1 600A 40kA circuit switcher	10/7/2019		AEP	1/30/2018
		At Big Darby switch, Dry Run switch, and Ballah switch, upgrade with 2000 A switches at new locations. Retire old switches.	9/30/2019		AEP	1/30/2018
29	s1432	Rebuild from Ross to Heppner (formerly Coalton). Single-circuit 138 kV rebuild with aluminum conductor steel cable Curlew conductor (148 MVA rating).	12/31/2021	\$50.3	AEP	1/8/2018
		Replace switches at Ginger with a new 138 kV phase-over-phase switch with motor-operated air breakers. Replace switches at Vigo with a new box bay and 138 kV breakers. Replace Pine Ridge switch with a new 138 kV phase-over-phase switch with motor-operated air breakers.	12/31/2021		AEP	1/8/2018



Ohio – TO Supplemental Projects (cont.)

(Greater than \$5 million)

Map ID	Project	Description	Projected In-Service Date	Project Cost (\$M)	TO Zone	2018 TEAC Review
30	s1488	Rebuild the 20-mile 69 kV transmission line between Newcomerstown and Dennison stations with aluminum conductor steel cable (148 MVA rating).	11/1/2019	\$33.4	AEP	1/8/2018
		Rebuild the 1.6 mile radial tap to Lock 17 station as a double-circuit 69 kV loop with aluminum conductor steel cable (148 MVA rating).	12/1/2019		AEP	1/8/2018
		At Lock 17 69 kV station, add a 69 kV station bay structure and two 69 kV motor-operated air breaker switches. Relocate the 69 kV capacitor bank and expand to 10.8 MVAR. Replace the transformer protection with a circuit switcher.	11/1/2019		AEP	1/8/2018
		Replace East Newcomerstown 69 kV switch with a new two-way switch. Retire Belden 69 kV switch.	12/1/2019		AEP	1/8/2018
31	s1478	Rebuild the Brookside-Homer 69 kV (29.6 miles) mix of conductor sizes as single circuit 69 kV with aluminum conductor steel cable but designed for future capability of double circuit 138/69 kV.	6/1/2018	\$27.4	ATSI	1/8/2018
32	s1475	Convert Dilworth substation to a five-breaker ring bus.	4/10/2019	\$23.1	ATSI	1/8/2018
		Rebuild 3.2 miles of 69 kV single-circuit aluminum conductor steel cable between Garrettsville and Ledges as double circuit steel cable to establish the Garrettsville-Dilworth and Garrettsville-Newton Falls 69 kV lines.	4/10/2019		ATSI	1/8/2018
		Install 14.4 MVAR capacitor at Parkman substation.	4/10/2019		ATSI	1/8/2018
33	s1510	At Kirk, install four 345 kV circuit breakers and end bus to complete the 345 kV breaker-and-a-half configuration. Replace 345/138 kV transformer with 675 MVA unit. Connect in different 345 kV bay and on new 138 kV string before removing old unit. Upgrade two 138 kV circuit breakers and retire one circuit breaker. Install two 138 kV circuit breakers. Install three new 138 kV circuit breakers. Upgrade three 138 kV circuit breakers with 3,000 A model. Separate 138/69 kV and 138/34 kV transformer connections and install a 138kV circuit switcher on distribution bank. Replace 138/34 kV transformer and two 34 kV circuit breakers.	12/1/2019	\$23	AEP	2/14/2018
		At Bixby, replace Kirk 345 kV line risers and line switch and upgrade relaying.	11/5/2019		AEP	2/14/2018
		Upgrade relaying at Junderground Street.	12/10/2020		AEP	2/14/2018
		Upgrade relaying at Junderground Street.	11/12/2019		AEP	2/14/2018
		Upgrade relaying at West Hebron.	6/4/2019		AEP	2/14/2018



Ohio – TO Supplemental Projects (cont.)

(Greater than \$5 million)

Map ID	Project	Description	Projected In-Service Date	Project Cost (\$M)	TO Zone	2018 TEAC Review
34	s1479	Rebuild Lemoyne-Midway 138 kV line with aluminum conductor steel cable (24.5 miles).	12/1/2017	\$19	ATSI	1/8/2018
35	s1429	Rebuild the Marion-Parson double circuit 40 kV line as single-circuit 69 kV energized to 40 kV.	3/7/2019	\$17.31	AEP	1/8/2018
		At Harrison station, relocate and install existing spare 138/40 kV transformer, 138 kV circuit breaker, and 69 kV circuit breaker.	3/7/2019		AEP	1/8/2018
		Parsons station, Replace two 40kV circuit breaker's with two 2,000A 69KV circuit breaker's, install 9.4MVAR capacitor bank	3/7/2019		AEP	1/8/2018
		Marion station, Install 9.4 MVAR capacitor bank and retire unused equipment.	3/7/2019		AEP	1/8/2018
36	s1485	Rebuild 5.8 miles of feeder between Warren and Nickel 138 kV substations with new structures, hardware and conductor for line capacity increase from 198 MVA to 300 MVA.	12/31/2018	\$15	DEO&K	1/8/2018
37	s1477	Rebuild 12.6 miles of single circuit aluminum conductor steel cable Kirby-Radnor 69 kV line with aluminum conductor steel cable and replace two-way switch with two separate one-way switches.	5/1/2019	\$14.3	ATSI	1/8/2018
38	s1476	Convert Adam substation to a four-breaker, future five-ring bus.	2/28/2019	\$12.4	ATSI	1/8/2018
		Reconfigure Adams substation to include terminals for: Carriage-Adams 69 kV, Adams-Shinrock 69 kV, Adams transformers No. 1 and No. 2 to make the substation layout to support line-load-line configuration.	5/8/2019		ATSI	1/8/2018
39	s1472	Convert Ford Road substation to a four breaker ring bus.	12/31/2018	\$10	ATSI	1/8/2018
		Reconfigure line exits for Ford Road-Maclean 69 kV, Ford Road-Vulcan 69 kV, 69 kV capacitor bank and Ford Road transformer to make the substation layout support line-load-line configuration.	12/31/2018		ATSI	1/8/2018



Ohio – TO Supplemental Projects (cont.)

(Greater than \$5 million)

Map ID	Project	Description	Projected In-Service Date	Project Cost (\$M)	TO Zone	2018 TEAC Review
40	s1692	At Friendship station, install a 69 kV line circuit breaker & line motor-operated air break. At Sugar Hill station, upgrade bus through-path and replace switches to accommodate the line reconfigurations. At North Portsmouth, replace 138-69 kV transformer with a 90 MVA unit with a 138 kV circuit switcher, replace 138 kV circuit breaker C and 69 kV circuit breaker A. Remove bus tie 138 kV circuit breaker D and install a new 138 kV circuit breaker to isolate Millbrook Park line. Install a new 69 kV circuit breaker on low side of the transformer. At Millbrook Park, replace relay & install a CCVT on North Portsmouth Line. At Central Portsmouth, replace 138 kV circuit breakers G & H. At Rosemount, install two line MOAB switches inside substation and replace the ground switch MOAB with a 69 kV circuit switcher.	3/24/2023	\$54.4	AEP	8/31/2018
		Build a new 8.5 mile 69 kV line from Friendship Station to Central Portsmouth Station, using 556 ACSR (102 MVA) and remove the old Central Portsmouth-Sugar Hill Line. Rebuild the remaining 13.9 miles of the Friendship Loop from North Portsmouth to Rosemount, from Rosemount to Sugar Hill and from Sugar Hill to Friendship using 556 ACSR (102 MVA) and ADSS.	11/6/2020		AEP	8/31/2018
41	s1700	Angola-Eber-Vulcan 138 kV three-terminal line elimination project	6/1/2021	\$13.4	ATSI	9/28/2018
42	s1701	Build new Snyder 69 kV switching station	6/1/2020	\$13.2	ATSI	9/28/2018
43	s1702	Lemoyne-Woodville-Fostoria 138 kV four-terminal line elimination project	6/1/2020	\$11.3	ATSI	9/28/2018
44	s1703	Expand Brim 138/69 kV substation	3/1/2020	\$19.9	ATSI	9/28/2018
45	s1705	Expand 69 kV bus at Ryan substation	3/1/2020	\$10.8	ATSI	9/28/2018
46	s1711	Rebuild Beaver-Wellington 138 kV line to double circuit	12/31/2020	\$20	ATSI	9/28/2018
47	s1714	Build new Ashland 138/69 kV Substation	8/28/2020	\$12.9	ATSI	9/28/2018
48	s1715	Rebuild Columbiana-State 69 kV line	12/31/2019	\$16.7	ATSI	9/28/2018
49	s1716	Rebuild New Castle-State 69 kV line	12/31/2021	\$29.2	ATSI	9/28/2018
50	s1718	Rebuild Holloway-Nottingham-Knox 138 kV line	6/1/2021	\$79.9	ATSI	9/28/2018
	s1468	Construct a four breaker 138 kV ring bus substation near the existing Nash substation. Loop and terminate the Eastlake-Leroy Center Q15 and Q16 13 8kV lines through the new ring bus	12/31/2019	\$8.6	ATSI	1/8/2018



Ohio – TO Supplemental Projects (cont.)

(Greater than \$5 million)

Map ID	Project	Description	Projected In-Service Date	Project Cost (\$M)	TO Zone	2018 TEAC Review
	s1470	Convert Stevens 69 kV substation to a four breaker ring bus. Reconfigure Stevens substation to include terminals for: Galion-Stevens 69 kV, Stevens-Leaside 69 kV, Stevens-Galion Muni (Chevy) 69 kV, and Stevens transformer to make the Station layout support line-load-line configuration	5/1/2019	\$5.6	ATSI	1/8/2018
	S1521	Install four 69 kV circuit breakers in a ring bus configuration at Somerset Switch.	12/15/2020	\$5.7	AEP	2/14/2018
	s1553	Remove Lisle tertiary capacitor banks and install 138 kV capacitor banks; Increase the thermal capability of the 345-138 kV autotransformer.	5/15/2019	\$6	ComEd	2/14/2018
	s1557	Rebuild the North Liberty Sw-West Bellville Sw section (12 miles) of the Mount Vernon-Howard 69 kV line with the conductor size 959.6 ACSR/TW (141 MVA rating).	6/28/2019	\$8.5	AEP	2/14/2018
	s1604	Rebuild 69 kV transmission line from Oneida Switch to Pekin (3.5 miles) with 795 ACSR (125 MVA rating). Update and modify right-of-way to accommodate the rebuild. Remove the old T-Line.	12/1/2019	\$5.4	AEP	3/27/2018
	S1618	Rebuild the existing 69 kV yard as a six-circuit breaker ring bus station, using 2000A, 40 kA breakers. The Plant's existing auxiliary power source, the 138-69 kV transformer No. 2, will terminate into the ring along with the local service 138-69 kV transformer No. 1. Add 1 new circuit breaker (138 kV) at the high side of the transformer No. 1. The station's auxiliary power will then be supplied from the ring. Associated PCE upgrades	10/14/2019	\$9.2	AEP	4/17/2018
	s1658	Rebuild 6.1 miles of feeder between Princeton and Trenton substations with 137 new structures, hardware, and conductor. Replace two 69 kV switches. Capacity of the line will increase from 97 MVA to 107 MVA (bus limited).	12/31/2020	\$7.8	DEOK	5/21/2018
	s1662	At the Tidd 138 kV station, replace the five remaining 'ATB' air-blast circuit breakers with new 4000A 63kA units. Install two 138 kV bus-tie breakers. Install new protection and communications equipment in a new drop-in control module and demolish the old control house. Install a 58 MVAR cap bank. To address safety hazards, replace and relocate a number of manual disconnect switches throughout the station.	12/1/2020	\$9.1	AEP	4/17/2018

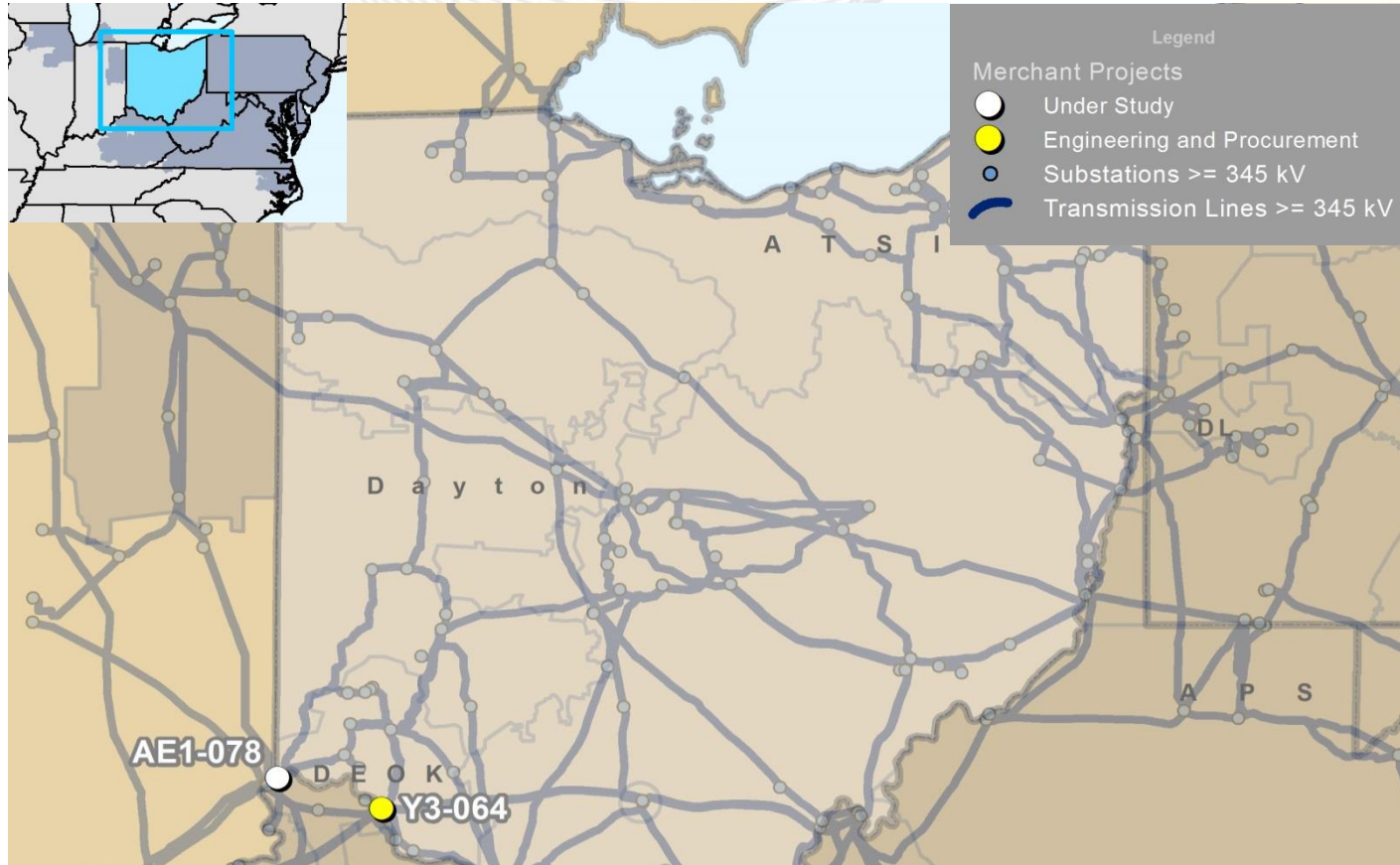


Ohio – TO Supplemental Projects (cont.)

(Greater than \$5 million)

Map ID	Project	Description	Projected In-Service Date	Project Cost (\$M)	TO Zone	2018 TEAC Review
	s1689	At Divelbiss station install four 69 kV 2000 A 40 kA circuit breakers in a ring bus configuration. Also install fiber cable extension at the station.	10/29/2019	\$7.5	AEP	7/27/2018
	s1696	Expand 138 kV ring bus at Crissinger substation	12/31/2019	\$5.8	ATSI	8/31/2018
	s1698	Richland-Wauseon-Midway 138 kV Three-Terminal Line Elimination Project	12/31/2019	\$7.7	ATSI	8/31/2018
	s1706	Expand 138 kV Bus at Talmadge substation	12/31/2020	\$6.1	ATSI	8/31/2018
	s1707	Expand 138 kV Bus at Dixie substation	6/1/2020	\$7.7	ATSI	8/31/2018
	s1708	Expand 138 kV Bus at Darrow substation	5/23/2020	\$8.1	ATSI	8/31/2018
	s1709	Expand 138 kV Bus at Aetna substation	12/31/2021	\$6.5	ATSI	8/31/2018
	s1745	Expand and Reconfigure Ebenezer 138/69/33 kV Substation	12/31/2020	\$9	DEOK	8/31/2018
	s1746	Rebuild 69 kV Line (6631) from Cisco Substation to Botkins Substation	12/31/2019	\$7.43	Dayton	8/31/2018
	s1754	Replace Avon 345/138 kV No. 91 transformer. Replace existing Avon No. 91 345/138 kV transformer (448 MVA) with a new 345/138 kV transformer (560 MVA). Replace terminal equipment including the substation conductor.	12/31/2019	\$5.8	ATSI	10/26/2018
	s1755	Replace Fox 345/138 kV No. 5 Transformer. Replace existing Fox No. 5 345/138 kV transformer (224 MVA) with a new 345/138 kV transformer (280 MVA). Replace terminal equipment including 138 kV circuit breaker Q5, substation conductor, CCVT and associated relaying.	12/31/2019	\$6.3	ATSI	10/26/2018

Ohio – Merchant Transmission Project Requests

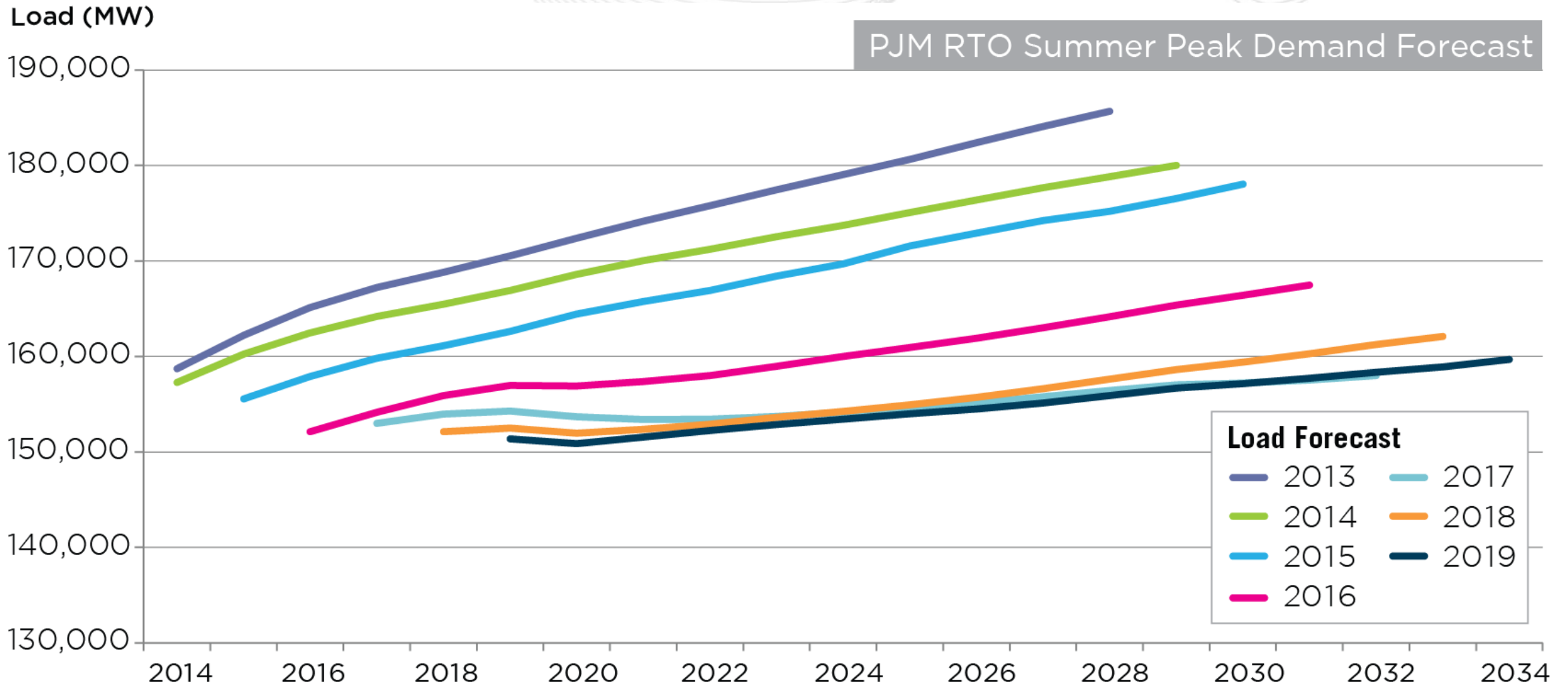


Queue	Project Name	Maximum Output (MW)	Status	Projected In-Service Date	TO Zone
Y3-064	Pierce-Beckjord 138 kV	160	Engineering and Procurement	4/3/2019	DEO&K
AE1-078	Greendale-Miami Fort 138 kV	50	Active	6/1/2020	DEO&K

Planning

Load Forecast

PJM RTO Summer Peak Demand Forecast





Ohio – 2019 Load Forecast Report

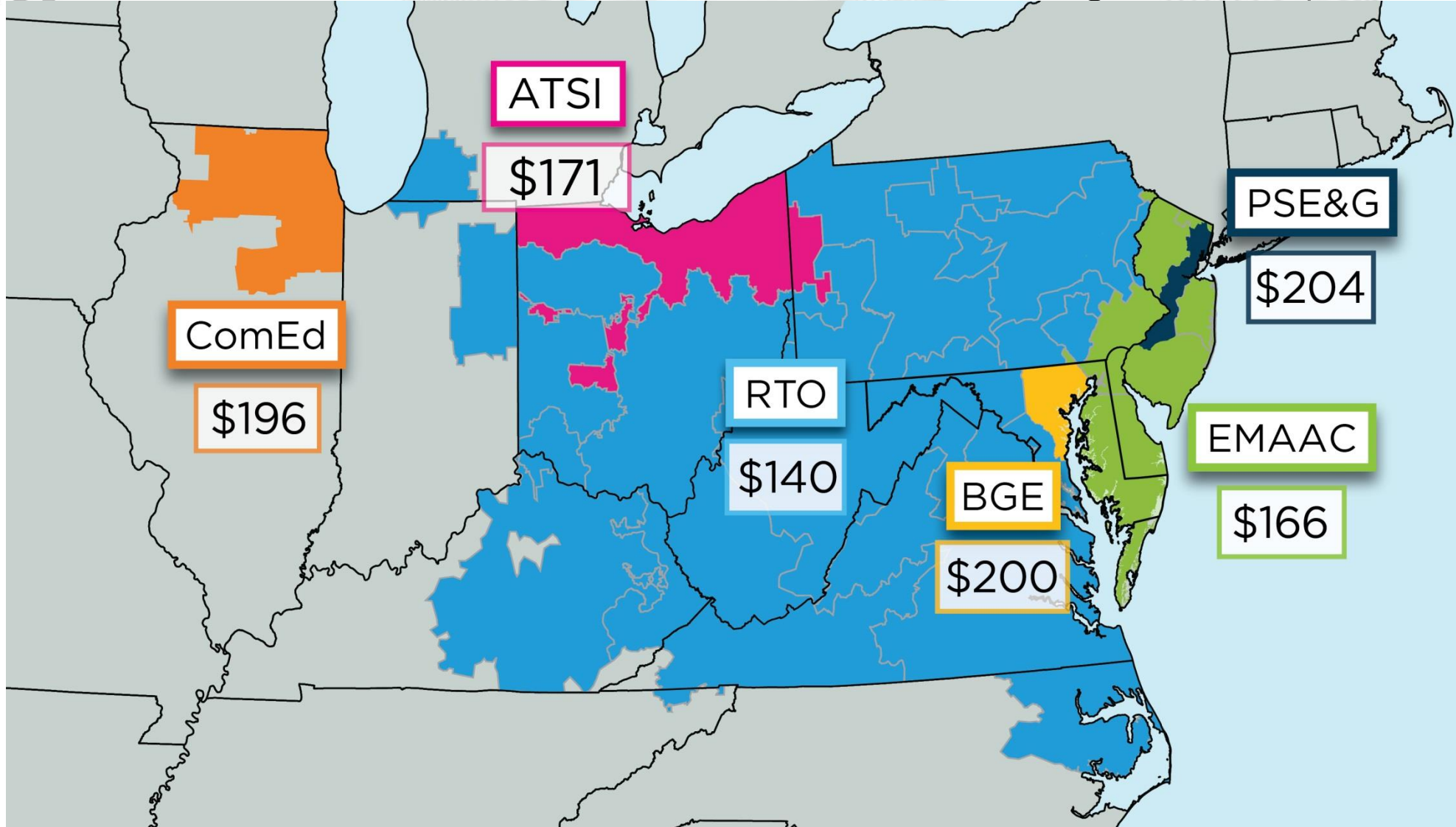
Transmission Owner	Summer Peak (MW)			Winter Peak (MW)		
	2019	2029	Growth Rate (%)	2018/19	2028/29	Growth Rate (%)
American Electric Power Company *	10,404	10,915	0.5%	9,089	9,515	0.5%
American Transmission Systems, Inc. *	11,921	12,164	0.2%	9,702	9,819	0.1%
Dayton Power and Light	3,408	3,525	0.3%	2,864	2,945	0.3%
Duke Energy Ohio and Kentucky *	4,575	4,794	0.5%	3,695	3,839	0.4%
PJM RTO	151,358	156,689	0.3%	131,082	136,178	0.4%

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

Markets

Capacity Market Results

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





Ohio – Cleared Resources in 2021/22 Auction

(May 23, 2018)

	Cleared MW (Unforced Capacity)	Change from 2020/21 Auction
Generation	18,301	(1,722)
Demand Response	2,184	492
Energy Efficiency	348	123
Total	20,833	(1,107)

RTO Locational Clearing Price

\$140

ATSI Locational Clearing Price

\$171

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



Ohio – Offered and Cleared Resources in 2021/22 Auction

(May 23, 2018)

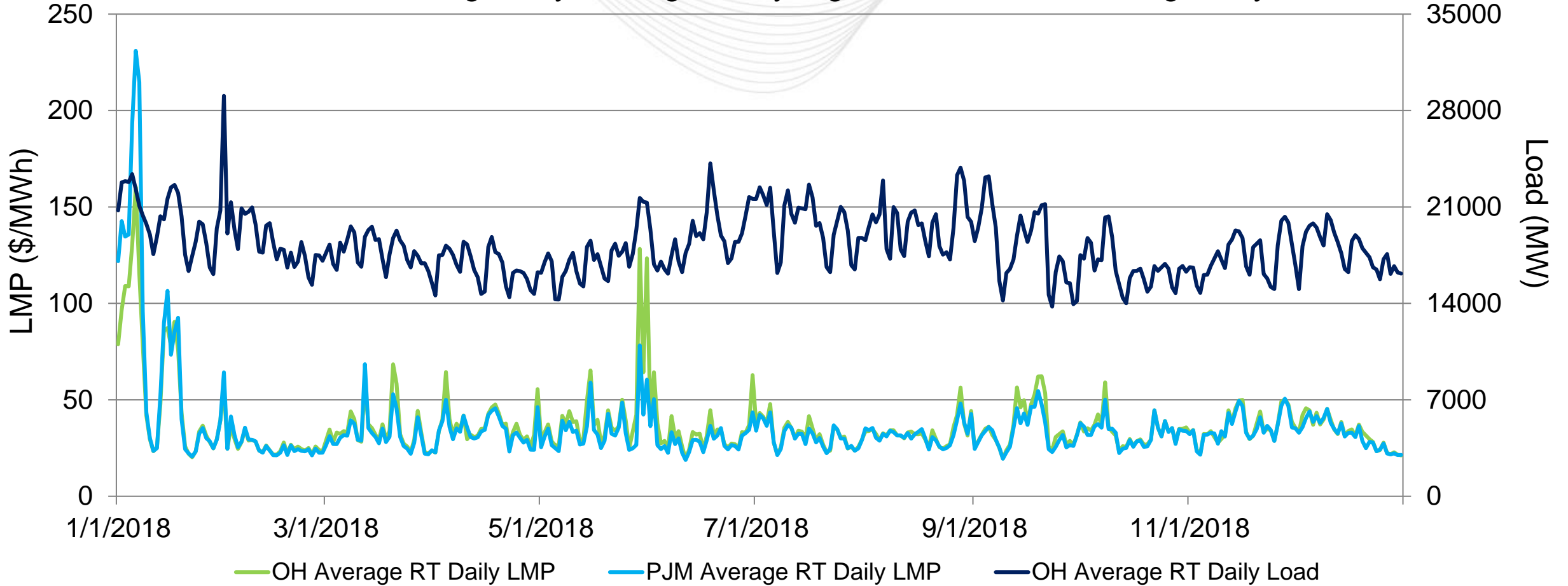
		Unforced Capacity
Generation	Offered MW	22,641
	Cleared MW	18,301
Demand Response	Offered MW	2,346
	Cleared MW	2,184
Energy Efficiency	Offered MW	378
	Cleared MW	348
Total Offered MW		25,365
Total Cleared MW		20,833

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

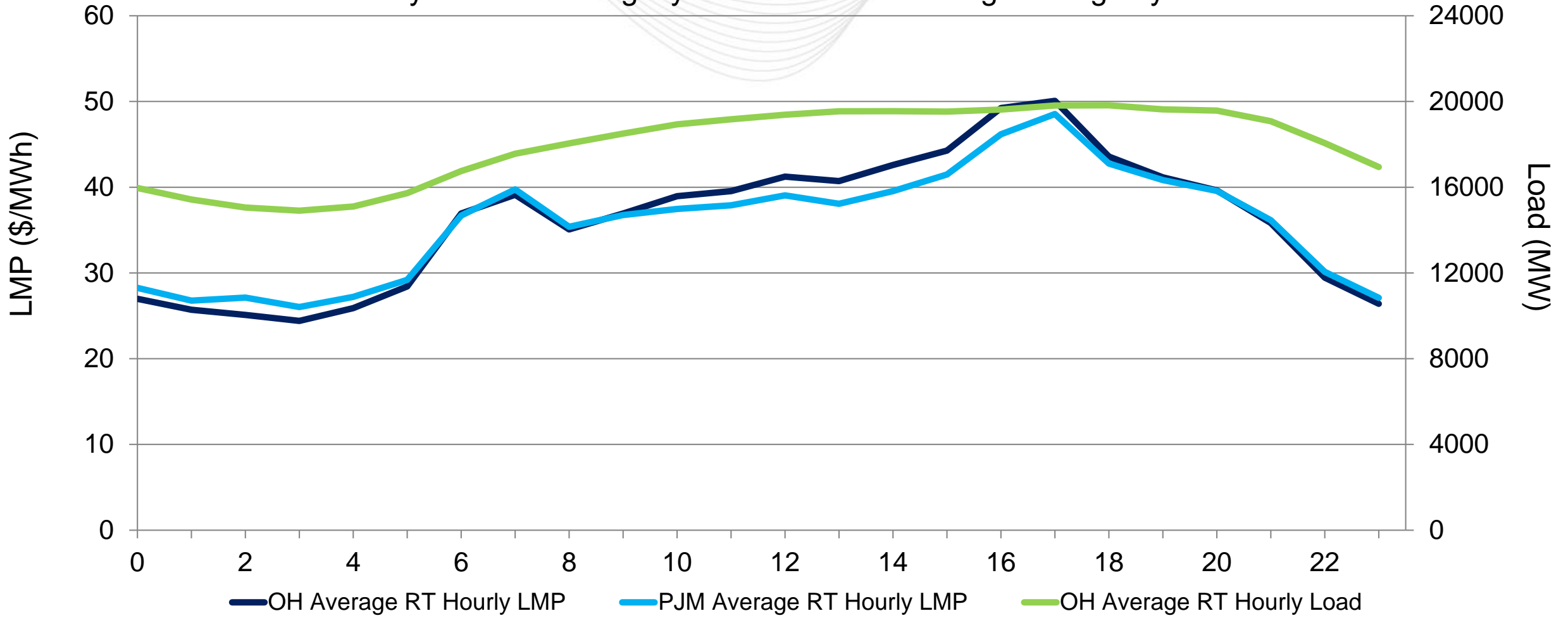
Market Analysis

Ohio'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.

Ohio's hourly LMPs were slightly above the PJM average during daytime hours

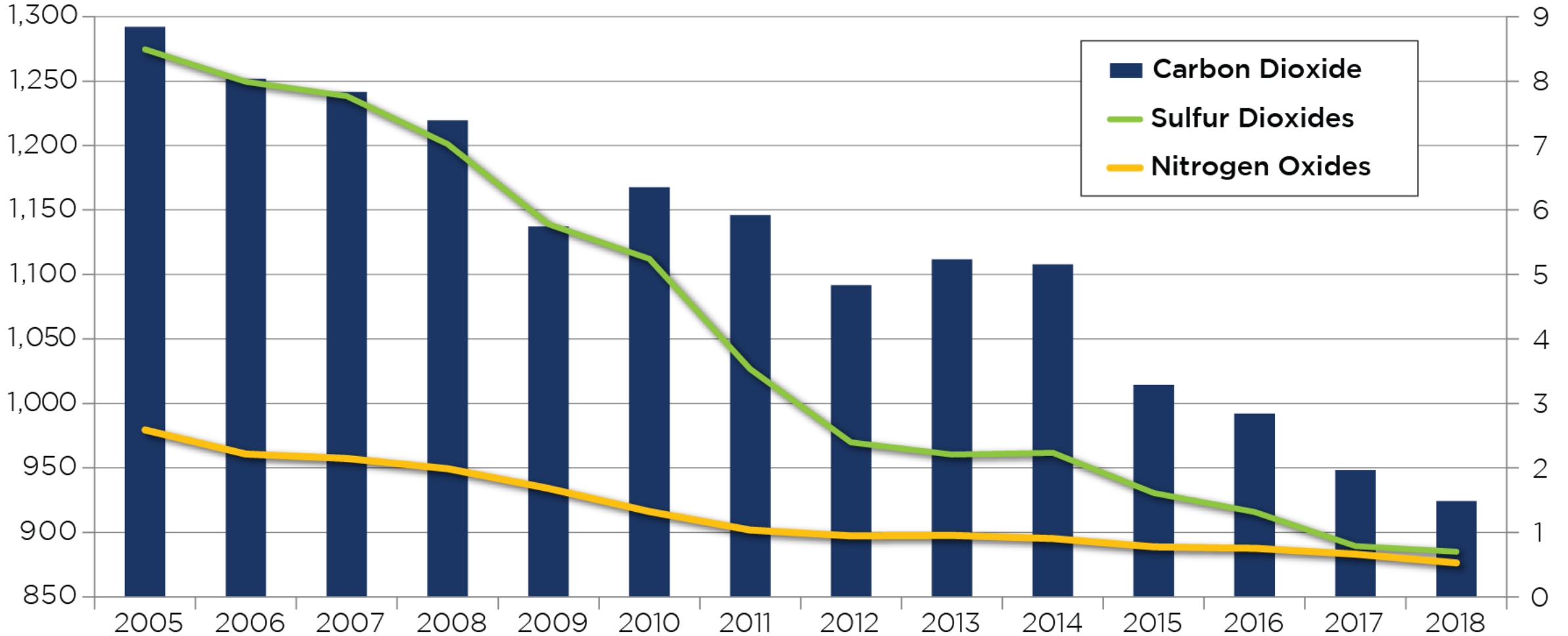


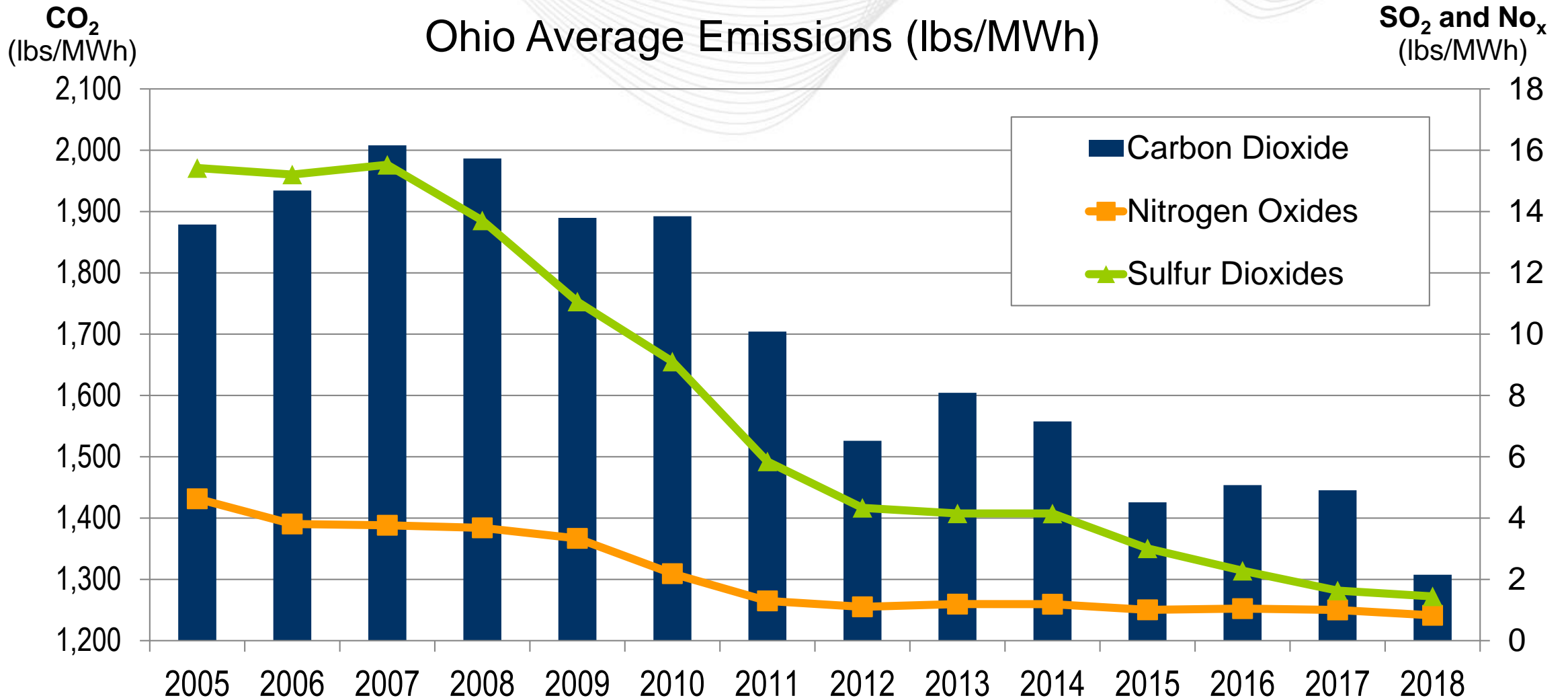
Operations Emissions Data

2005-2018 PJM Average Emissions

CO₂
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>