



# 2017 Kentucky State Infrastructure Report

(January 1, 2017 – December 31, 2017)

May 2018

This report reflects information for the portion of Kentucky within the PJM service territory.

## 1. Planning

- Generation Portfolio Analysis
- Transmission Analysis
- Load Forecast

## 2. Markets

- Capacity Market Results
- Market Analysis

## 3. Operations

- Emissions Data

**Note: all Kentucky-specific information in this slide deck refers only to the portion of Kentucky served by PJM.**

- **Existing Capacity:** Coal represents approximately 55.3 percent of the total installed capacity in the PJM portion of Kentucky while natural gas represents approximately 41.8 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 94 percent of new interconnection requests in Kentucky.
- **Deactivations:** Kentucky had no generation deactivations or deactivation notifications in 2017.
- **RTEP 2017:** Kentucky RTEP 2017 projects total more than \$140 million in investment. Approximately 44 percent of that represents supplemental projects.
- **Load Forecast:** Kentucky load growth is nearly flat, averaging between 0.4 and 0.6 percent per year over the next 10 years. This aligns with PJM RTO load growth projections.

- **2021/22 Capacity Market:** Kentucky cleared 81 MW more Demand Response resources than in the prior auction.
- **6/1/2015 – 12/31/2017 Market Performance:** Kentucky's average LMPs were consistent with PJM average LMPs.
- **Emissions:** 2017 carbon dioxide emissions are slightly up from 2016; 2017 sulfur dioxide emissions fell slightly from 2016 levels while nitrogen oxide emissions remained steady.



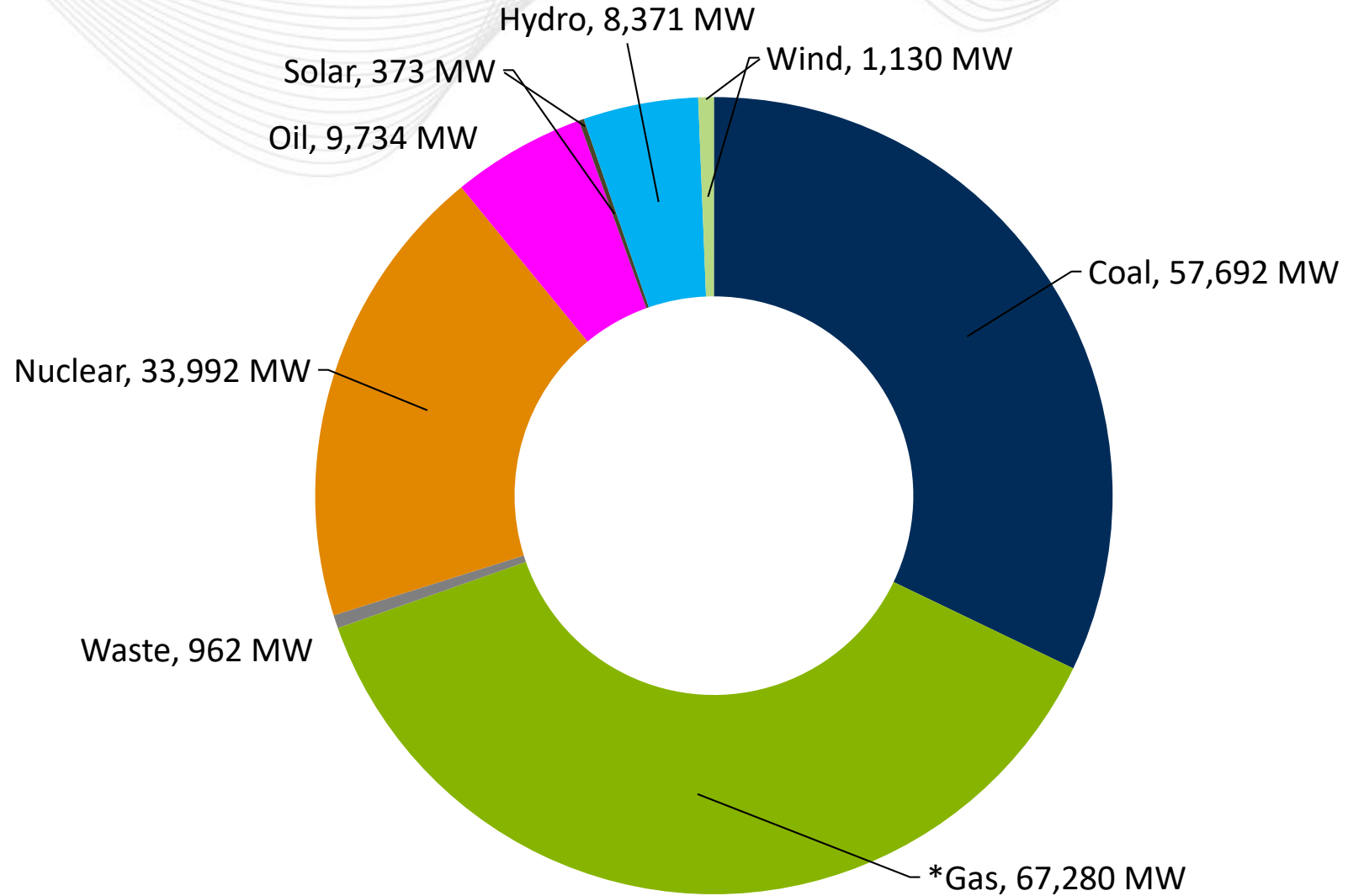
# Planning

## 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 of total installed capacity. Nuclear represents another 18.9 percent.

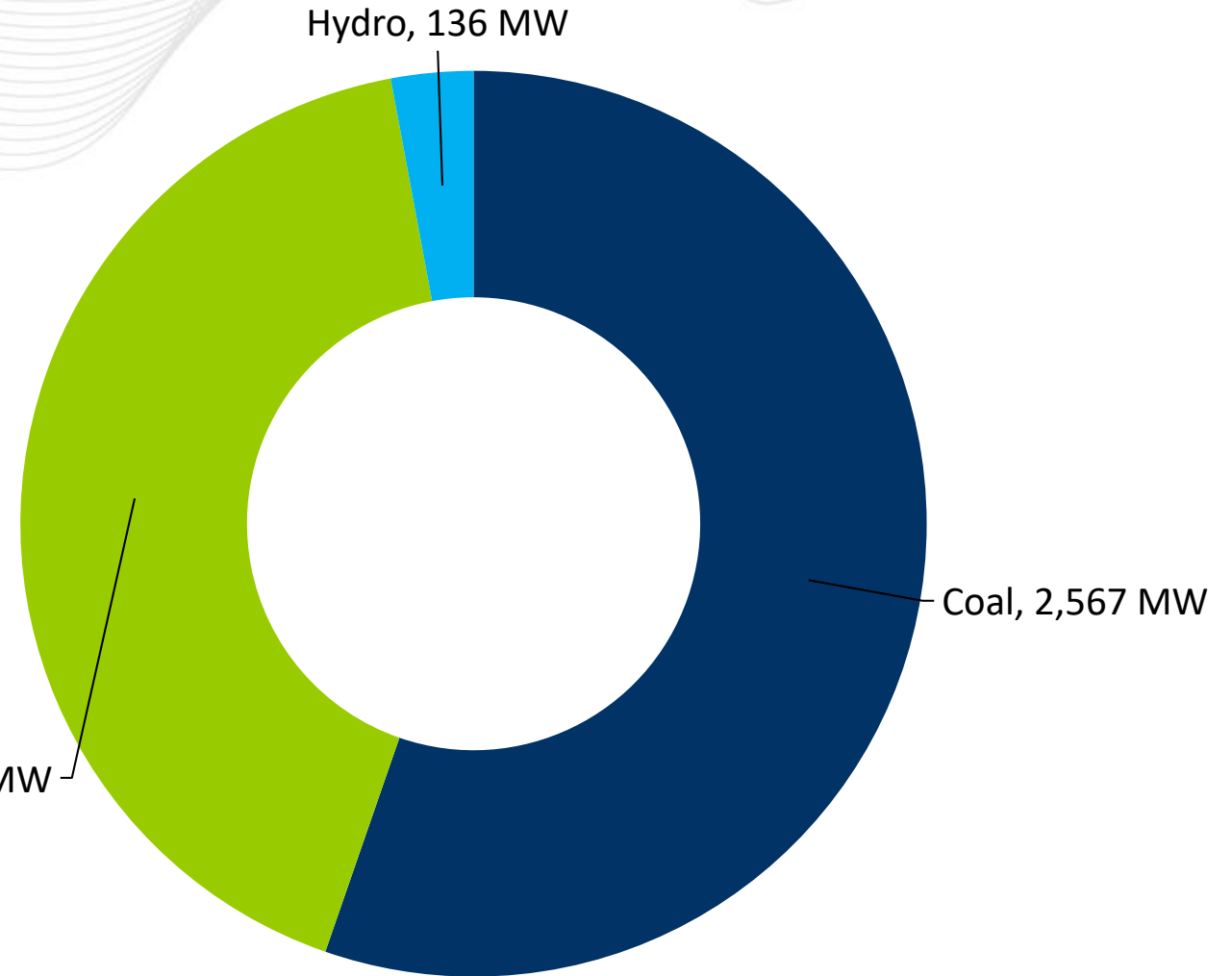


* Gas Contains	
Natural Gas	66,836.3 MW
Other Gas	443.8 MW

## Summary:

Natural gas represents approximately 41.8 percent of the total installed capacity in Kentucky while coal represents approximately 55.3 percent.

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



* Gas Contains	
Natural Gas	1,939 MW
Other Gas	0 MW

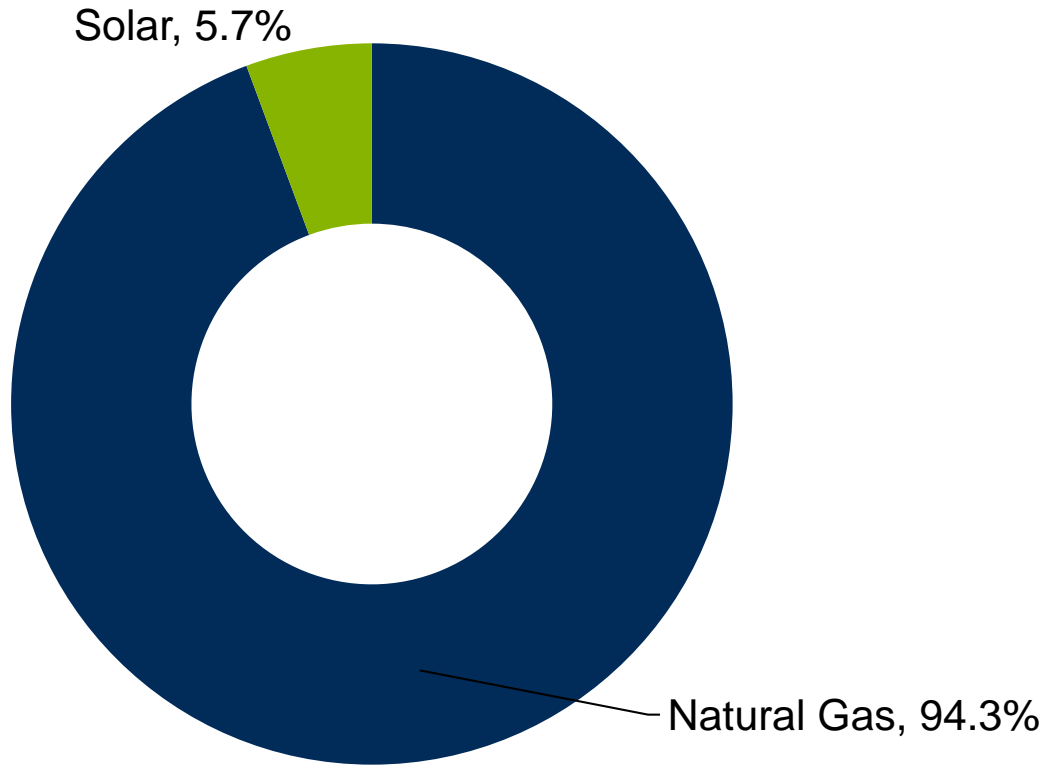


# Kentucky – Interconnection Requests

(Requested Capacity Rights, December 31, 2017)

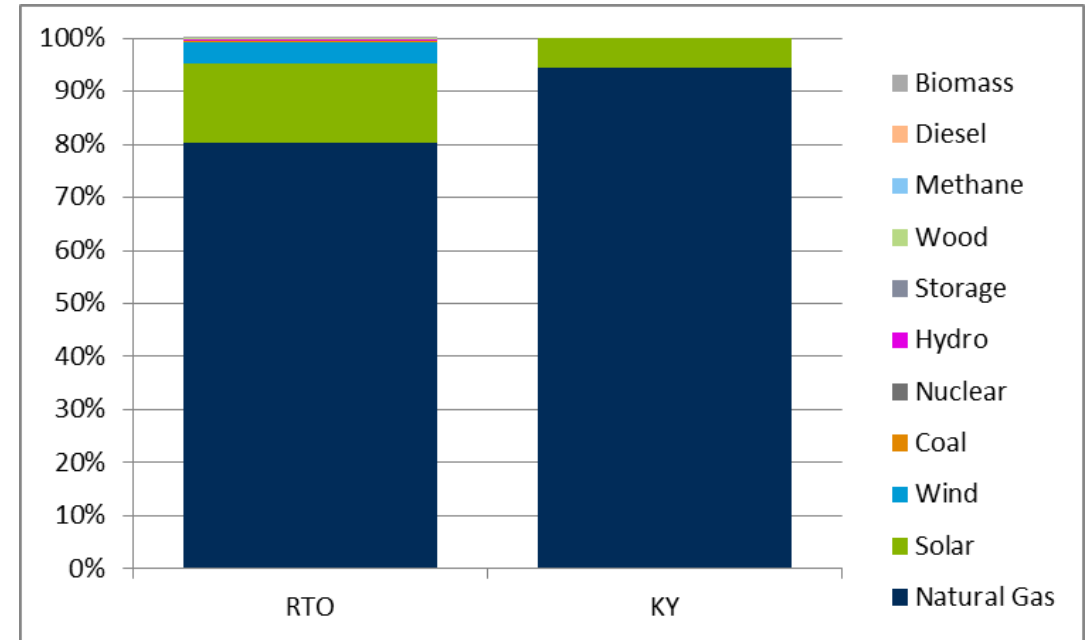
Natural gas represents approximately 94 percent of new interconnection requests in Kentucky.

Total MW Capacity by Fuel Type



Fuel Source	Capacity, MW	Nameplate Capability, MW
Natural Gas	1,791.0	1,846.0
Solar	107.3	200.0
<b>Total</b>	<b>1,898.3</b>	<b>2,046.0</b>

Fuel as a Percentage of Projects in Queue





# Kentucky – Interconnection Requests

(As of December 31, 2017)

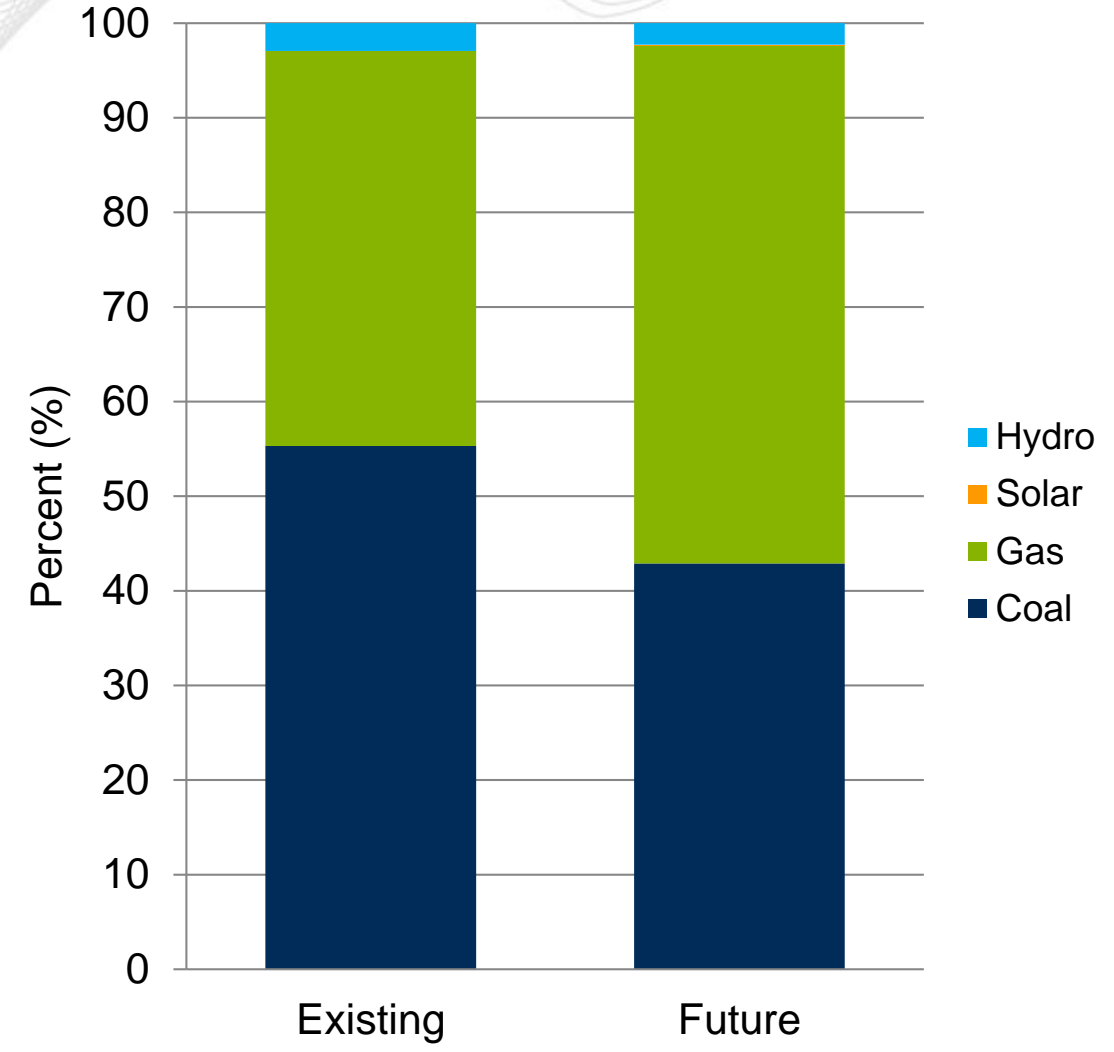
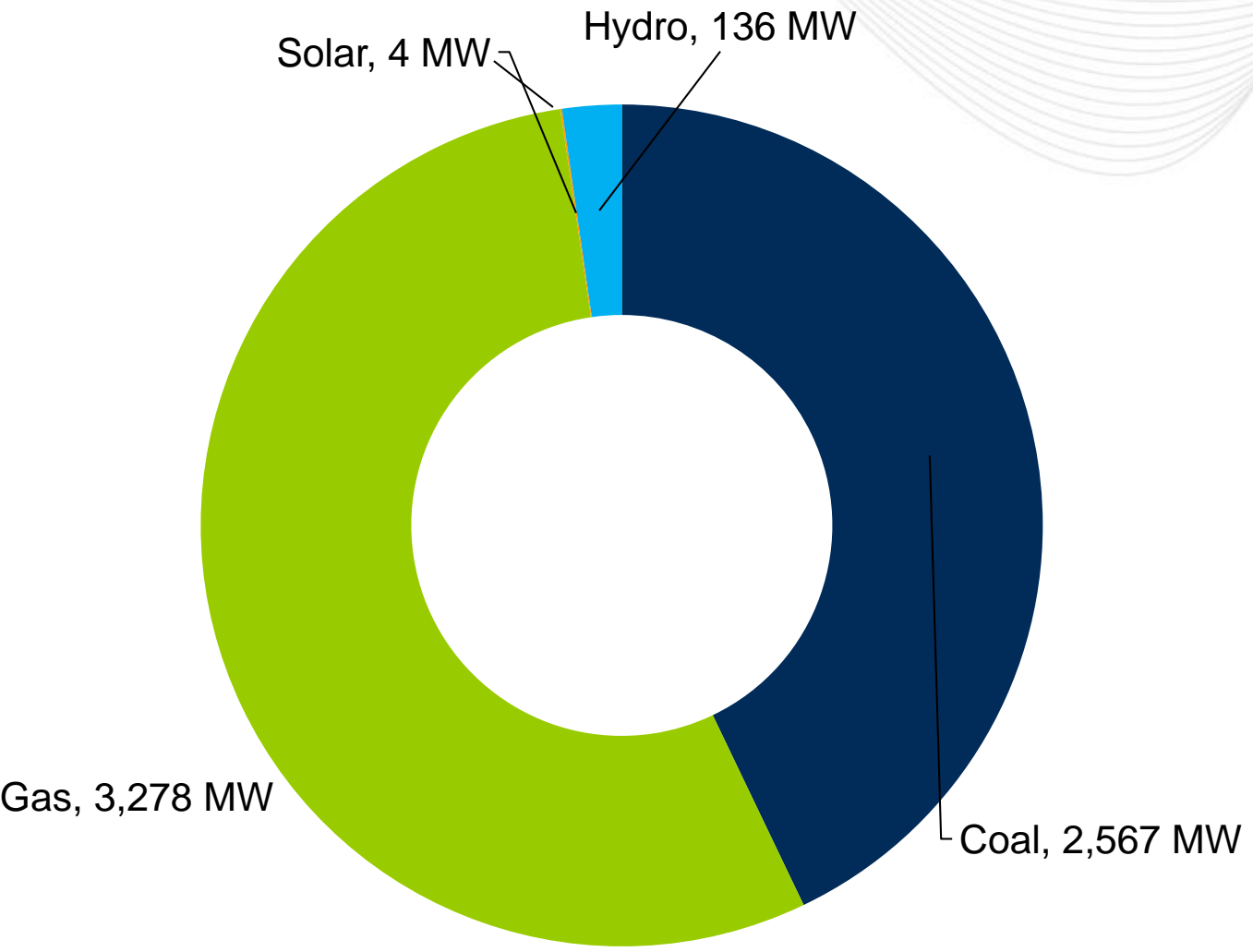
	Complete				In Queue						Grand Total	
	In Service		Withdrawn*		Active		Suspended**		Under Construction**			
	MW	# of Projects	MW	# of Projects	MW	# of Projects	MW	# of Projects	MW	# of Projects	MW	# of Projects
<b>Non-Renewable</b>	40	2	4,601	10	1,200	4	585	1	6	1	6,432	18
<b>Coal</b>			2,969	6							2,969	6
<b>Natural Gas</b>	40	2	1,632	4	1,200	4	585	1	6	1	3,463	12
<b>Renewable</b>			411	14	107	4					518	18
<b>Biomass</b>			199	5							199	5
<b>Hydro</b>			70	1							70	1
<b>Solar</b>			115	6	107	4					222	10
<b>Wind</b>			27	2							27	2
<b>Grand Total</b>	<b>40</b>	<b>2</b>	<b>5,012</b>	<b>24</b>	<b>1,307</b>	<b>8</b>	<b>585</b>	<b>1</b>	<b>6</b>	<b>1</b>	<b>6,950</b>	<b>36</b>

\*May have executed final agreement

\*\* Executed final agreement (ISA / WMPA)

# Kentucky – Future Capacity Mix

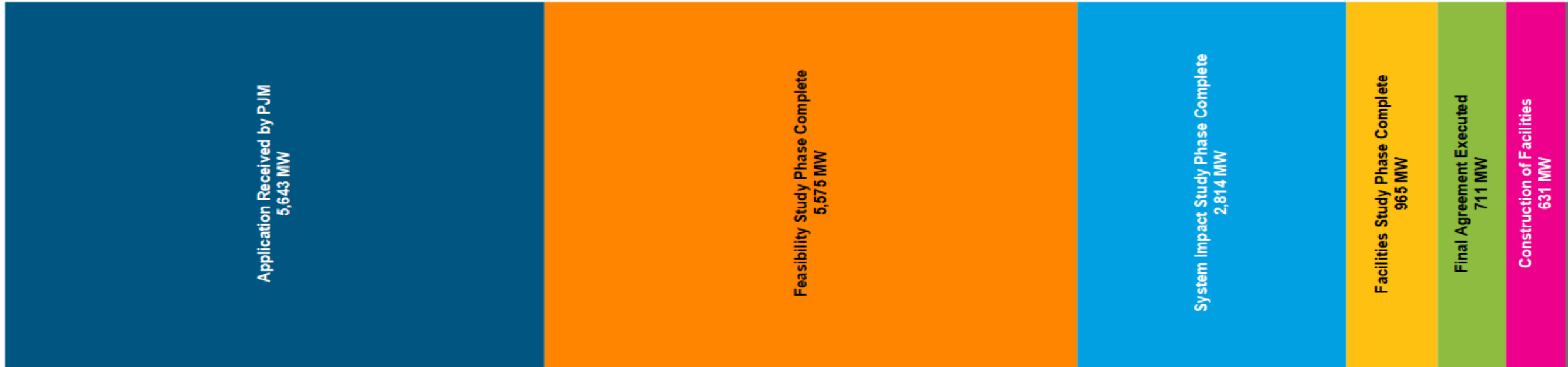
Based on known queued interconnection requests and deactivation notices through December 31, 2022, adjusted to reflect the probability of commercialization as indicated by historical trends specific to an interconnection request's state/zonal location and fuel type.





# Kentucky – 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	1.00	80.00	80.00

0.7% of requested capacity megawatt and 7.1% of projects reaches commercial operation



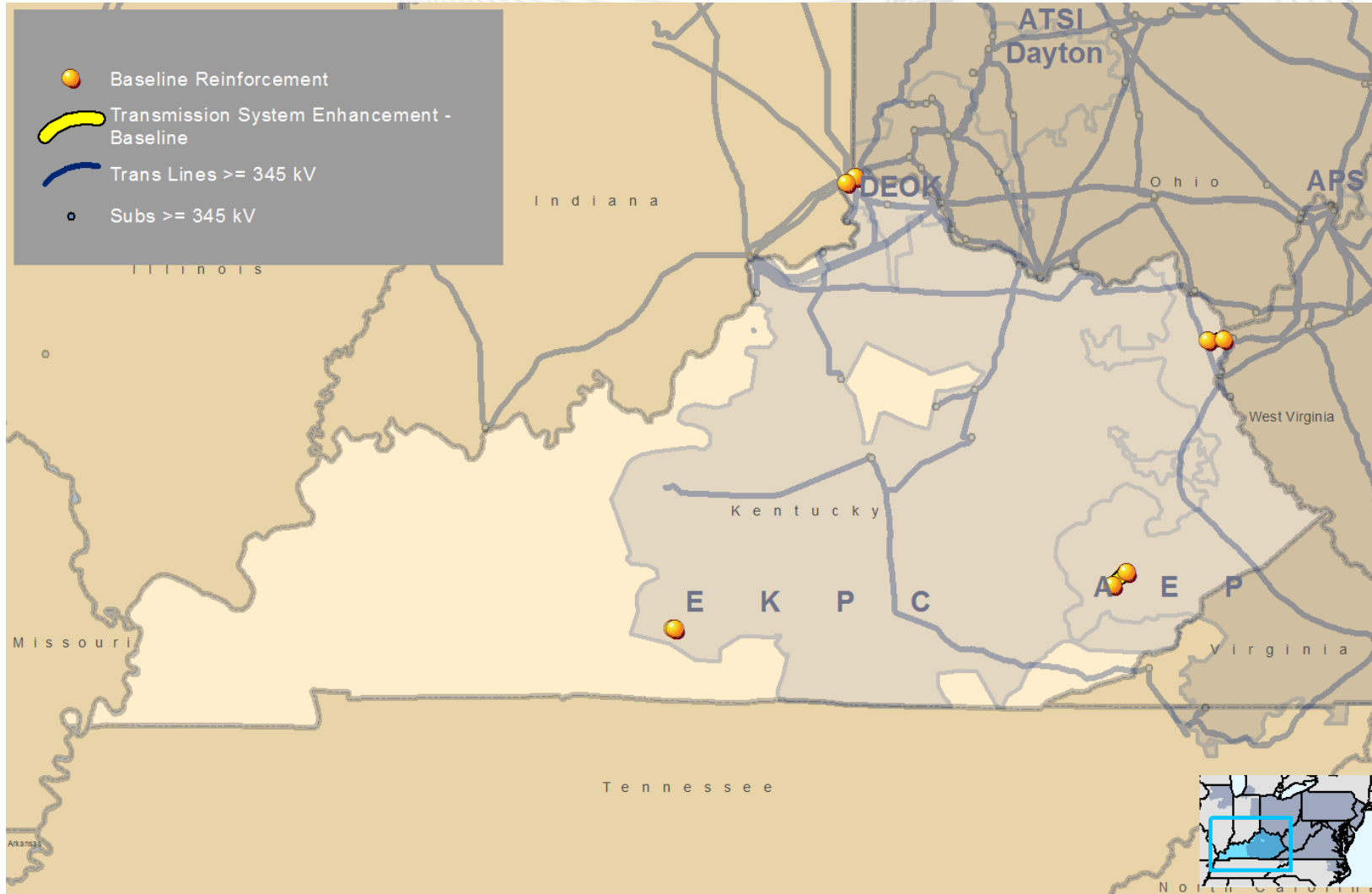


# Kentucky – Actual Generation Deactivations and Deactivation Notifications Received in 2017

Kentucky had no generation deactivations or deactivation notifications in 2017.

# Planning

## Transmission Infrastructure Analysis



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

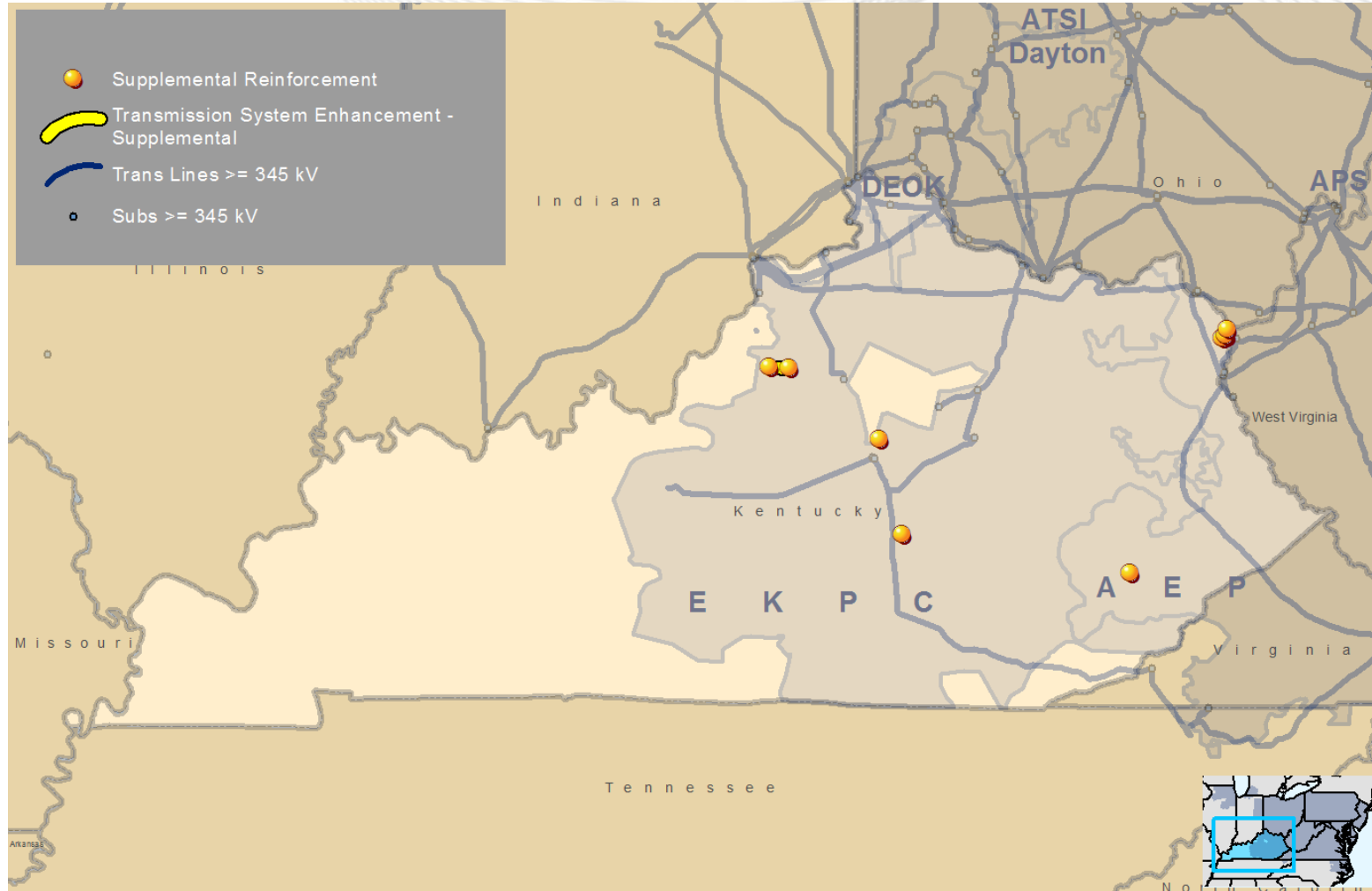


# Kentucky – RTEP Baseline Projects

(Greater than \$5 million)

Project ID	Project	Project Driver	Required In Service Date	Project Cost (\$M)	TO Zone(s)	2017 TEAC Review
b2831	Upgrade the Tanner Creek - Miami Fort 345 kV circuit (DEOK portion) to achieve new ratings of 2151 MVA Summer Normal and 2151 MVA Summer Emergency	Baseline Load Growth Deliverability & Reliability	6/1/2021	\$ 7.8	DEOK	1/12/2017
	Upgrade Tanner Creek to Miami Fort 345 kV line (AEP portion) to achieve new ratings of 1825 MVA Summer Normal and 1868 MVA Summer Emergency		11/1/2018		AEP	
b2899	Rebuild 230kV Line #231 to current standard with a summer emergency rating of 1046 MVA. Proposed conductor is 2-636 ACSR.	TO Criteria Violation	12/1/2020	\$ 22.0	Dominion	7/13/2017
b2921	New TVA 161kV Interconnection to TVA's East Glasgow Tap-East Glasgow 161 KV line section (~1 mile due West of Fox Hollow). Add Fox Hollow 161/69 KV 150 MVA transformer. Construct new Fox Hollow-Fox Hollow Jct 161 KV line section using 795 MCM ACSR (~1 m	TO Criteria Violation	6/1/2018	\$ 18.1	EKPC	7/21/2017
b2880	Rebuild approximately 4.77 miles of the Cannonsburg – South Neal 69 kV line section utilizing 795 ACSR conductor (90 MVA rating, 83%)	TO Criteria Violation	6/1/2021	\$ 12.5	AEP	5/31/2017
b2761	Rebuild the Hazard – Wooton 161 kV line utilizing 795 26/7 ACSR conductor (300 MVA rating).	Baseline Load Growth Deliverability & Reliability	6/1/2021	\$ 18.8	AEP	11/2/2017





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.



# Kentucky – TO Supplemental Projects

(Greater than \$5 million)

Project ID	Description	Required Date	Project Cost (\$M)	TO Zone(s)	2017 TEAC Date
s1250	Build approximately 1 mile of 69 kV line from near Bekaert to the LGE/KU Simpsonville-Shelbyville 69 kV line and a 69 kV switching station at the connection point.	12/1/2019	\$ 5.1	EKPC	1/5/2017
s1301	At Chadwick 138kV station, install two 138 kV circuit breakers in place of the MOAB switches "V" and "Y".	6/7/2017	\$ 9.8	AEP	5/31/2017
	Replace 69kV circuit breakers C and D with 3000 A 40 kA breakers				
	At Leach station, replace 69 kV breaker E with a 3000 A 40 kA breaker.				
	At England Hill, replace 69 kV circuit breakers A and B with 3000 A 40 kA breakers.				
s1360	Construct a new Broughtontown 69-26.4 kV, 12/16/20 MVA Distribution Substation and associated 69 KV tap line (7.4 miles). 30 Year NPV \$20.4 Million	12/1/2021	\$ 8.0	EKPC	6/30/2017
s1361	Construct a new Pekin Pike 69-13.2 kV, 12/16/20 MVA Distribution Substation & 6.4 Mile 69 kV Tap Line. 30 Year NPV \$15.6 Million	12/1/2019	\$ 8.2	EKPC	6/30/2017



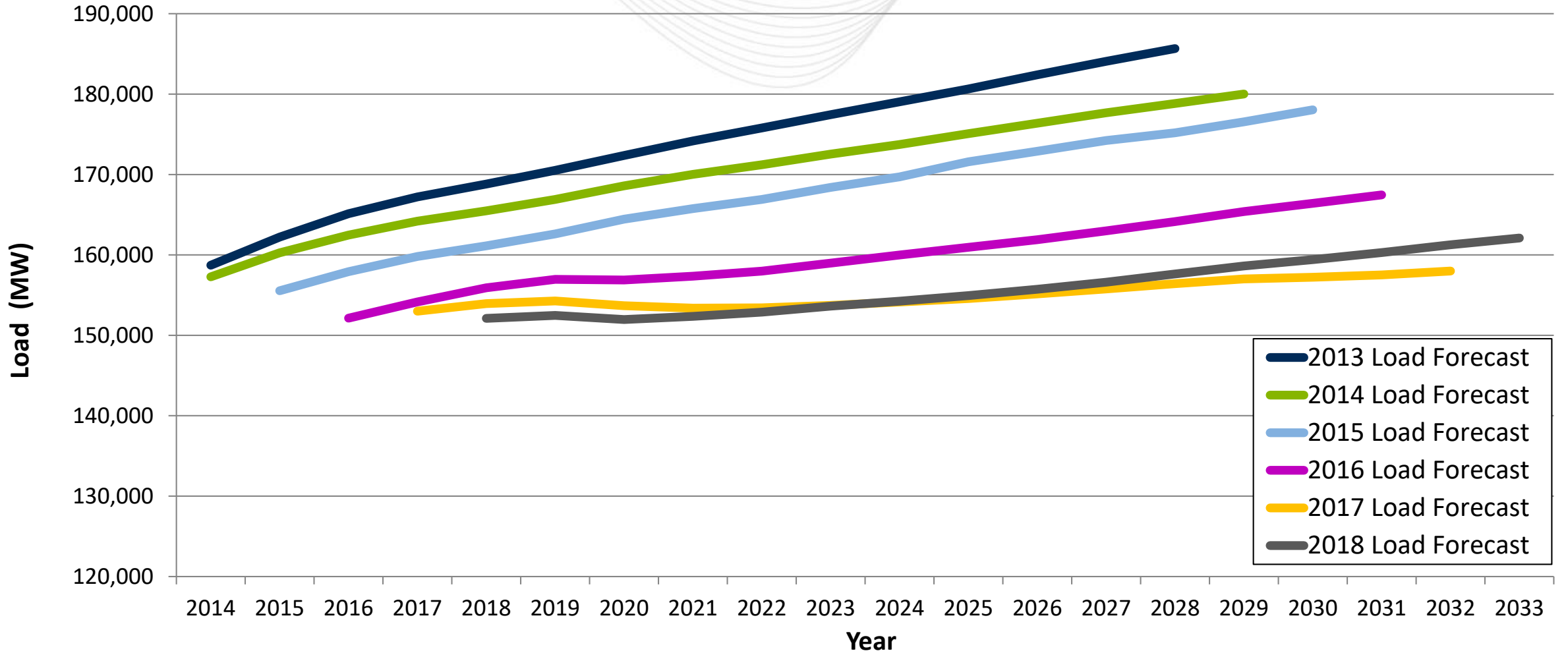
# Kentucky – TO Supplemental Projects

(Greater than \$5 million)

Project ID	Description	Required Date	Project Cost (\$M)	TO Zone(s)	2017 TEAC Date
s1412	Address Safety and access issues associated with existing equipment platforms and drainage issues at the station at Hazard station.	12/31/2019	\$ 20.0	AEP	12/18/2017
	Replace 138kV capacitor bank and switcher BB with a new switcher and 43.2 MVAR capacitor bank at Hazard station.				
	Install a new 3000A 40 kA 138kV circuit breaker at Hazard station on the line exit towards Beckham station. Add a 138kV circuit switcher to the high side of transformer #4 at Hazard station.				
	Add a 3000A 40 kA 138kV circuit breaker to the low side of 161/138kV transformer #3 at Hazard station.				
	Hazard station				
	Replace 138/69 kV transformers #1 and #2 with new 138/69 kV 130 MVA transformers with 138kV circuit switchers on the high side and 3000A 40 kA 69 kV breakers on the low side at Hazard station.				
	Replace the 161 kV circuit breaker M towards Wooton with a 161 kV 3000 A 40 kA breaker.				
	Replace 69 kV capacitor bank and switcher CC with a new switcher and 28.8 MVAR capacitor bank and retire the 69 kV capacitor bank and switcher AA at Hazard station.				
Replace 69 kV circuit breakers S, E, and F with 3000A 40 kA 69 kV circuit breakers and with a bus tie 3000A 69 kV circuit breaker being installed between the existing 69 kV box bays at Hazard station.					
s1301	Replace circuit breakers at Chadwick, Leach, England Hill and Keonva	6/7/2017	\$ 9.8	AEP	5/31/2017

# Planning Load Forecast

## PJM RTO Summer Peak Demand Forecast





# Kentucky – 2018 Load Forecast Report

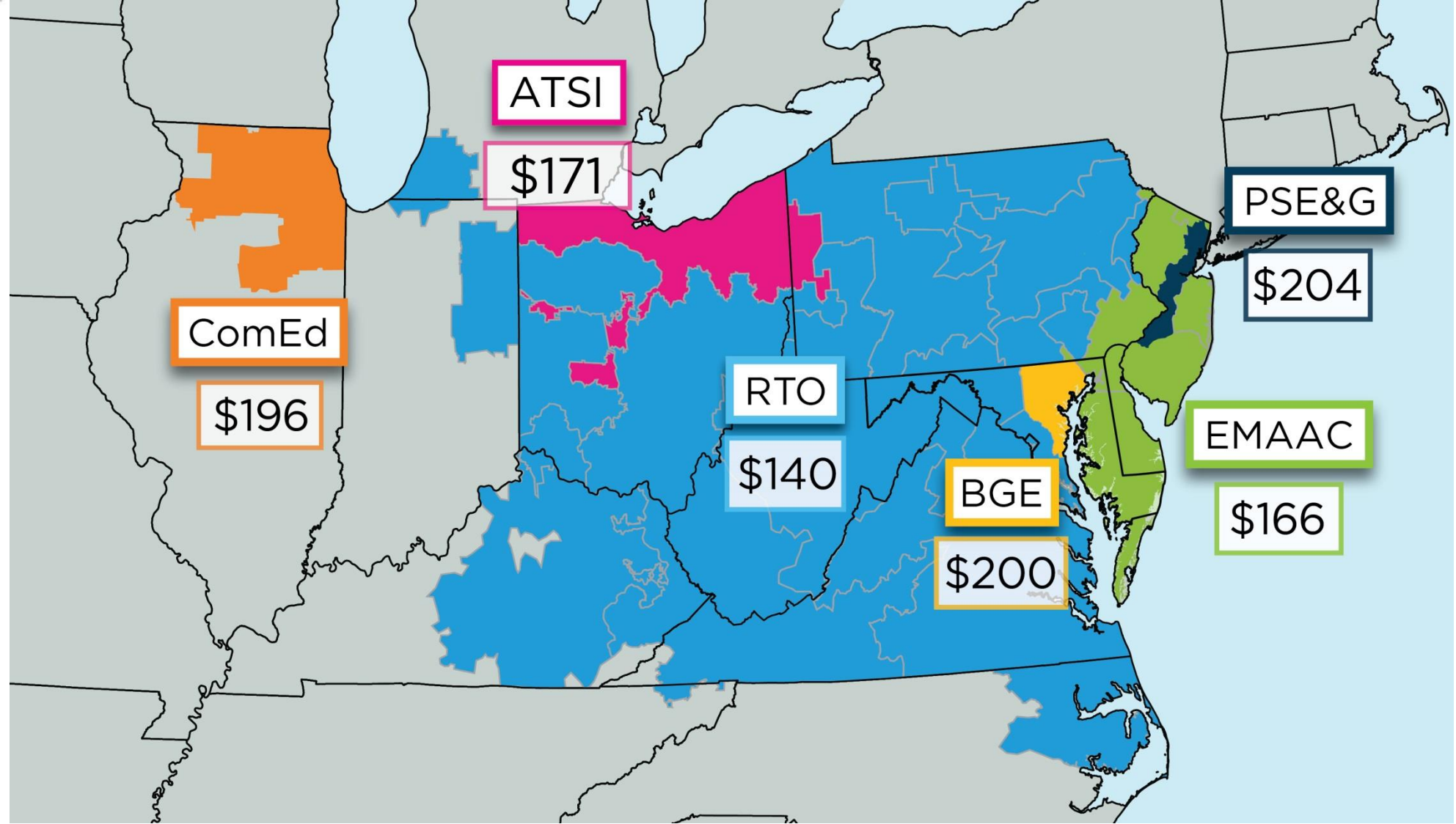
Transmission Owner	Summer Peak (MW)			Winter Peak (MW)		
	2018	2028	Growth Rate (%)	2017/18	2027/28	Growth Rate (%)
American Electric Power Company *	1,001	1,051	0.5%	1,199	1,260	0.5%
Duke Energy Ohio and Kentucky *	923	979	0.6%	746	784	0.5%
East Kentucky Power Cooperative	1,960	2,033	0.4%	2,587	2,693	0.4%
PJM RTO	152,108	157,635	0.4%	131,463	136,702	0.4%

\* PJM notes that AEP and Duke Energy serve load other than in Kentucky. 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 Kentucky. Estimated amounts were calculated based on the average share of each transmission owner's real-time summer and winter peak load located in Kentucky over the past five years.

# Markets

## Capacity Market Results

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







# Kentucky - Cleared Resources in 2021/22 Auction

(May 23, 2018)

	Cleared MW (Unforced Capacity)	Change from 2020/21 Auction
Generation	3,853	212
Demand Response	276	81
Energy Efficiency	24*	8
<b>Total</b>	<b>4,153</b>	<b>302</b>

## RTO Locational Clearing Price

\$140

\*Figure is estimated from Kentucky portion of AEP and DEOK.

*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

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



# Kentucky – Offered and Cleared Resources in 2021/22 Auction

(May 23, 2018)

		Unforced Capacity
<b>Generation</b>	Offered MW	3,853
	Cleared MW	3,853
<b>Demand Response</b>	Offered MW	287
	Cleared MW	276
<b>Energy Efficiency</b>	Offered MW	25
	Cleared MW	24
<b>Total Offered MW</b>		<b>4,165</b>
<b>Total Cleared MW</b>		<b>4,153</b>

*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

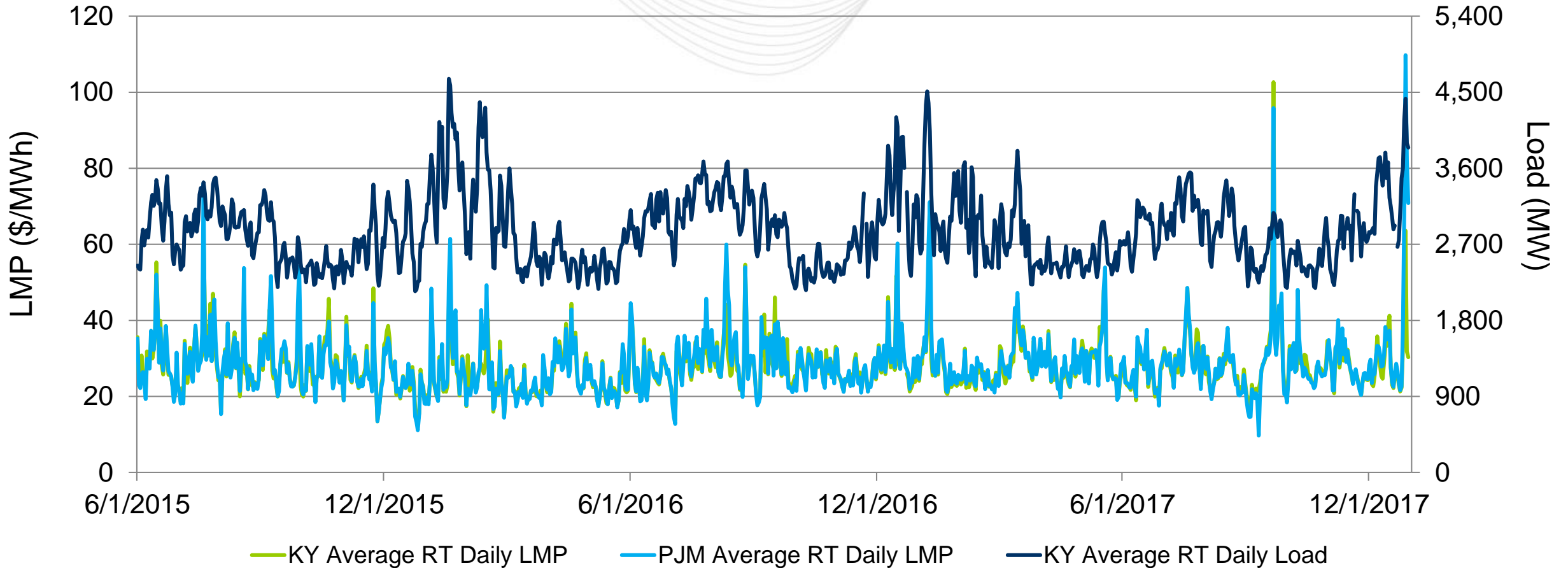
## Market Analysis



# Kentucky - Average Daily Load and LMP

(June 1, 2015 - December 31, 2017)

Kentucky's average daily LMPs generally align with PJM average daily LMPs.



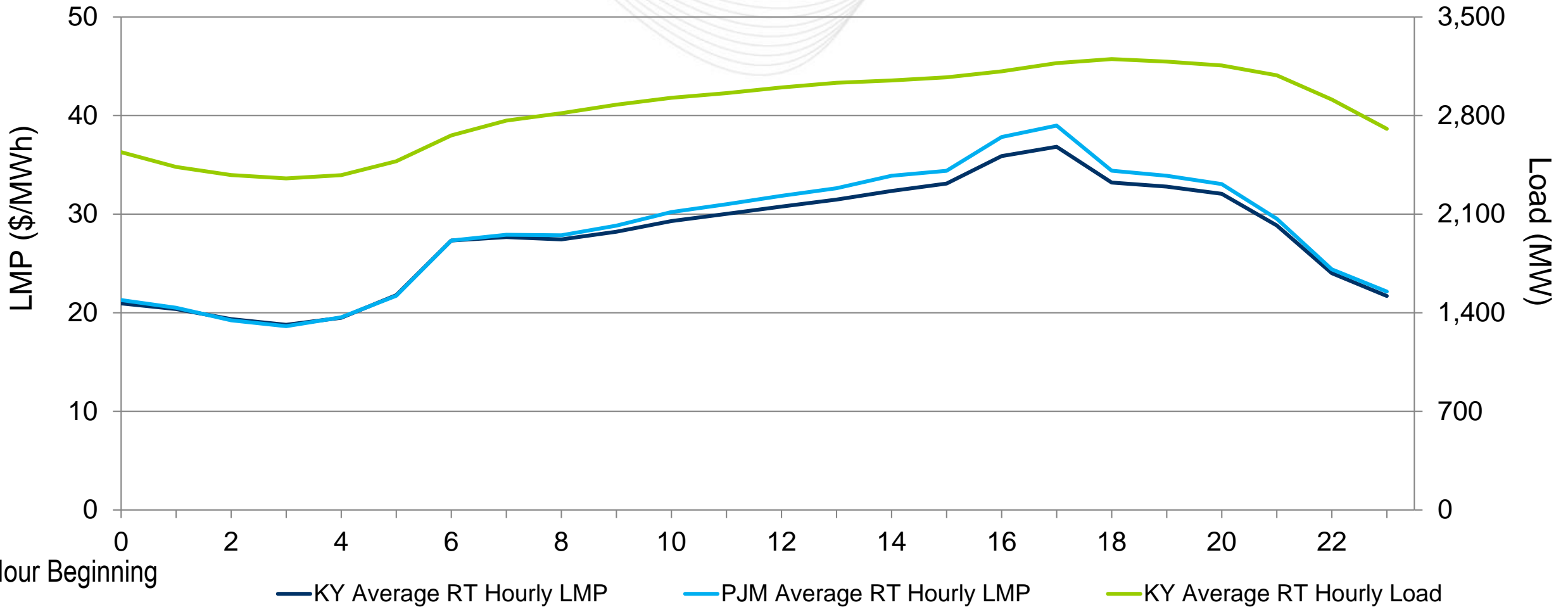
Note: The price spike on 9/21/2017 reflects the PJM shortage pricing event. The price spike starting 12/28/2017 reflects the beginning of the Cold Snap.



# Kentucky – Hourly Average LMP and Load

(June 1, 2015 – December 31, 2017)

Kentucky's hourly LMPs were consistent with or below PJM average hourly LMPs.

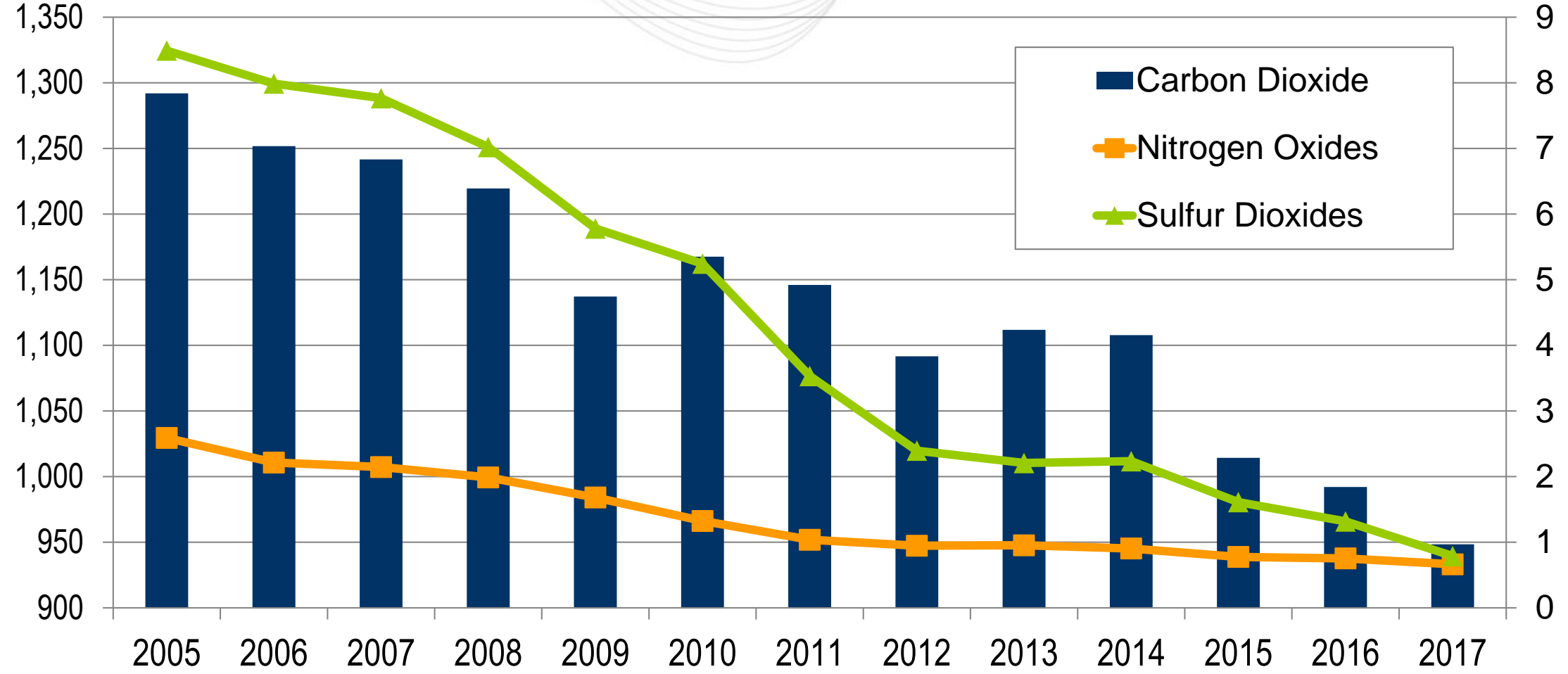


# Operations Emissions Data

**CO<sub>2</sub>**  
(lbs/MWh)

## PJM Average Emissions (lbs/MWh)

**SO<sub>2</sub> and No<sub>x</sub>**  
(lbs/MWh)





CO<sub>2</sub>  
(lbs/MWh)

## Kentucky Average Emissions (lbs/MWh)

SO<sub>2</sub> and NO<sub>x</sub>  
(lbs/MWh)

