



# 2017 Michigan State Infrastructure Report

(January 1, 2017 – December 31, 2017)

May 2018

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

## 1. Planning

- Generation Portfolio Analysis
- Transmission Analysis
- Load Forecast

## 2. Markets

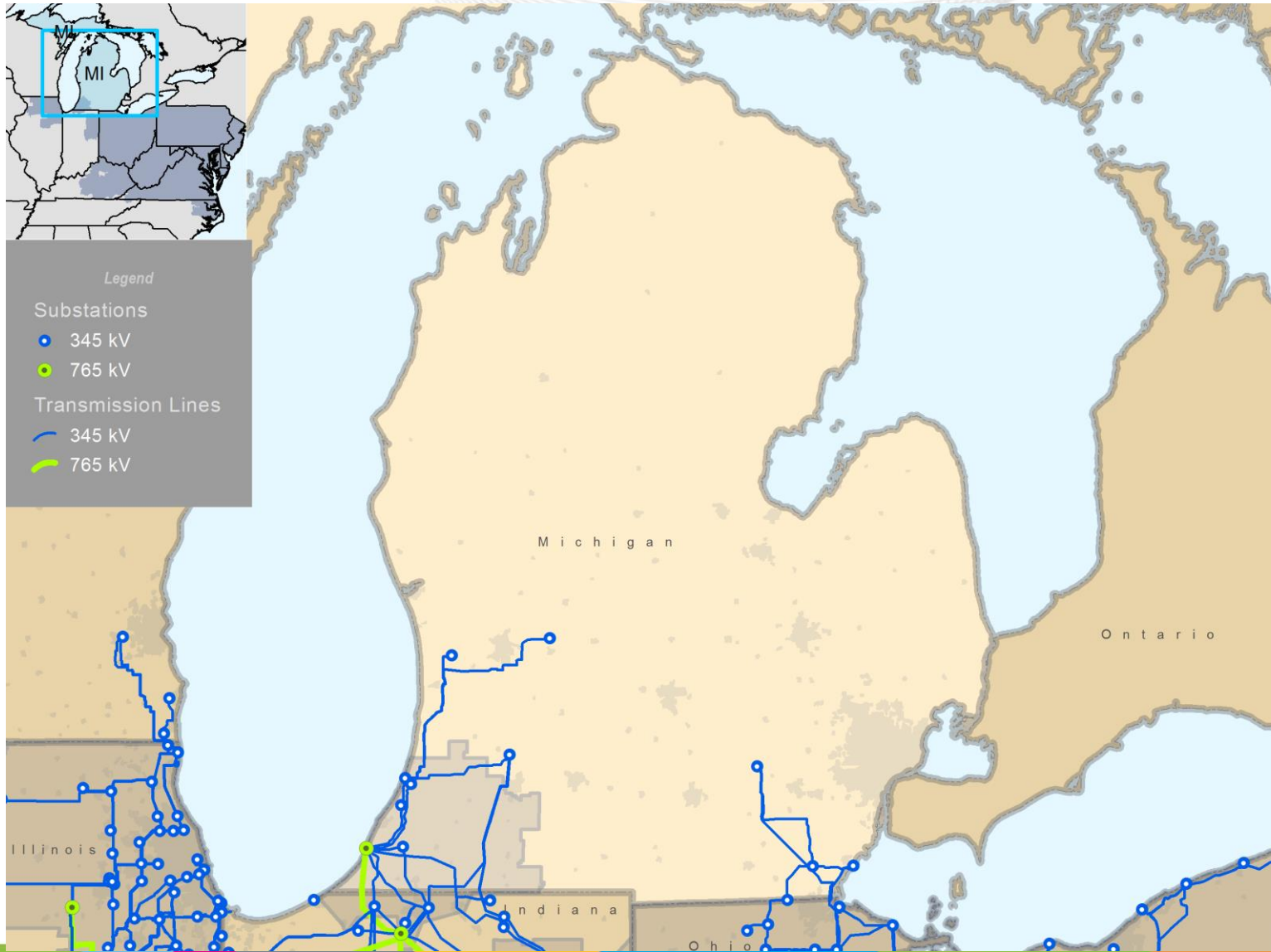
- Capacity Market Results
- Market Analysis

## 3. Operations

- Emissions Data

- **Existing Capacity:** Natural gas represents approximately 32.2 percent of the total installed capacity in Michigan while nuclear represents approximately 67.1 percent. No coal resources are installed in the PJM territory. 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 91 percent of new interconnection requests in Michigan.
- **Deactivations:** Michigan had no generation deactivations or deactivation notifications in 2017.
- **RTEP 2017:** Michigan RTEP 2017 projects total nearly \$296 million in investment. Approximately 51 percent of that represents supplemental projects.
- **Load Forecast:** Michigan load growth is nearly flat, averaging .5 percent per year over the next 10 years. This aligns with PJM RTO load growth projections.

- **2020/21 Capacity Market:** Michigan cleared 34 MW more Demand Response and Energy Efficiency resources than in the prior auction.
- **6/1/15 – 12/31/17 Performance:** Michigan's average locational marginal prices were consistent with PJM average LMPs. Nuclear resources represented 81.0 percent of generation produced in Michigan while gas averaged 18.5 percent. Michigan exports 79 percent of the energy produced within the PJM portion of the state. This electricity could go to other states or portions of Michigan outside of the PJM region.
- **Emissions:** Due to the high percentage of nuclear within Michigan, carbon dioxide, nitrogen oxide, and sulfur dioxide emissions have been flat for the past decade.



PJM operates bulk electric system facilities (and others monitored at lower voltages) in southwestern Michigan, including those of American Electric Power (AEP). Southwestern Michigan's transmission system delivers power to customers from native generation resources and those throughout the RTO – arising out of PJM market operations – as well as power imported interregionally from systems outside PJM.

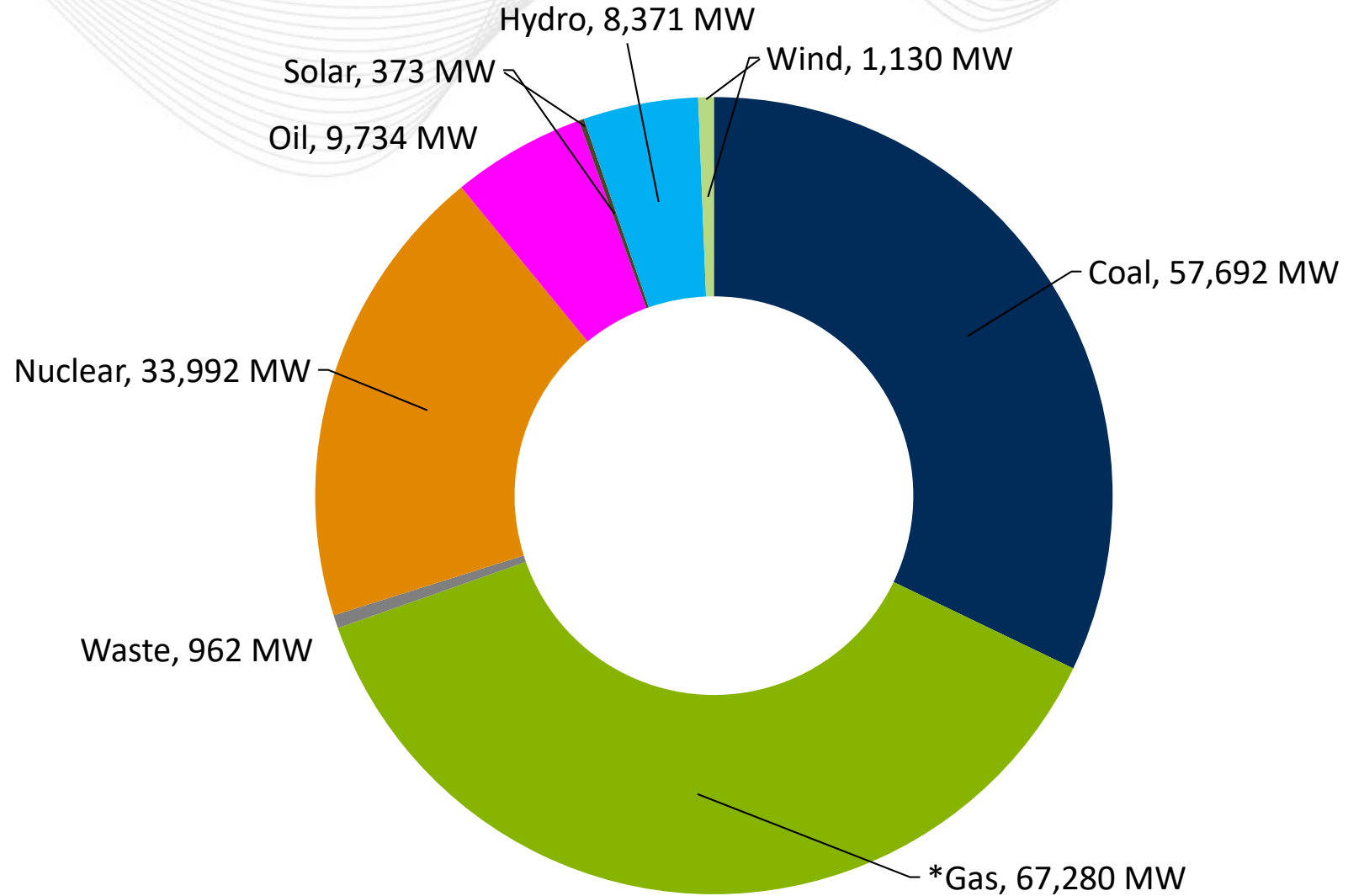
# Planning

## 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.

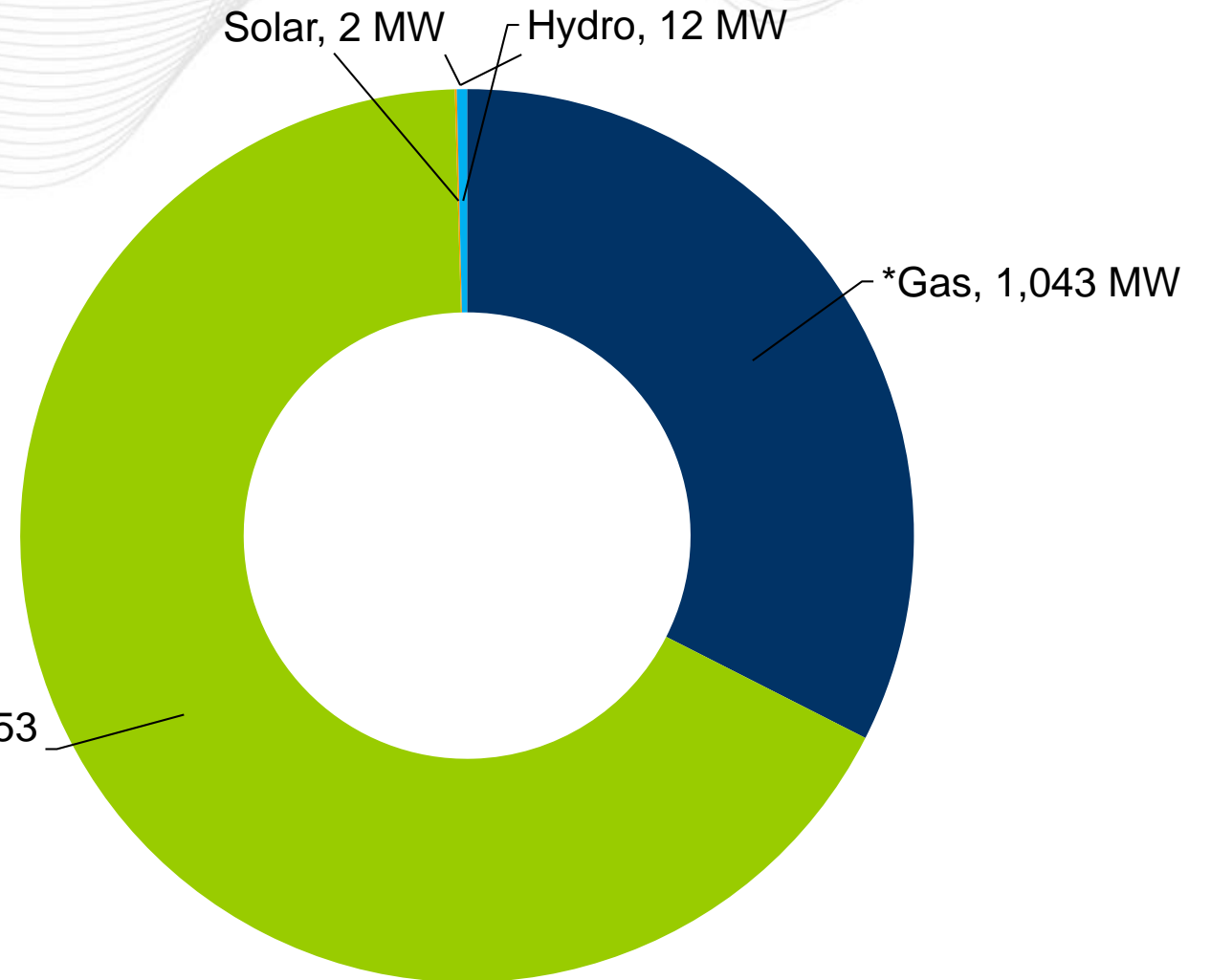


* Gas Contains	
Natural Gas	66,836.3 MW
Other Gas	443.8 MW

## Summary:

Natural gas represents approximately 32.2 percent of the total installed capacity in the Michigan territory while nuclear represents approximately 67.1 percent.

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



* Gas Contains	
Natural Gas	1,035 MW
Other Gas	7.8 MW

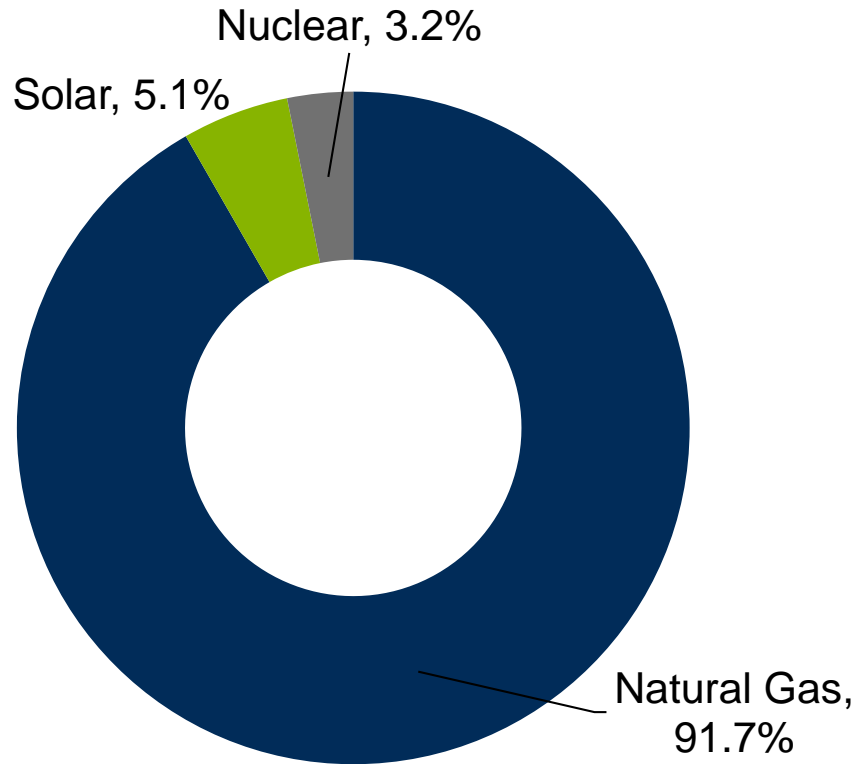


# Michigan – Interconnection Requests

(Requested Capacity Rights, December 31, 2017)

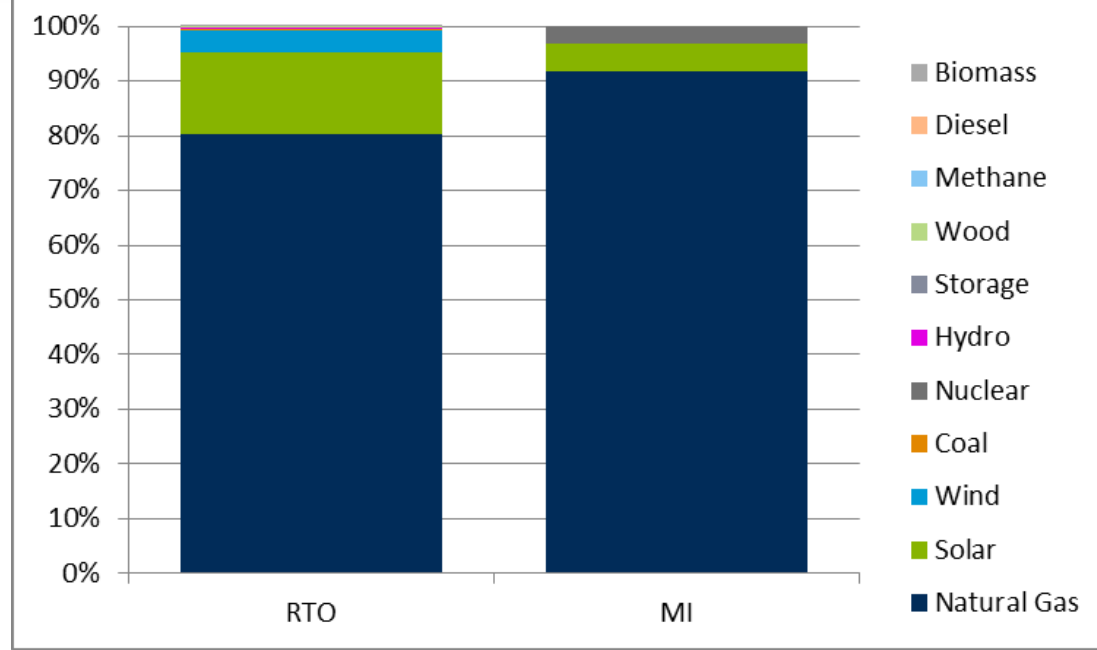
Natural gas represents approximately 91 percent of new interconnection requests in Michigan.

Total MW Capacity by Fuel Type



Fuel Source	Capacity, MW	Nameplate Capability, MW
Natural Gas	1,105.0	1,105.0
Solar	61.9	100.0
Nuclear	38.0	28.0
<b>Total</b>	<b>1,204.9</b>	<b>1,233.0</b>

Fuel as a Percentage of Projects in Queue





# Michigan – Interconnection Requests

(As of December 31, 2017)

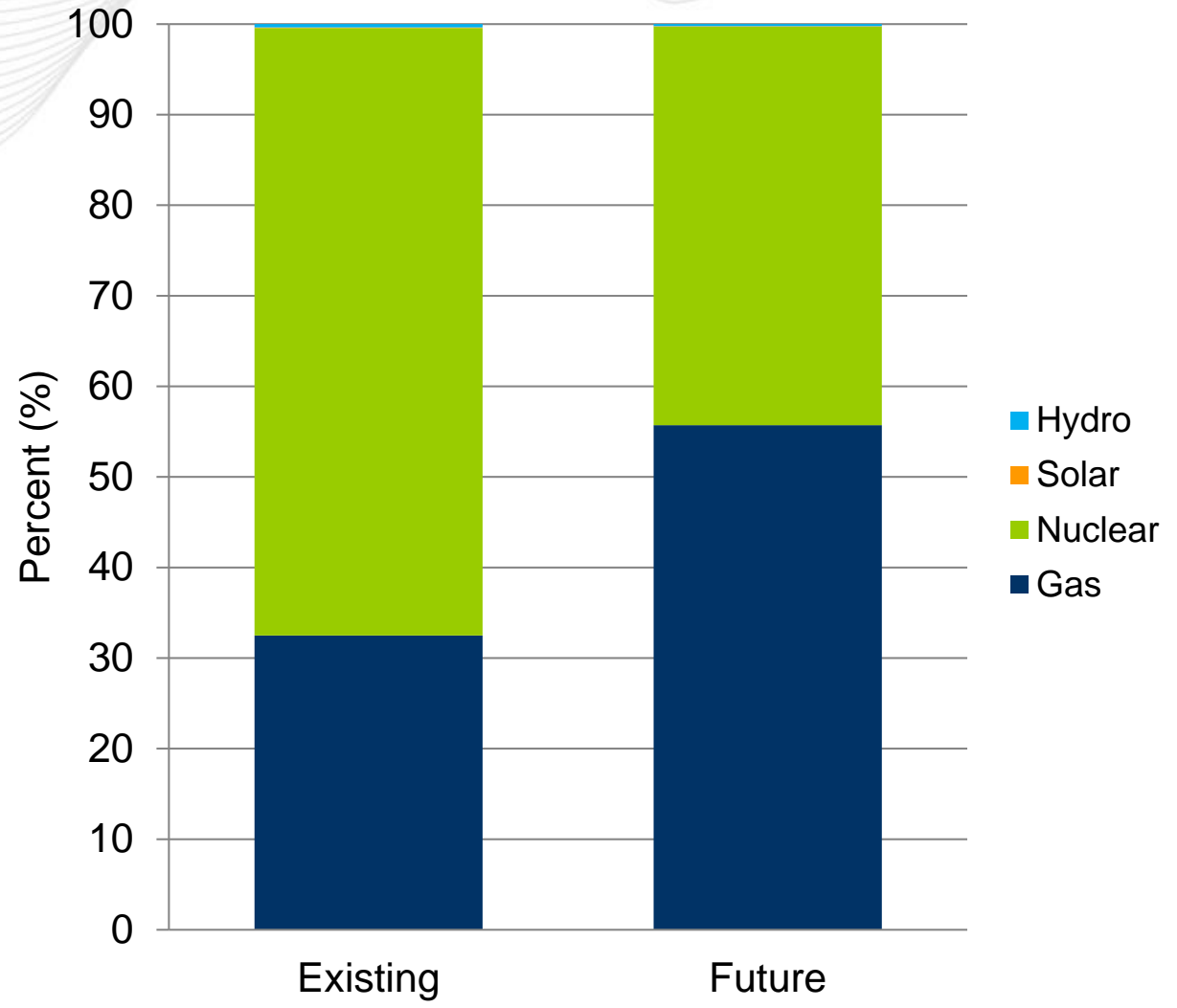
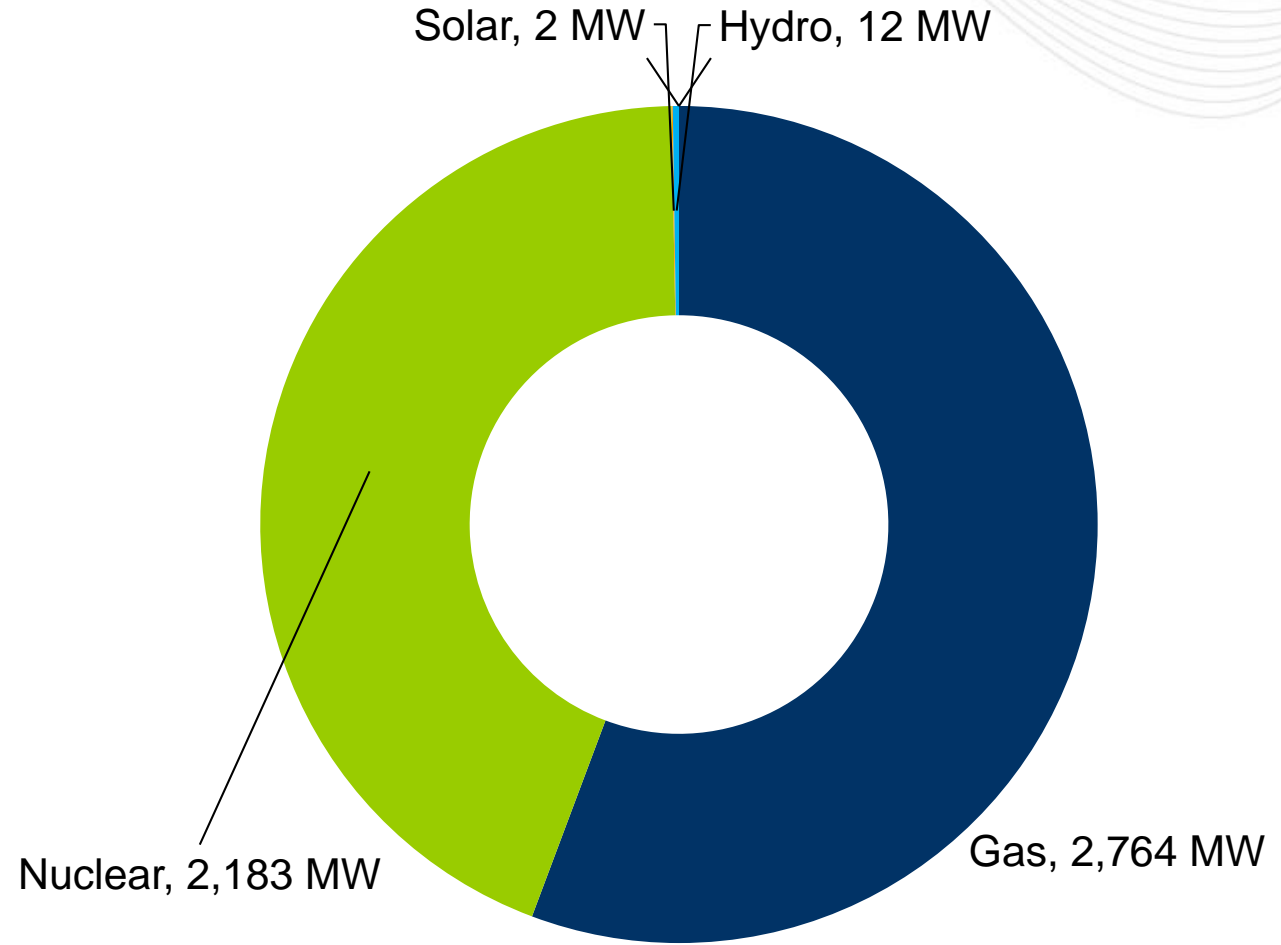
	Complete				In Queue				Grand Total	
	In Service		Withdrawn*		Active		Suspended**			
	MW	# of Projects	MW	# of Projects	MW	# of Projects	MW	# of Projects	MW	# of Projects
<b>Non-Renewable</b>	1,202	3	1,120	2	149	3	994	1	3,465	9
<b>Natural Gas</b>	1,035	1	1,120	1	111	2	994	1	3,260	5
<b>Nuclear</b>	167	2			38	1			205	3
<b>Other</b>				1						1
<b>Renewable</b>	12	3	92	2	62	1			166	6
<b>Methane</b>	10	2							10	2
<b>Solar</b>	2	1	66	1	62	1			130	3
<b>Wind</b>			26	1					26	1
<b>Grand Total</b>	<b>1,214</b>	<b>6</b>	<b>1,212</b>	<b>4</b>	<b>211</b>	<b>4</b>	<b>994</b>	<b>1</b>	<b>3,631</b>	<b>15</b>

\*May have executed final agreement

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

# Michigan – 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.





# Michigan – Progression History Interconnection Requests

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



Projects that withdrew after a final agreement

None

35.5% of requested capacity megawatt and 54.5% of projects reaches commercial operation

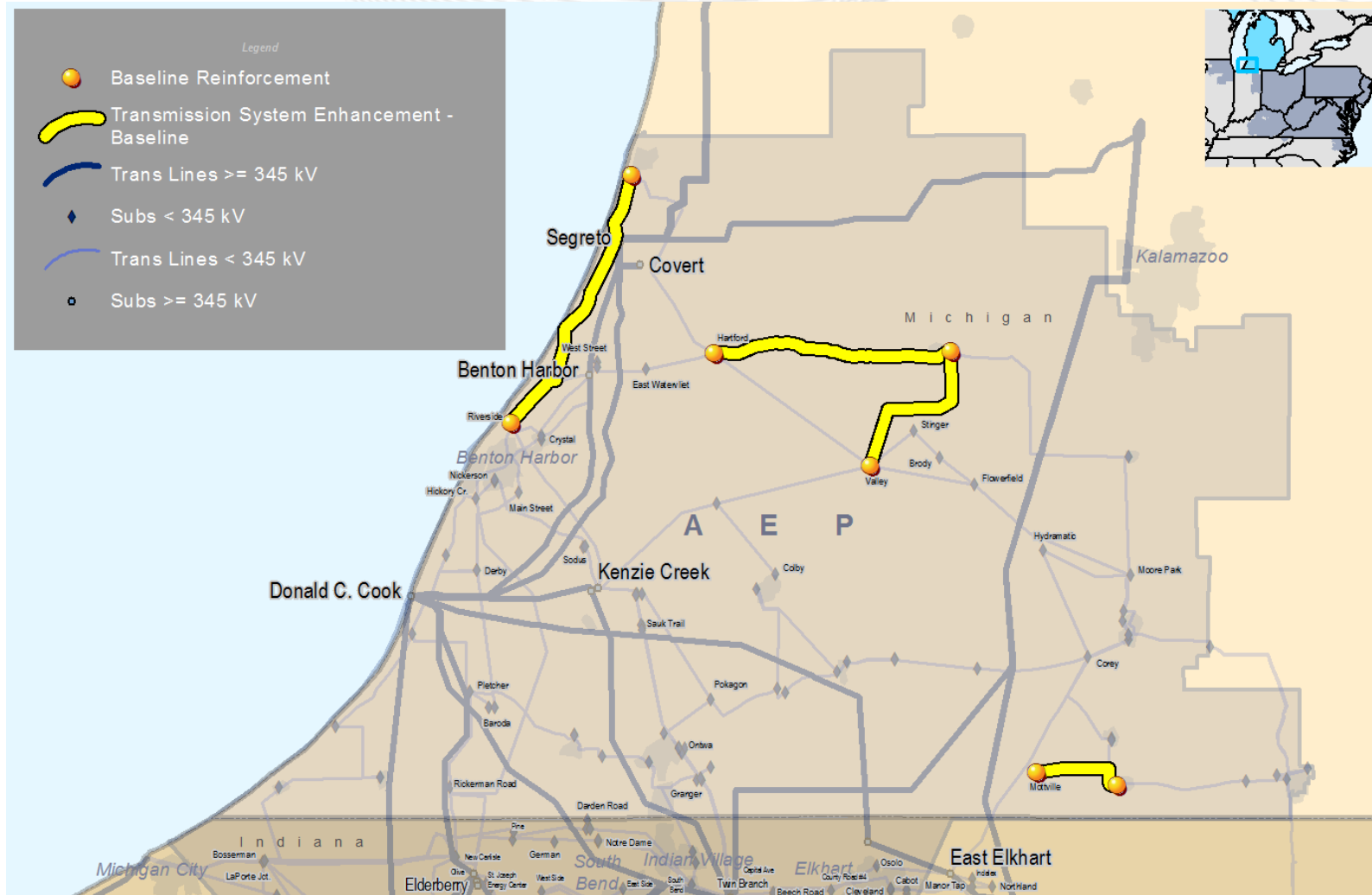


# Michigan – Actual Generation Deactivations and Deactivation Notifications Received in 2017

Michigan had no generation deactivations or deactivation notifications in 2017.

# Planning

## Transmission Infrastructure Analysis





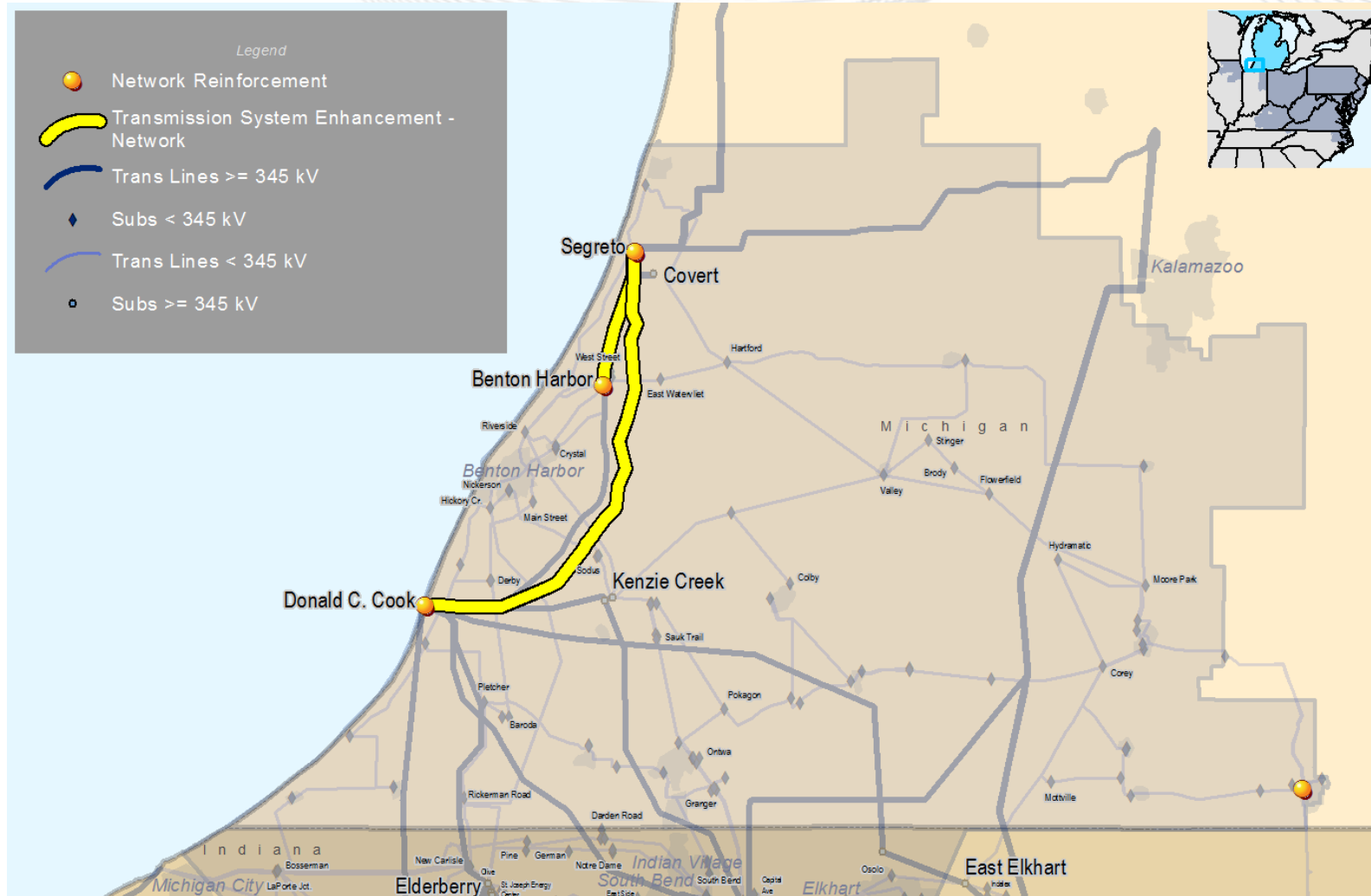
# Michigan – RTEP Baseline Projects

(Greater than \$5 million)

Project ID	Project	Project Driver	Required In Service Date	Project Cost (\$M)	TO Zone(s)	2017 TEAC Review
b2799	At Valley station, add new 138kV line exit with a 3000 A 40 kA breaker for the new 138 kV line to Almena and replace CB D with a 3000 A 40 kA breaker.	TO Criteria Violation	6/1/2021	\$ 53.0	AEP	5/31/2017
	At Almena station, install a 90MVA 138kV/69kV transformer with low side 3000 A 40 kA breaker and establish a new 138kV line exit towards Valley.					
	At Hartford station, install a second 90MVA 138/69kV transformer with a circuit switcher and 3000 A 40 kA low side breaker.					
	Rebuild Valley-Almema, Almema-Hartford, Riverside-South Haven 69kV lines. New line exit at Valley Station. New transformers at Almema and Hartford					
	Rebuild 12 miles of Valley – Almema 69kV line as a double circuit 138kV/69kV line using 795 ACSR conductor (360 MVA rating) to introduce a new 138 kV source into the 69 kV load pocket around Almema station.					
	Rebuild 3.2 miles of Almema to Hartford 69kV line using 795 ACSR conductor (90 MVA rating).					
	Rebuild 3.8 miles of Riverside – South Haven 69V line using 795 ACSR conductor (90 MVA rating).					
b2936	Rebuild approximately 6.7 miles of 69kV line between Mottville and Pigeon River using 795 ACSR conductor (129 MVA rating). New construction will be designed to 138kV standards but operated at 69kV.	TO Criteria Violation	6/1/2020	\$ 13.5	AEP	9/11/2017
	Pigeon River Station: Replace existing MOAB Sw. 'W' with a new 69kV 3000 A 40 kA breaker, and upgrade existing relays towards HMD station. Replace CB H with a 3000 A 40 kA breaker.					
	Rebuild Mottville-Pigeon River. Replace MOAB with at Pigeon River.					

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





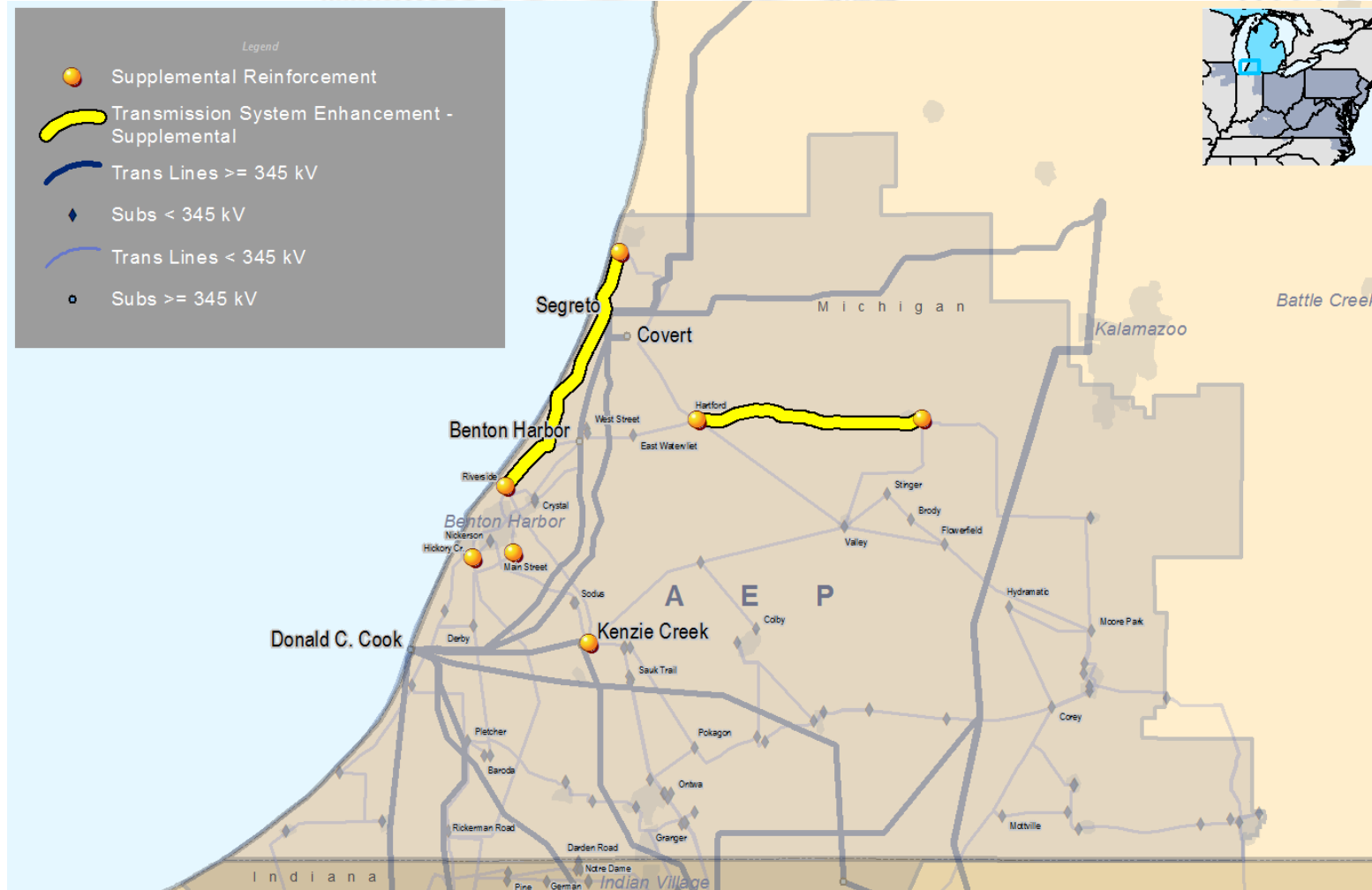
Note: Network upgrades are new or upgraded facilities required primarily to eliminate reliability criteria violations caused by proposed generation, merchant transmission or long term firm transmission service requests.



# Michigan – RTEP Network Projects

(Greater than \$5 million)

Project ID	Description	Project Driver	Queue	Required In Service Date	Project Cost (\$M)	TO Zone(s)	2017 TEAC Review
n5106	Reconductor or rebuild depending on the existing structures the portions of 345 kV lines between the Benton Harbor and Sagreto 345 kV substations.	Not Specified	Not Specified	9/30/2017	\$ 19.0	AEP	10/12/2017
n5311	Rebuild or Reconductor approximately 30 miles of the Cook – T-094 (Segreto) 345 kV line.	Not Specified	Not Specified	12/1/2016	\$ 60.0	AEP	10/12/2017



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.



# Michigan – TO Supplemental Projects

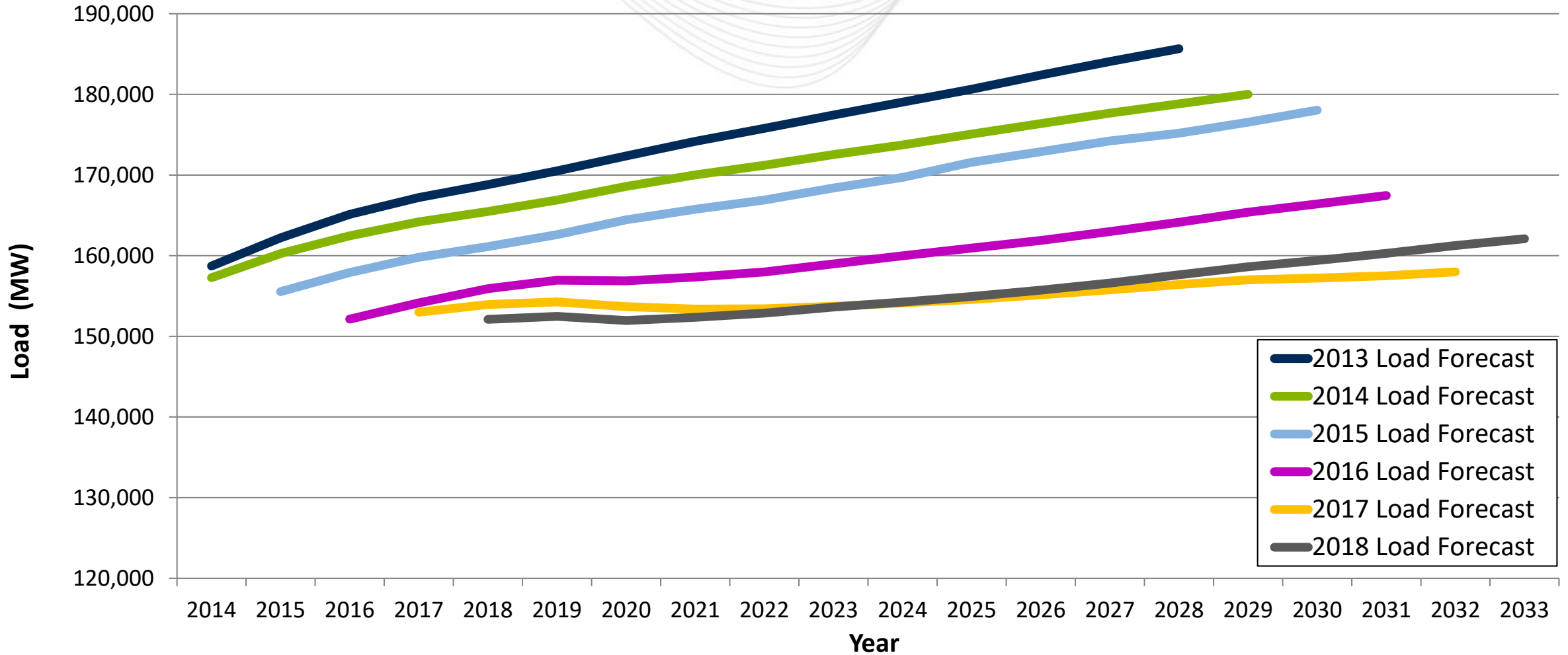
(Greater than \$5 million)

Project ID	Description	Required Date	Project Cost (\$M)	TO Zone(s)	2017 TEAC Date
s1297	At Hartford station, replace transformer 138/69kV 1 with a 90 MVA unit and replace 69kV CB H and G with 3000 A 40 kA breakers.	6/1/2021	\$ 143.0	AEP	5/31/2017
	At Riverside station, replace Transformer 5 with a new 90MVA 138/69kV transformer, replace 69 kV CB L and 138 kV CB R with 3000 A 40 kA breakers.				
	Valley Area Reinforcement project				
	At Main Street station, rebuild the entire station on existing property at the site and install a 90 MVA transformer with 3000 A 40 kA breakers.				
	At Hickory Creek station, rebuild the 34.5 kV yard, replace the 138kV CBs with 3000 A 40 kA breakers, replace the existing 138/34.5 kV transformers #1 and #3 with a single 138/69/34.5 kV 90 MVA bank and move the distribution feeds from 34.5 kV to 138 kV s				
	At South Haven station, retire bus tie CB A and install two new 69kV 3000 A 40 kA breakers towards Riverside and Hartford remote end stations.				
	At the Covert FBEC hard tap location, install a new phase-over-phase switch (Vector Switch) with load splitting capability.				
	Rebuild remaining 13.8 miles of Almena to Hartford 69kV line using 795 ACSR conductor (90 MVA rating).				
	Rebuild remaining 21.2 miles of Riverside – South Haven 69V line using 795 ACSR conductor (90 MVA rating).				
Hagar 69kV Station: Upgrade MOAB switch and install SCADA control.					
s1448	At Kenzie Creek station, retire 345kV MOABS 'W' and 'Y'. Install 3 345kV 5000A 63kA breakers in a ring bus configuration. Set up station to allow for future 'B' and 'C' breaker strings.	12/31/2018	\$ 7.4	AEP	12/14/2017

# Planning

## Load Forecast

## PJM RTO Summer Peak Demand Forecast





# Michigan – 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 *	904	949	0.5%	696	732	0.5%
PJM RTO	152,108	157,635	0.4%	131,463	136,702	0.4%

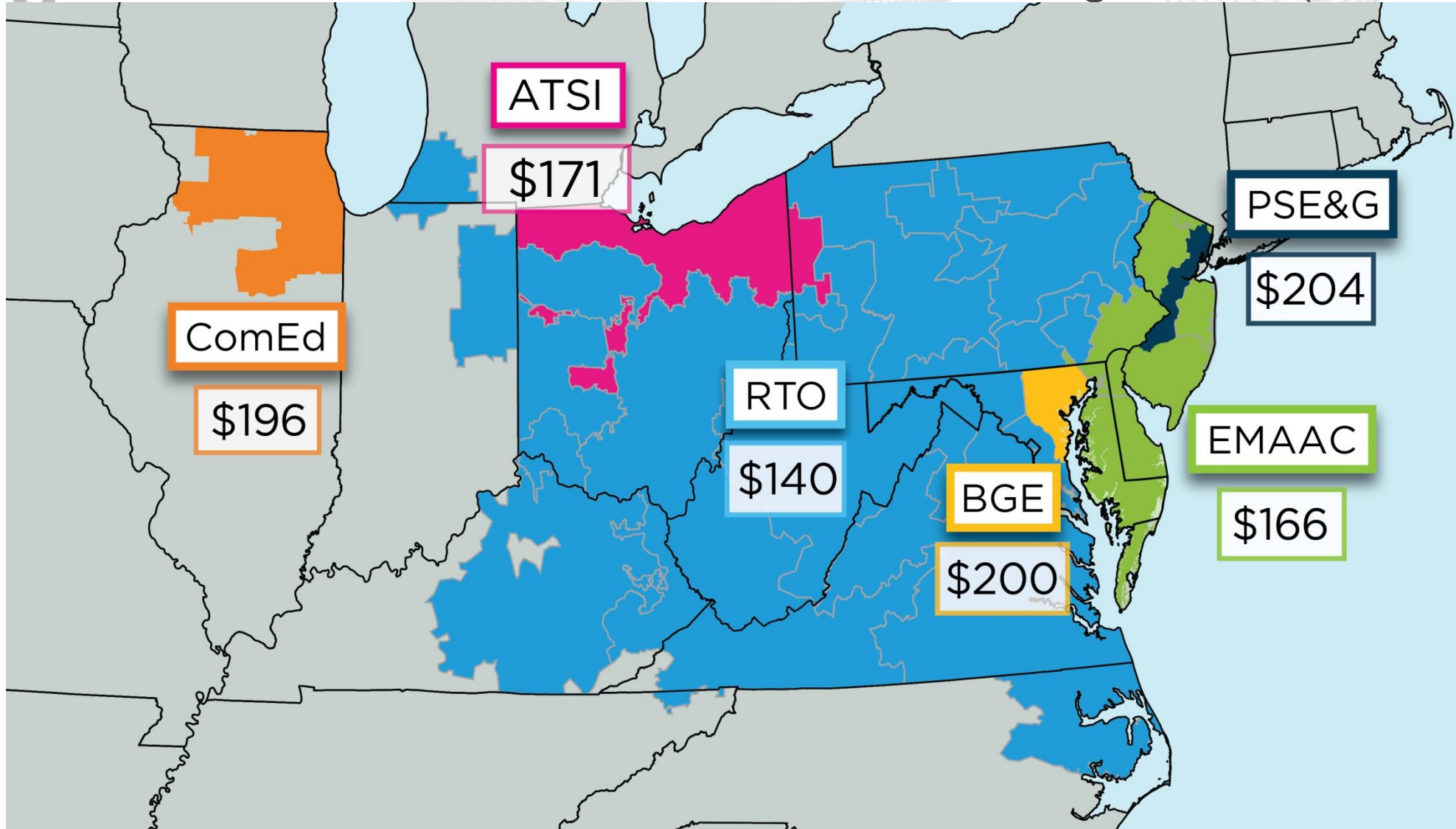
\* PJM notes that American Electric Power Company serves load other than in Michigan. The Summer Peak and Winter Peak MW values in this table each reflect the estimated amount of forecasted load to be served by American Electric Power Company solely in Michigan. Estimated amounts were calculated based on the average share of American Electric Power Company's real-time summer and winter peak load located in Michigan over the past five years.

# Markets

## Capacity Market Results



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





# Michigan - Cleared Resources in 2021/22 Auction

(May 23, 2018)

	Cleared MW (Unforced Capacity)	Change from 2020/21 Auction
Generation	1,154	(39)
Demand Response	59	31
Energy Efficiency	6	3
<b>Total</b>	<b>1,219</b>	<b>(4)</b>

## 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

	<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>	<b>162,912 MW</b>	<b>716 MW</b>	<b>716 MW</b>	<b>164,343 MW</b>



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

(May 23, 2018)

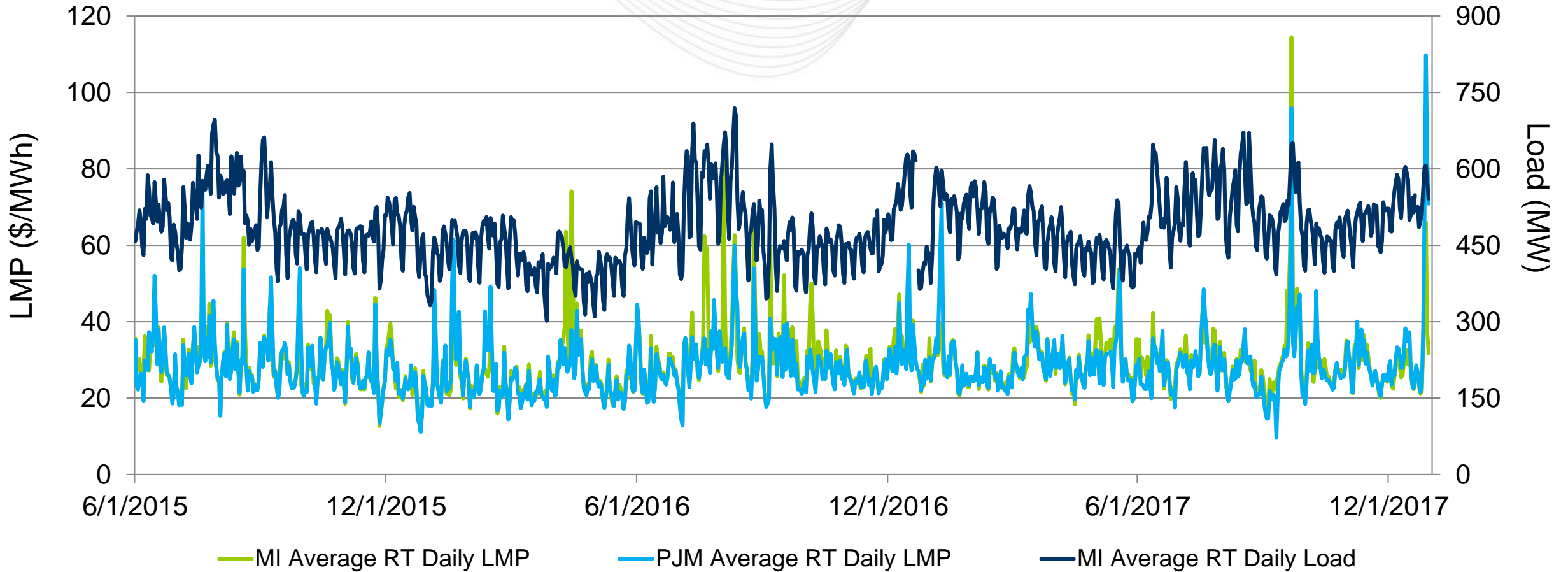
		Unforced Capacity
<b>Generation</b>	Offered MW	1,179
	Cleared MW	1,154
<b>Demand Response</b>	Offered MW	64
	Cleared MW	59
<b>Energy Efficiency</b>	Offered MW	7
	Cleared MW	6
<b>Total Offered MW</b>		<b>1,250</b>
<b>Total Cleared MW</b>		<b>1,219</b>

*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

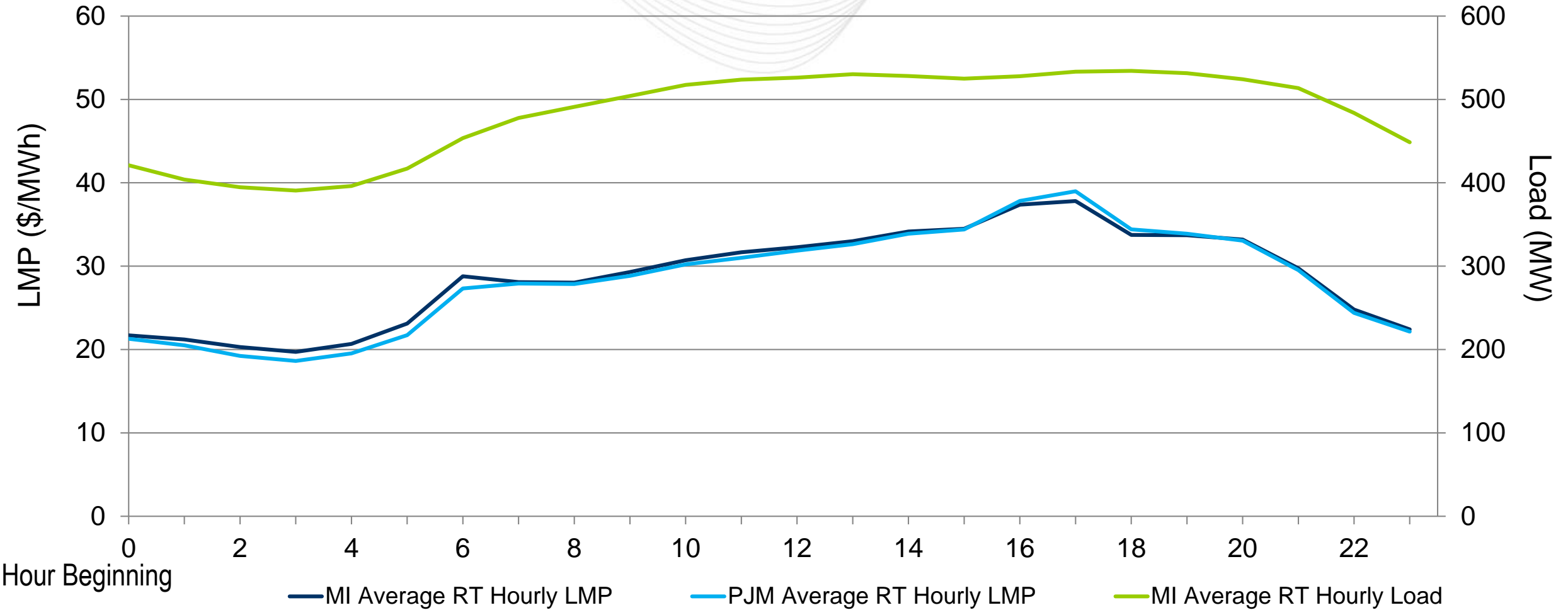
## Market Analysis

Michigan'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.

Michigan's hourly LMPs generally aligned with the PJM average.



# Operations Emissions Data



