



# 2017 Virginia State Infrastructure Report

(January 1, 2017 – December 31, 2017)

May 2018

This report reflects information for the portion of Virginia 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 45.0 percent of the total installed capacity in Virginia while coal represents approximately 15.2 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 60 percent of new interconnection requests in Virginia.
- **Deactivations:** Virginia did not have any generation deactivations in 2017.
- **RTEP 2017:** Virginia RTEP 2017 projects total more than \$791 million in investment. Approximately 22 percent of that represents supplemental projects.
- **Load Forecast:** Virginia load growth is nearly flat, averaging between .2 and .9 percent per year over the next 10 years. This aligns with PJM RTO load growth projections.

- **2021/22 Capacity Market:** Virginia cleared 920 MW more Demand Response and Energy Efficient resources than in the prior auction.
- **6/1/15 – 12/31/17 Performance:** Virginia's average daily locational marginal prices were consistently at or above PJM average daily LMPs. Natural gas resources represented 30.9 percent of generation produced in Virginia while nuclear averaged 26.1 percent.
- **Emissions:** 2017 carbon dioxide, sulfur dioxide, and nitrogen oxide emissions are all down from 2016.



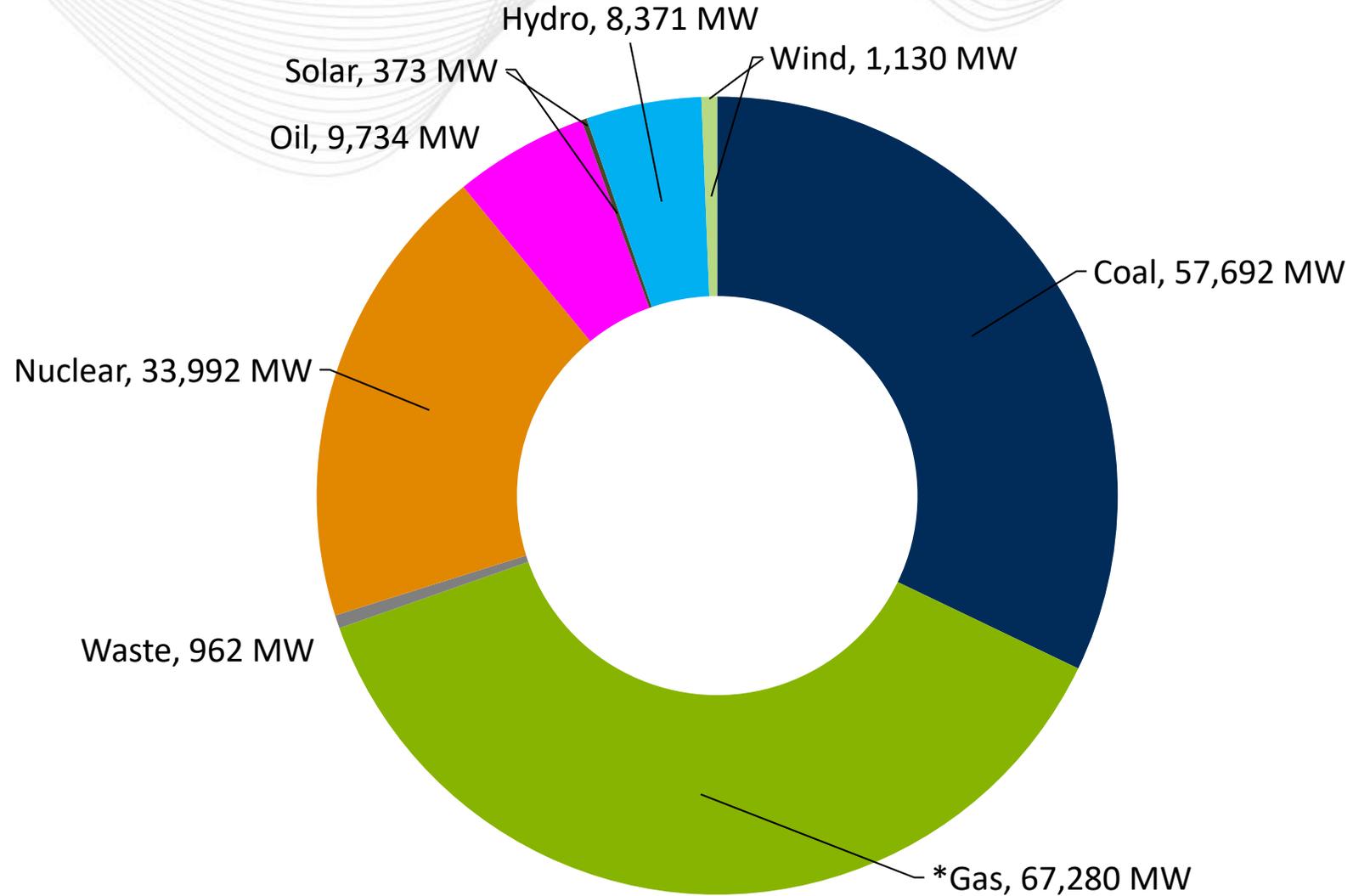
# Planning

## Generation Portfolio Analysis

# PJM – Existing Installed Capacity

(MW submitted to PJM, December 31, 2017)

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



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

# Virginia – Existing Installed Capacity

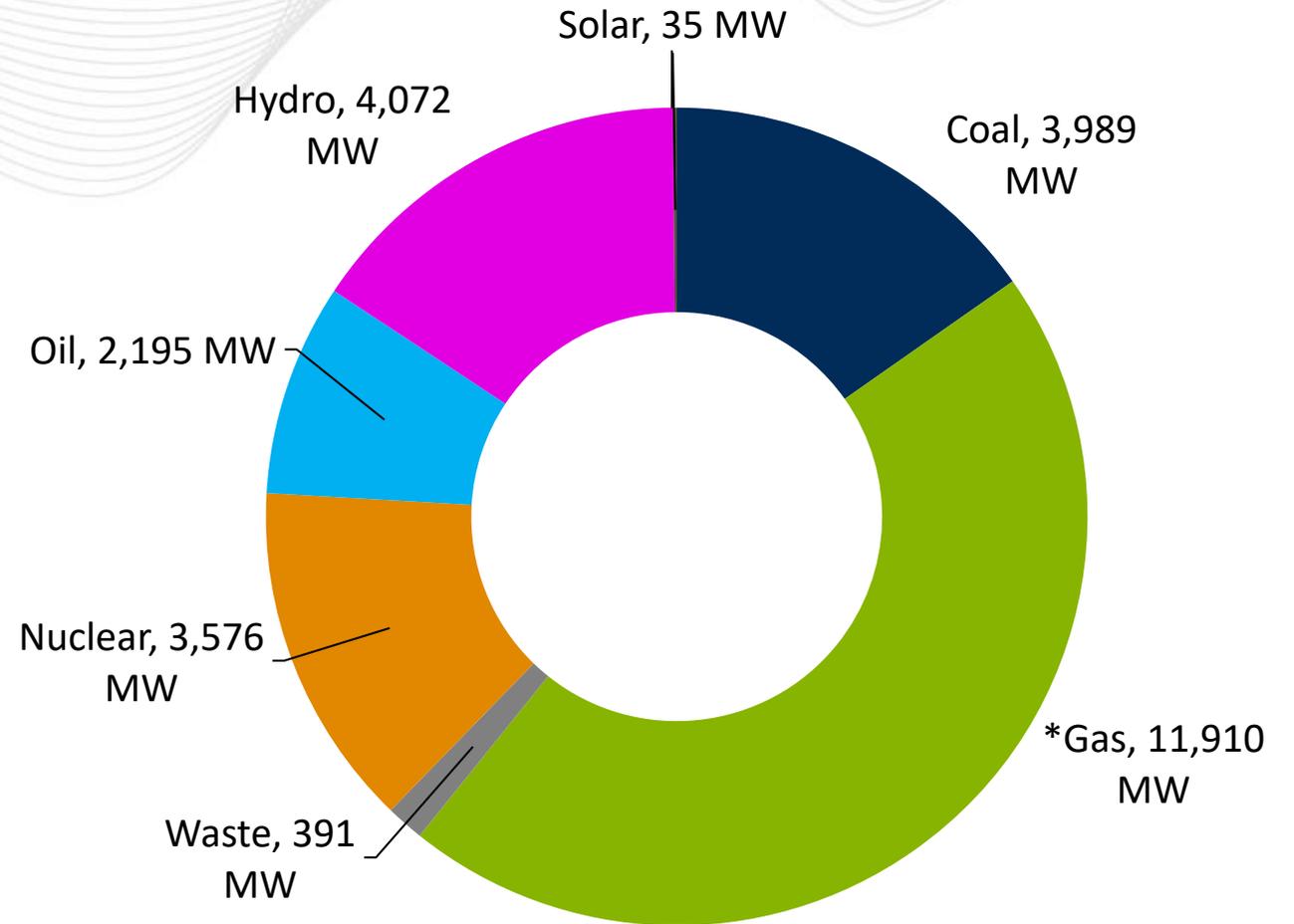
(MW submitted to PJM, December 31, 2017)

## Summary:

Natural gas represents approximately 45.0 percent of the total installed capacity in the Virginia territory while coal represents approximately 15.2 percent.

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

* Gas Contains	
Natural Gas	11,788.7 MW
Other Gas	121.6 MW



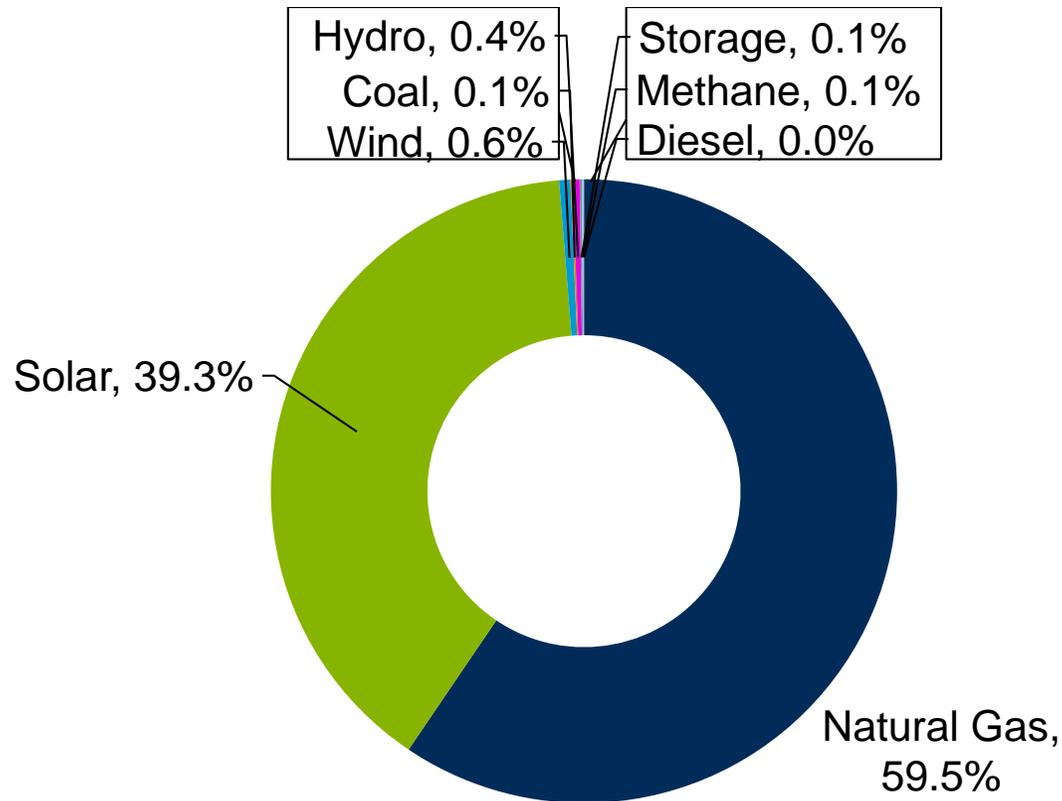
Note: Capacity from generating units owned by Virginia jurisdictional utilities and included in regulated rates charged to Virginia customers, but physically located outside of Virginia, is not included in the above chart.

# Virginia – Interconnection Requests

(Requested Capacity Rights, December 31, 2017)

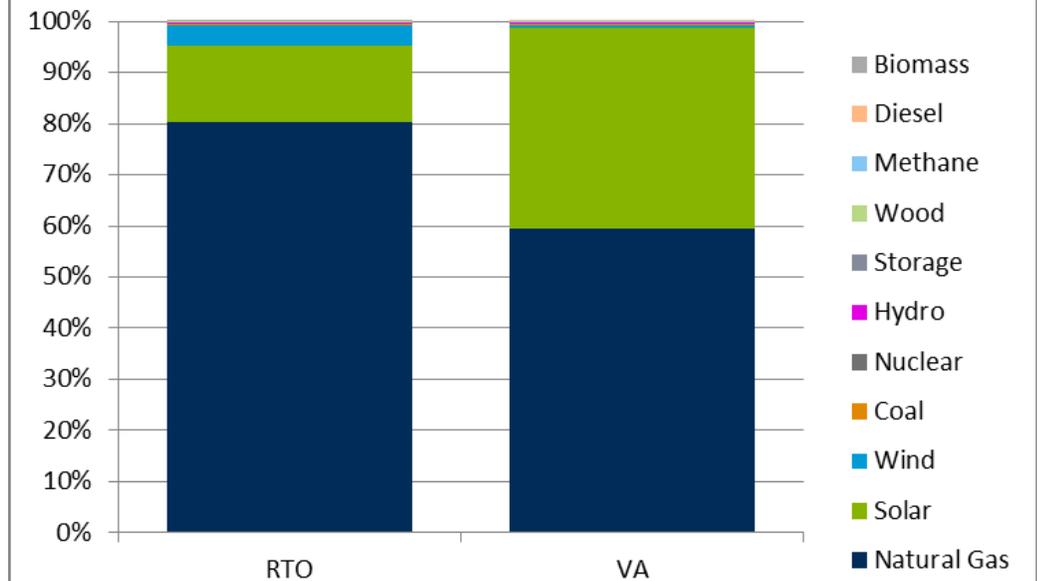
Natural gas represents approximately 60 percent of new interconnection requests in Virginia.

Total MW Capacity by Fuel Type



Fuel Source	Capacity, MW	Nameplate Capability, MW
Natural Gas	6,597.1	6,649.6
Solar	4,356.4	7,242.2
Wind	63.8	475.2
Hydro	39.5	39.5
Coal	13.2	14.0
Storage	12.5	22.0
Methane	10.2	8.0
Diesel	1.9	-
<b>Total</b>	<b>11,094.6</b>	<b>14,450.5</b>

Fuel as a Percentage of Projects in Queue





# Virginia – Interconnection Requests

(As of December 31, 2017)

	Complete				In Queue						Grand Total	
	In Service		Withdrawn*		Active		Suspended**		Under Construction**			
	MW	# of Projects	MW	# of Projects	MW	# of Projects	MW	# of Projects	MW	# of Projects	MW	# of Projects
<b>Non-Renewable</b>	6,461	60	15,594	41	4,543	18	-	1	2,082	6	28,679	126
Coal	706	8	35	2	13	1					754	11
Diesel	0	1	-	1					2	1	2	3
Natural Gas	5,083	36	13,812	30	4,517	15			2,080	5	25,492	86
Nuclear	350	8	1,570	1							1,920	9
Oil	322	6	40	2							362	8
Other		1	136	2							136	3
Storage			-	3	13	2	-	1			13	6
<b>Renewable</b>	814	47	2,102	110	4,323	119	17	4	130	17	7,387	297
Biomass	147	5	70	4							217	9
Hydro	382	6	254	2	40	2					675	10
Methane	97	14	82	11					10	2	189	27
Solar	185	21	1,244	65	4,248	115	7	3	102	12	5,785	216
Wind			396	26	35	2	10	1	18	3	460	32
Wood	4	1	57	2							61	3
<b>Grand Total</b>	<b>7,275</b>	<b>107</b>	<b>17,696</b>	<b>151</b>	<b>8,865</b>	<b>137</b>	<b>17</b>	<b>5</b>	<b>2,212</b>	<b>23</b>	<b>36,066</b>	<b>423</b>

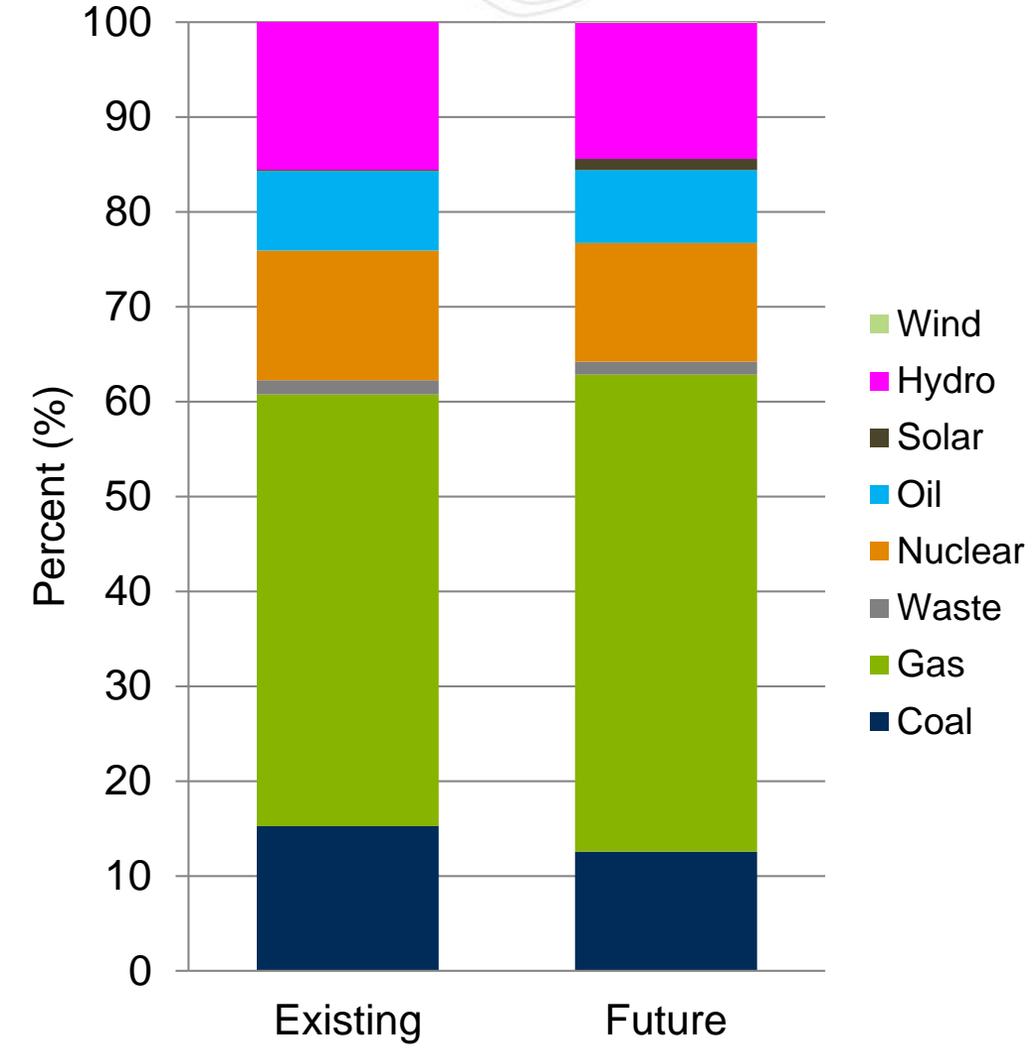
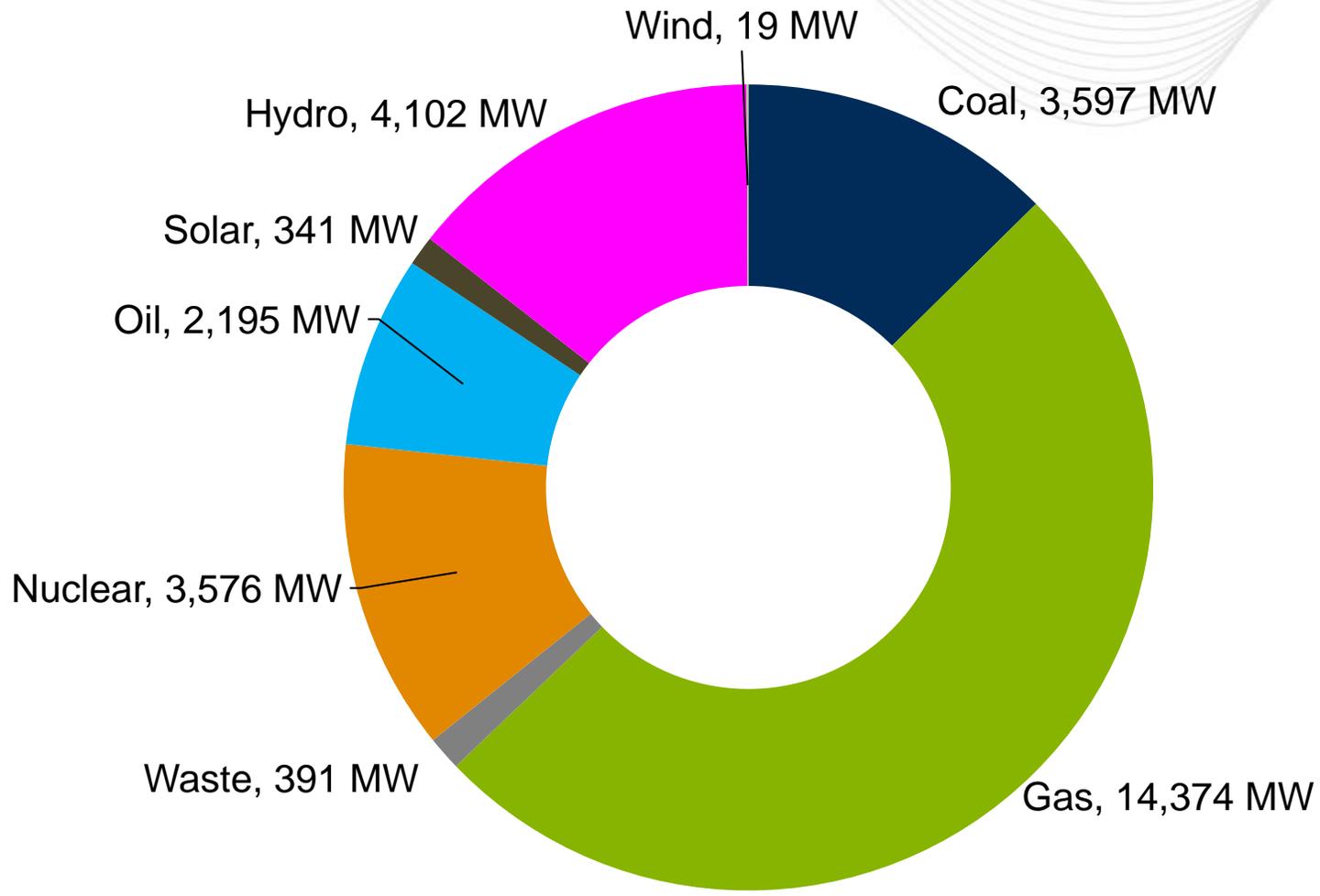
\*May have executed final agreement

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



# Virginia – Future Capacity Mix

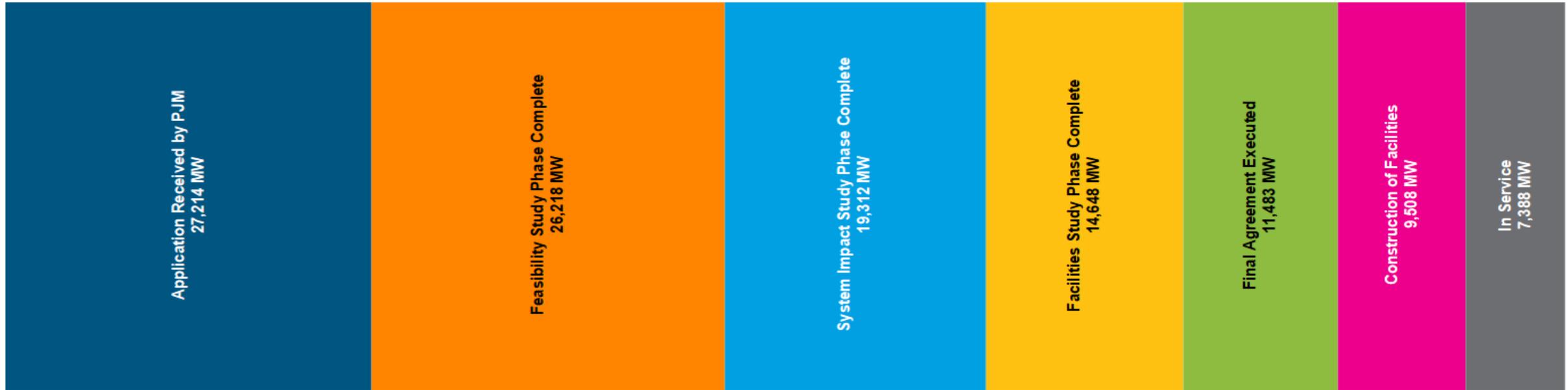
Based on known queued interconnection requests and deactivation notices through December 31, 2022, adjusted to reflect the probability of commercialization as indicated by historical trends specific to an interconnection request's state/zonal location and fuel type.





# Virginia – Progression History Interconnection Requests

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

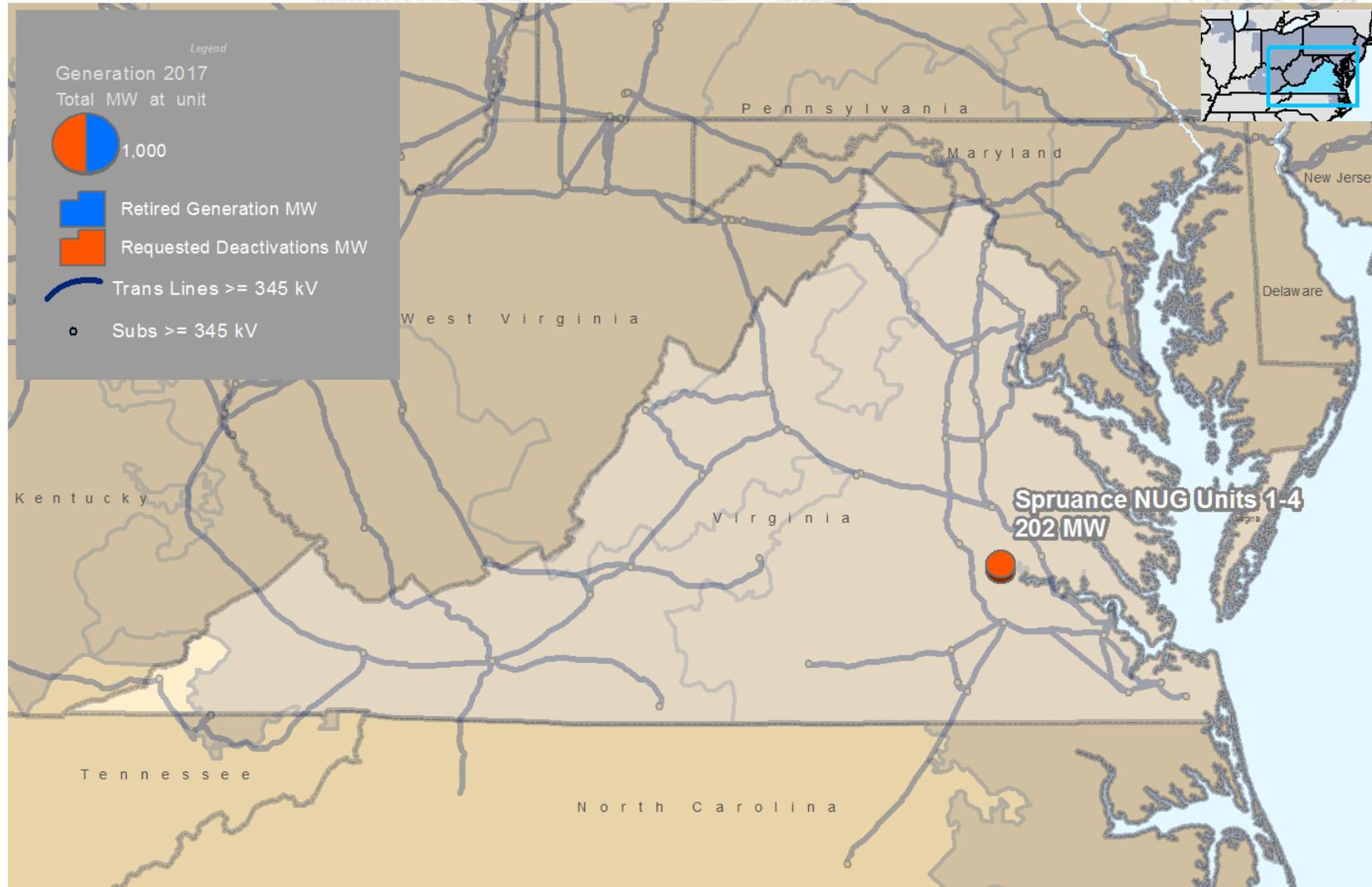


## Projects that withdrew after a final agreement

	Number of Projects	Capacity, MW	Nameplate Capability, MW
ISA	15	1,934	2,275
WMPA	3	30	50

27.1% of requested capacity megawatt and 39.0% of projects reaches commercial operation

# Virginia – Deactivation Notifications Received in 2017





# Virginia – Deactivation Notifications Received in 2017

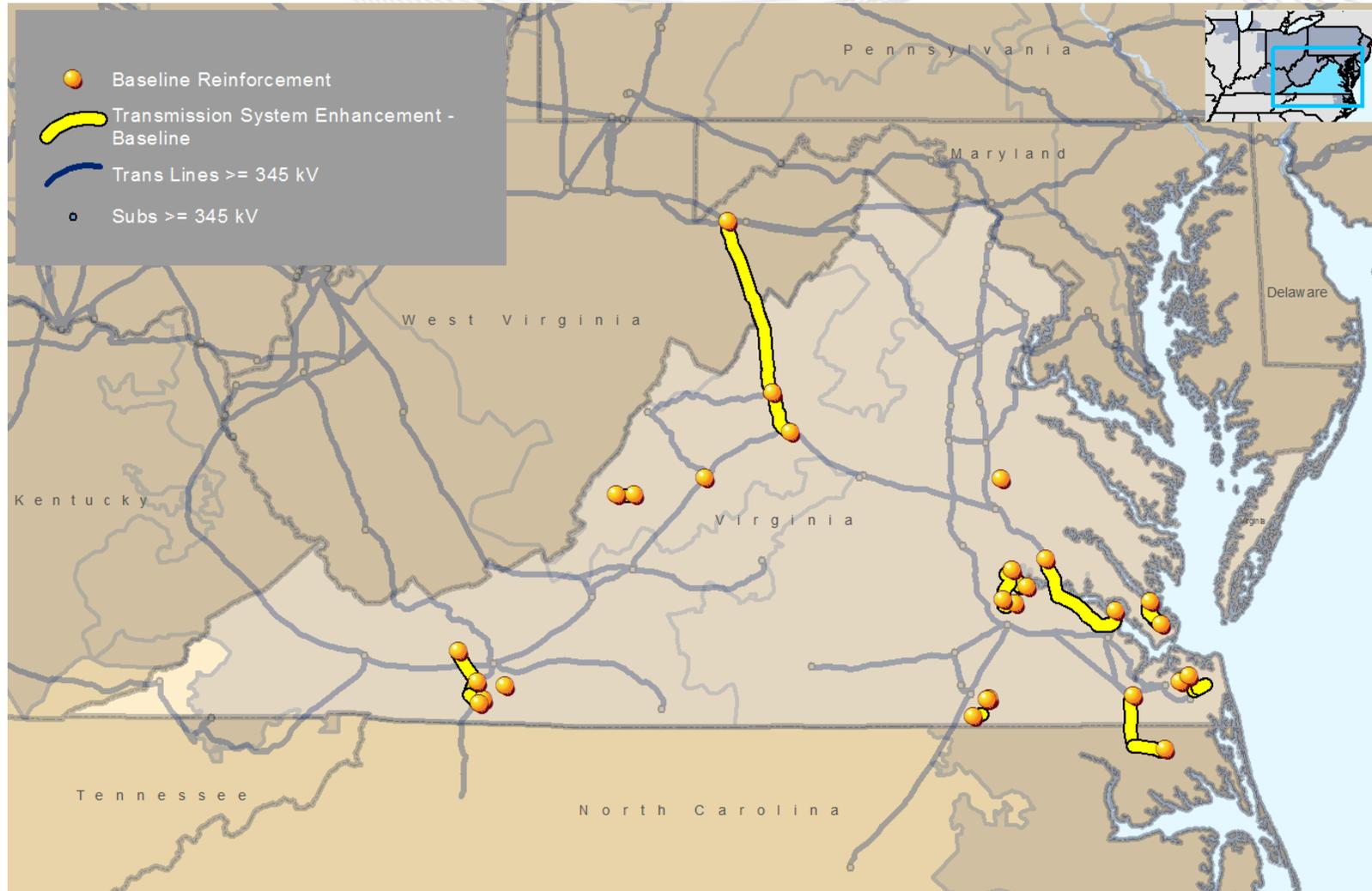
Unit	MW Capacity	TO Zone	Age	Projected Deactivation Date
Spruance NUG 1	116	Dominion	25	1/12/2019
Spruance NUG 2	86	Dominion	25	1/12/2019

### Summary:

- In 2017, two generating units in Virginia announced their intention to deactivate.
- In 2017 there were a total of 12 PJM generating units that announced their intent to deactivate, ranging in date from 2018 - 2020.
- Virginia did not have any generation deactivations in 2017.

# Planning

## Transmission Infrastructure Analysis



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



# Virginia – RTEP Baseline Projects

(Greater than \$5 million)

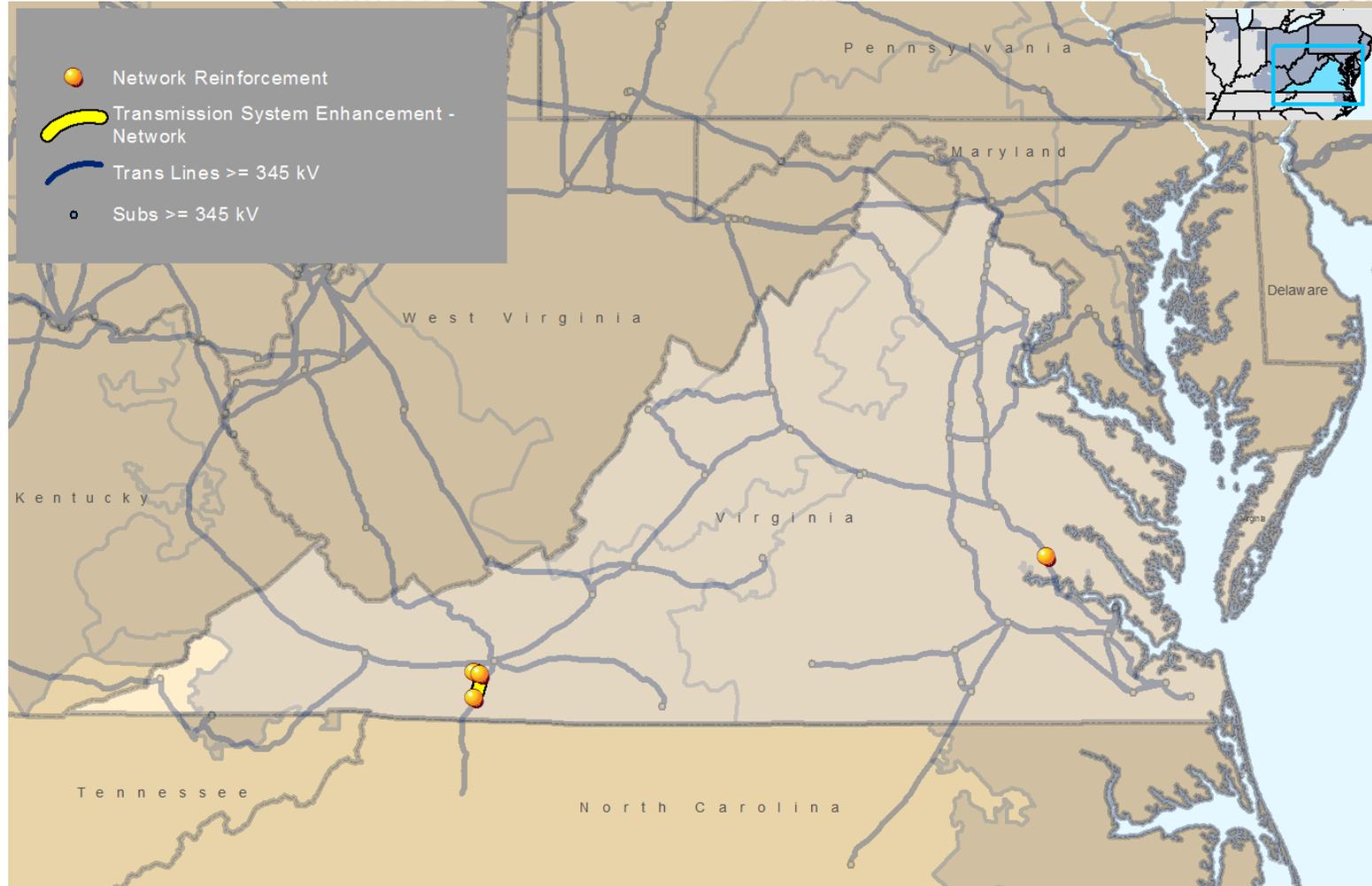
Project ID	Project	Project Driver	Required In Service Date	Project Cost (\$M)	TO Zone(s)	2017 TEAC Review
b2871	Rebuild 230kV line #247 from Swamp to Suffolk (31 miles) to current standards with a summer emergency rating of 1047 MVA at 230kV.	TO Criteria Violation	12/30/2022	\$ 31.0	Dominion	5/4/2017
b2815	Build a new Pinewood 115kV switching station at the tap serving North Doswell DP with a 115kV four breaker ring bus	TO Criteria Violation	6/1/2017	\$ 12.8	Dominion	12/1/2016
b2758	Rebuild Line #549 Dooms – Valley 500kV	TO Criteria Violation	6/1/2016	\$ 58.2	Dominion	10/6/2016
b2759	Rebuild Line #550 Mt. Storm – Valley 500kV	TO Criteria Violation	6/1/2016	\$ 225.0	Dominion	10/6/2016
b2800	The 7 mile section from Dozier to Thompsons Corner of line #120 will be rebuilt to current standards using 768.2 ACSS conductor with a summer emergency rating of 346 MVA at 115kV. Line is proposed to be rebuilt on single circuit steel monopole structure	TO Criteria Violation	6/1/2017	\$ 6.5	Dominion	6/9/2017
b2649	Rebuild of 1.7 mile tap to Metcalf and Belfield DP (MEC) due to poor condition. The existing summer rating of the tap is 48 MVA and existing conductor is 4/0 ACSR on wood H-frames. The proposed new rating is 176 MVA using 636 ACSR conductor.	TO Criteria Violation	12/31/2019	\$ 38.8	Dominion	6/9/2017
	Rebuild of 4.1 mile tap to Brinks DP (MEC) due to wood poles built in 1962. The existing summer rating of the tap is 48 MVA and existing conductor is 4/0 ACSR and 393.6 ACSR on wood H-frames. The proposed new rating is 176 MVA using 636 ACSR conductor.					
b2877	Rebuild Line #112 from Fudge Hollow - Lowmoor 138 kV (5.16 miles) to current standards with a summer emergency rating of 314 MVA at 138kV.	TO Criteria Violation	10/31/2020	\$ 8.0	Dominion	6/9/2017
b2801	Line #76 and #79 will be rebuilt to current standard using 768.2 ACSS conductor with a summer emergency rating of 346 MVA at 115kV. Proposed structure for rebuild is double circuit steel monopole structure	TO Criteria Violation	12/30/2020	\$ 22.0	Dominion	6/9/2017



# Virginia – RTEP Baseline Projects

(Greater than \$5 million)

Project ID	Project	Project Driver	Required In Service Date	Project Cost (\$M)	TO Zone(s)	2017 TEAC Review
b2922	Rebuild 8 of 11 miles of 230kV Lines #211 and #228 to current standard with a summer emergency rating of 1046 MVA for rebuilt section. Proposed conductor is 2-636 ACSR.	TO Criteria Violation	12/1/2020	\$ 28.1	Dominion	8/10/2017
b2928	Rebuild four structures of 500kV Line #567 from Chickahominy to Surry using galvanized steel and replace the river crossing conductor with 3-1534 ACSR. This will increase the Line #567 Line Rating from 1954 MVA to 2600 MVA.	TO Criteria Violation	12/30/2017	\$ 41.0	Dominion	9/14/2017
b2889	Byllesby – Wythe 69kV: Retire all 13.77 miles (1/0 CU) of this circuit (~4 miles currently in national forest)	TO Criteria Violation	6/1/2021	\$ 30.0	AEP	5/31/2017
	Galax – Wythe 69kV: Retire 13.53 miles (1/0 CU section) of line from Lee Highway down to Byllesby. This section is currently double circuited with Byllesby – Wythe 69kV. Terminate the southern 3/0 ACSR section into the newly opened position at Byllesby					
	Cliffview Station: Establish 138kV bus. Install two 138/69kV XFRs (130 MVA), six 138kV CBs (40kA 3000A) and four 69kV CBs (40kA 3000A).					
	Expand Cliffview station					
	Cliffview Line: Tap the existing Pipers Gap – Jubal Early 138kV line section. Construct double circuit in/out (~2 miles) to newly established 138kV bus, utilizing 795 26/7 ACSR conductor.					
b2960	Replace fixed series capacitors on 500kV Line #547 at Lexington and on 500kV Line #548 at Valley	TO Criteria Violation	4/1/2020	\$ 28.9	Dominion	11/2/2017
b2961	Rebuild approximately 3 miles of Line #205 & Line #2003 from Chesterfield to Locks & Poe respectively.	TO Criteria Violation	12/31/2022	\$ 9.5	Dominion	11/2/2017



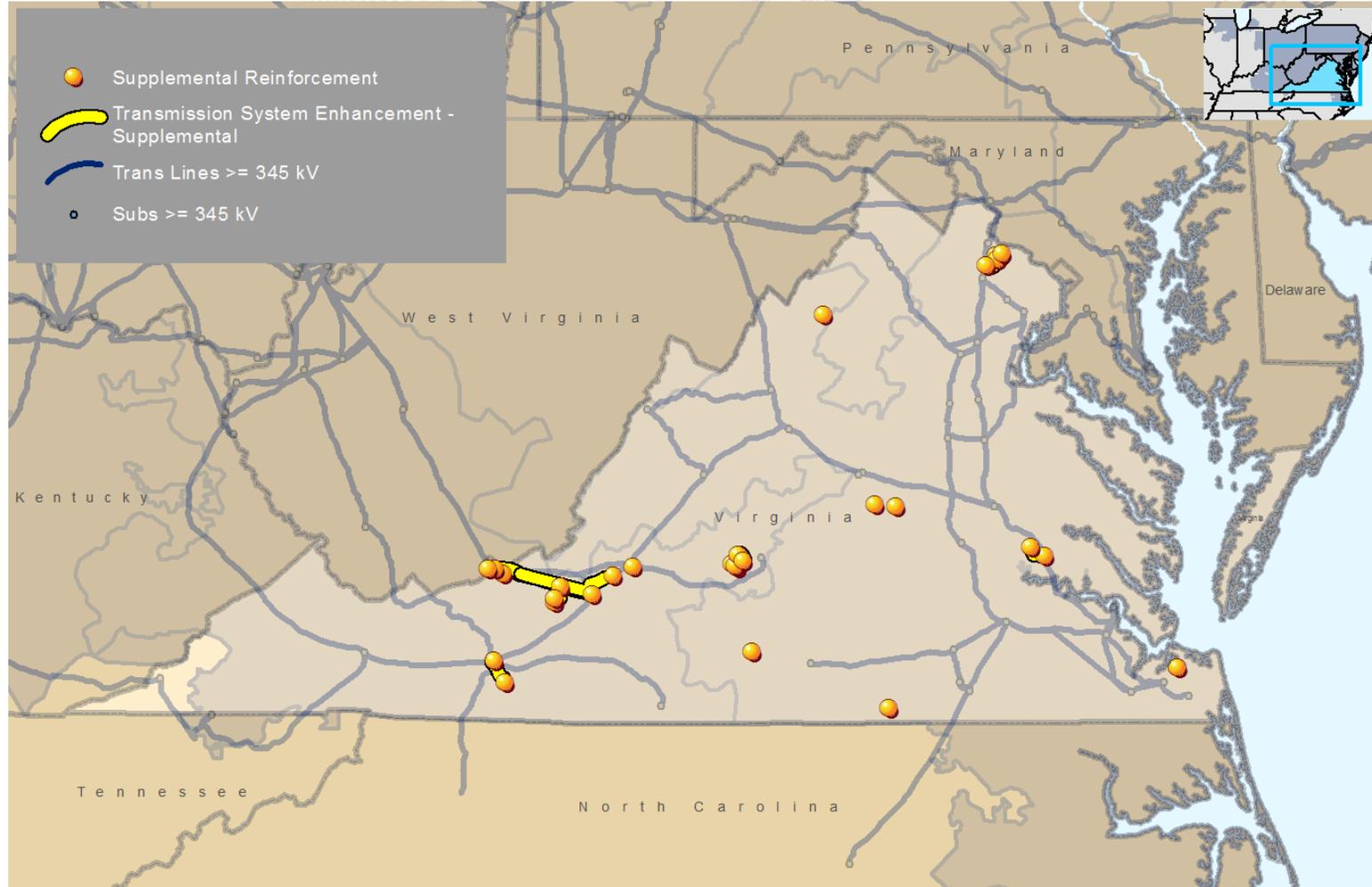
Note: Network upgrades are new or upgraded facilities required primarily to eliminate reliability criteria violations caused by proposed generation, merchant transmission or long term firm transmission service requests.



# Virginia – 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
n3666	Install 138 kV Revenue Metering at the new Iron Ridge 138kV substation	Generation	Y1-006	10/31/2019	\$ 7.5	AEP	10/12/2017
	Install ADSS Fiber at the new Iron Ridge 138kV substation						
	Construct Jubal Early – Austinville 138kV T-Line Cut In						
	Construct a new Iron Ridge 138kV Switching Station						
n5212	Add three new 500 kV breakers and associated equipment to the exiting Chickahominy 500 kV Substation	Generation	AB2-068	3/31/2020	\$ 6.5	Dominion	10/12/2017
n5409	Build New AB2-158 Switching Substation (interconnection substation)	Generation	AB2-158	10/1/2018	\$ 6.3	Dominion	10/12/2017
n5460	Wreck and rebuild the Penniman-Waller 230 kV line. New Rating 1047 MVA	Generation	AC1-159	6/1/2020	\$ 13.0	Dominion	10/12/2017
n5461	Wreck and rebuild the Kings Mill-Penniman 230 kV line. New Rating 1047 MVA	Generation	AC1-159	6/1/2020	\$ 6.8	Dominion	10/12/2017
n5462	Add a third Chesapeake 230/115 kV transformer	Generation	AC1-159	6/1/2020	\$ 7.0	Dominion	10/12/2017
n5463	Wreck and rebuild 11 miles Chesapeake-Greenwich 230 kV line	Generation	AC1-159	6/1/2020	\$ 21.2	Dominion	10/12/2017
n5465	Wreck and rebuild the Skiff Creek-Kings Mill 230 kV line. New Rating 1047 MVA	Generation	AC1-107	6/1/2020	\$ 8.4	Dominion	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.



# Virginia – TO Supplemental Projects

(Greater than \$5 million)

Project ID	Description	Required Date	Project Cost (\$M)	TO Zone(s)	2017 TEAC Date
s1187	Construct McConville station to serve distribution load on the Brookville-Graves Mill 138 kV line.	6/30/2017	\$ 7.4	AEP	1/5/2017
s1238	Interconnect new Roundtable substation by cutting and extending both Line #2149 (Enterprise-Waxpool) and Line #2137 (Brambleton-BECO). Terminate the lines into a six-breaker 230kV ring bus. Install a 230kV circuit switcher, high side switches and necess	11/30/2018	\$ 9.4	Dominion	1/5/2017
s1271	New Reeves Ave 230kV configuration: Install three 230kV breakers to form a 4-breaker ring bus	1/31/2018	\$ 11.7	Dominion	5/4/2017
	115kV configuration: Install 115kV breakers on high side of transformer #2, #3, and #6.	12/30/2018			
s1272	Replace TX#4 and TX#5 with new 168MVA (nameplate rating) transformers.	1/26/2018	\$ 8.7	Dominion	5/4/2017
s1291	Rebuild Peakland – Dearington 69 kV circuit (approximately 4.4 miles) utilizing 795 26/7 ACSR conductor. A portion of this line shares a common tower with the Dearington – Blackwater 34.5 kV circuit. This line is currently comprised of 4/0 Copper, 1/0 Co	12/1/2018	\$ 12.7	AEP	5/31/2017
s1295	Pipers Gap: Install five 138kV CBs (40kA 3000A).	6/1/2021	\$ 35.0	AEP	5/31/2017
	Jacksons Ferry: Install one 138kV CB				
	New Jacksons Ferry-Pipers Gap line				
	Jacksons Ferry – Pipers Gap 138kV: Construct a new 138kV line (~10 miles) from Jacksons Ferry – Pipers Gap utilizing 1033.5 ACSR conductor.				



# Virginia – TO Supplemental Projects

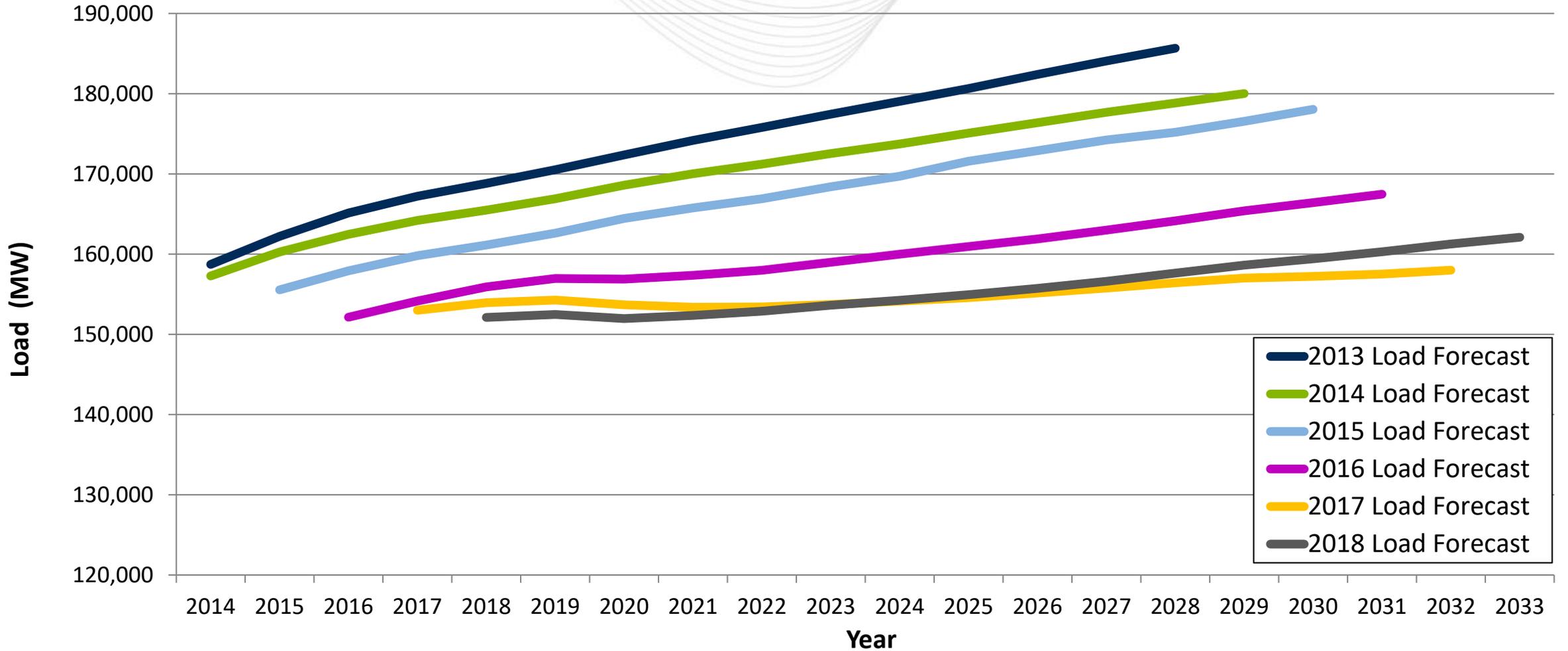
(Greater than \$5 million)

Project ID	Description	Required Date	Project Cost (\$M)	TO Zone(s)	2017 TEAC Date
s1313	Glen Lyn 138kV Station: Replace two 138kV CBs with 3000 A 40 kA breakers	6/1/2018	\$ 37.5	AEP	5/31/2017
	Catawba 138kV Station: Install two 3000 A 40 kA 138kV CBs, two 138kV switchers on the transformers, and three 3000 A 40 kA 69kV CBs				
	North Blacksburg Station: Install 3000 A 40 kA 138kV CBs and switchers on the transformers				
	Update relay and communication at various sites. Replace circuit breakers				
	North Blacksburg – Matt Funk 138kV line relaying/fiber				
	Glen Lyn – Catawba – Cloverdale 138kV line relaying/fiber				
	Glen Lyn – Peters MT. 138kV relaying/fiber				
	North Blacksburg – Celanese 138kV line relaying				
	Merrimac 69kV Station: Replace two 69kV CBs with 3000 A 40 kA breakers				
	North Blacksburg – Lane 69kV relaying/fiber				
	North Blacksburg – Blacksburg 69kV relaying/fiber				
	Lane – Merrimac 69kV relaying/fiber				
Merrimac – North Blacksburg 69kV relaying/fiber					
s1374	Replace Bremo 138-115kV transformer #8 with a 225 MVA transformer	7/31/2018	\$ 7.0	Dominion	10/30/2017
s1389	Rebuild Beechwood (MEC), 115kV Line #90 (to be #1004), 4.51 miles	12/1/2018	\$ 7.0	Dominion	6/9/2017
s1390	Rebuild Columbia (CVEC), 115kV Line #4, 4.00 miles	12/1/2019	\$ 5.0	Dominion	6/9/2017
s1391	Rebuild Hickory Grove (MEC), 115kV Line #31 (to be #1022), 8.25 miles	12/1/2020	\$ 12.3	Dominion	6/9/2017
s1399	Rebuild Mt. Jackson (SVEC), 115kV Line #128, 0.05 mile	12/1/2021	\$ 10.0	Dominion	6/9/2017
s1452	Install a 230kV switching station and delivery point by tapping the 230kV Line #2091 (Chickahominy – White Oak) in and out of the proposed customer site.	10/25/2018	\$ 11.0	Dominion	12/14/2017

# Planning

## Load Forecast

## PJM RTO Summer Peak Demand Forecast





# Virginia – 2018 Load Forecast Report

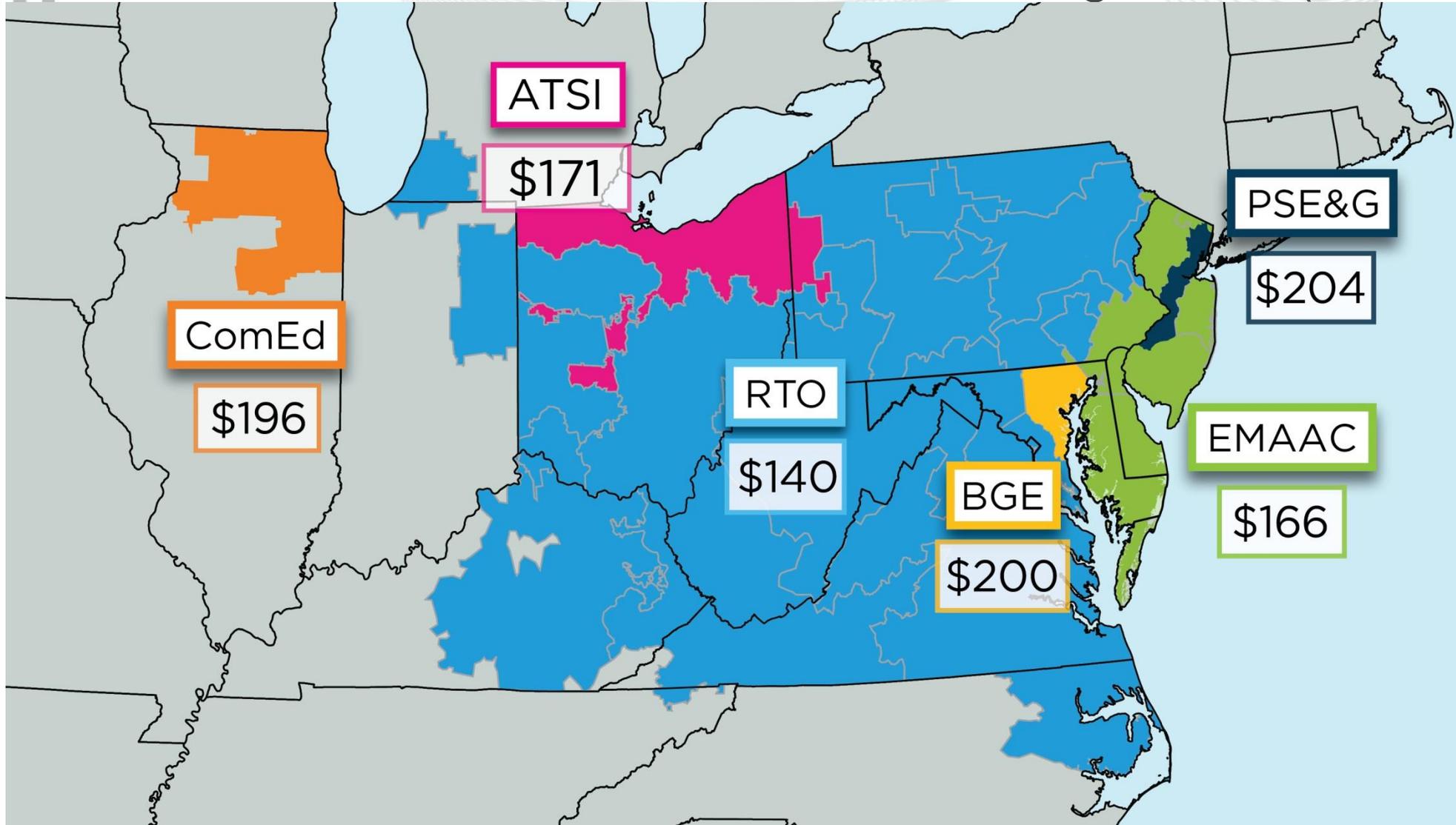
Transmission Owner	Summer Peak (MW)			Winter Peak (MW)		
	2018	2028	Growth Rate (%)	2017/18	2027/28	Growth Rate (%)
American Electric Power Company *	3,367	3,535	0.5%	4,070	4,279	0.5%
Allegheny Power *	665	712	0.7%	697	757	0.8%
Delmarva Power and Light *	143	146	0.2%	145	150	0.3%
Dominion Virginia Power *	18,569	20,052	0.8%	17,091	18,672	0.9%
PJM RTO	152,108	157,635	0.4%	131,463	136,702	0.4%

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

# Markets

## Capacity Market Results

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





# Virginia - Cleared Resources in 2021/22 Auction

(May 23, 2018)

	Cleared MW (Unforced Capacity)	Change from 2019/20 Auction
Generation	23,727	(1,144)
Demand Response	1,407	549
Energy Efficiency	565	371
<b>Total</b>	<b>25,699</b>	<b>(223)</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>	162,912 MW	716 MW	716 MW	164,343 MW



# Virginia – Offered and Cleared Resources in 2020/21 Auction

(May 23, 2017)

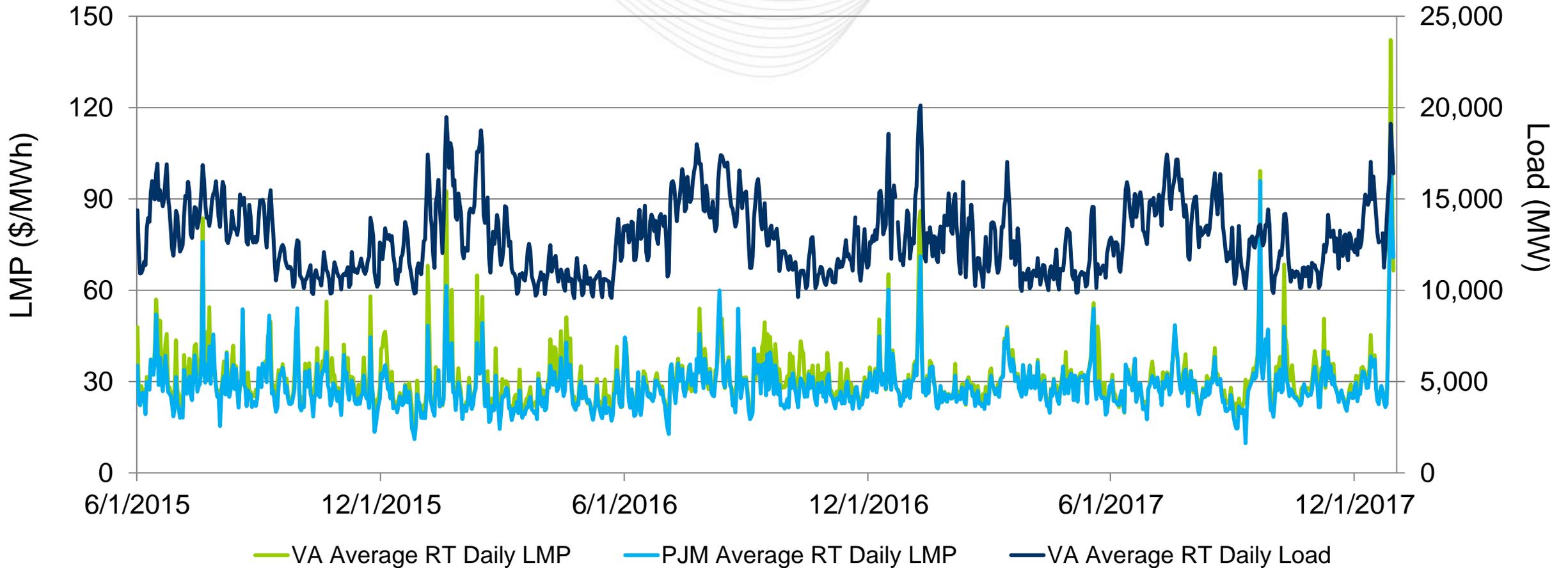
		Unforced Capacity
<b>Generation</b>	Offered MW	25,297
	Cleared MW	24,871
<b>Demand Response</b>	Offered MW	968
	Cleared MW	858
<b>Energy Efficiency</b>	Offered MW	294
	Cleared MW	193
<b>Total Offered MW</b>		<b>26,558</b>
<b>Total Cleared MW</b>		<b>25,922</b>

*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

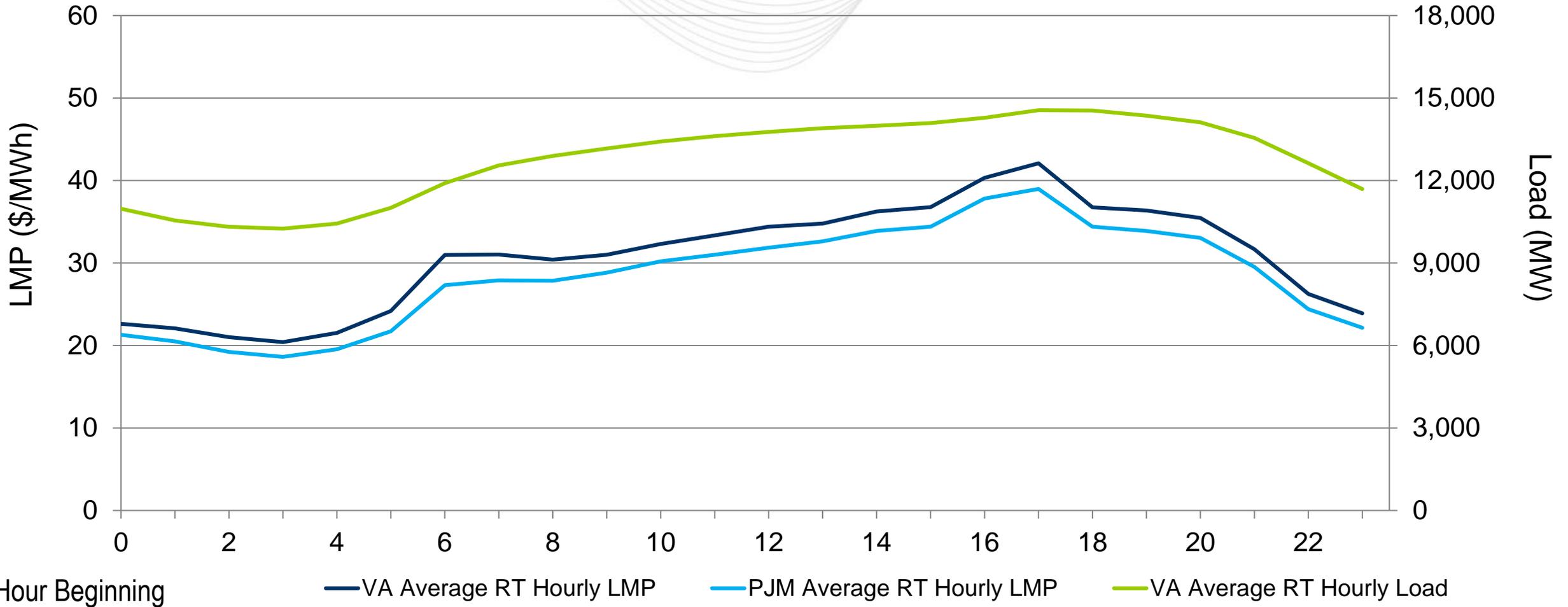
## Market Analysis

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



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

Virginia's average hourly LMPs are higher than the PJM average.



# Operations Emissions Data

