Informational Base Scenario Capacity Expansion (Order No.1920 Scenario Development Track)

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Resource Adequacy Planning

TEAC Special Session - Order 1920

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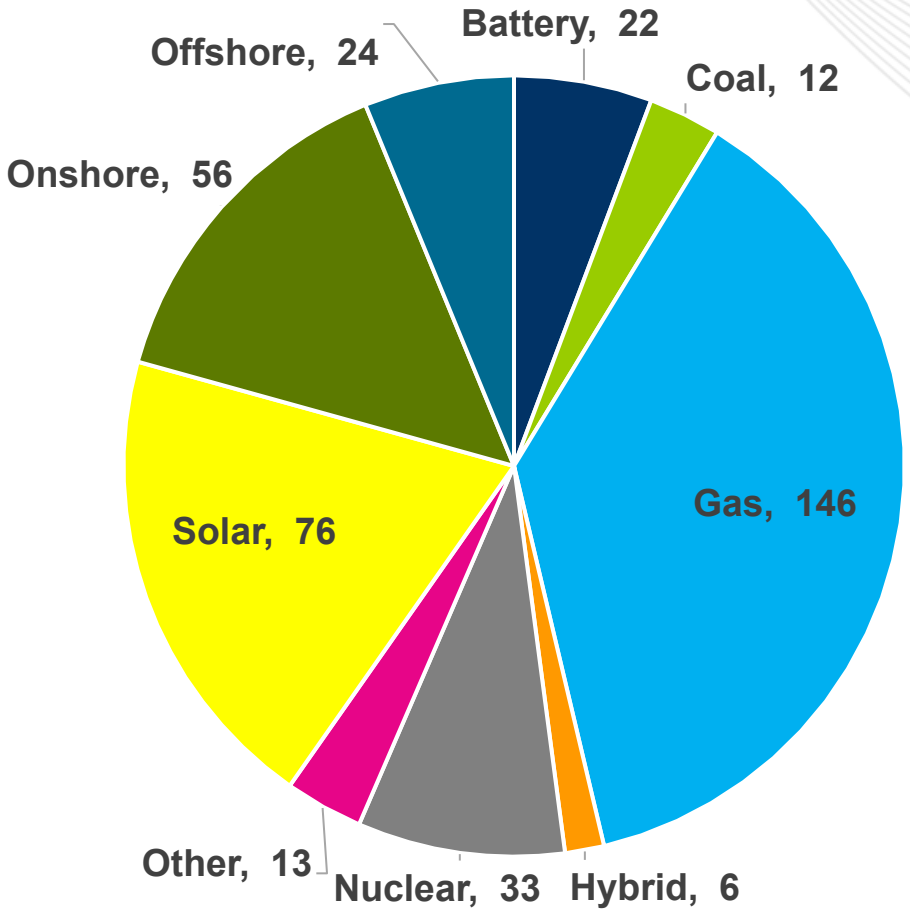
Assumptions

- Load assumptions
- Generation and storage technologies
- Fixed and Variable costs components
  - Fixed: Capital, fixed O&M, geographic adjustments coefficients
  - Variable: Heat rates, fuel costs, variable O&M
- Financial assumptions (fixed charge rate and discount rate)
- Renewable capacity factors
- Policy assumptions (new generation and deactivations)
- Resource adequacy
- Starting resource mix
- Build limits for capacity expansion (Siting opportunities)

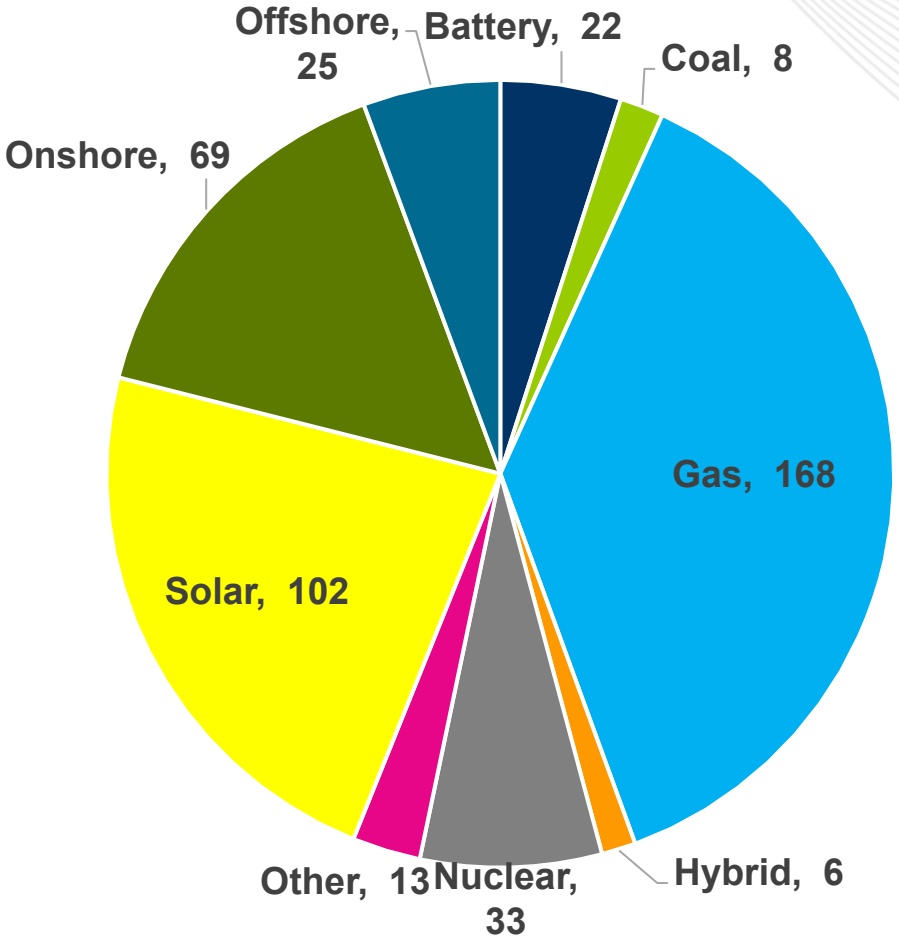
Capacity Expansion Results: 2035 Resource Mix



Total: 387 GW

Zone	Battery	Coal	Gas	Hybrid	Nuclear	Offshore	Onshore	Solar	Other
AEP	5.9	1.6	33.0	2.2	2.2	-	21.5	25.8	1.0
APS	2.8	-	19.6	0.8	-	-	15.6	3.5	0.2
AE	0.7	-	0.8	0.1	1.2	0.4	-	0.5	0.0
BGE	0.9	-	0.3	-	1.7	-	-	1.5	0.3
COMED	2.2	-	5.5	0.5	10.5	-	9.3	8.1	0.3
DAYTON	0.2	-	3.3	0.1	-	-	0.8	2.3	0.0
DPL	0.2	0.7	3.0	0.0	-	8.8	-	1.7	0.8
VEPCO	5.7	0.9	17.5	1.6	3.6	5.2	0.8	19.8	4.0
DUKE	0.1	-	7.5	-	-	-	-	0.3	0.2
DQE	0.1	-	4.1	0.0	1.8	-	-	0.1	0.0
EKPC	0.1	1.6	2.5	0.2	-	-	5.0	3.4	0.1
ATSI	0.6	0.3	20.8	0.2	2.1	-	1.6	3.0	0.2
JCPL	0.3	-	2.4	0.1	-	0.8	-	0.7	0.6
METED	0.3	0.0	2.7	0.1	-	-	-	0.5	0.4
PENLC	0.5	0.6	2.4	0.3	-	-	1.2	3.5	0.6
PL	0.2	4.7	6.6	0.1	2.5	-	0.2	1.2	0.7
PEPCO	0.5	1.2	3.0	-	-	-	-	0.1	0.3
PECO	-	0.0	4.2	-	4.8	-	-	0.0	2.5
PS	0.5	-	4.7	-	2.3	8.9	-	0.3	0.2
RECO	0.4	-	1.9	-	-	-	-	-	-
Total	**22.1**	**11.6**	**145.6**	**6.2**	**33.2**	**24.1**	**56.1**	**76.3**	**12.5**

Capacity Expansion Results: 2045 Resource Mix



Total: 446 GW

Zone	Battery	Coal	Gas	Hybrid	Nuclear	Offshore	Onshore	Solar	Other
AEP	5.9	0.5	47.3	2.2	2.2	-	21.5	25.8	1.0
APS	2.8	-	26.6	0.8	-	-	15.6	3.5	0.2
AE	0.7	-	0.8	0.1	1.2	0.4	-	0.5	0.0
BGE	0.9	-	0.3	-	1.7	-	-	1.5	0.3
COMED	2.2	-	3.7	0.5	10.5	-	22.1	8.1	0.3
DAYTON	0.2	-	4.7	0.1	-	-	0.8	2.3	0.0
DPL	0.2	0.7	3.0	0.0	-	8.8	-	1.7	0.8
VEPCO	5.7	-	9.5	1.6	3.6	5.2	0.8	46	4.0
DUKE	0.1	-	11.7	-	-	-	-	0.3	0.2
DQE	0.1	-	5.9	0.0	1.8	-	-	0.1	0.0
EKPC	0.1	-	3.4	0.2	-	-	5.0	3.4	0.1
ATSI	0.6	0.3	23.0	0.2	2.1	-	1.6	3.0	0.2
JCPL	0.3	-	2.4	0.1	-	0.8	-	0.7	0.6
METED	0.3	0.0	2.7	0.1	-	-	-	0.5	0.4
PENLC	0.5	0.6	2.4	0.3	-	-	1.2	3.5	0.6
PL	0.2	4.7	6.6	0.1	2.5	-	0.2	1.2	0.7
PEPCO	0.5	1.2	3.0	-	-	-	-	0.1	0.3
PECO	-	0.0	4.2	-	4.8	-	-	0.0	2.5
PS	0.5	-	4.7	-	2.3	10.0	-	0.3	0.2
RECO	0.4	-	2.3	-	-	-	-	-	-
Total	**22.1**	**8.0**	**168.1**	**6.2**	**33.2**	**25.2**	**68.8**	**102.5**	**12.5**

Next Steps

- Solicit stakeholders' feedback
- Update the capacity expansion study for Informational Base Scenario in Q4

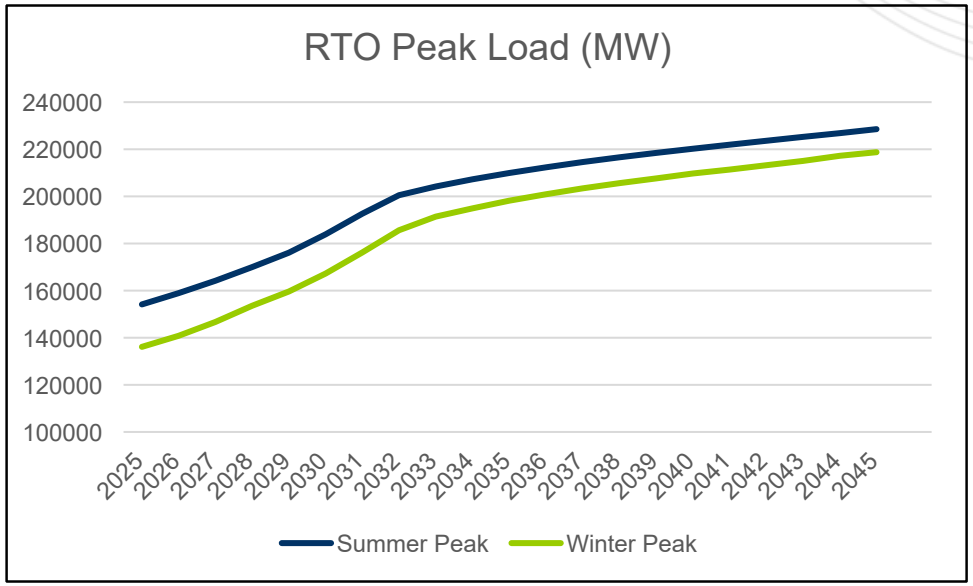
Appendix

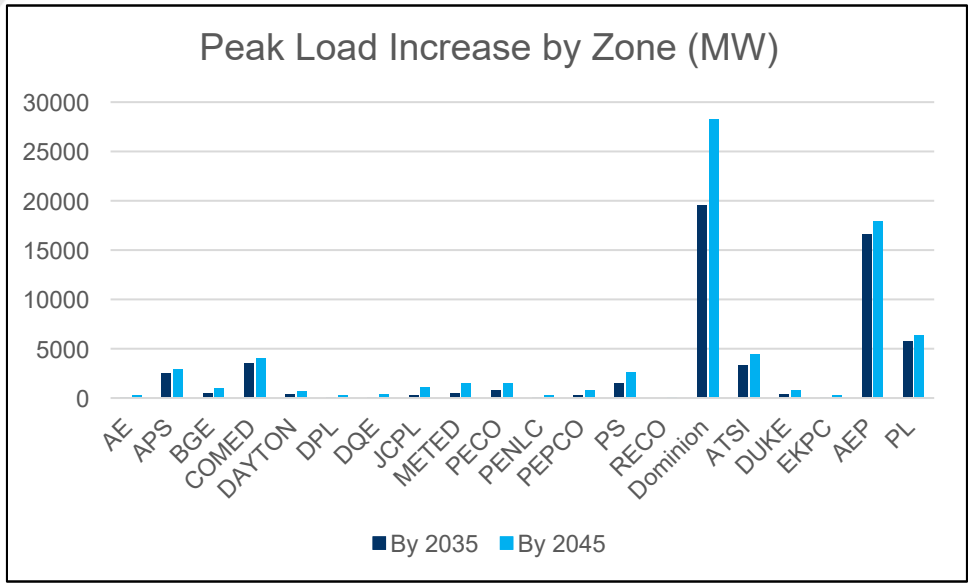
Assumptions

- Load assumptions
- Generation and storage technologies
- Fixed and Variable costs components
  - Fixed: Capital, fixed O&M, geographic adjustments coefficients
  - Variable: Heat rates, fuel costs, variable O&M
- Financial assumptions (fixed charge rate and discount rate)
- Renewable capacity factors
- Policy assumptions (new generation and deactivations)
- Resource adequacy
- Starting resource mix
- Build limits for capacity expansion (Generation Interconnection data and siting opportunities)

Load Assumptions

- PJM's 2025 Demand forecast





Generation and storage technologies

- Solar PV
- Onshore Wind
- Offshore Wind
- Battery Energy Storage
- Hybrid (Solar + Battery)
- Combustion Turbine
- Combined Cycle

Fixed Costs, Variable Costs, and Financial Assumptions

- Fixed Costs, Variable Costs, and Financial assumptions based on available resources in the following order:
  - 2025 PJM Quadrennial Review
  - Energy Exemplar Eastern Interconnection data
  - NREL (Annual Technology Baseline) and NETL (Cost and Performance Baseline studies)
- Changes to note (relative to the assumptions provided during the May 9 Special TEAC):
  - Initially planned to use some input elements from S&P North American Power Market Outlook
  - Incorporated changes to align with the newly passed legislation (the "Big Beautiful Bill")

Fixed Costs

	Overnight Capital Cost (2028$/kW)	*FOM (2028$/kW-year)*
Combined Cycle		
EMAAC	1517	41.0
SWMAAC	1411	61.0
Rest of RTO	1419	57.0
WMAAC	1476	48.0
COMED	1649	38.0
Combustion Turbine		
EMAAC	1395	21.0
SWMAAC	1339	33.0
Rest of RTO	1361	25.0
WMAAC	1390	21.0
COMED	1495	21.0
BESS 4-hr		
EMAAC	1832	57.0
SWMAAC	1753	62.0
Rest of RTO	1750	55.0
WMAAC	1784	57.0
COMED	1980	59.0

Brattle 2025 CONE Report for PJM (Quadrennial Review)
https://www.pjm.com/-/media/DotCom/committees-groups/committees/mic/2025/20250411-special/item-01-2-cone-report-final.pdf

Variable Costs

	VOM (2028$/MWh)	*Heat Rate (Btu/kWh)*
Combined Cycle		
EMAAC	2.6	6318
SWMAAC	2.6	6345
Rest of RTO	2.7	6303
WMAAC	2.7	6314
COMED	2.6	6294
Combustion Turbine		
EMAAC	1.1	9166
SWMAAC	1.1	9161
Rest of RTO	1.0	9141
WMAAC	1.1	9149
COMED	1.1	9133

Heat rate for combined cycle is without duct firing

Brattle 2025 CONE Report for PJM (Quadrennial Review)

https://www.pjm.com/-/media/DotCom/committees-groups/committees/mic/2025/20250411-special/item-01-2-cone-report-final.pdf

Financial Assumptions

- Fixed charge rate: Annualization coefficient for overnight capital cost (referred to as “Capital Charge Rate” in Quadrennial Review)

	Combined Cycle	*Combustion Turbine*	*Battery*
EMAAC	17.0%	16.0%	9.6%
SWMAAC	16.9%	15.9%	9.6%
Rest of RTO	16.9%	15.9%	9.6%
WMAAC	16.9%	15.9%	9.6%
COMED	18.8%	17.8%	9.6%

Capital charge rate shown for Battery incorporates the 30% ITC

Brattle 2025 CONE Report for PJM (Quadrennial Review)

https://www.pjm.com/-/media/DotCom/committees-groups/committees/mic/2025/20250411-special/item-01-2-cone-report-final.pdf

- Discount rate: 20-year treasury rate 4.8% as of May 5, 2025

Siting Constraints

- Many regulations governing the siting of wind and solar projects are established at the county or township level. Local zoning ordinances might affect the availability of land for wind and solar development.
- The most common zoning ordinances include setbacks from structures, roads, and property lines; sound restrictions; height limitations; and an increasing number of moratoriums or bans.
- PJM will use NREL's Limited Access siting scenario for wind and solar[1].
  - The Limited Access scenario uses environmental constraints, and national defense concerns, as well as conservative wind and solar setbacks based on local ordinances surveyed in Lopez et al.[2]

1 "Renewable Energy Technical Potential and Supply Curves for the Contiguous United States: 2024 Edition" https://www.nrel.gov/docs/fy25osti/91900.pdf
2 "Impact of siting ordinances on land availability for wind and solar development" https://www.nature.com/articles/s41560-023-01319-3

Initial Position and Build Limits

Initial position 2025 RTEP* (2030) (MW)

Zone	Battery	Coal	Gas	Hybrid	Nuclear	Offshore	Onshore	Solar	Other
Total	4.2	31.8	82.9	2.8	32.7	5.1	15.4	39.8	12.8

(*Between 2025 and 2030 there are ~10GW of anticipated coal and ~5GW of anticipated gas retirements)

Build Limits based on Siting Constraints (MW)

Zone	Onshore Wind	Solar
AEP	17,491	270,701
APS	14,138	115,161
AE	198	12,839
BGE	-	4,847
COMED	25,890	93,898
DAYTON	777	35,807
DPL	-	28,726
VEPCO	9,838	357,969
DUKE	-	12,977
DQE	-	3,257
EKPC	4,965	116,648
ATSI	1,351	91,782
JCPL	69	8,742
METED	1,116	13,425
PENLC	10,192	91,961
PL	6,086	40,963
PEPCO	-	5,217
PECO	54	2,238
PS	-	3,768
RECO	27	1,560
Total	92,190	1,312,489

North Carolina Offshore and Michigan Energy Storage Targets

- PJM is not currently modeling North Carolina's offshore wind target as interconnecting into PJM.
- PJM will model a portion of Michigan's energy storage target based on the share of battery storage capacity in the Michigan portion of PJM's interconnection queue relative to that in MISO.

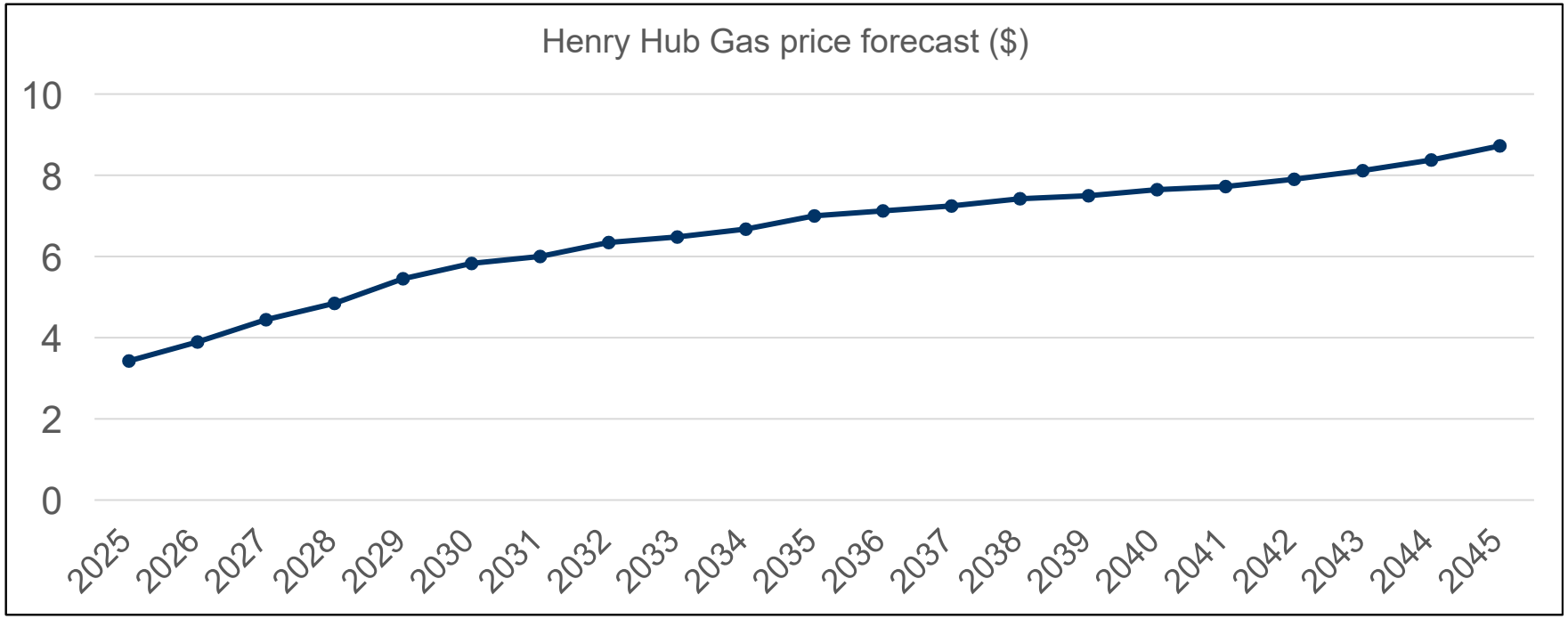
Geographic Adjustment Coefficients for Renewables

	Solar	Onshore	Offshore	Battery	Hybrid
Delaware	1.07	1.07	1.06	1.01	1.06
DC	1.01	1.03		1.01	1.01
Illinois	1.13	1.20	1.19	1.07	1.12
Indiana	1.00	1.02		1.02	1.00
Kentucky	1.00	1.01		1.02	1.01
Maryland	1.01	1.01	1.01	1.01	1.01
Michigan (Grand Rapids)	1.00	1.00	1.00	1.00	1.00
New Jersey	1.12	1.19	1.18	1.06	1.11
North Carolina	0.99	0.99	0.99	1.00	0.99
Ohio	0.99	0.98		0.99	0.99
Pennsylvania (Philadelphia)	1.11	1.18		1.06	1.10
Pennsylvania (Scranton)	1.02	1.03		1.01	1.02
Tennessee	1.00	1.02		1.04	1.01
Virginia (Alexandria)	1.00	1.02	1.02	1.01	1.01
Virginia (Roanoke)	0.99	0.98	0.98	1.00	0.99
West Virginia	1.01	1.00		1.00	1.01

Sargent & Lundy (2024) "Capital Cost and Performance Characteristic Estimates for Utility Scale Electric Power Generating Technologies"

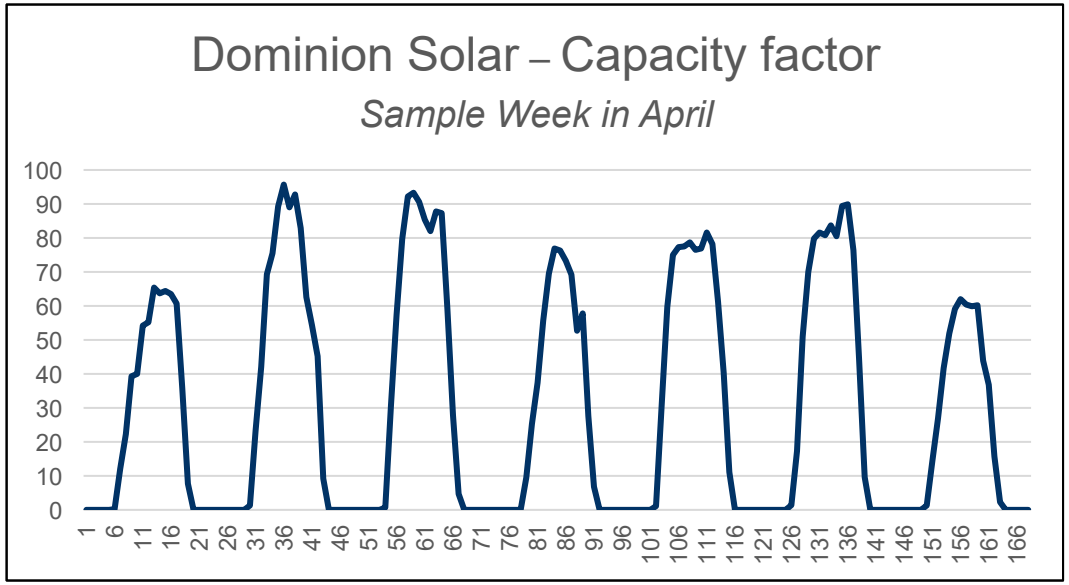
From PJM's Market efficiency:

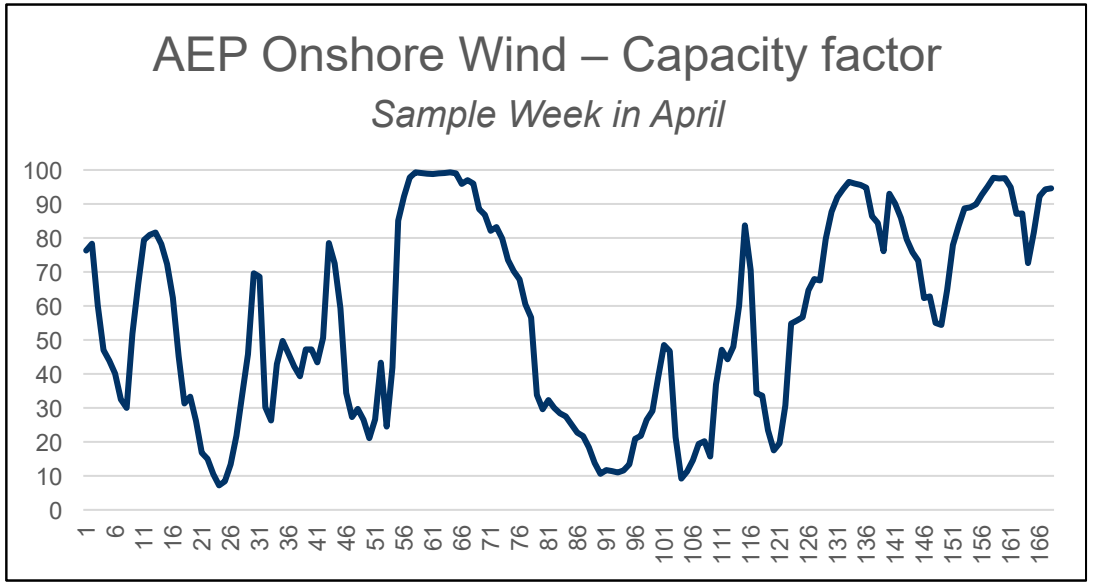
- The discount rate for this year's analysis will be 7.20%



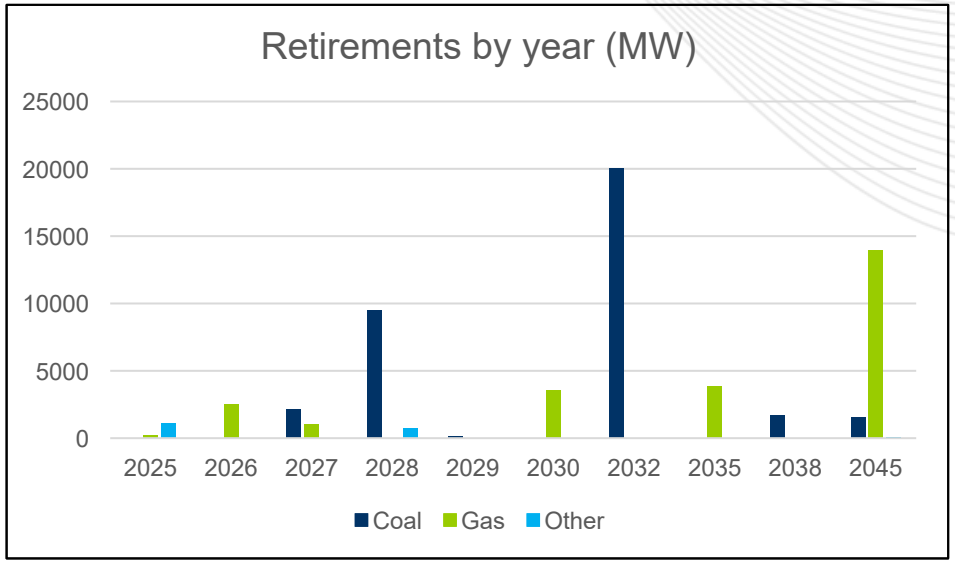
Renewable Capacity Factors

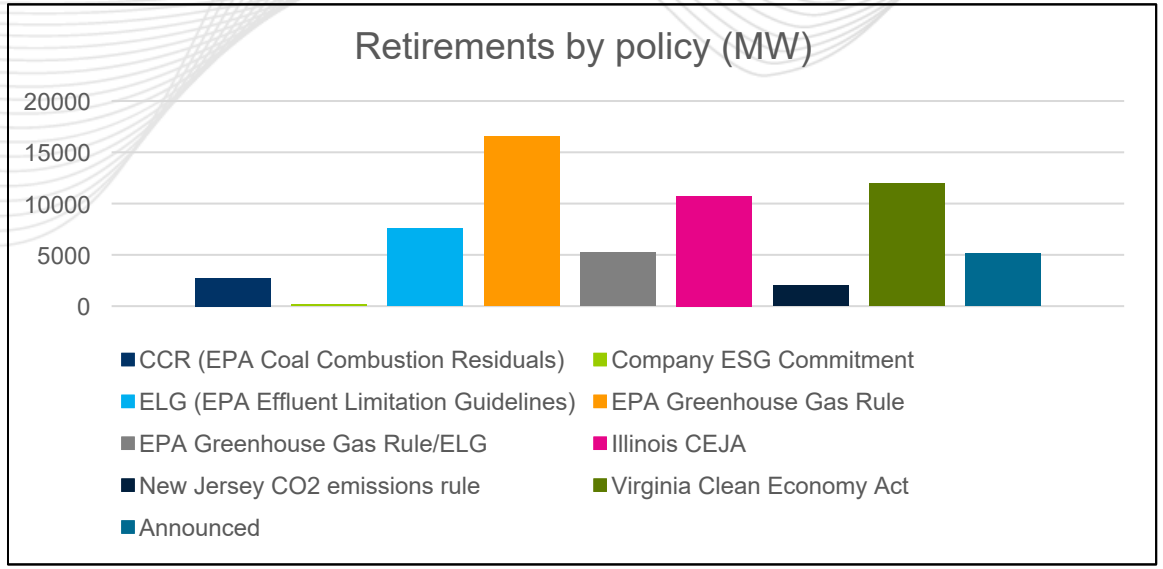
- Use Energy Exemplar's Eastern Interconnection hourly profiles for renewable capacity factors which are defined at the zonal level

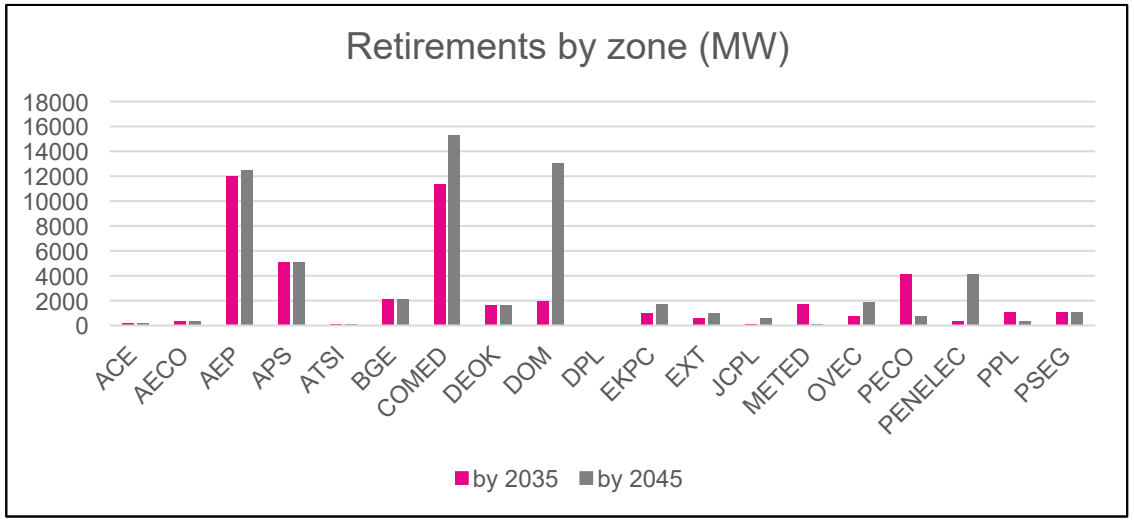




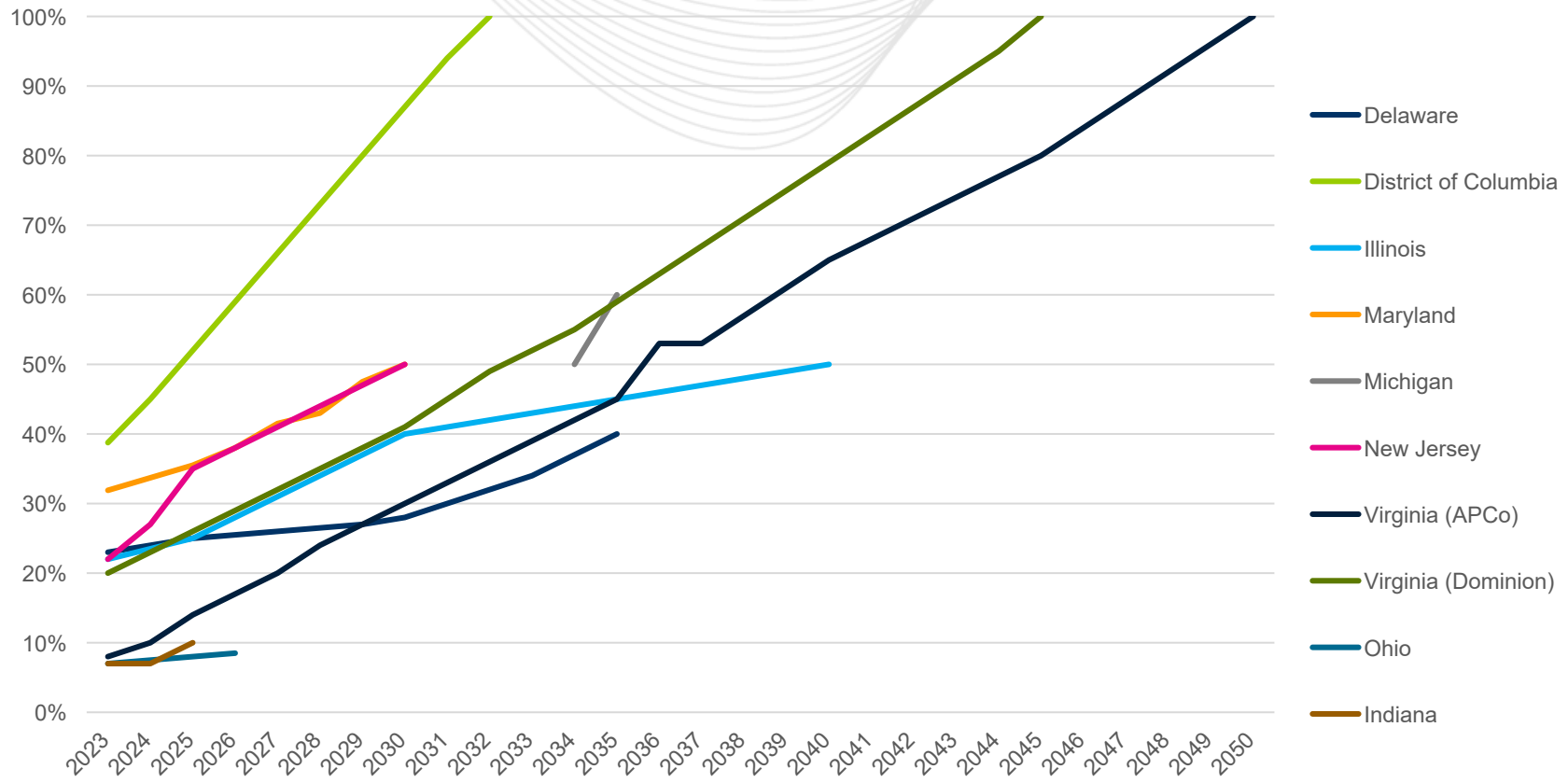
Retirements





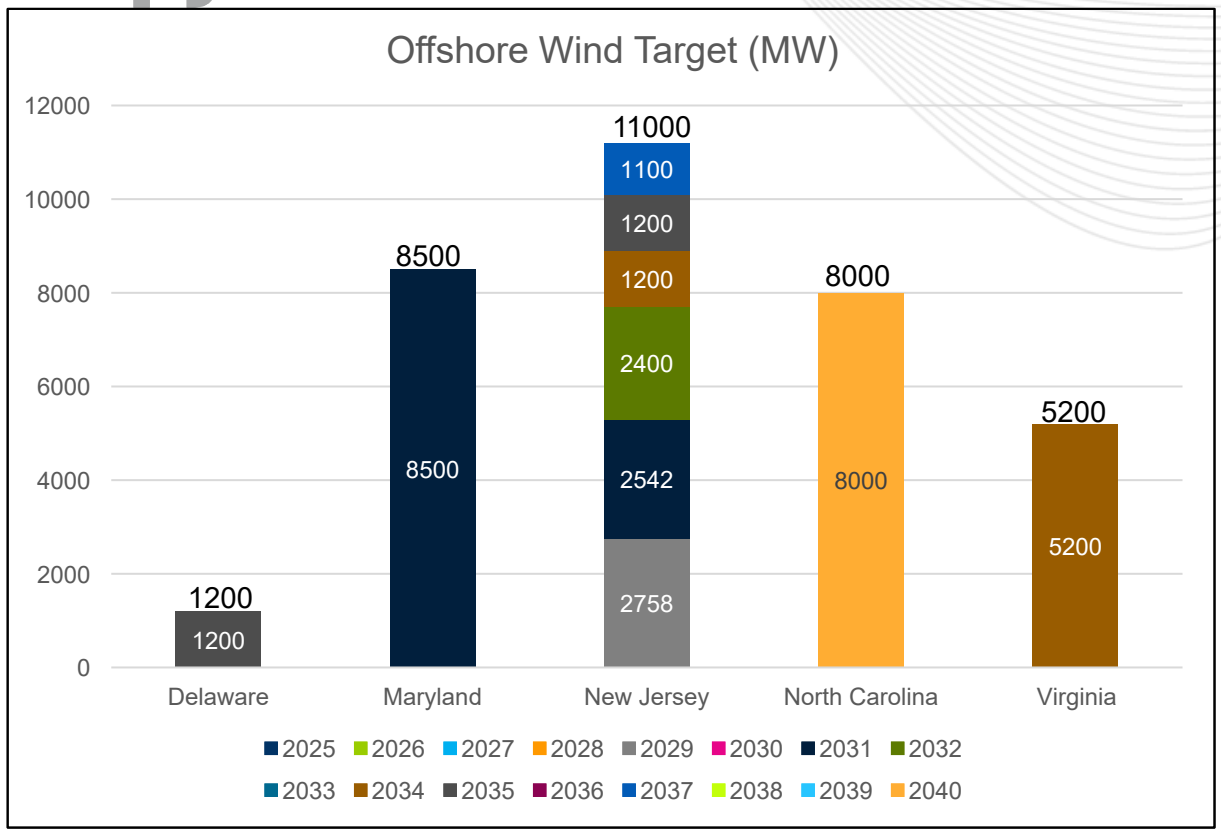


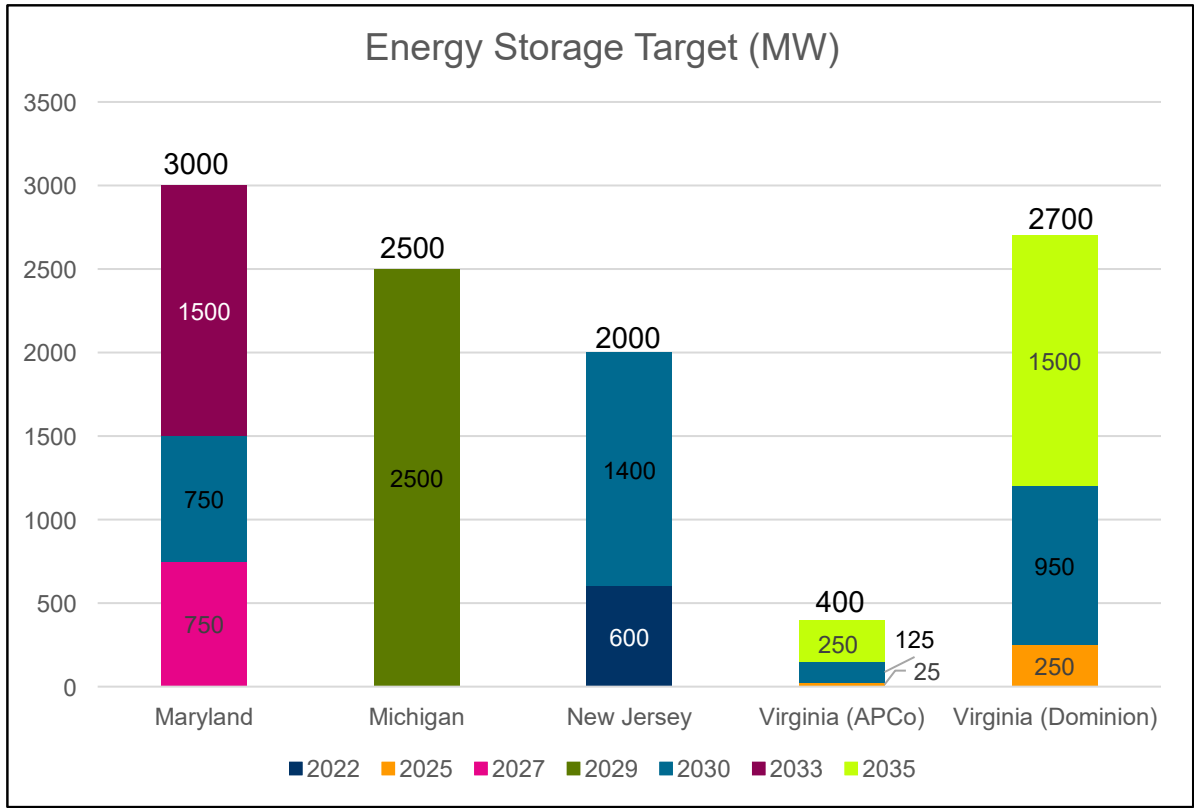
State RPS Policy



*PJM will model the geographic and technology eligibility rules for RPS Policies

Offshore and Energy Storage Targets

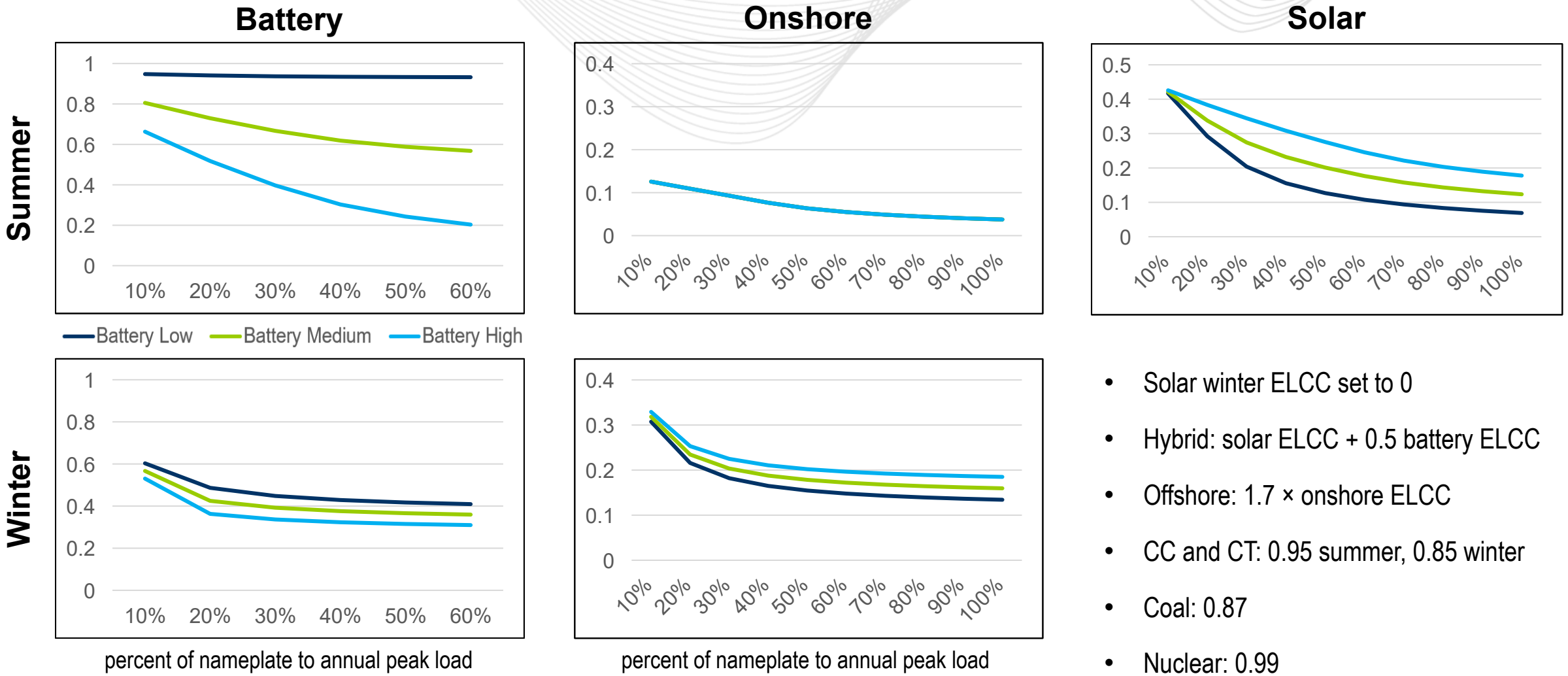




Resource Adequacy

- Enforce the 1-in-10 resource adequacy constraint in the model
  - Resource specific targets will not be considered in satisfying this constraint
- Set ELCC-based capacity constraints to obtain resource adequate expansion (see next slide for ELCC curves)

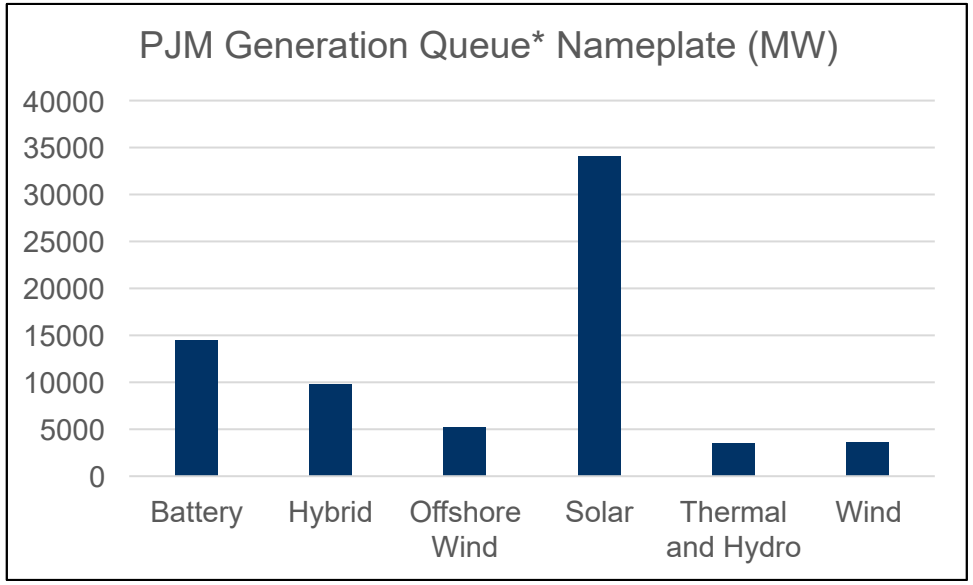
ELCC Assumptions



- Solar winter ELCC set to 0
- Hybrid: solar ELCC + 0.5 battery ELCC
- Offshore: 1.7 × onshore ELCC
- CC and CT: 0.95 summer, 0.85 winter
- Coal: 0.87
- Nuclear: 0.99

Starting Resource Mix and Build Limits

- Starting resource mix: Consistent with 2025 RTEP model-year 2030 (Existing generation, GIA/ISA generation, Suspended ISA generation, Fast Lane Queue, CVOW and Chesterfield plants)
- The build limits through year 7 are based on the PJM's generation interconnection queue
- After year 7, the model is allowed to build beyond the queue (earlier, if the queue is insufficient)



*RRI resources are going to be added when they become part of Transition Cycle #2