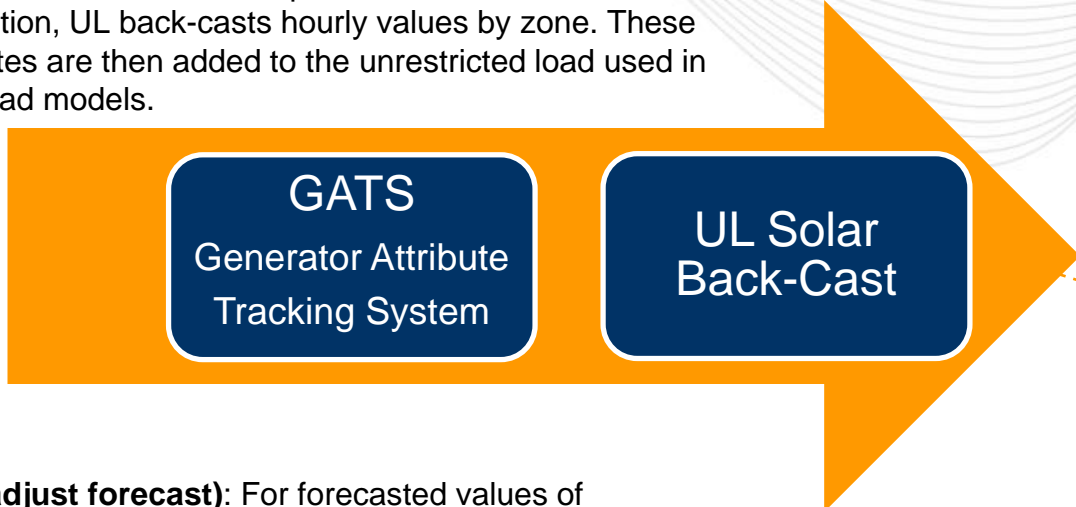


Distributed Solar and Battery Generation Update

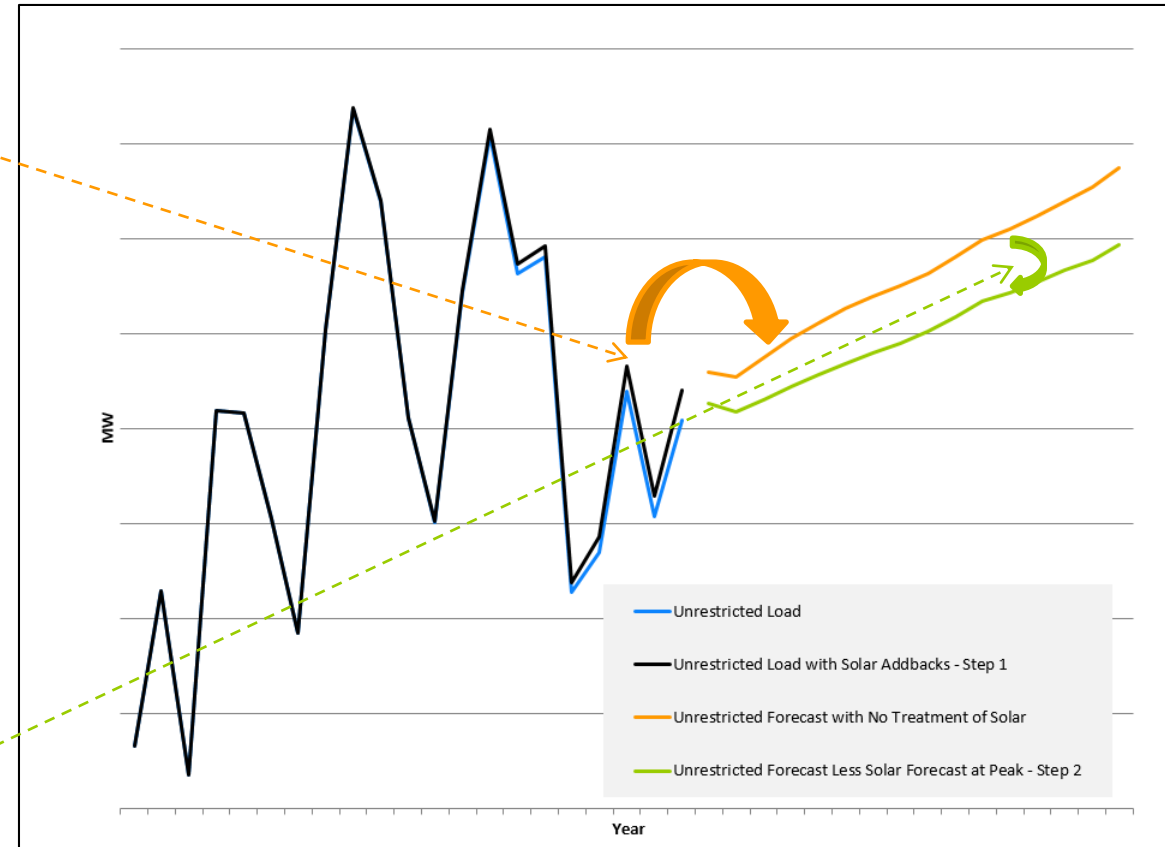
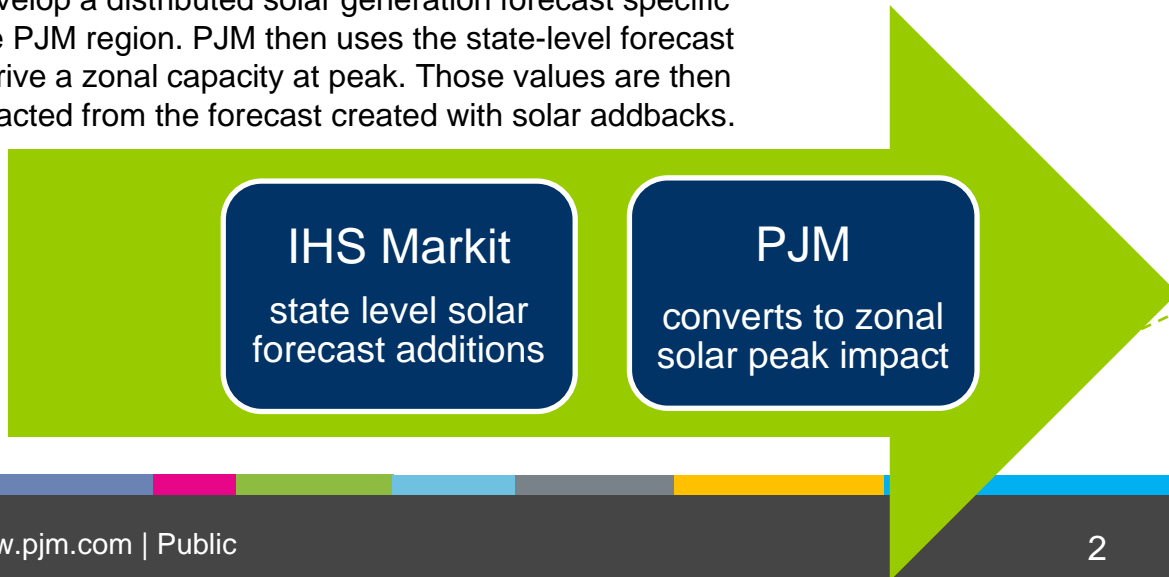
Load Analysis Subcommittee
December 6, 2021

Molly Mooney
Sr. Analyst
Resource Adequacy Planning

Step 1 (gather data/update historical loads): To account for the historical impacts of distributed solar generation, UL back-casts hourly values by zone. These estimates are then added to the unrestricted load used in PJM load models.



Step 2 (adjust forecast): For forecasted values of distributed solar capacity, PJM contracts with IHS Markit to develop a distributed solar generation forecast specific to the PJM region. PJM then uses the state-level forecast to derive a zonal capacity at peak. Those values are then subtracted from the forecast created with solar addbacks.





Historical GATS Installations

Historical Nameplate Capacity of Distributed Solar Generation (MW - AC)

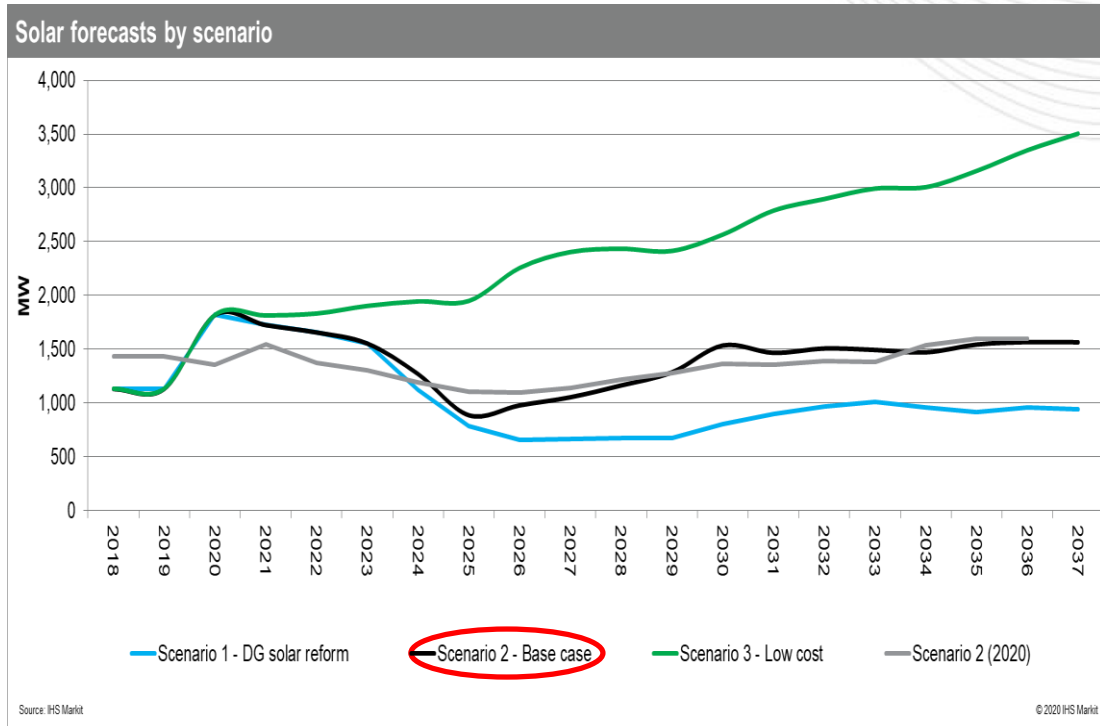
	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
AE						0.1	0.4	1.6	4.3	5.6	11.8	24.7	45.1	96.7	129.3	154.4	186.3	220.3	287.5	335.8	403.8	455.3	510.0	544.5
AEP					0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.5	13.5	17.3	23.1	29.1	35.6	39.3	44.7	45.8	67.8	74.9	82.2	141.8
APS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	1.0	5.1	11.4	16.5	20.6	30.3	55.6	97.6	128.0	128.0	138.6	150.2	178.9
ATSI					0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.5	5.3	19.1	36.5	44.3	47.9	53.2	59.6	89.2	93.8	101.4	112.0	118.3
BGE							0.0	0.0	0.0	0.1	1.6	3.5	8.9	23.0	40.0	53.8	78.7	162.1	259.2	296.3	325.7	377.8	429.1	466.9
COMED			0.0	0.0	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.3	0.9	1.3	24.0	25.0	25.9	28.3	33.2	43.8	50.4	101.3	263.3	458.8
DAYTON										0.0	0.0	0.1	0.5	2.2	8.9	11.1	12.6	17.0	17.5	17.5	23.9	39.1	39.1	39.1
DPL		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.8	2.2	4.8	8.0	33.4	61.7	83.3	98.3	128.7	159.6	182.6	213.5	239.8	273.9	280.9
DQE							0.0	0.0	0.0	0.0	0.0	0.0	0.6	1.1	3.6	4.1	4.3	4.8	6.6	16.1	19.3	21.0	22.8	27.6
DUKE		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.3	0.6	1.7	6.1	11.4	11.9	13.3	15.3	15.8	15.9	24.4	24.9	24.1	24.2
EKPC										0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.3	0.5	0.6	11.1	11.0	11.0	11.0	10.9
JCPL			0.0	0.0	0.1	0.9	1.8	5.4	11.4	15.4	24.1	37.2	66.4	161.9	236.2	298.7	355.3	408.3	486.3	519.1	594.7	695.9	772.4	811.2
METED			0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.2	1.5	13.2	32.7	35.2	35.9	36.9	38.4	42.8	51.2	54.6	65.2	74.2	92.0
PECO	0.0	0.0	0.0	0.0	0.1	0.2	0.3	0.3	0.5	0.6	0.9	3.5	15.5	33.5	44.0	48.7	49.5	51.3	64.7	77.2	83.6	92.2	108.3	119.7
PENLC			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	1.3	4.0	4.5	5.0	5.5	5.7	6.8	7.1	7.6	8.8	11.0	14.3
PEPCO						0.0	0.0	0.0	0.1	0.2	0.5	3.4	6.5	13.6	27.9	41.2	60.6	116.3	209.4	260.6	303.5	346.2	434.5	479.3
PL								0.0	0.0	0.1	0.2	2.5	29.0	67.3	77.1	80.2	82.4	93.7	107.5	120.1	134.5	147.7	170.7	194.9
PS			0.0	0.3	0.5	0.6	1.1	4.7	14.4	21.4	32.4	65.4	115.7	264.0	414.8	507.7	547.5	598.2	692.8	756.6	895.6	989.7	1,119.1	1,245.2
RECO			0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.9	1.0	1.6	2.1	5.0	11.0	12.2	12.5	12.9	13.8	14.8	16.1	18.4	26.5	29.2
UGI											0.0	0.1	0.2	0.4	0.4	0.4	0.5	0.4	0.5	0.5	0.4	0.5	0.5	0.5
VEPCO		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.6	2.9	4.5	11.3	25.5	109.7	269.1	543.1	566.5	708.7	805.3	992.3	1,102.1
PJM RTO	0.0	0.1	0.1	0.5	0.9	2.1	3.9	12.7	31.7	45.8	76.4	152.1	342.5	798.3	1217.7	1493.4	1793.8	2319.3	3149.5	3555.6	4161.0	4755.0	5627.1	6380.2

Note: All years except for 2021 are based on calendar year, 2021 is through 8/31/2021

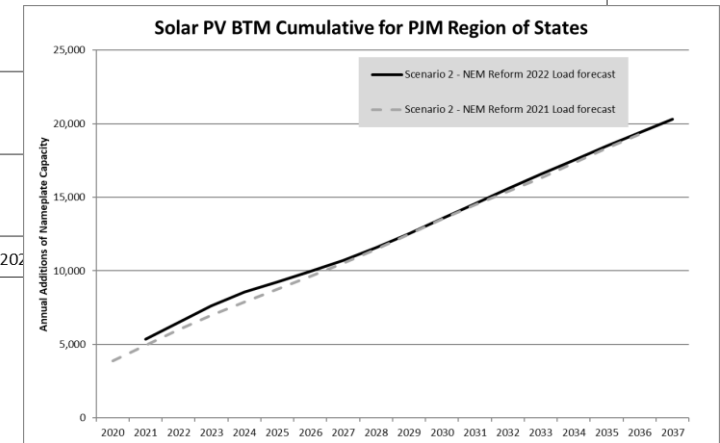
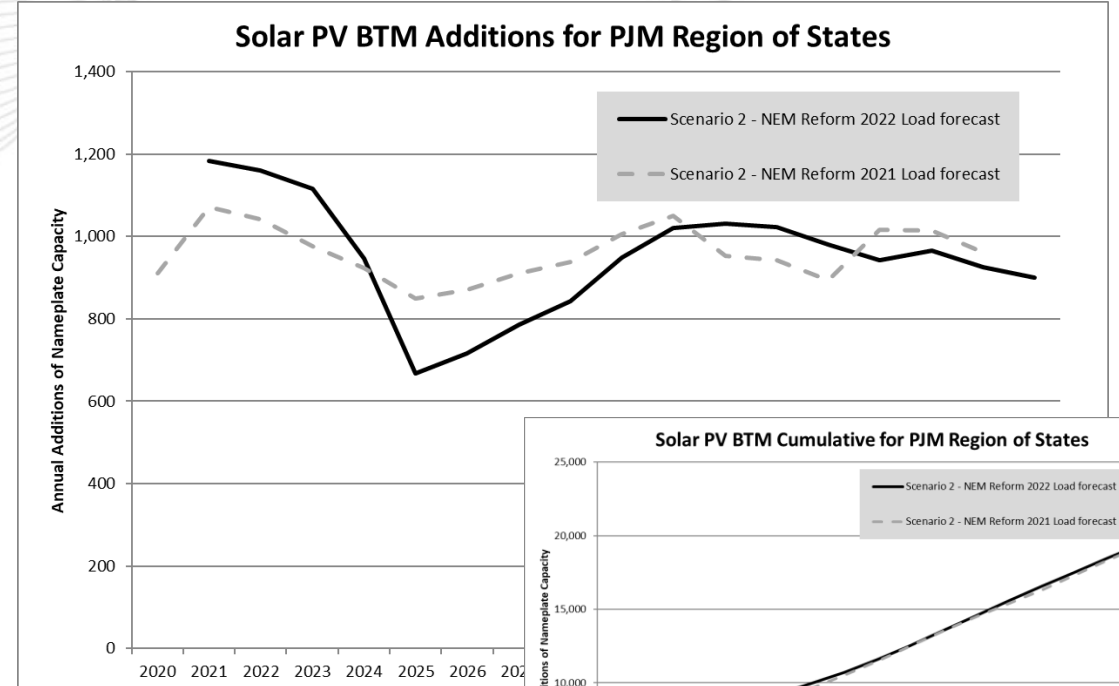


IHS Forecast Scenarios

IHS produces three scenarios; PJM will use Scenario 2 – Base case (NEM Reform) in the 2022 Load Forecast



- Calendar year additions
- Entire PJM States
- Distribution/BTM solar capacity additions



- Q3 to Q3 additions
- PJM Region of states
- Distribution/BTM solar capacity additions with degradation

Distributed Solar Generation Forecast by State
IHS Scenario 2 – NEM Reform
 PJM Region Only
 Annual Additions of Nameplate Capacity

	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
DC	28.5	30.2	30.7	24.4	13.2	9.3	9.6	10.6	11.9	9.2	6.7	5.6	2.6	6.8	5.3	5.3
DE	24.5	12.9	14.8	11.1	11.8	12.7	12.7	16.8	47.3	85.1	91.9	89.6	78.1	60.3	58.0	57.7
IL	241.9	223.8	201.0	151.1	121.4	133.8	144.4	143.3	157.9	157.7	154.5	120.8	124.5	141.5	128.9	130.5
IN	5.2	6.5	5.0	4.2	3.8	4.1	7.0	8.0	7.8	5.6	5.8	5.8	5.8	7.0	7.1	7.2
KY	2.3	2.1	2.0	1.4	2.8	4.0	5.9	6.8	6.9	6.0	7.1	7.1	7.0	7.0	7.0	6.9
MD	139.8	150.7	124.6	78.9	69.2	101.3	146.1	204.6	210.1	278.1	298.8	296.5	295.0	293.5	219.4	214.5
MI	1.3	1.3	1.2	1.0	0.7	0.8	1.4	1.9	2.2	2.0	2.1	4.1	4.3	5.4	5.7	5.9
NC	9.8	6.9	5.1	3.0	1.4	1.3	1.8	2.3	3.2	4.2	6.0	6.1	6.0	6.0	8.2	8.7
NJ	232.6	263.3	252.8	217.6	178.7	153.1	132.0	117.8	152.5	165.7	174.1	171.2	144.7	167.7	218.3	217.2
OH	165.8	159.9	111.3	44.7	41.8	37.8	35.9	40.9	43.7	35.0	39.0	51.6	56.8	60.9	62.0	58.5
PA	92.2	92.8	80.9	61.4	55.8	58.5	63.0	71.8	78.7	75.6	96.8	123.2	123.3	119.4	101.7	84.9
TN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VA	203.7	152.7	104.6	57.9	130.5	153.6	154.8	186.4	160.2	123.5	100.0	74.9	69.6	59.5	64.6	64.2
WV	11.7	12.1	11.8	11.7	84.8	116.4	127.8	137.3	138.8	82.6	40.4	24.5	25.3	30.2	39.3	39.2
Total	1,159.3	1,115.1	945.8	668.4	715.9	786.8	842.2	948.4	1,021.2	1,030.3	1,023.2	981.0	943.0	965.2	925.6	900.9

Distributed Solar Generation Forecast of Additions by State Comparison of 2021 and 2022 Forecast

	2022 Forecast (Scenario 2 NEM Reform)				2021 Forecast (Scenario 2 NEM Reform)				Percent Change			
	2022	2023	2024	2025	2022	2023	2024	2025	2022	2023	2024	2025
DC	28.5	30.2	30.7	24.4	24.3	21.8	19.3	27.6	17%	38%	59%	-12%
DE	24.5	12.9	14.8	11.1	22.2	19.2	17.9	17.7	10%	-33%	-18%	-37%
IL	241.9	223.8	201.0	151.1	139.2	140.8	140.2	102.5	74%	59%	43%	47%
IN	5.2	6.5	5.0	4.2	3.9	3.9	2.7	3.7	32%	65%	89%	13%
KY	2.3	2.1	2.0	1.4	4.1	3.8	3.4	1.4	-45%	-46%	-43%	1%
MD	139.8	150.7	124.6	78.9	210.7	212.6	216.7	254.1	-34%	-29%	-43%	-69%
MI	1.3	1.3	1.2	1.0	0.7	0.6	0.6	0.6	83%	107%	95%	58%
NC	9.8	6.9	5.1	3.0	6.9	5.1	3.4	1.6	42%	35%	48%	85%
NJ	232.6	263.3	252.8	217.6	273.9	233.0	211.3	191.5	-15%	13%	20%	14%
OH	165.8	159.9	111.3	44.7	81.9	71.8	59.3	29.9	102%	123%	88%	49%
PA	92.2	92.8	80.9	61.4	85.2	72.1	61.8	35.2	8%	29%	31%	74%
TN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
VA	203.7	152.7	104.6	57.9	186.9	190.0	184.9	179.5	9%	-20%	-43%	-68%
WV	11.7	12.1	11.8	11.7	2.8	1.9	2.0	3.6	319%	527%	480%	224%
Total	1,159.3	1,115.1	945.8	668.4	1,042.7	976.7	923.7	849.1	11%	14%	2%	-21%

Distributed Solar Generation Forecast by Zone Cumulative Additions of Nameplate Capacity

	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
AE	29.4	62.6	94.3	121.5	143.9	163.0	179.4	194.1	213.0	233.5	255.1	276.2	294.0	314.7	341.5	368.1
AEP	105.1	201.3	270.6	307.3	391.6	495.1	607.8	733.7	857.4	940.7	1,000.7	1,055.0	1,110.8	1,171.5	1,238.3	1,304.0
APS	41.4	82.6	117.4	142.5	203.7	285.2	378.0	484.5	592.6	679.7	751.1	817.4	883.7	951.4	1,012.5	1,070.7
ATSI	67.5	132.7	178.5	197.7	215.6	232.0	247.8	265.8	285.0	300.7	318.6	342.1	367.5	394.3	420.9	445.7
BGE	69.3	144.4	206.6	246.1	280.9	332.1	406.1	510.1	617.2	759.5	912.8	1,065.5	1,218.0	1,370.1	1,484.2	1,596.1
COMED	241.9	465.7	666.7	817.8	939.3	1,073.1	1,217.5	1,360.8	1,518.7	1,676.4	1,830.9	1,951.7	2,076.2	2,217.7	2,346.6	2,477.1
DAYTON	17.9	35.1	47.1	51.9	56.4	60.5	64.4	68.8	73.5	77.3	81.5	87.1	93.2	99.9	106.6	113.0
DPL	37.8	64.6	90.8	109.2	127.7	150.1	176.6	212.7	279.7	390.5	509.9	626.9	732.2	819.7	898.2	976.0
DQE	8.2	16.6	23.9	29.4	34.5	39.8	45.5	52.0	59.1	66.0	74.7	85.8	96.8	107.5	116.6	124.2
DUKE	24.1	47.5	64.0	70.8	77.5	83.8	90.4	97.8	105.7	112.2	119.5	128.7	138.6	149.2	160.0	170.3
EKPC	1.2	2.4	3.4	4.2	5.7	7.9	11.1	14.8	18.5	21.8	25.6	29.5	33.3	37.1	41.0	44.7
JCPL	67.3	143.7	217.1	280.3	332.4	377.0	415.5	450.0	494.7	543.3	594.4	644.8	687.4	736.9	801.3	865.6
METED	9.5	19.1	27.5	33.8	39.6	45.7	52.2	59.7	68.0	75.9	86.0	99.0	112.0	124.6	135.4	144.4
PECO	23.6	47.4	68.1	83.8	98.0	112.9	128.8	147.0	166.9	186.0	210.4	241.3	272.3	302.3	327.9	349.1
PENLC	10.4	20.8	29.9	36.8	43.1	49.7	56.8	64.9	73.7	82.3	93.3	107.3	121.3	135.0	146.6	156.3
PEPCO	70.4	145.6	213.2	260.9	294.3	333.0	384.6	453.6	525.0	612.2	701.9	789.1	872.3	958.6	1,023.1	1,085.7
PL	24.3	48.7	70.0	86.2	100.9	116.4	133.1	152.1	173.0	193.1	218.9	251.8	284.8	316.7	344.0	366.8
PS	131.6	280.5	423.6	546.7	647.8	734.3	809.0	875.6	961.8	1,055.5	1,153.8	1,250.6	1,332.3	1,427.0	1,550.2	1,672.9
RECO	4.3	9.2	13.8	17.7	21.0	23.7	26.1	28.2	30.9	33.8	36.9	39.8	42.4	45.3	49.0	52.7
UGI	0.6	1.2	1.8	2.2	2.6	3.0	3.4	3.9	4.4	4.9	5.5	6.4	7.2	8.0	8.6	9.2
VEPCO	173.3	302.9	392.1	441.6	548.1	673.1	799.6	952.1	1,084.5	1,188.3	1,275.1	1,341.8	1,404.1	1,458.3	1,518.9	1,579.6
PJM RTO	1,159.3	2,274.4	3,220.2	3,888.6	4,604.5	5,391.3	6,233.5	7,181.9	8,203.2	9,233.4	10,256.6	11,237.6	12,180.6	13,145.7	14,071.4	14,972.2



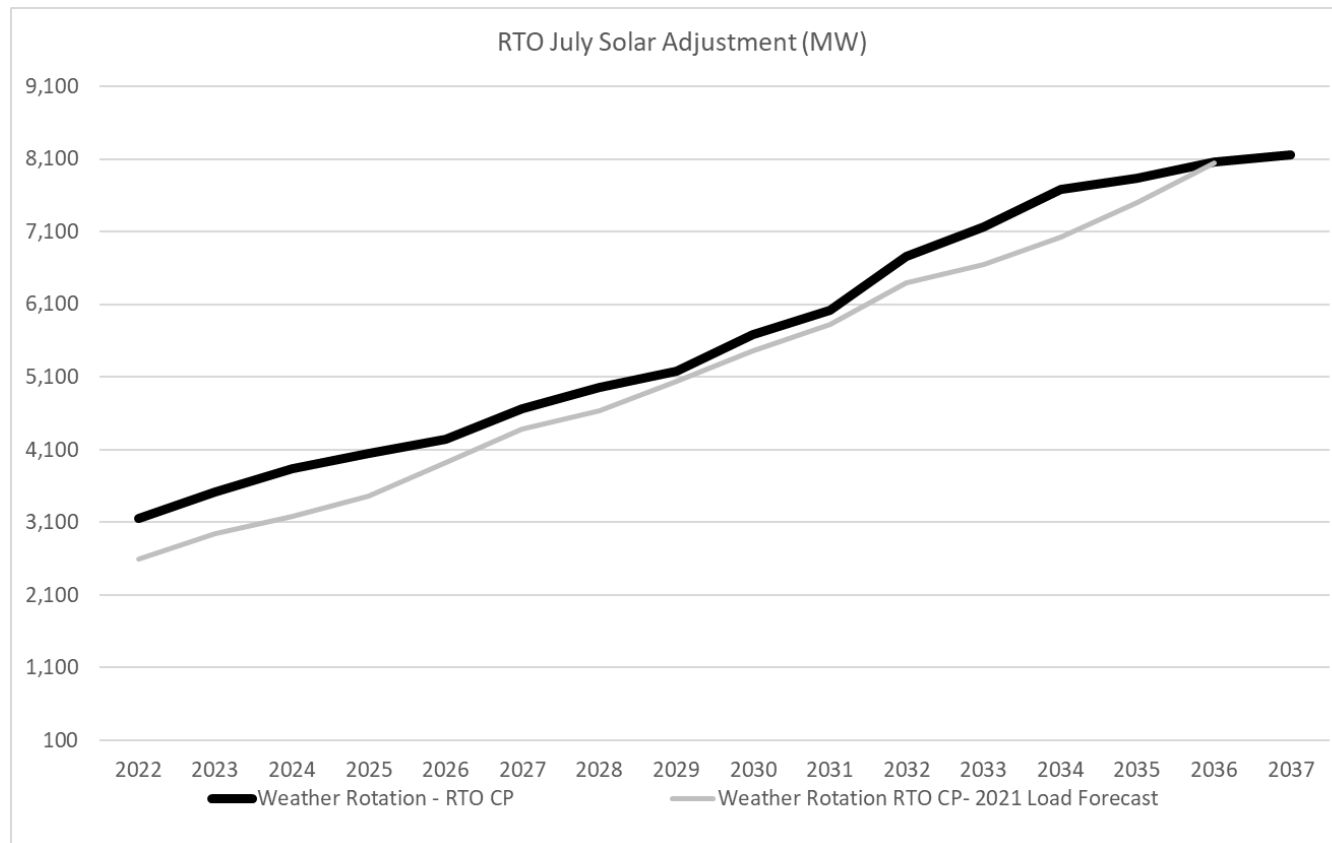
Historical and IHS Nameplate Capacity

Distributed Solar Generation Forecast by Zone Cumulative Nameplate Capacity

Includes Historical Degraded Values and IHS Forecast

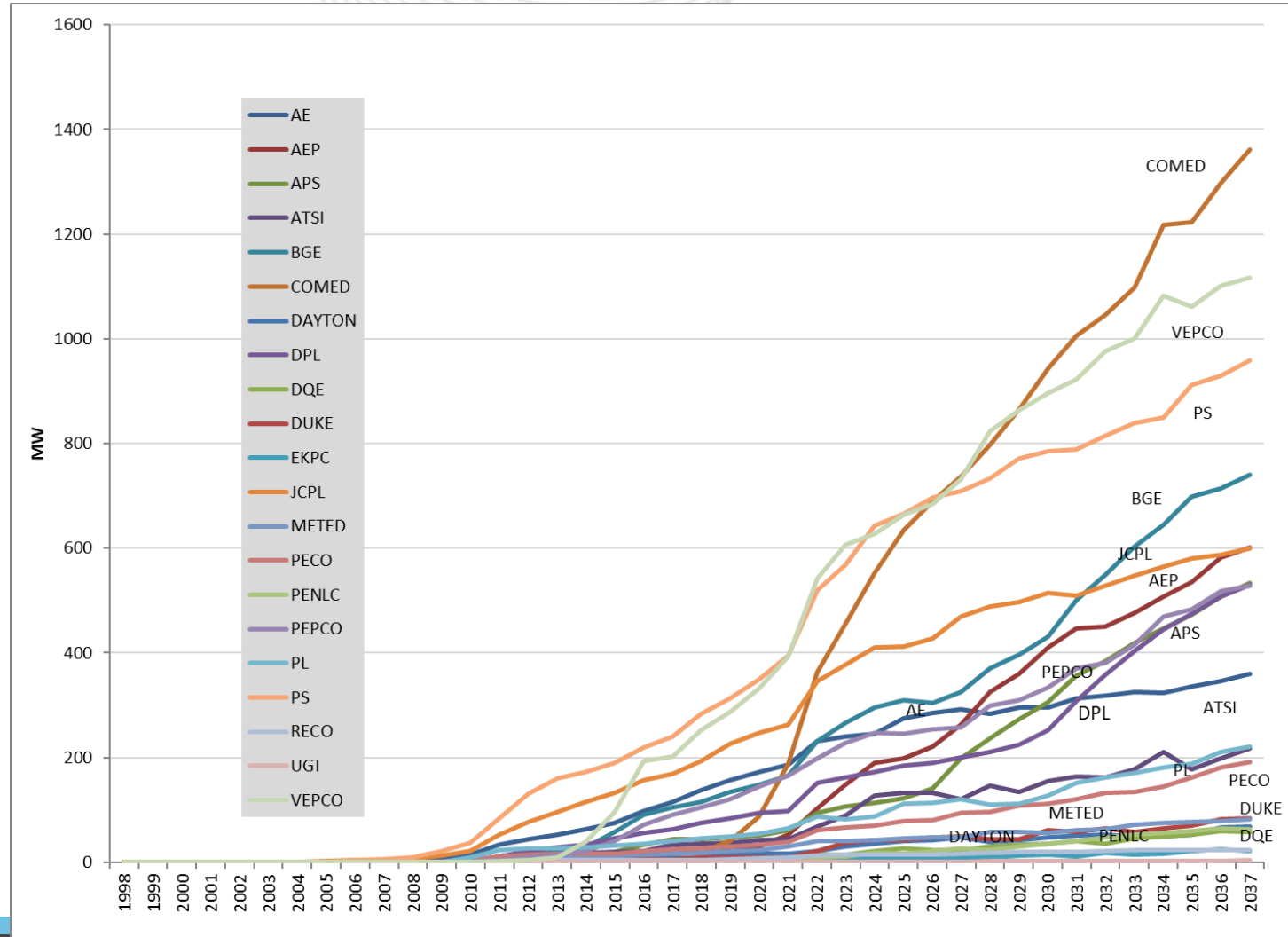
	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
AE	569.6	598.4	625.9	648.9	667.0	681.9	694.2	704.7	719.6	736.1	753.6	770.7	784.6	801.3	824.2	846.9
AEP	245.7	340.8	409.0	444.6	527.8	630.2	741.8	866.7	989.3	1,071.6	1,130.5	1,183.7	1,238.6	1,298.2	1,364.0	1,428.7
APS	218.9	258.7	292.0	315.8	375.6	455.7	547.2	652.3	759.0	844.9	915.0	979.9	1,044.9	1,111.3	1,171.1	1,228.0
ATSI	184.8	249.1	293.9	312.2	329.2	344.7	359.6	376.7	395.0	409.9	426.9	449.5	474.0	500.0	525.8	549.7
BGE	532.5	603.8	662.4	698.3	729.5	777.1	847.5	948.0	1,051.6	1,190.3	1,340.2	1,489.5	1,638.6	1,787.4	1,898.1	2,006.7
COMED	697.0	917.2	1,114.5	1,262.1	1,380.0	1,510.3	1,651.2	1,791.0	1,945.4	2,099.7	2,250.9	2,368.3	2,489.5	2,627.6	2,753.3	2,880.5
DAYTON	56.7	73.6	85.3	89.8	94.0	97.7	101.3	105.4	109.8	113.3	117.3	122.6	128.4	134.8	141.3	147.4
DPL	316.4	341.0	365.1	381.2	397.6	417.8	442.2	476.1	541.0	649.7	767.1	881.9	985.3	1,070.7	1,147.2	1,223.1
DQE	35.6	43.7	50.8	56.1	61.0	66.1	71.6	77.9	84.8	91.4	99.9	110.8	121.7	132.2	141.0	148.4
DUKE	48.1	71.3	87.6	94.2	100.7	106.9	113.2	120.5	128.2	134.5	141.6	150.6	160.4	170.8	181.4	191.6
EKPC	12.1	13.1	14.1	14.8	16.2	18.3	21.4	25.0	28.6	31.8	35.6	39.4	43.2	46.9	50.6	54.3
JCPL	872.1	942.0	1,009.0	1,065.9	1,111.6	1,150.0	1,182.4	1,210.7	1,249.3	1,291.9	1,337.0	1,381.4	1,418.2	1,461.8	1,520.5	1,579.0
METED	100.8	109.7	117.3	122.9	128.0	133.4	139.2	146.0	153.6	160.8	170.3	182.6	194.9	206.9	217.0	225.4
PECO	142.4	165.2	185.0	199.7	213.0	226.9	242.0	259.2	278.2	296.4	319.9	350.0	380.2	409.3	433.9	454.4
PENLC	24.5	34.9	43.8	50.6	56.8	63.2	70.2	78.2	87.0	95.5	106.3	120.2	134.2	147.7	159.2	168.9
PEPCO	545.9	617.3	681.1	725.0	754.7	789.8	837.7	903.1	970.9	1,054.5	1,140.7	1,224.4	1,304.1	1,387.0	1,448.0	1,507.2
PL	217.6	240.4	260.2	274.9	288.1	302.1	317.3	334.9	354.3	373.0	397.3	428.8	460.3	490.9	516.8	538.2
PS	1,366.8	1,505.9	1,639.1	1,752.5	1,844.0	1,921.0	1,986.1	2,043.3	2,120.2	2,204.6	2,293.7	2,381.4	2,454.0	2,539.7	2,654.1	2,767.9
RECO	33.3	37.9	42.3	46.0	49.0	51.6	53.7	55.6	58.0	60.7	63.6	66.4	68.7	71.3	74.9	78.4
UGI	1.1	1.7	2.3	2.7	3.1	3.4	3.9	4.3	4.9	5.4	6.0	6.8	7.6	8.4	9.1	9.6
VEPCO	1,266.6	1,387.4	1,467.9	1,508.8	1,606.8	1,723.3	1,841.4	1,985.6	2,109.7	2,205.3	2,284.0	2,342.5	2,396.9	2,443.2	2,495.8	2,548.8
PJM RTO	7,488.5	8,553.0	9,448.5	10,067.1	10,733.6	11,471.4	12,265.0	13,165.1	14,138.5	15,121.3	16,097.3	17,031.6	17,928.2	18,847.4	19,727.4	20,583.0

- Starting in the 2020 forecast PJM uses the weather rotation for solar estimates. A daily capacity factor linked to the historical UL data will be used. Hour ending 17 will be used for the summer.



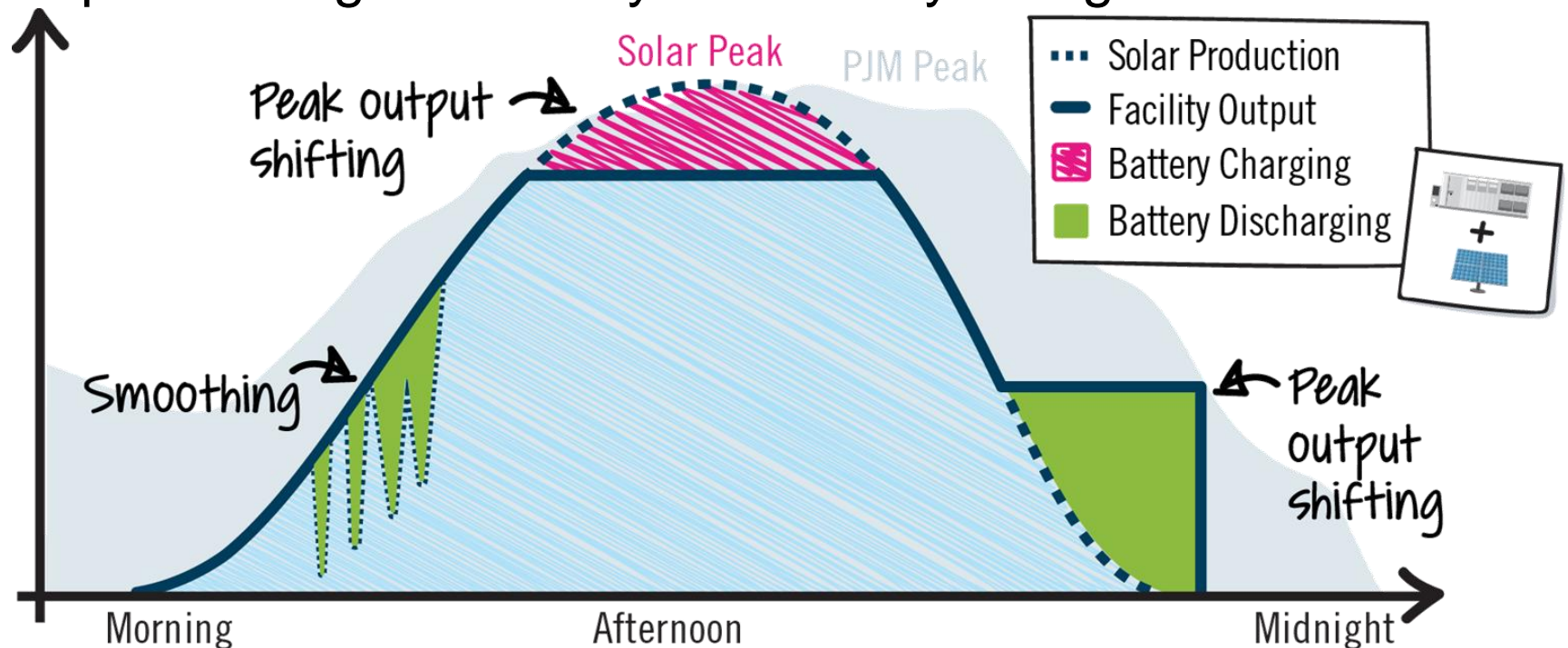
Distributed Solar Generation 2022 Forecast by Zone

Capacity in July



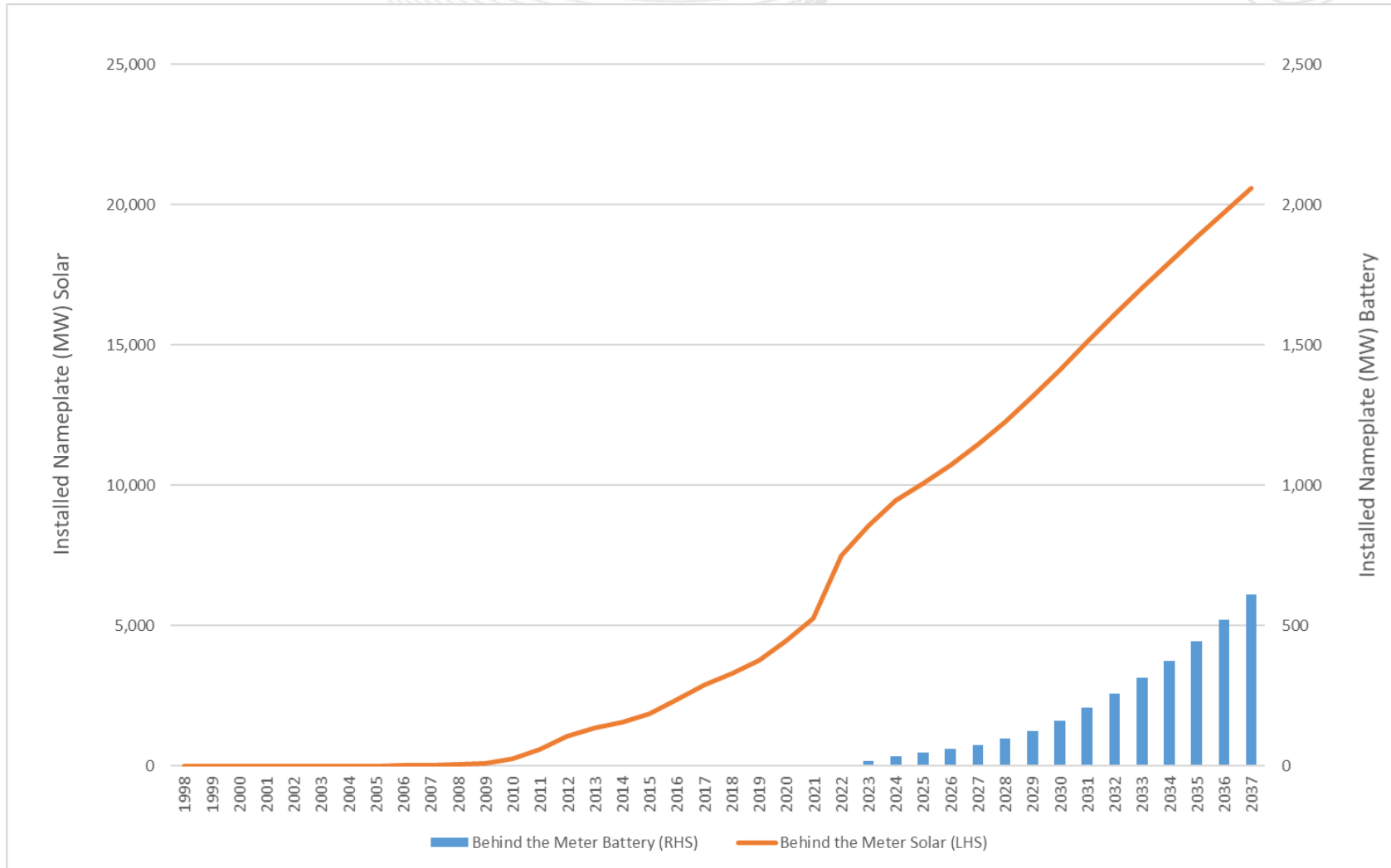
Behind the Meter Battery Storage

- Starting this year, PJM will use a battery forecast for use in conjunction with the distributed solar forecast.
- The full amount of battery forecast will be used when incorporating into the forecast – the assumption being the battery will be fully charged so it is available at peak.



Behind the Meter Battery Forecast by Zone Annual Additions of Nameplate Capacity

	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
AE	0.1	0.3	0.5	0.3	0.3	0.4	0.5	0.7	1.0	0.9	1.0	0.9	0.9	1.1	1.3	1.5
AEP	0.5	0.9	1.3	1.2	1.2	1.6	1.9	2.6	3.3	3.3	3.9	4.5	5.3	6.3	7.5	9.0
APS	0.3	0.6	0.8	0.7	0.6	0.8	1.0	1.4	1.7	2.5	2.9	3.3	3.8	4.2	4.1	4.5
ATSI	0.2	0.5	0.6	0.6	0.6	0.8	1.0	1.3	1.7	1.7	2.1	2.3	2.8	3.5	4.3	5.2
BGE	0.2	0.8	1.2	0.9	0.6	0.8	1.1	1.8	2.4	5.3	6.0	6.8	7.5	8.3	7.4	8.1
COMED	0.9	2.0	2.6	2.1	2.0	2.6	3.5	4.2	5.2	6.2	7.4	7.1	7.2	9.3	11.3	13.9
DAYTON	0.1	0.1	0.2	0.1	0.2	0.2	0.3	0.3	0.4	0.4	0.5	0.6	0.7	0.9	1.1	1.4
DPL	0.2	0.4	0.5	0.4	0.3	0.4	0.5	0.7	0.9	2.2	2.2	2.4	2.5	2.6	2.2	2.5
DQE	0.1	0.1	0.2	0.2	0.2	0.2	0.3	0.3	0.4	0.5	0.6	0.7	0.8	0.8	0.8	0.9
DUKE	0.1	0.2	0.2	0.2	0.2	0.3	0.4	0.5	0.6	0.6	0.8	0.9	1.0	1.3	1.6	2.0
EKPC	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
JCPL	0.3	0.8	1.1	0.8	0.7	0.9	1.2	1.7	2.3	2.2	2.3	2.1	2.2	2.5	3.0	3.7
METED	0.1	0.2	0.2	0.2	0.2	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	0.9	1.0	1.0
PECO	0.2	0.4	0.6	0.6	0.5	0.6	0.7	1.0	1.2	1.4	1.7	1.9	2.2	2.2	2.3	2.5
PENLC	0.1	0.2	0.2	0.3	0.2	0.3	0.3	0.4	0.6	0.6	0.8	0.8	1.0	1.0	1.0	1.1
PEPCO	0.2	0.8	1.1	0.9	0.6	0.8	1.0	1.6	2.1	3.5	3.9	4.3	4.4	4.7	4.1	4.5
PL	0.2	0.4	0.6	0.6	0.5	0.6	0.8	1.0	1.3	1.4	1.8	2.0	2.3	2.4	2.4	2.6
PS	0.5	1.5	2.1	1.5	1.3	1.7	2.3	3.3	4.4	4.3	4.5	4.1	4.3	4.8	5.8	7.0
RECO	0.0	0.0	0.1	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2
UGI	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1
VEPCO	0.8	1.6	2.4	2.2	2.2	2.9	3.4	4.8	6.2	7.2	8.6	9.8	11.3	12.1	14.3	17.5
PJM RTO	5.1	11.7	16.5	14.0	12.7	16.0	20.4	28.3	36.5	45.1	52.0	55.5	61.6	69.4	75.9	89.3



- Increased penetration of solar impacting monthly peak shift from July to August
- Hourly model framework to include solar and battery hourly shape
- Shift in daily peak hour in some zones from hour ending 17 to hour ending 18

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Distributed Solar and Battery Update



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