Distributed Solar Generation Update

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Two-Step Approach for Distributed Solar in Long Term Load Forecast

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

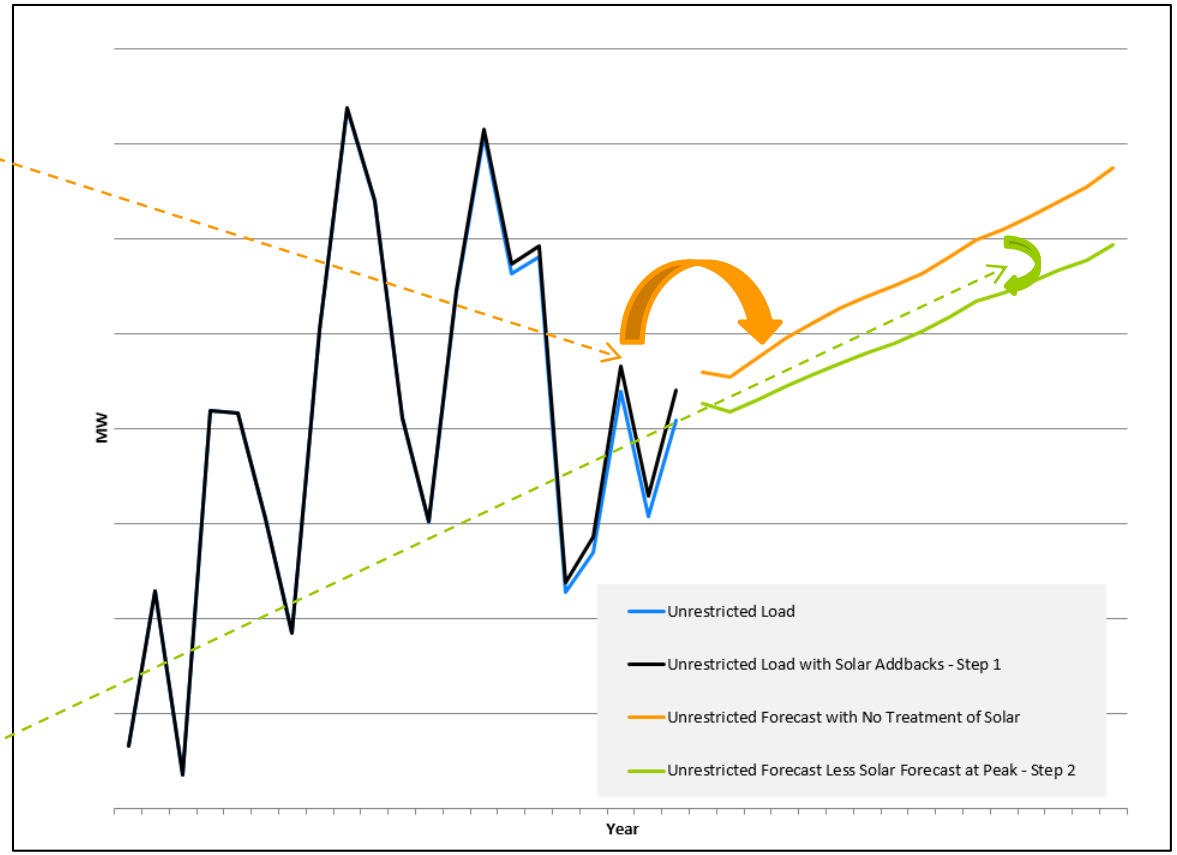
GATS
Generator Attribute Tracking System

AWS-T Solar Back-Cast

Step 2 (adjust forecast): For forecasted values of distributed solar capacity, PJM contracts with IHS Energy 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.

IHS Energy
state level solar forecast additions

PJM
converts to zonal solar peak impact



Historical GATS Installations

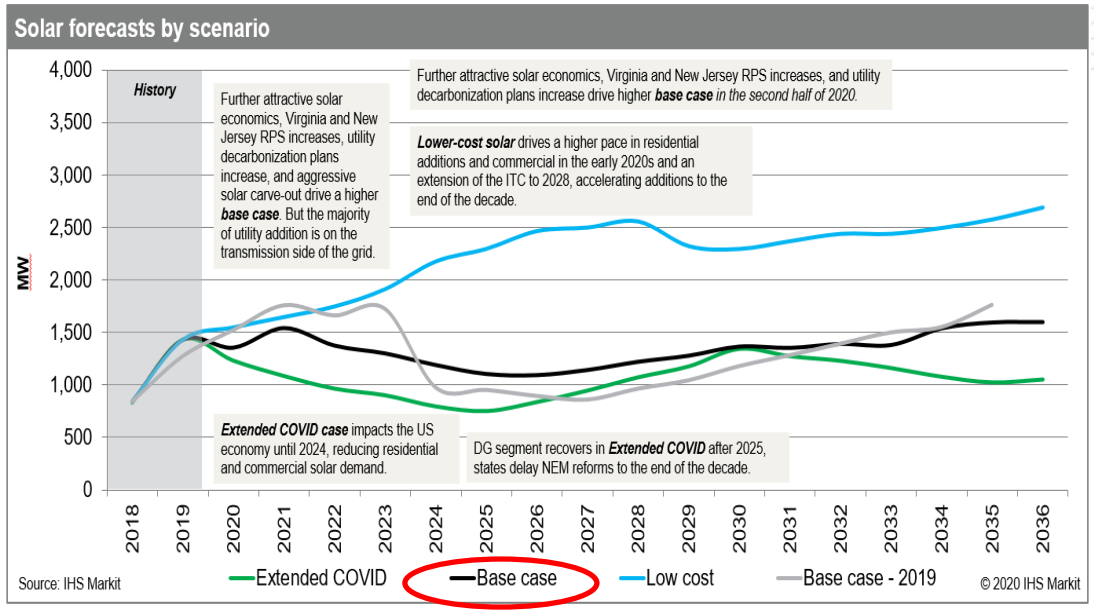
Historical Nameplate Capacity of Distributed Solar Generation (MW - AC)

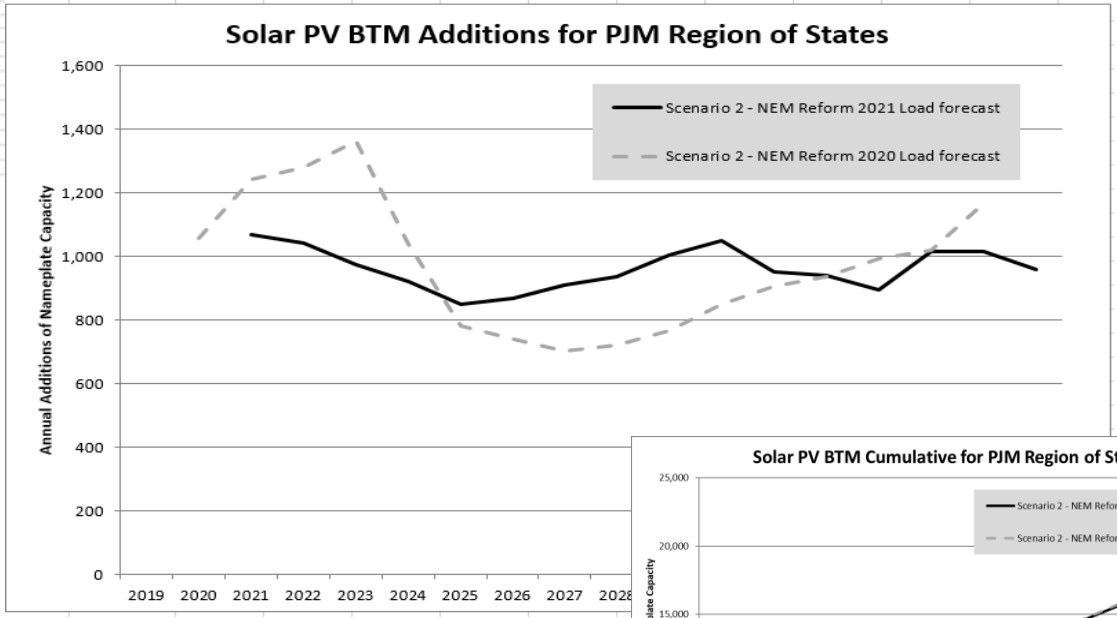
	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
AE						0.1	0.4	1.6	4.3	5.6	11.8	24.7	45.1	96.7	129.3	154.4	186.3	220.3	287.5	335.8	403.8	455.3	501.1
AEP					0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.5	13.5	17.3	23.1	29.1	35.6	39.3	44.7	45.8	67.8	74.9	81.8
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	147.6
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	111.7
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	417.8
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	214.4
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
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	271.4
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	22.3
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
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
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	764.2
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	70.5
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	104.9
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	10.5
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	420.1
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	159.7
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	1,102.3
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	25.6
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
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	934.9
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**	**5435.6**

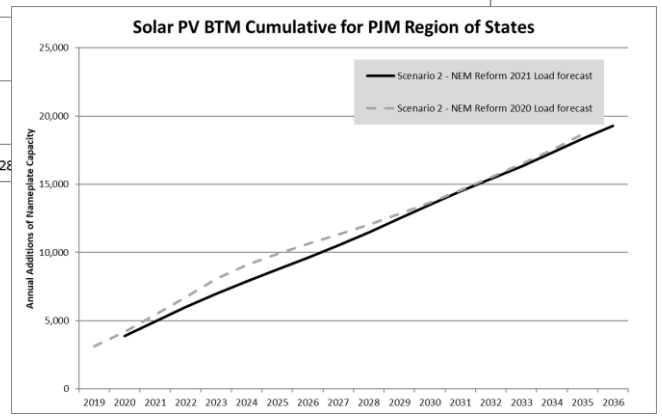
Note: All years except for 2020 are based on calendar year, 2020 is through 8/31/2020

IHS Forecast Scenarios

IHS produces three scenarios; PJM will use Scenario 2 – Base case (NEM Reform) in the 2021 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

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
DC	17.5	24.3	21.8	19.3	27.6	24.1	27.3	30.3	30.2	36.8	53.4	79.6	79.2	58.8	18.8	18.7
DE	21.2	22.2	19.2	17.9	17.7	20.1	23.2	24.9	28.8	32.7	48.9	60.7	60.4	50.9	34.9	35.7
IL	122.0	139.2	140.8	140.2	102.5	103.6	113.6	106.2	106.4	113.8	105.6	102.1	93.9	106.5	127.3	114.9
IN	6.7	3.9	3.9	2.7	3.7	2.5	2.9	5.7	6.0	6.4	6.0	5.9	5.9	5.9	7.1	7.2
KY	4.1	4.1	3.8	3.4	1.4	2.7	3.6	5.7	7.1	6.2	7.1	7.0	7.0	7.0	6.9	6.9
MD	162.2	210.7	212.6	216.7	254.1	315.0	334.4	356.3	408.8	411.1	406.8	397.7	371.5	361.3	343.6	239.7
MI	0.8	0.7	0.6	0.6	0.6	0.6	0.7	1.4	1.9	2.4	2.4	2.4	4.3	4.4	5.7	5.8
NC	10.2	6.9	5.1	3.4	1.6	1.0	0.4	0.8	1.2	2.0	3.9	6.1	6.0	6.0	6.0	8.1
NJ	292.5	273.9	233.0	211.3	191.5	145.8	123.7	101.1	64.8	79.7	92.0	113.0	138.2	123.6	151.7	202.4
OH	83.0	81.9	71.8	59.3	29.9	32.9	30.6	31.9	28.7	29.1	30.1	27.4	25.0	197.3	203.0	203.6
PA	96.6	85.2	72.1	61.8	35.2	36.7	41.3	48.8	57.5	64.7	55.6	54.8	51.3	52.1	60.3	55.8
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	251.6	186.9	190.0	184.9	179.5	183.7	206.8	222.8	259.6	259.7	134.3	80.2	40.4	30.4	35.1	48.2
WV	2.5	2.8	1.9	2.0	3.6	2.2	1.9	1.9	5.7	5.8	5.9	5.0	11.1	11.9	14.3	14.5
Total	**1,071.0**	**1,042.7**	**976.7**	**923.7**	**849.1**	**870.8**	**910.3**	**937.8**	**1,006.6**	**1,050.3**	**952.0**	**941.9**	**894.1**	**1,016.0**	**1,014.8**	**961.4**

Comparison of Forecasts

Distributed Solar Generation Forecast of Additions by State
Comparison of 2020 and 2021 Forecast

	2021 Forecast (Scenario 2 NEM Reform)				2020 Forecast (Scenario 2 NEM Reform)				Percent Change			
	2021	**2022**	**2023**	**2024**	**2021**	**2022**	**2023**	**2024**	**2021**	**2022**	**2023**	**2024**
DC	17.5	24.3	21.8	19.3	21.2	23.2	19.6	14.6	-18%	5%	11%	33%
DE	21.2	22.2	19.2	17.9	46.0	47.6	35.4	13.8	-54%	-53%	-46%	29%
IL	122.0	139.2	140.8	140.2	136.0	102.5	95.2	82.9	-10%	36%	48%	69%
IN	6.7	3.9	3.9	2.7	10.4	11.0	11.1	6.3	-35%	-65%	-64%	-57%
KY	4.1	4.1	3.8	3.4	2.7	3.8	2.0	2.7	50%	10%	95%	27%
MD	162.2	210.7	212.6	216.7	280.0	349.4	379.5	335.0	-42%	-40%	-44%	-35%
MI	0.8	0.7	0.6	0.6	0.6	0.6	0.7	0.6	21%	17%	-7%	4%
NC	10.2	6.9	5.1	3.4	78.4	60.1	46.2	38.3	-87%	-88%	-89%	-91%
NJ	292.5	273.9	233.0	211.3	330.6	234.7	192.3	110.1	-12%	17%	21%	92%
OH	83.0	81.9	71.8	59.3	95.3	178.1	289.5	240.5	-13%	-54%	-75%	-75%
PA	96.6	85.2	72.1	61.8	64.6	87.2	104.7	64.2	50%	-2%	-31%	-4%
TN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
VA	251.6	186.9	190.0	184.9	173.7	175.7	183.9	109.6	45%	6%	3%	69%
WV	2.5	2.8	1.9	2.0	1.6	5.6	4.7	20.4	53%	-50%	-59%	-90%
Total	**1,071.0**	**1,042.7**	**976.7**	**923.7**	**1,241.3**	**1,279.5**	**1,364.8**	**1,039.1**	**-14%**	**-19%**	**-28%**	**-11%**

Distributed Solar Generation Forecast by Zone
Cumulative Additions of Nameplate Capacity

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
APS	42.4	87.4	130.8	173.1	216.7	267.4	321.8	380.5	450.0	521.0	586.2	648.1	708.1	767.1	826.4	872.9
ATSI	34.8	68.6	98.0	122.3	134.5	147.9	160.5	173.7	186.0	198.5	211.1	222.6	233.1	306.0	380.9	455.5
BGE	78.8	181.3	284.8	390.4	514.4	668.5	832.1	1,006.7	1,207.3	1,409.3	1,609.4	1,805.3	1,988.4	2,166.7	2,336.4	2,454.9
COMED	122.0	261.2	402.0	542.2	644.7	748.3	861.9	968.2	1,074.6	1,188.4	1,294.0	1,396.1	1,489.9	1,596.4	1,723.8	1,838.6
DAYTON	8.7	17.3	24.7	30.8	33.8	37.2	40.3	43.5	46.4	49.3	52.3	55.0	57.5	77.2	97.4	117.6
DPL	36.9	78.7	117.8	156.1	197.7	247.4	302.2	361.2	429.3	502.0	589.9	688.7	784.8	870.6	939.0	998.4
DQE	8.6	16.1	22.4	27.9	31.0	34.2	37.8	42.0	47.0	52.6	57.4	62.1	66.4	70.8	75.9	80.6
DUKE	12.9	25.6	36.9	46.3	51.0	56.5	61.7	67.6	73.4	79.0	84.9	90.5	95.6	126.8	158.9	191.3
EKPC	2.2	4.5	6.5	8.4	9.2	10.7	12.6	15.8	19.8	23.2	27.1	31.1	35.0	38.9	42.8	46.7
JCPL	83.7	161.8	228.1	288.1	342.4	383.8	418.9	447.6	466.0	488.6	514.8	547.0	586.3	621.5	664.8	722.5
METED	9.8	18.6	26.0	32.3	36.0	39.8	44.2	49.4	55.5	62.4	68.4	74.4	80.0	85.7	92.3	98.5
PECO	24.9	46.7	65.1	80.8	89.7	98.9	109.2	121.4	135.7	151.7	165.4	179.0	191.6	204.3	219.1	232.7
PENLC	10.7	20.0	27.9	34.6	38.4	42.4	46.8	52.1	58.2	65.2	71.1	77.0	82.5	88.1	94.6	100.5
PEPCO	67.6	156.4	242.8	327.6	431.6	549.9	676.6	812.3	962.8	1,120.0	1,291.9	1,486.8	1,673.1	1,835.6	1,952.5	2,039.2
PL	25.4	47.8	66.9	83.3	92.7	102.5	113.5	126.7	142.2	159.7	174.7	189.7	203.7	217.9	234.4	249.8
PS	165.9	321.5	454.0	574.3	683.3	766.2	836.6	894.1	930.9	976.2	1,028.5	1,092.7	1,171.1	1,241.3	1,327.3	1,442.1
RECO	5.5	10.6	15.0	18.9	22.5	25.2	27.6	29.4	30.7	32.1	33.9	36.0	38.5	40.8	43.7	47.4
UGI	0.6	1.2	1.6	2.0	2.2	2.5	2.7	3.0	3.4	3.7	4.1	4.4	4.7	5.0	5.3	5.7
VEPCO	212.9	370.6	529.4	682.8	830.1	980.2	1,148.6	1,330.4	1,542.7	1,755.9	1,869.2	1,940.6	1,979.5	2,010.3	2,045.0	2,092.5
PJM RTO	**1,071.0**	**2,113.7**	**3,090.3**	**4,014.0**	**4,863.2**	**5,734.0**	**6,644.3**	**7,582.2**	**8,588.8**	**9,639.1**	**10,591.1**	**11,533.0**	**12,427.1**	**13,443.0**	**14,457.8**	**15,419.2**

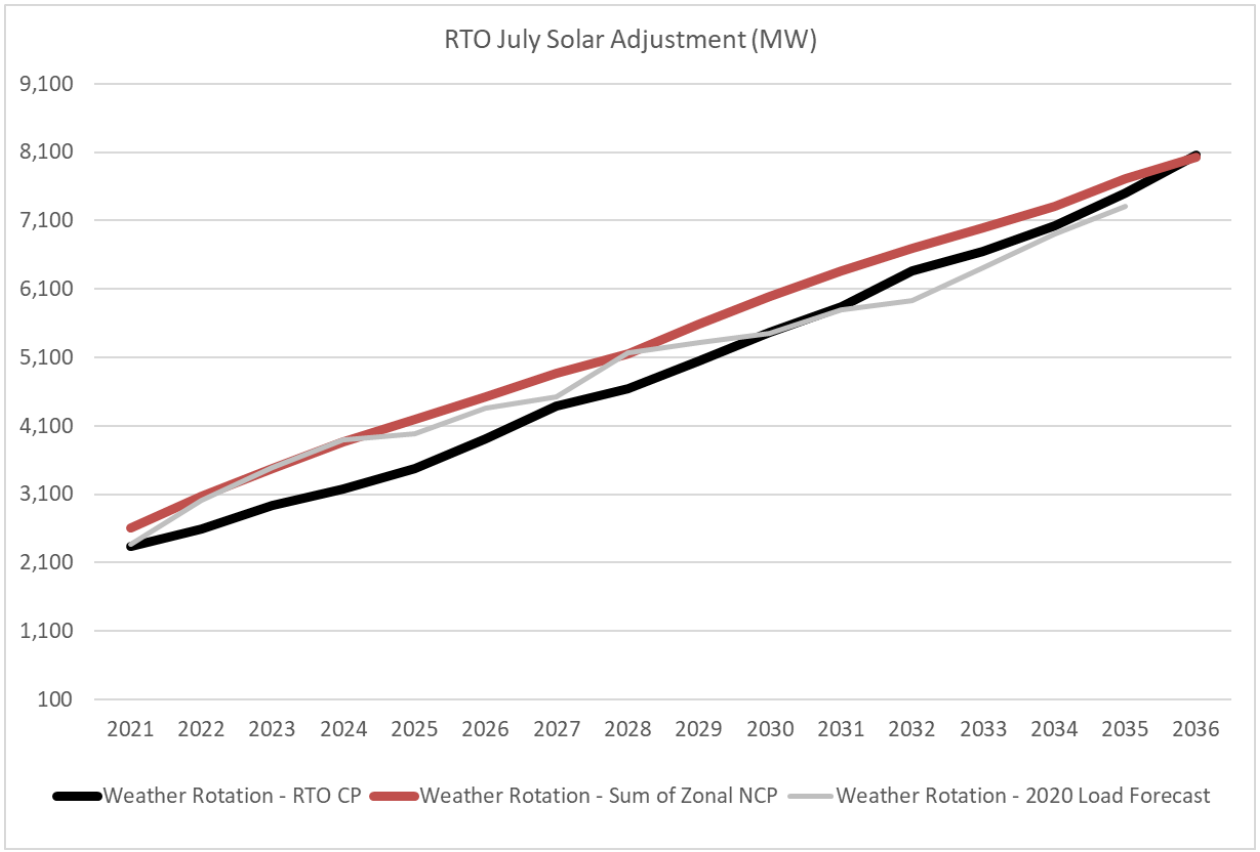
Historical and IHS Nameplate Capacity

Distributed Solar Generation Forecast by Zone
Cumulative Nameplate Capacity
Includes Historical Degraded Values and IHS Forecast

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
AE	534.5	565.6	591.6	614.8	635.5	650.3	662.4	671.7	676.2	682.8	690.9	701.8	716.0	728.3	744.3	766.9
AEP	158.6	222.6	282.6	335.8	378.6	421.4	467.2	519.9	579.6	640.1	683.2	716.9	749.3	847.5	952.6	1,060.4
APS	189.5	233.8	276.3	317.8	360.5	410.2	463.6	521.4	590.0	660.1	724.4	785.4	844.3	902.3	960.7	1,006.2
ATSI	145.6	178.6	207.2	230.6	242.0	254.6	266.3	278.7	290.1	301.8	313.6	324.3	334.0	406.2	480.4	554.3
BGE	493.0	591.7	691.4	793.3	913.5	1,063.6	1,223.4	1,394.1	1,590.7	1,788.7	1,984.8	2,176.8	2,356.1	2,530.6	2,696.6	2,811.6
COMED	334.7	472.2	611.3	749.8	850.7	952.6	1,064.6	1,169.2	1,274.0	1,386.2	1,490.2	1,590.8	1,683.1	1,788.0	1,913.8	2,027.2
DAYTON	47.6	55.8	62.9	68.7	71.5	74.5	77.3	80.3	82.9	85.5	88.2	90.7	92.9	112.3	132.2	152.2
DPL	306.0	345.6	382.5	418.6	458.1	505.5	558.2	615.0	681.0	751.5	837.2	933.9	1,027.9	1,111.6	1,177.9	1,235.3
DQE	30.6	37.9	44.0	49.3	52.2	55.2	58.6	62.6	67.4	72.8	77.4	81.9	86.0	90.3	95.1	99.6
DUKE	36.7	49.2	60.2	69.4	73.9	79.1	84.2	89.9	95.5	100.9	106.7	112.1	117.1	147.9	179.6	211.5
EKPC	13.1	15.2	17.2	18.9	19.6	21.0	22.9	25.9	29.7	33.0	36.8	40.6	44.4	48.2	52.0	55.8
JCPL	841.8	913.8	974.1	1,028.1	1,076.6	1,112.0	1,141.3	1,164.2	1,176.9	1,193.9	1,214.4	1,240.9	1,274.7	1,304.5	1,342.2	1,394.5
METED	79.7	87.8	94.6	100.4	103.5	106.8	110.5	115.1	120.7	127.1	132.5	137.9	142.9	148.1	154.2	159.8
PECO	128.8	149.7	167.1	181.8	189.8	198.2	207.7	219.0	232.4	247.5	260.4	273.0	284.8	296.7	310.6	323.4
PENLC	21.1	30.3	38.0	44.6	48.3	52.1	56.5	61.6	67.6	74.5	80.3	86.1	91.4	96.9	103.3	109.1
PEPCO	484.9	571.0	654.8	737.0	838.6	954.6	1,079.1	1,212.8	1,361.3	1,516.7	1,686.8	1,879.7	2,064.2	2,224.7	2,339.6	2,424.1
PL	183.6	204.6	222.3	237.3	245.4	253.9	263.7	275.5	289.7	305.9	319.7	333.4	346.1	359.1	374.4	388.5
PS	1,259.4	1,406.3	1,530.1	1,641.8	1,742.2	1,816.7	1,878.7	1,927.8	1,956.4	1,993.5	2,037.6	2,093.7	2,164.2	2,226.4	2,304.5	2,411.5
RECO	30.9	35.8	40.0	43.8	47.2	49.7	51.8	53.5	54.5	55.8	57.3	59.3	61.6	63.8	66.4	70.0
UGI	1.1	1.6	2.1	2.5	2.7	2.9	3.1	3.4	3.8	4.1	4.5	4.8	5.1	5.4	5.7	6.0
VEPCO	1,142.0	1,293.5	1,446.2	1,593.6	1,734.8	1,879.0	2,041.6	2,217.9	2,424.8	2,632.9	2,740.1	2,805.2	2,837.6	2,861.8	2,890.0	2,931.3
PJM RTO	**6,463.1**	**7,462.7**	**8,396.5**	**9,277.8**	**10,084.8**	**10,913.9**	**11,782.8**	**12,679.5**	**13,645.3**	**14,655.2**	**15,567.0**	**16,469.1**	**17,323.7**	**18,300.5**	**19,276.4**	**20,199.3**

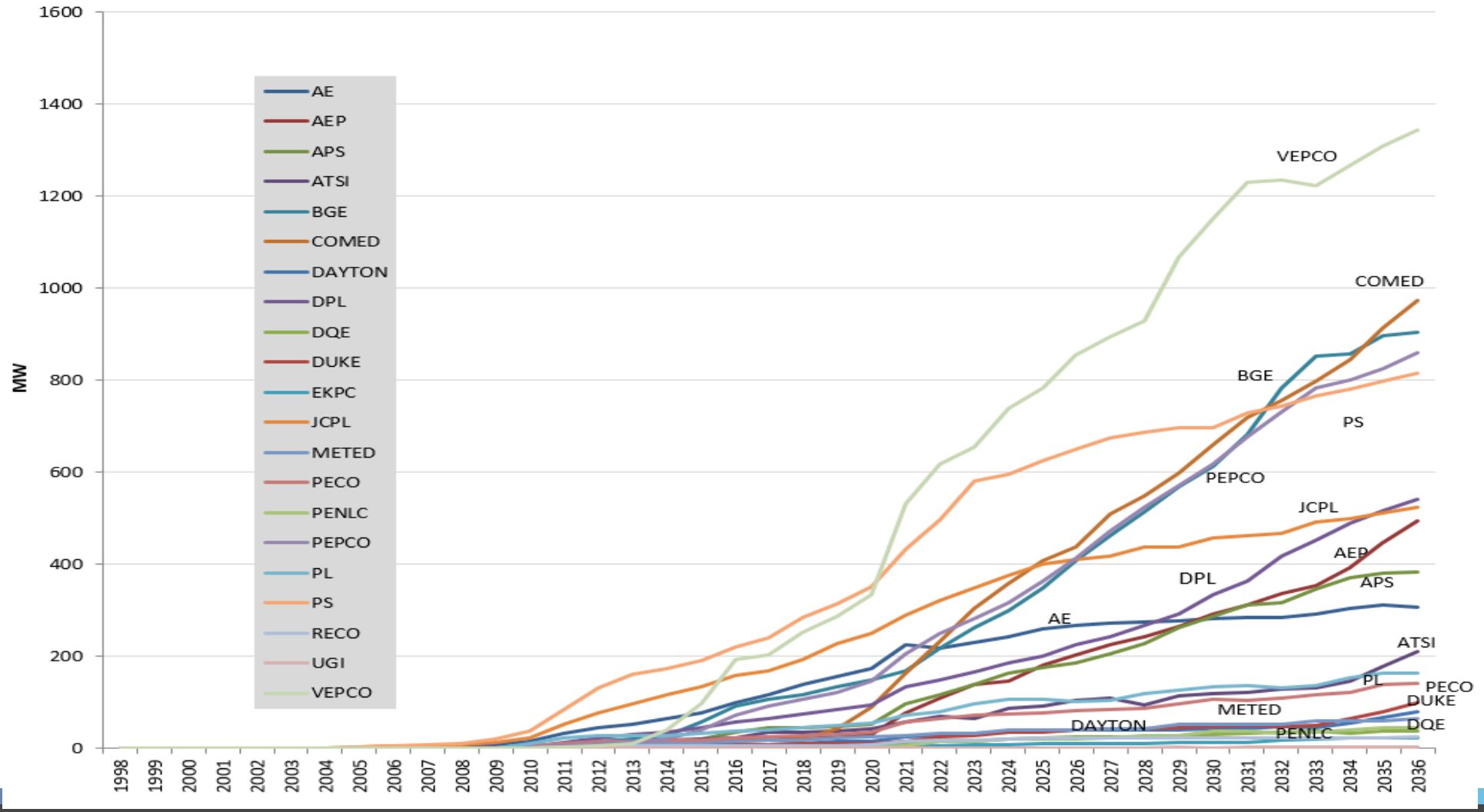
Using Weather Rotation for Solar

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



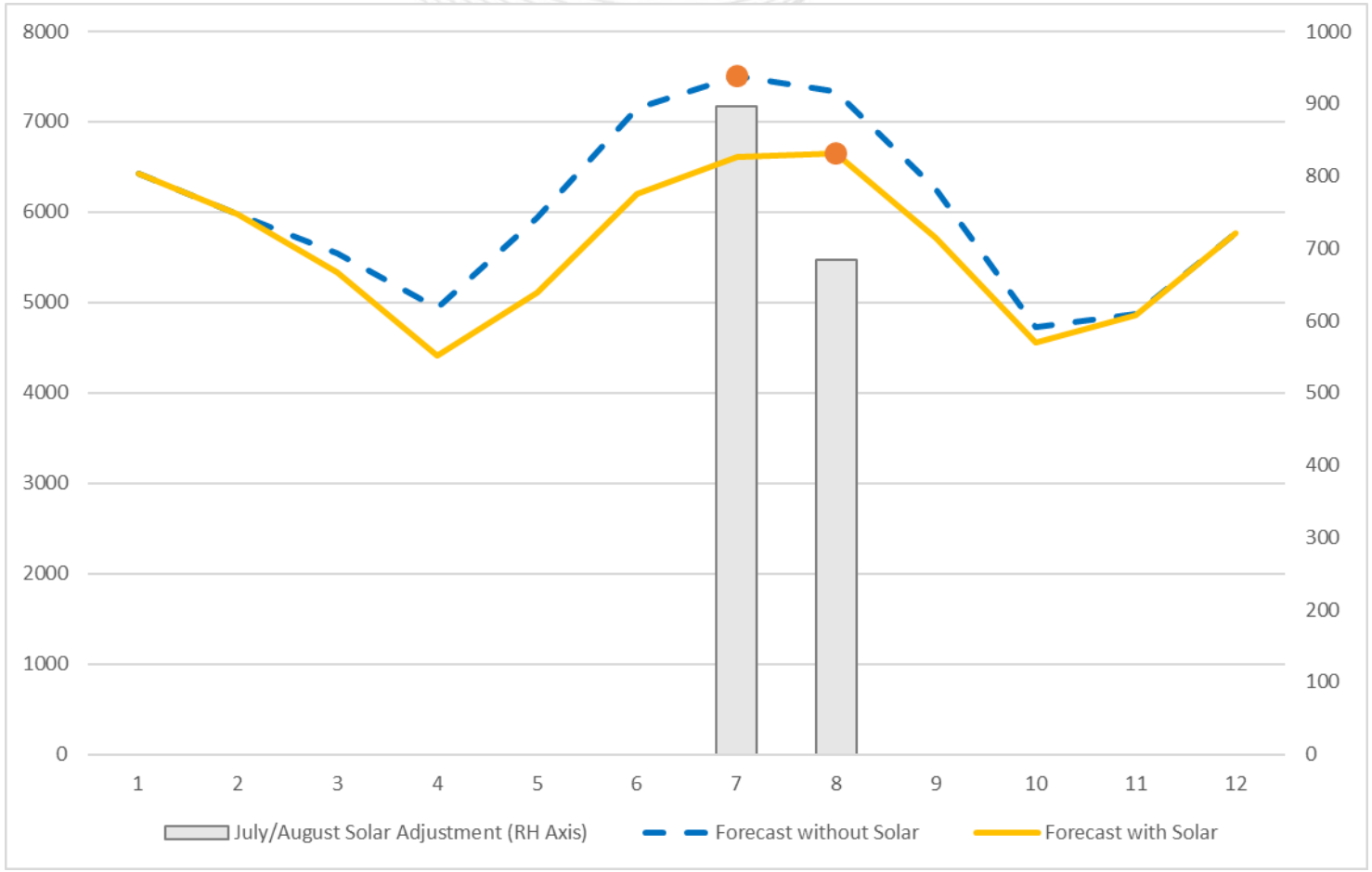
Distributed Solar Generation 2021 Forecast by Zone

Capacity in July



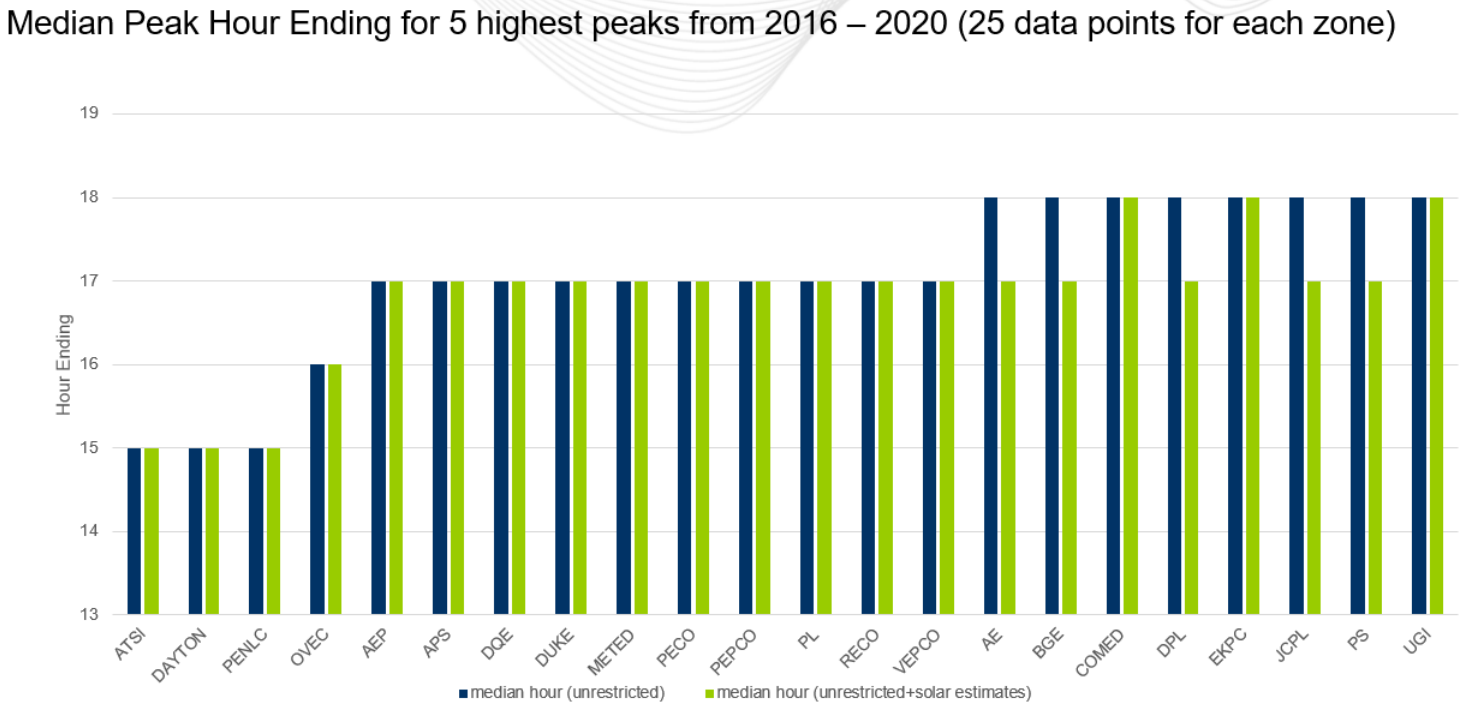
Impact of Increasing Solar Penetration

Increasing solar penetration impacts summer peak month



Impact of Increasing Solar Penetration

- No changes to the hour ending 17 assumption for Summer Peak impact in the 2021 forecast but will investigate further next year



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Distributed Solar Update

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