

Capacity Market Issues

OPSI Spring
Meeting
04.11.2022

Joe Bowring



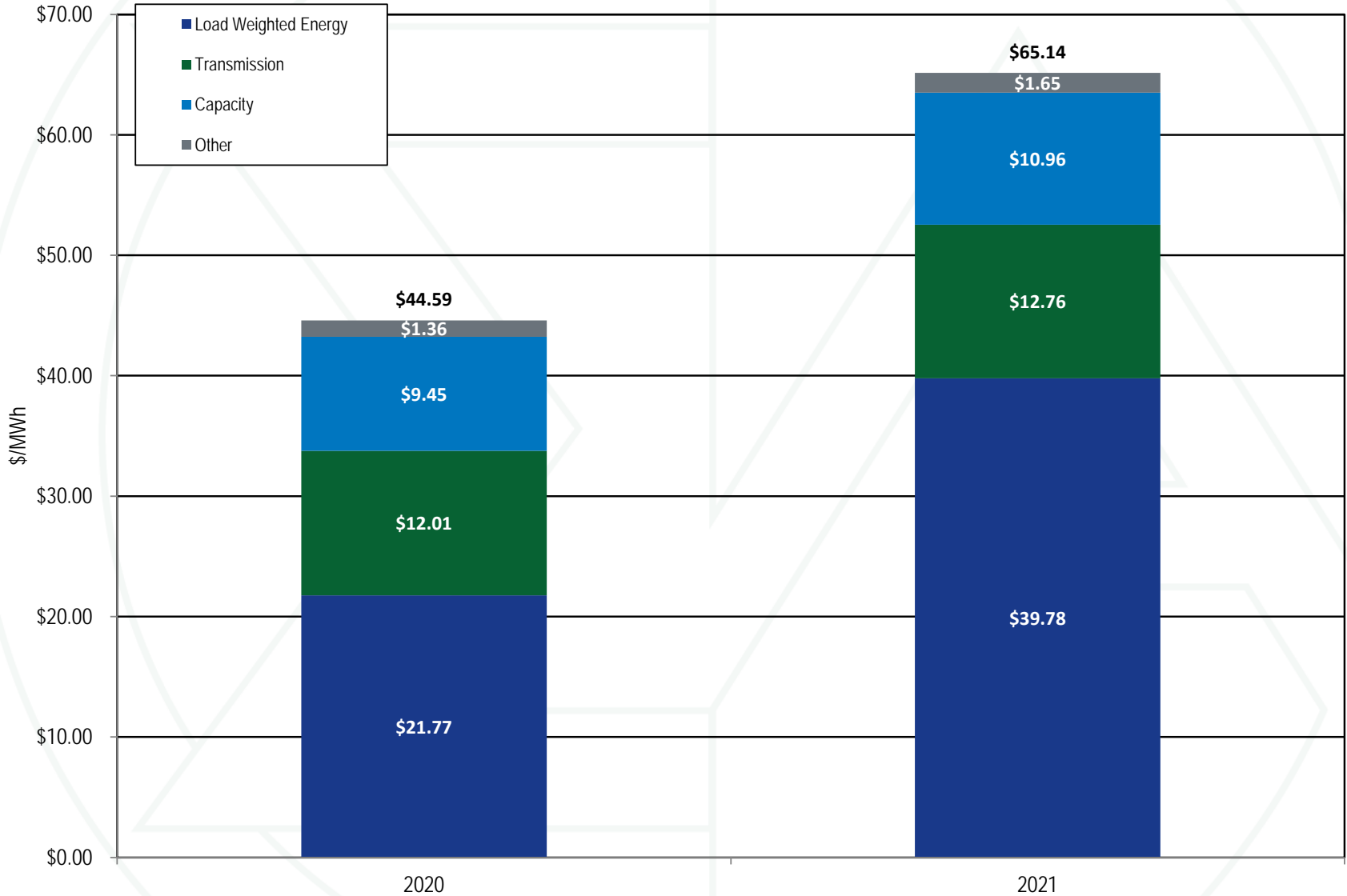
Monitoring Analytics

Capacity market history

- **PA PUC**
- **Required for retail competition**
- **Daily (capacity credit market)**
- **Annual (reliability pricing model)**
- **Impact on net revenues to generation assets**



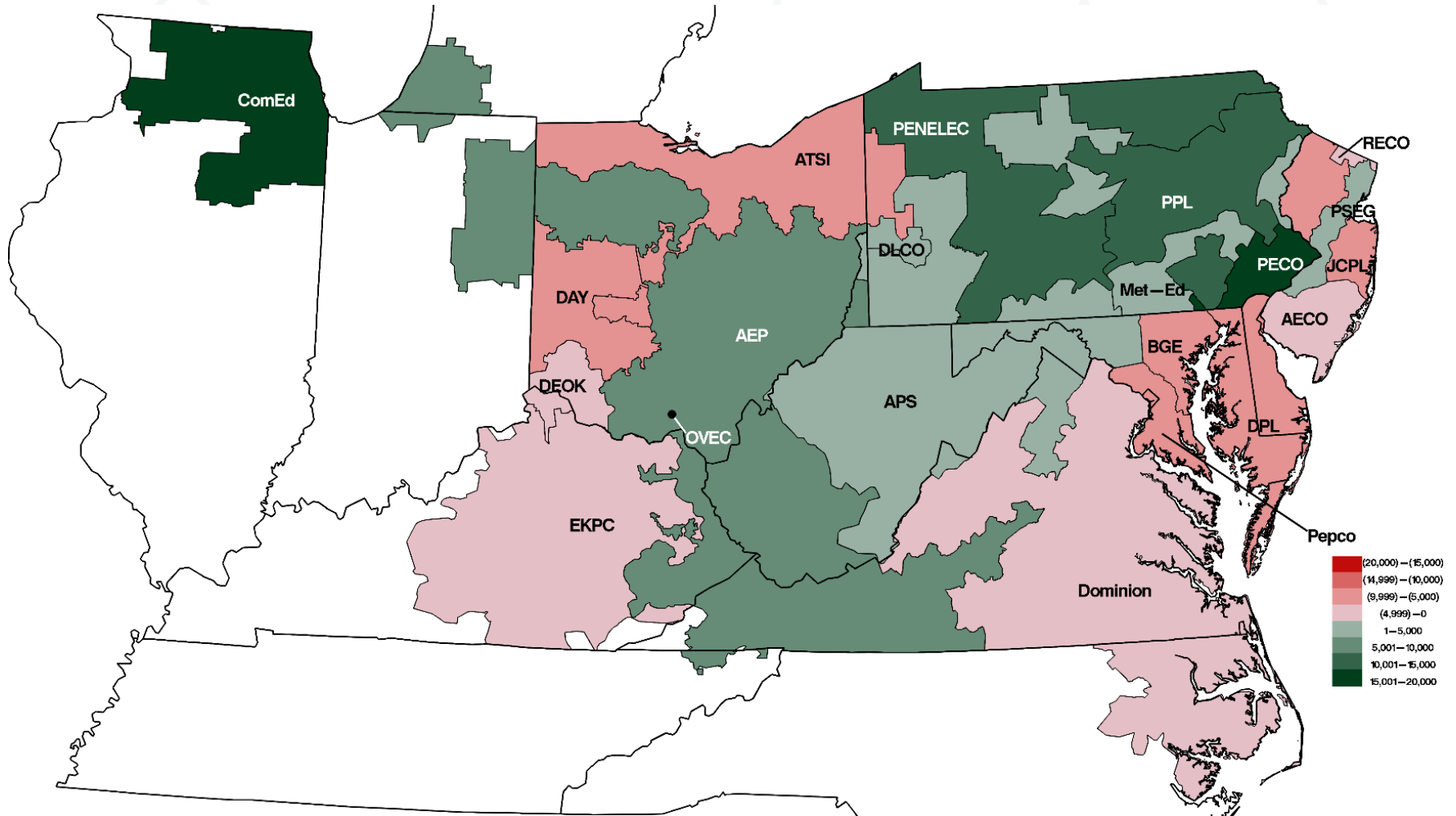
Total price of wholesale power



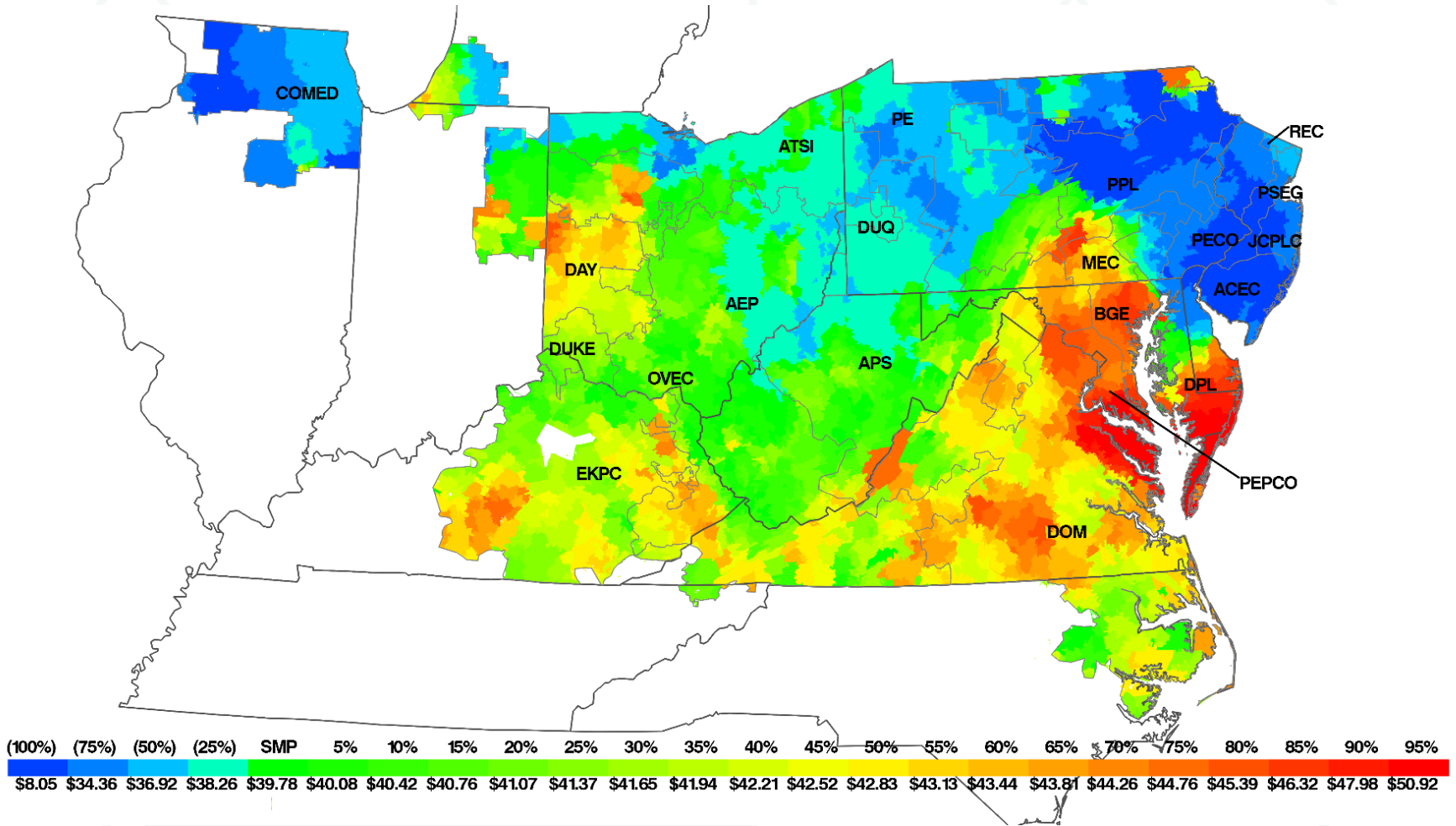
Generation by fuel source

	2020		2021		Change in Output
	GWh	Percent	GWh	Percent	
Coal	156,575.0	19.3%	184,412.3	22.2%	17.8%
Bituminous	143,556.3	17.7%	163,753.6	19.7%	14.1%
Sub Bituminous	7,726.0	1.0%	14,421.7	1.7%	86.7%
Other Coal	5,292.7	0.7%	6,237.0	0.7%	17.8%
Nuclear	276,607.6	34.2%	272,670.4	32.8%	(1.4%)
Gas	322,505.4	39.8%	314,885.1	37.9%	(2.4%)
Natural Gas CC	294,712.8	36.4%	289,136.6	34.8%	(1.9%)
Natural Gas CT	18,849.2	2.3%	19,894.4	2.4%	5.5%
Natural Gas Other Units	6,995.6	0.9%	4,132.1	0.5%	(40.9%)
Other Gas	1,947.8	0.2%	1,722.0	0.2%	(11.6%)
Hydroelectric	16,423.3	2.0%	16,624.8	2.0%	1.2%
Pumped Storage	4,950.4	0.6%	5,037.3	0.6%	1.8%
Run of River	10,036.7	1.2%	10,278.6	1.2%	2.4%
Other Hydro	1,436.2	0.2%	1,308.9	0.2%	(8.9%)
Wind	26,433.2	3.3%	27,651.4	3.3%	4.6%
Waste	4,423.1	0.5%	4,475.9	0.5%	1.2%
Oil	2,054.8	0.3%	2,290.7	0.3%	11.5%
Heavy Oil	86.0	0.0%	65.6	0.0%	(23.7%)
Light Oil	282.2	0.0%	524.4	0.1%	85.8%
Diesel	30.1	0.0%	27.7	0.0%	(8.0%)
Other Oil	1,656.4	0.2%	1,673.1	0.2%	1.0%
Solar	3,869.5	0.5%	7,412.2	0.9%	91.6%
Battery	36.1	0.0%	36.5	0.0%	1.0%
Biofuel	914.3	0.1%	1,191.7	0.1%	30.3%
Total	809,842.4	100.0%	831,650.8	100.0%	2.7%

RT generation less RT load



RT load-weighted average LMP



The capacity market results were not competitive

Market Element	Evaluation	Market Design
Market Structure: Aggregate Market	Not Competitive	
Market Structure: Local Market	Not Competitive	
Participant Behavior	Not Competitive	
Market Performance	Not Competitive	Mixed

Capacity market issues

- **Market seller offer cap (MSOC)**
- **VRR curve shape and location**
- **Definition of capacity**
- **Intermittent capacity definition: ELCC**
- **DR/EE**
- **MOPR**
- **Reserve margin**

2022/2023 RPM Base Residual Auction

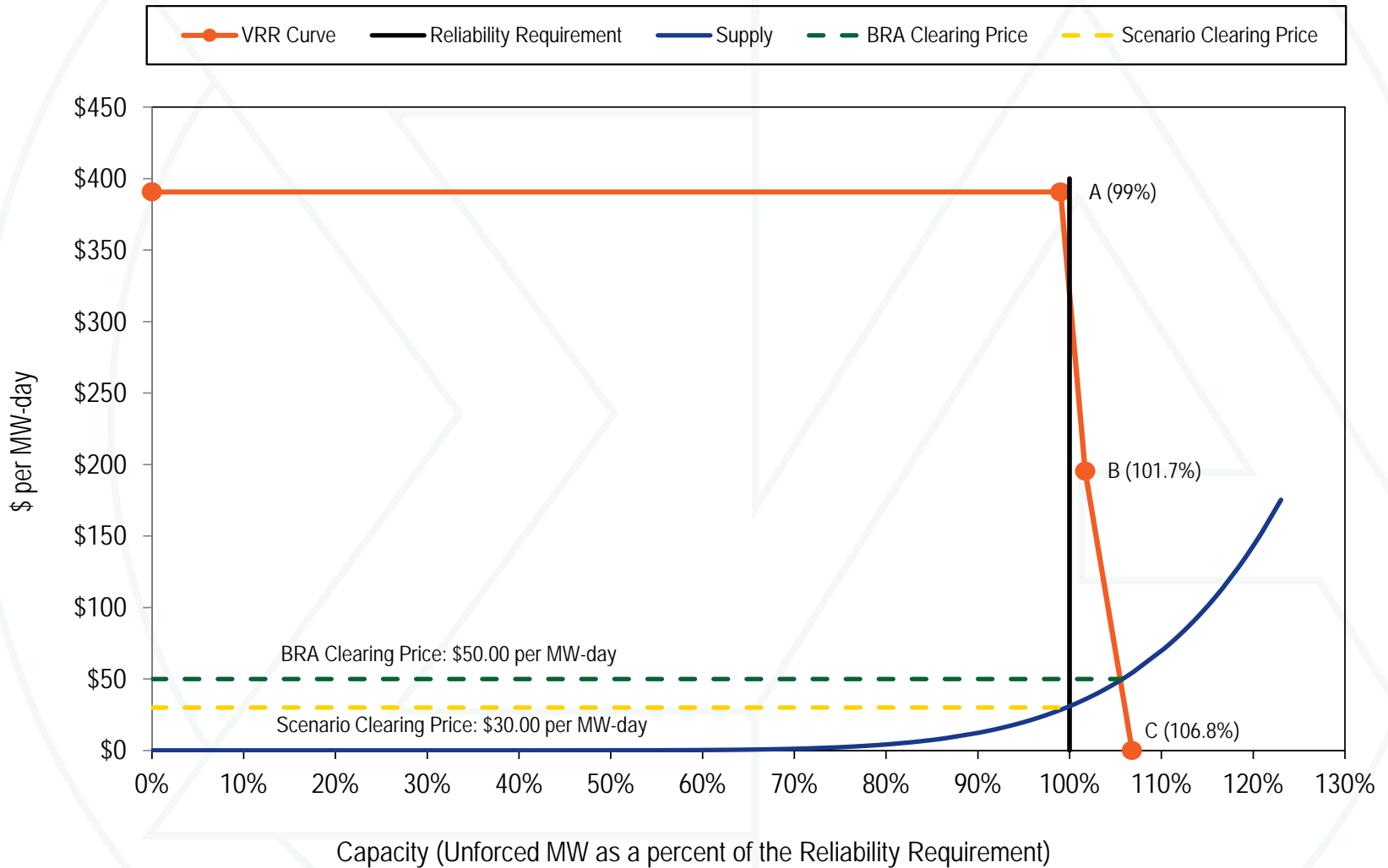
Scenario	Scenario Description	RPM Revenue	Scenario Impact	Percent
		(\$ per Delivery Year)	RPM Revenue (\$ per Delivery Year)	
0	Actual Results	\$3,916,990,303	NA	NA
1	Impact of Downward Sloping VRR Curve	\$2,659,527,128	\$1,257,463,175	47.3%
2	Impact of Forecast Peak Load	\$3,038,859,236	\$878,131,066	28.9%
3	Impact of ComEd CETL	\$4,045,468,797	(\$128,478,494)	(3.2%)
4	Impact of Dominion FRR	\$4,009,821,399	(\$92,831,097)	(2.3%)
5	Impact of Intermittent Capacity	\$4,209,145,809	(\$292,155,506)	(6.9%)
6	Inclusion of Demand Resources	\$4,667,530,509	(\$750,540,206)	(16.1%)
7	Inclusion of EE Offers and EE Addback	\$3,723,175,053	\$193,815,249	5.2%
8	Impact of Incorrect EE Addback	\$3,860,997,114	\$55,993,189	1.5%
9	Inclusion of PRD	\$3,971,098,221	(\$54,107,919)	(1.4%)
10	Inclusion of Seasonal Products	\$4,088,669,913	(\$171,679,610)	(4.2%)
11	Inclusion of Seasonal Matching Across LDAs	\$4,007,550,697	(\$90,560,395)	(2.3%)
12	Inclusion of Offers from External Generation	\$4,227,125,093	(\$310,134,790)	(7.3%)
13	Impact of DR, EE, PRD, Seasonal Resources, Capacity Imports, and Intermittent Capacity Overstatement	\$6,657,417,211	(\$2,740,426,908)	(41.2%)
14	Impact of Low MOPR Offers	\$4,078,113,024	(\$161,122,722)	(4.0%)
15	Inclusion of Nuclear Offers	\$3,480,464,207	\$436,526,096	12.5%
16	Impact of Noncompetitive Offers	\$3,694,010,658	\$222,979,644	6.0%



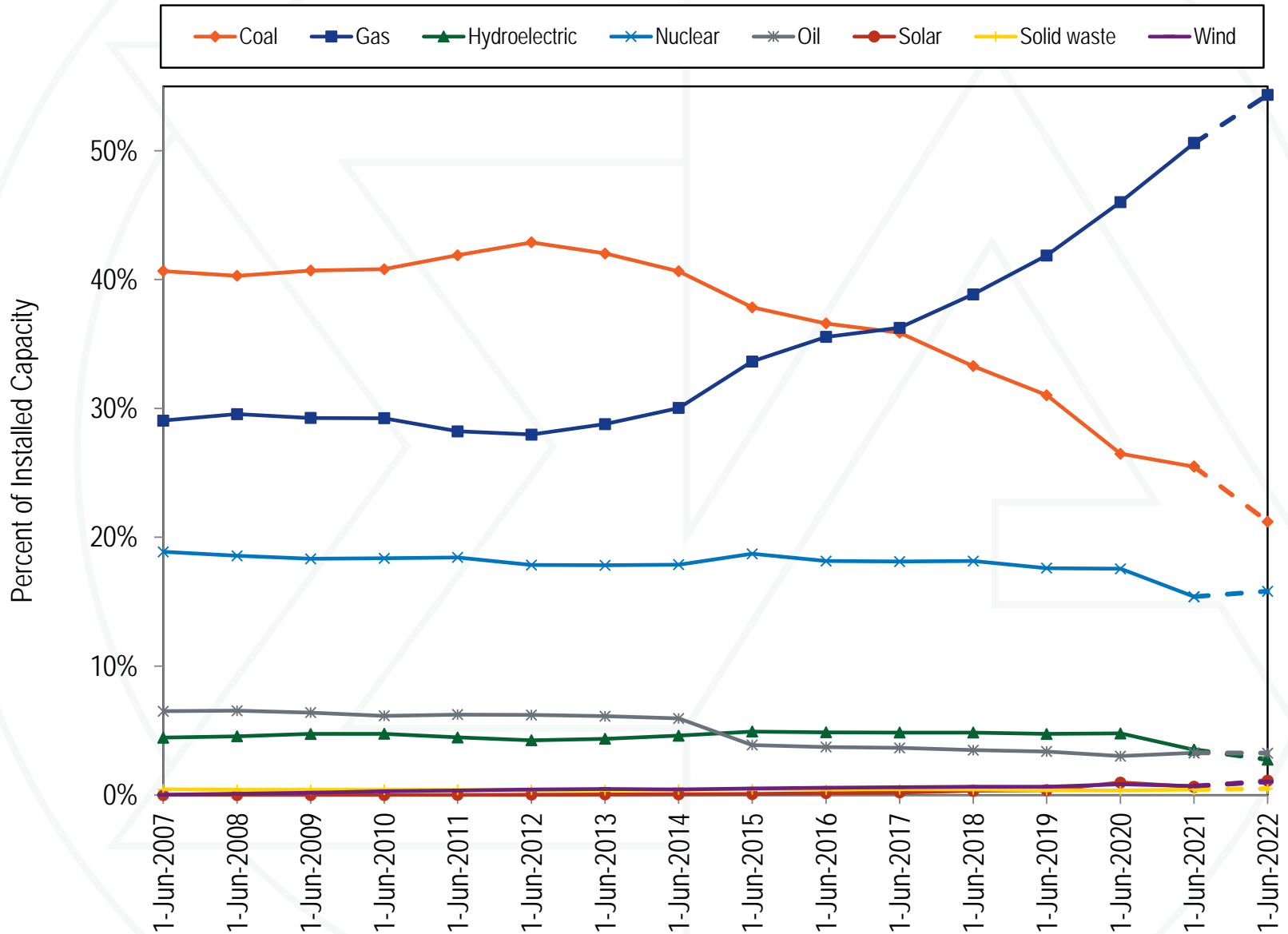
2022/2023 RPM Base Residual Auction

Scenario	Scenario Description	Cleared UCAP (MW)	Scenario Impact	
			Cleared UCAP (MW)	Percent
0	Actual Results	144,477.3	NA	NA
1	Impact of Downward Sloping VRR Curve	132,006.7	12,470.6	9.4%
2	Impact of Forecast Peak Load	138,811.6	5,665.7	4.1%
3	Impact of ComEd CETL	144,581.9	(104.6)	(0.1%)
4	Impact of Dominion FRR	143,140.5	1,336.8	0.9%
5	Impact of Intermittent Capacity	144,184.3	293.0	0.2%
6	Inclusion of Demand Resources	138,083.6	6,393.7	4.6%
7	Inclusion of EE Offers and EE Addback	139,272.3	5,205.0	3.7%
8	Impact of Incorrect EE Addback	144,068.6	408.7	0.3%
9	Inclusion of PRD	144,727.2	(249.9)	(0.2%)
10	Inclusion of Seasonal Products	144,052.8	424.5	0.3%
11	Inclusion of Seasonal Matching Across LDAs	144,363.9	113.4	0.1%
12	Inclusion of Offers from External Generation	143,951.3	526.0	0.4%
13	Impact of DR, EE, PRD, Seasonal Resources, Capacity Imports, and Intermittent Capacity Overstatement	136,610.7	7,866.6	5.8%
14	Impact of Low MOPR Offers	144,310.2	167.1	0.1%
15	Inclusion of Nuclear Offers	144,581.9	(104.6)	(0.1%)
16	Impact of Noncompetitive Offers	144,477.3	0.0	0.0%

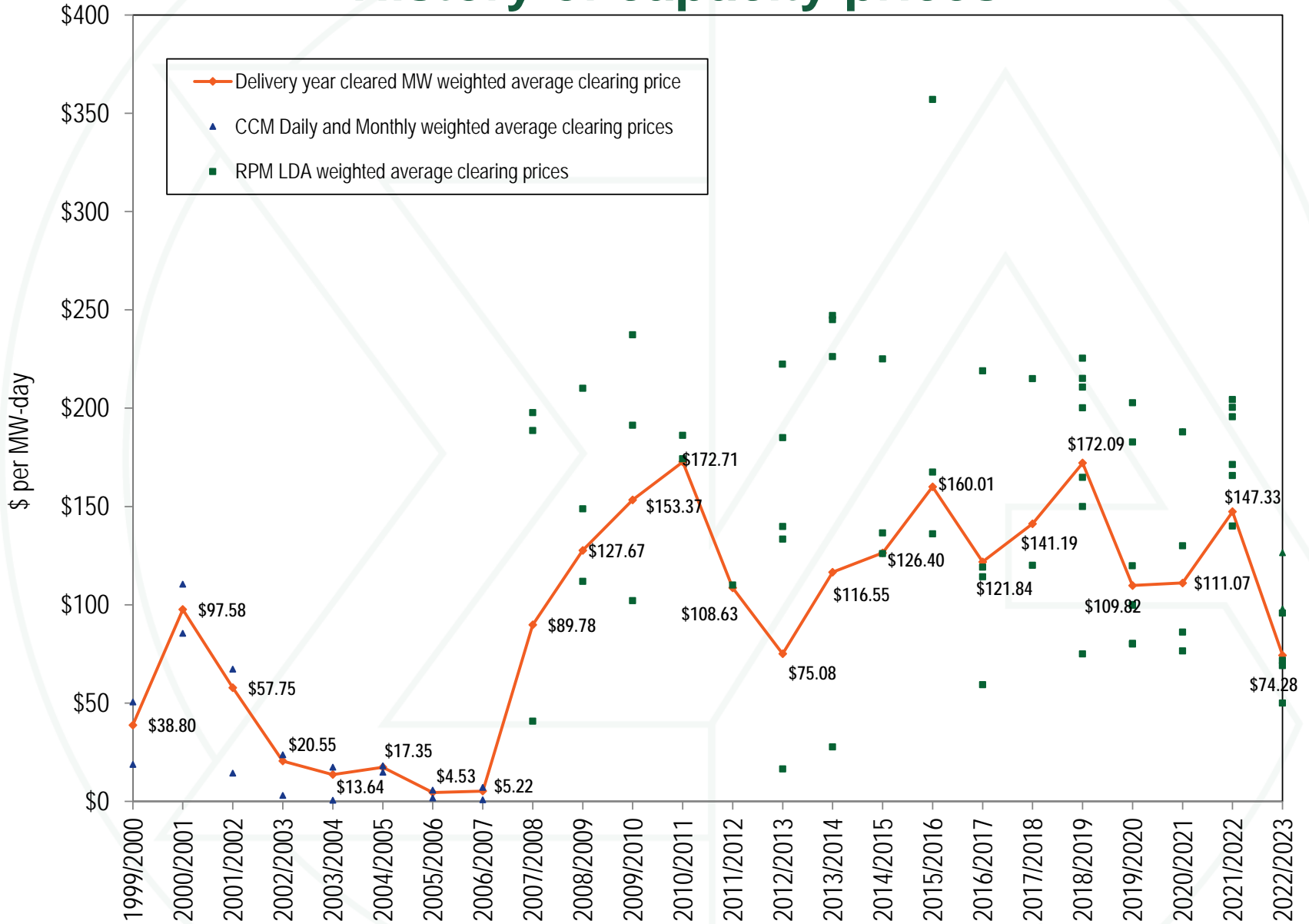
VRR curve impacts: 2022/2023 Delivery Year



Installed capacity by fuel source

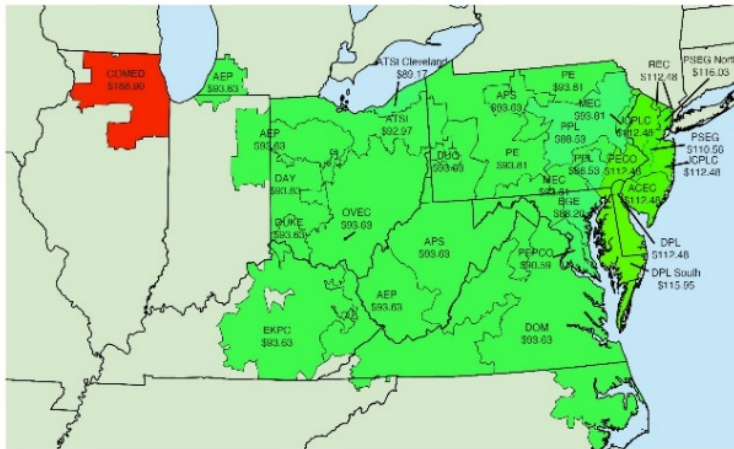


History of capacity prices

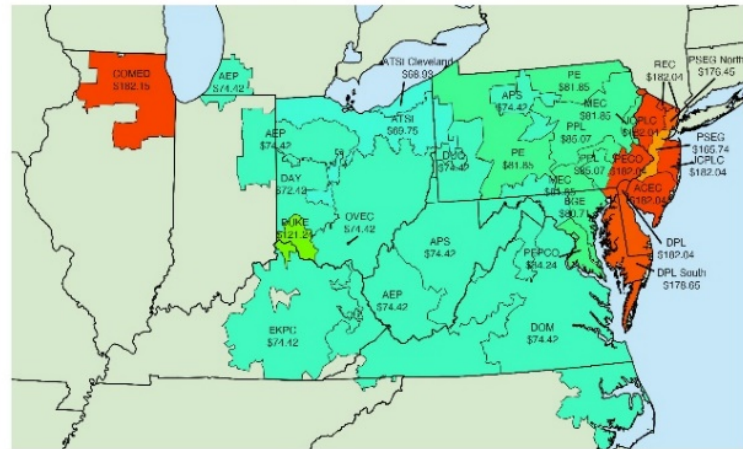


Map of RPM capacity prices

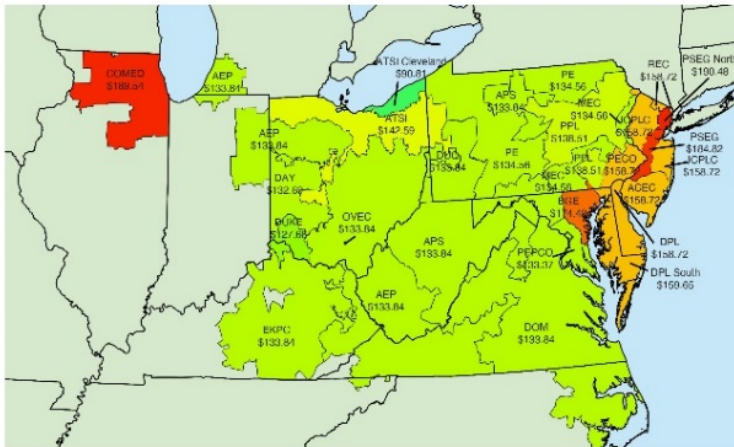
2019/2020



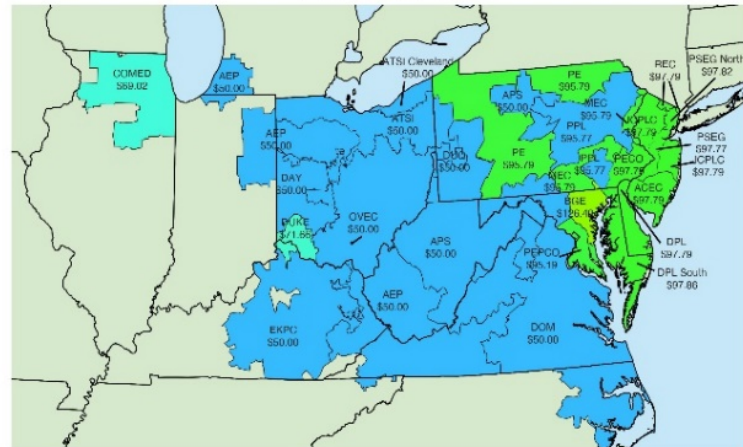
2020/2021



2021/2022



2022/2023



RPM reserve margin

	01-Jun-18	01-Jun-19	01-Jun-20	01-Jun-21	01-Jun-22	
Forecast peak load ICAP (MW)	152,407.9	151,643.5	148,355.3	149,482.9	150,229.0	A
FRR peak load ICAP (MW)	12,732.9	12,284.2	11,488.3	11,717.7	28,535.5	B
PRD ICAP (MW)	0.0	0.0	558.0	510.0	230.0	C
Installed reserve margin (IRM)	16.1%	16.0%	15.5%	14.7%	14.5%	D
Pool wide average EFORD	6.07%	6.08%	5.78%	5.22%	5.08%	E
Forecast pool requirement (FPR)	1.0905	1.0895	1.0882	1.0871	1.0868	$F=(1+D)*(1-E)$
RPM committed less deficiency UCAP (MW) (generation and DR)	161,242.6	162,276.1	159,560.4	156,633.6	139,666.7	G
RPM committed less deficiency ICAP (MW) (generation and DR)	171,662.5	172,781.2	169,348.8	165,260.2	147,141.5	$H=G/(1-E)$
RPM peak load ICAP (MW)	139,675.0	139,359.3	136,309.0	137,255.2	121,463.5	$J=A-B-C$
Reserve margin ICAP (MW)	31,987.5	33,421.9	33,039.8	28,005.0	25,678.0	$K=H-J$
Reserve margin (%)	22.9%	24.0%	24.2%	20.4%	21.1%	$L=K/J$
Reserve margin in excess of IRM ICAP (MW)	9,499.8	11,124.4	11,911.9	7,828.5	8,065.8	$M=K-D*J$
Reserve margin in excess of IRM (%)	6.8%	8.0%	8.7%	5.7%	6.6%	$N=M/J$
RPM peak load UCAP (MW)	131,196.7	130,886.3	128,430.3	130,090.5	115,293.2	$P=J*(1-E)$
RPM reliability requirement UCAP (MW)	152,315.6	151,832.0	148,331.5	149,210.1	132,006.5	$Q=J*F$
Reserve margin UCAP (MW)	30,045.9	31,389.8	31,130.1	26,543.1	24,373.5	$R=G-P$
Reserve cleared in excess of IRM UCAP (MW)	8,927.0	10,444.1	11,228.9	7,423.5	7,660.2	$S=G-Q$
Projected replacement capacity UCAP (MW)	0.0	0.0	0.0	0.0	0.0	T
Projected reserve margin	22.9%	24.0%	24.2%	20.4%	21.1%	$U=(H-T)/(1-E))/J-1$



Reserve margin

- **Total reserves: 24,373.5 MW**
- **Excess reserves: 7,660.2**
- **Cleared DR: 8,710.3 MW**
 - **> Excess reserves**
- **Cleared capacity with no must offer requirement: 8,113.0 MW**
 - **> Excess reserves**
- **Sum of DR and no must offer: 16,823.3 MW**
 - **> Required reserves**
 - **69.0 percent of total reserves**

Effective capacity in interconnection queues

Unit Type	MW in Queue	Completion Rate Adjusted MW in Queue	Completion Rate and Derate Adjusted MW in Queue
Battery	38,301.5	1,460.5	1,460.5
CC	18,707.9	11,128.3	11,128.3
CT - Natural Gas	5,828.3	4,025.0	4,025.0
CT - Oil	17.0	13.2	13.2
CT - Other	396.6	33.3	33.3
Fuel Cell	8.0	2.5	2.5
Hydro - Pumped Storage	730.0	707.2	707.2
Hydro - Run of River	124.9	56.8	56.8
Nuclear	189.5	73.8	73.8
RICE - Natural Gas	14.4	3.7	3.7
RICE - Oil	0.0	0.0	0.0
RICE - Other	0.0	0.0	0.0
Solar	118,957.0	16,424.1	7,670.1
Solar + Storage	31,628.6	618.6	288.9
Solar + Wind	209.0	0.0	0.0
Steam - Coal	76.0	25.9	25.9
Steam - Natural Gas	11.0	10.0	10.0
Steam - Oil	0.0	0.0	0.0
Steam - Other	20.0	5.4	5.4
Wind	39,588.7	6,485.9	1,050.7
Wind + Storage	106.3	0.0	0.0
Total	254,914.6	41,074.4	26,555.3

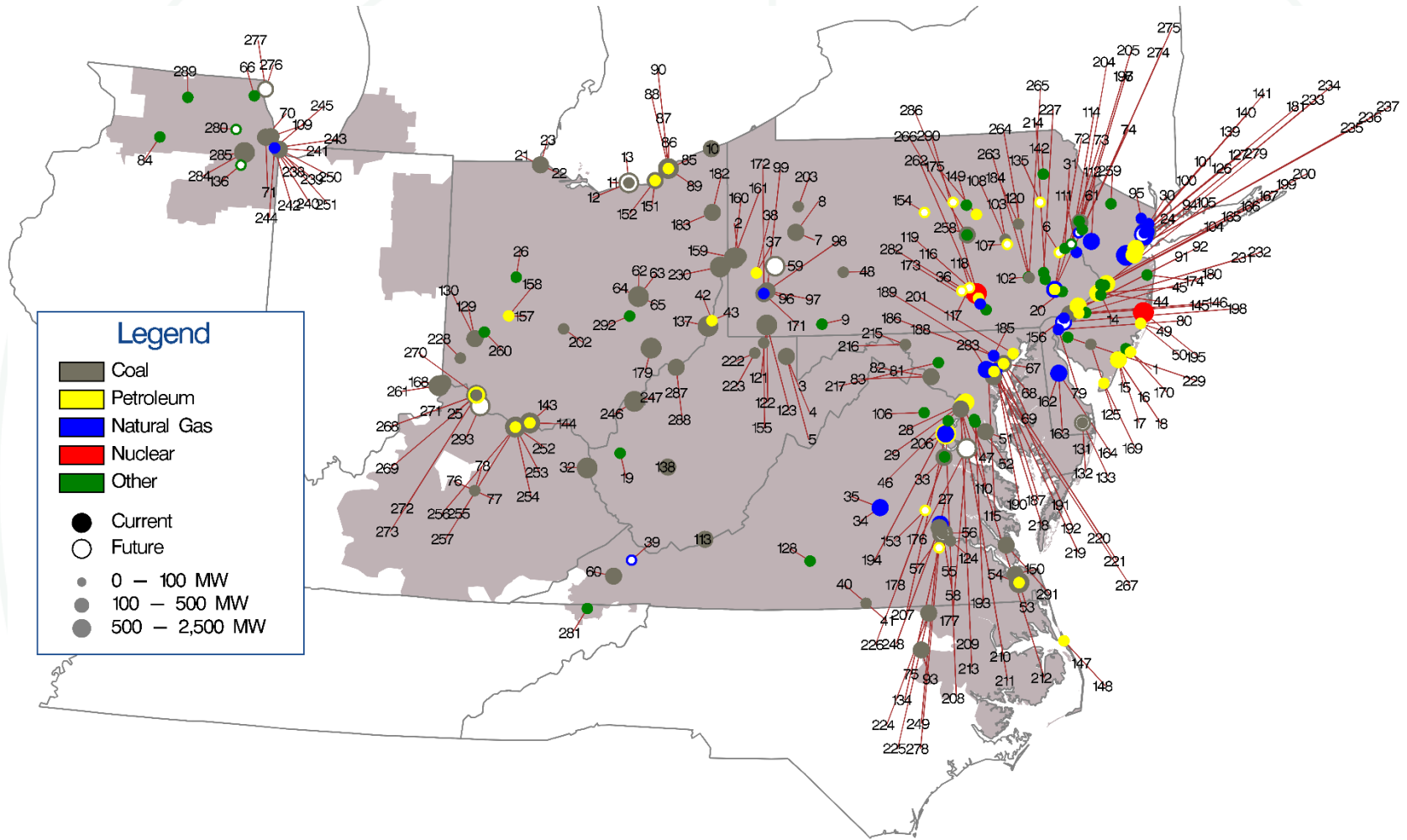
Proportion of units recovering avoidable costs

Technology	Units with full recovery from energy and ancillary net revenue											Units with full recovery from all markets										
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
CC - Combined Cycle	55%	46%	50%	72%	59%	63%	57%	66%	64%	67%	50%	85%	79%	79%	95%	88%	93%	89%	98%	90%	93%	83%
CT - Aero Derivative	15%	6%	6%	53%	15%	8%	10%	30%	46%	42%	2%	100%	96%	76%	98%	100%	99%	100%	99%	96%	96%	89%
CT - Industrial Frame	26%	23%	17%	38%	13%	8%	3%	21%	30%	21%	2%	99%	98%	83%	100%	100%	100%	100%	96%	92%	86%	84%
Coal Fired	31%	17%	27%	78%	16%	15%	12%	11%	2%	2%	22%	82%	36%	54%	83%	64%	40%	36%	63%	31%	5%	66%
Diesel	48%	42%	37%	69%	56%	33%	32%	39%	11%	37%	25%	100%	100%	77%	100%	100%	100%	100%	97%	91%	89%	83%
Hydro	74%	61%	95%	97%	81%	79%	95%	94%	90%	72%	95%	81%	77%	97%	98%	100%	100%	97%	98%	100%	74%	95%
Nuclear	-	-	50%	94%	17%	6%	17%	53%	0%	0%	88%	-	-	61%	100%	56%	17%	50%	88%	81%	0%	100%
Oil or Gas Steam	8%	6%	11%	15%	3%	0%	0%	10%	73%	6%	10%	92%	78%	86%	85%	91%	88%	81%	76%	66%	34%	67%
Pumped Storage	100%	100%	95%	100%	100%	100%	100%	100%	100%	100%	29%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Solar	-	95%	97%	99%	97%	95%	95%	98%	96%	95%	100%	-	95%	97%	99%	97%	95%	95%	98%	96%	95%	100%
Wind	88%	85%	96%	93%	92%	89%	93%	91%	88%	79%	94%	88%	85%	96%	93%	92%	89%	93%	91%	89%	79%	95%

New entrant CC net revenue and total cost by LDA



Map of unit retirements: 2011 through 2024



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