Unpacking the IRA: Data from PJM Markets

HEPG

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PJM Independent Market Monitor

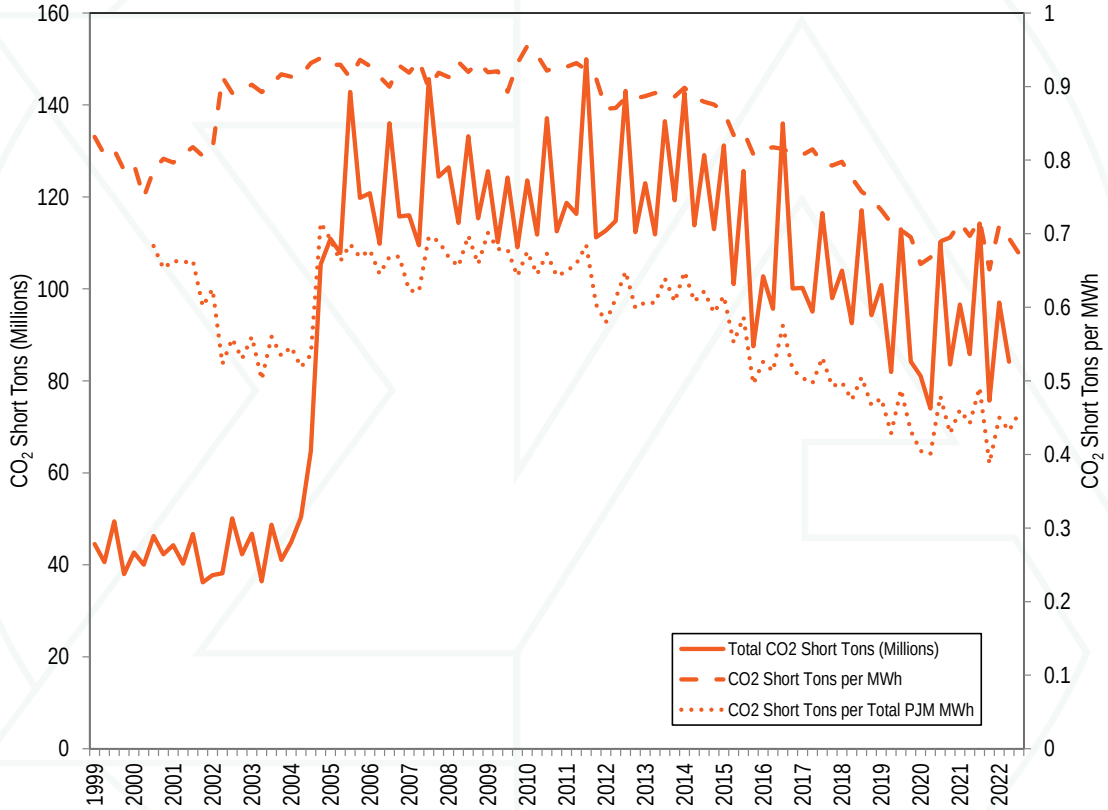
Monitoring Analytics

Incremental impact of IRA

- Current trends in emissions
  - CO_2, NO_X, SO_X
  - Coal output
  - Wind/solar output
- Displacement of existing incentives/subsidies?
  - State specific RECS for renewables
  - Federal subsidies
  - State specific subsidies for nuclear
  - Federal subsidies
- Impact on average and marginal emissions
  - Definition of marginal emissions

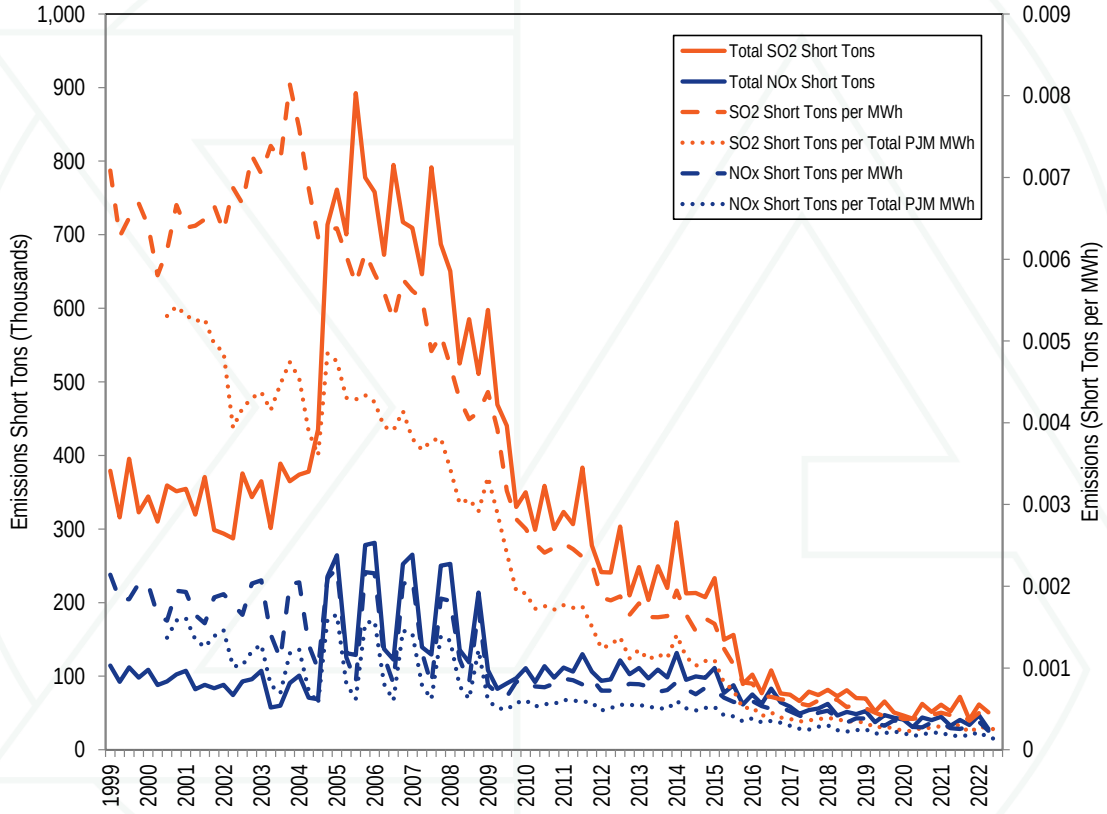
Emission Trends

CO_2 emissions by quarter by PJM units



Monitoring Analytics

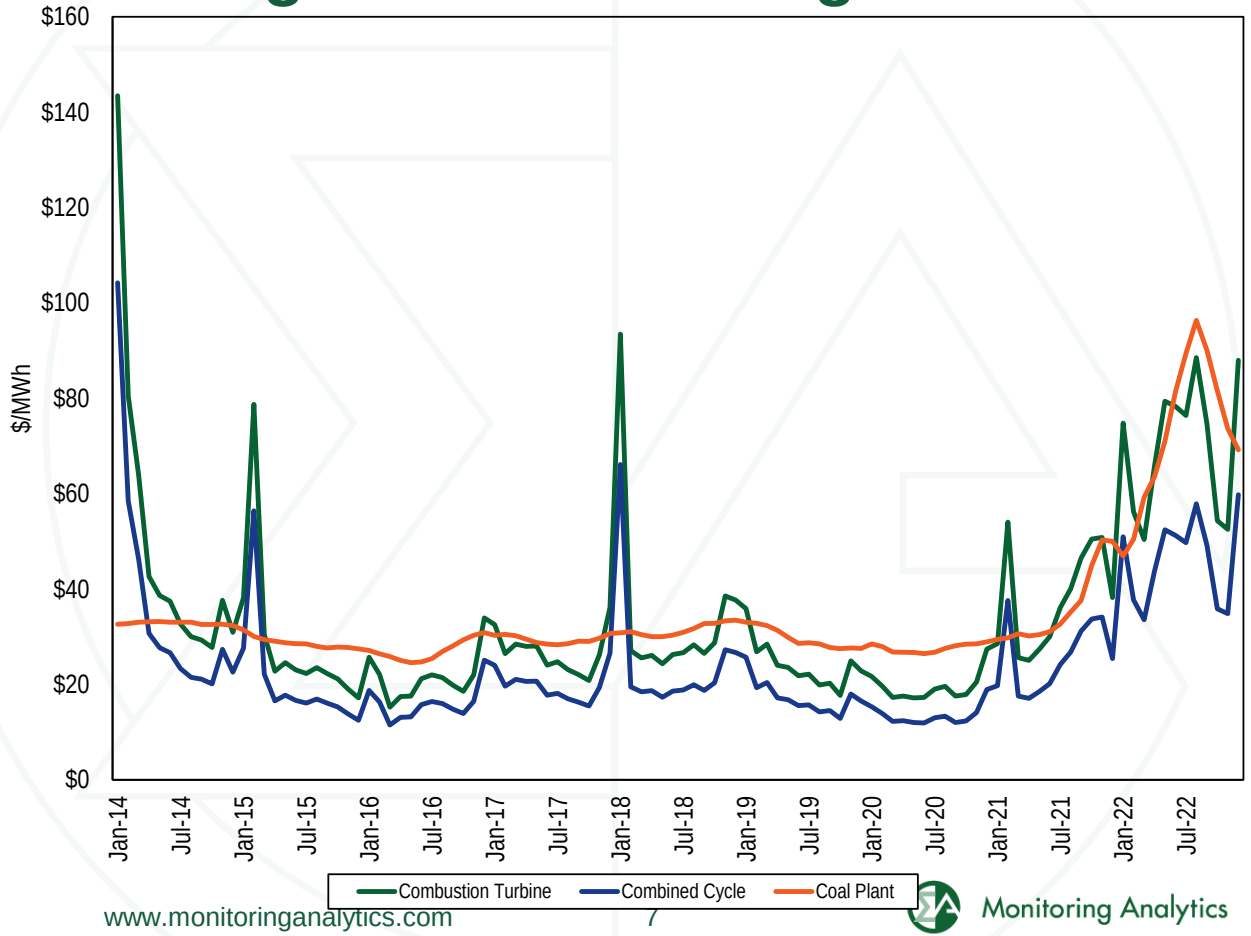
SO_2 and NO_X emissions by quarter by PJM units



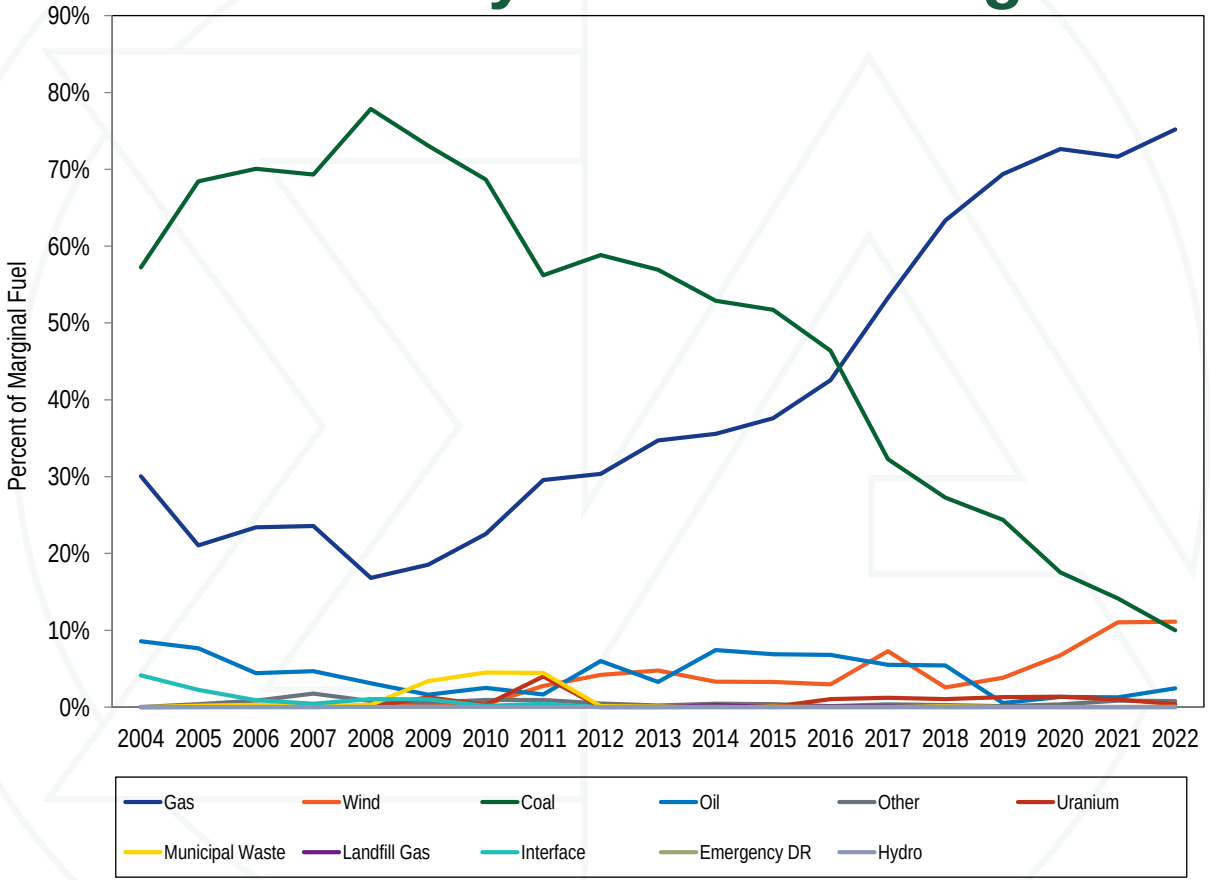
Factors Affecting Emission Trends

- **Change in resource mix**
  - **Long term generation economics**
  - **Unit retirements**
- **State and federal environmental regulations**

Average short run marginal costs



Type of fuel used by real-time marginal units



Share of generation by fuel source

	Natural Gas	Coal	Nuclear	Other Fuel Type
2008	7.4%	54.9%	34.7%	3.0%
2009	10.0%	50.3%	35.9%	3.7%
2010	11.7%	49.3%	34.6%	4.4%
2011	14.1%	47.1%	34.5%	4.3%
2012	18.8%	42.1%	34.6%	4.5%
2013	16.7%	44.2%	34.8%	4.3%
2014	17.8%	43.3%	34.4%	4.5%
2015	23.0%	36.2%	35.5%	5.3%
2016	26.5%	33.9%	34.4%	5.3%
2017	26.8%	31.8%	35.6%	5.9%
2018	30.6%	28.6%	34.2%	6.6%
2019	36.2%	23.8%	33.6%	6.4%
2020	39.6%	19.3%	34.2%	6.9%
2021	37.7%	22.2%	32.8%	7.4%
2022	39.8%	20.0%	32.3%	7.9%

Generation by fuel source

	2021		2022		Change in Output
	GWh	Percent	GWh	Percent	
Coal	184,412.3	22.2%	167,650.0	20.0%	(9.1%)
Bituminous	163,753.6	19.7%	144,880.5	17.2%	(11.5%)
Sub Bituminous	14,421.7	1.7%	16,210.5	1.9%	12.4%
Other Coal	6,237.0	0.7%	6,558.9	0.8%	5.2%
Nuclear	272,670.4	32.8%	271,522.1	32.3%	(0.4%)
Gas	314,885.1	37.9%	335,974.2	40.0%	6.7%
Natural Gas CC	289,136.6	34.8%	309,420.5	36.8%	7.0%
Natural Gas CT	19,894.4	2.4%	18,581.9	2.2%	(6.6%)
Natural Gas Other Units	4,132.1	0.5%	6,501.5	0.8%	57.3%
Other Gas	1,722.0	0.2%	1,470.4	0.2%	(14.6%)
Hydroelectric	16,624.8	2.0%	15,995.8	1.9%	(3.8%)
Pumped Storage	5,037.3	0.6%	6,092.9	0.7%	21.0%
Run of River	10,278.6	1.2%	7,945.5	0.9%	(22.7%)
Other Hydro	1,308.9	0.2%	1,957.4	0.2%	49.6%
Wind	27,651.4	3.3%	31,491.0	3.7%	13.9%
Waste	4,475.9	0.5%	4,056.0	0.5%	(9.4%)
Oil	2,290.7	0.3%	2,698.9	0.3%	17.8%
Heavy Oil	65.6	0.0%	76.4	0.0%	16.4%
Light Oil	524.4	0.1%	878.9	0.1%	67.6%
Diesel	27.7	0.0%	163.1	0.0%	489.3%
Other Oil	1,673.1	0.2%	1,580.5	0.2%	(5.5%)
Solar	7,412.2	0.9%	9,243.0	1.1%	24.7%
Battery	36.5	0.0%	25.4	0.0%	(30.2%)
Biofuel	1,191.7	0.1%	1,371.1	0.2%	15.1%
Total	831,650.8	100.0%	840,027.6	100.0%	1.0%

Capacity factor by unit type

Unit Type	2021 Generation (GWh)	2021 Capacity Factor	2022 Generation (GWh)	2022 Capacity Factor	Change in 2022 from 2021
Battery	36.5	1.3%	25.4	1.0%	(0.3%)
Combined Cycle	285,458.6	61.3%	304,041.0	62.4%	1.2%
Single Fuel	251,731.8	68.3%	263,740.3	68.8%	0.5%
Dual Fuel	33,726.8	34.6%	40,300.7	38.9%	4.3%
Combustion Turbine	20,320.5	7.9%	19,348.7	7.6%	(0.3%)
Single Fuel	14,906.4	8.3%	13,115.6	7.4%	(0.9%)
Dual Fuel	5,414.1	7.1%	6,233.1	8.2%	1.1%
Diesel	311.7	8.9%	431.3	12.0%	3.1%
Single Fuel	292.6	9.3%	390.2	12.1%	2.8%
Dual Fuel	19.1	5.3%	41.1	11.3%	6.1%
Diesel (Landfill gas)	1,450.6	53.4%	1,218.8	48.3%	(5.1%)
Fuel Cell	220.8	88.9%	208.7	84.0%	(4.9%)
Nuclear	272,670.4	95.0%	271,522.1	94.6%	(0.4%)
Pumped Storage Hydro	6,091.8	11.9%	7,797.7	16.0%	4.1%
Run of River Hydro	10,533.0	40.6%	8,198.1	31.6%	(9.0%)
Solar	7,335.0	19.6%	9,179.4	20.7%	1.0%
Steam	189,979.9	36.9%	175,556.0	36.2%	(0.7%)
Biomass	5,770.9	69.5%	5,515.6	67.3%	(2.1%)
Coal	178,271.0	42.6%	163,133.8	41.8%	(0.7%)
Single Fuel	173,418.5	43.7%	160,815.4	42.0%	(1.7%)
Dual Fuel	4,852.5	22.1%	2,318.4	32.6%	10.5%
Natural Gas	4,898.1	40.7%	5,942.5	42.0%	1.3%
Single Fuel	523.0	51.2%	521.2	51.6%	0.4%
Dual Fuel	4,375.1	18.0%	5,421.3	21.1%	3.0%
Oil	1,039.9	3.4%	964.1	4.3%	0.9%
Wind	27,650.7	28.4%	31,491.0	31.5%	3.1%
Total	822,059.3	47.1%	829,018.3	47.6%	0.5%

Retirements and expected retirements

	MW Retired													MW at Risk
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2011-2022	2023-2030
Coal	543	5,908	2,590	2,239	7,065	243	2,038	3,167	4,111	2,132	1,020	5,385	36,440	27,610
Natural Gas	523	250	82	294	1,319	74	34	1,441	447	233	220	340	5,256	19,541
Other	131	804	187	437	879	83	41	935	899	891	70	440	5,797	4,606
Total MW	1,197	6,962	2,859	2,970	9,263	400	2,113	5,543	5,456	3,255	1,310	6,164	47,492	51,757

Units expected to retire and at risk of retirement

	MW expected to retire								Total MW
	2023	2024	2025	2026	2027	2028	2029	2030	2023-2030
MW requested deactivation									
Coal	3,774	0	0	410	0	0	0	0	4,184
Natural Gas	1,459	132	0	0	0	0	0	0	1,590
Other	853	0	0	0	0	0	0	0	853
Total MW requested deactivation	6,086	132	0	410	0	0	0	0	6,628
MW expected to retire for regulatory reasons									
Coal	2,557	2,863	2,766	1,359	652	3,605	0	180	13,982
Natural Gas	320	318	0	1,027	2,375	0	0	4,900	8,940
Other	0	554	0	33	0	0	0	0	587
Total MW expected to retire for regulatory reasons	2,877	3,736	2,766	2,419	3,027	3,605	0	5,080	23,509
Additional MW uneconomic 2023-2025									
Coal									9,444
Natural Gas									9,011
Other									3,166
Total MW uneconomic									21,621
Total									
Coal	6,331	2,863	2,766	1,769	652	3,605	0	180	27,610
Natural Gas	1,779	450	0	1,027	2,375	0	0	4,900	19,541
Other	853	554	0	33	0	0	0	0	4,606
Total MW At Risk of Retirement	8,963	3,867	2,766	2,829	3,027	3,605	0	5,080	51,757

Existing Subsidies/Emissions Pricing

Estimated impact of carbon prices on LMP

		2021			2022		
Scenario	Carbon Price ($/Metric Ton)	Actual LMP ($/MWh)	Estimated LMP ($/MWh)	Percent Change	Actual LMP ($/MWh)	Estimated LMP ($/MWh)	Percent Change
Scenario 1	$5.00	$39.78	$39.70	(0.2%)	$80.14	$79.04	(1.4%)
Scenario 2	$10.00	$39.78	$41.42	4.1%	$80.14	$79.68	(0.6%)
Scenario 3	$15.00	$39.78	$43.15	8.4%	$80.14	$80.33	0.2%
Scenario 4	$25.00	$39.78	$46.59	17.1%	$80.14	$81.62	1.8%
Scenario 5	$50.00	$39.78	$55.20	38.8%	$80.14	$84.86	5.9%

Components of RT load-weighted average LMP

Element	2021 Contribution to LMP	2021 Percent	2022 Contribution to LMP	2022 Percent	Change in Percent
Gas	$21.43	53.9%	$41.42	51.7%	(2.2%)
Positive Markup	$3.68	9.2%	$7.29	9.1%	(0.2%)
Coal	$4.11	10.3%	$5.66	7.1%	(3.3%)
Scarcity	$0.22	0.6%	$5.05	6.3%	5.7%
Ten Percent Adder	$2.54	6.4%	$4.70	5.9%	(0.5%)
Transmission Constraint Penalty Factor	$3.31	8.3%	$4.63	5.8%	(2.6%)
Market-to-Market	$0.41	1.0%	$2.48	3.1%	2.1%
Variable Maintenance	$1.36	3.4%	$2.40	3.0%	(0.4%)
NO_x Cost	$0.19	0.5%	$2.17	2.7%	2.2%
Emergency Demand Response	$0.00	0.0%	$1.75	2.2%	2.2%
CO_2 Cost	$1.08	2.7%	$1.74	2.2%	(0.5%)
Opportunity Cost Adder	$0.16	0.4%	$1.58	2.0%	1.6%
Ancillary Service Redispatch Cost	$0.35	0.9%	$1.45	1.8%	0.9%
Oil	$0.25	0.6%	$1.42	1.8%	1.2%
Variable Operations	$0.84	2.1%	$0.94	1.2%	(0.9%)
LPA Rounding Difference	$0.18	0.5%	$0.64	0.8%	0.3%
Increase Generation Differential	$0.13	0.3%	$0.35	0.4%	0.1%
NA	$1.51	3.8%	$0.25	0.3%	(3.5%)
Other	$0.01	0.0%	$0.02	0.0%	0.0%
Landfill Gas	$0.00	0.0%	$0.02	0.0%	0.0%
SO_2 Cost	$0.00	0.0%	$0.00	0.0%	(0.0%)
LPA-SCED Differential	$0.07	0.2%	($0.03)	(0.0%)	(0.2%)
Decrease Generation Differential	($0.03)	(0.1%)	($0.04)	(0.1%)	0.0%
Renewable Energy Credits	($0.03)	(0.1%)	($0.39)	(0.5%)	(0.4%)
PJM Administrative Cap	$0.00	0.0%	($1.39)	(1.7%)	(1.7%)
Negative Markup	($1.99)	(5.0%)	($3.96)	(4.9%)	0.1%
Total	$39.78	100.0%	$80.14	100.0%	0.0%

Renewable and alternative energy standards of PJM jurisdictions: 2021 to 2030

Jurisdiction with RPS	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Delaware	21.00%	22.00%	23.00%	24.00%	25.00%	25.50%	26.00%	26.50%	27.00%	28.00%
Illinois	19.00%	20.50%	22.00%	23.50%	25.00%	28.00%	31.00%	34.00%	37.00%	40.00%
Maryland	33.30%	32.60%	34.40%	36.20%	38.00%	40.50%	44.00%	45.50%	50.00%	52.50%
Michigan	15.00%	15.00%	15.00%	15.00%	15.00%	15.00%	15.00%	15.00%	15.00%	15.00%
New Jersey	23.50%	24.50%	29.50%	37.50%	40.50%	43.50%	46.50%	49.50%	52.50%	52.50%
North Carolina	12.50%	12.50%	12.50%	12.50%	12.50%	12.50%	12.50%	12.50%	12.50%	12.50%
Ohio	6.00%	6.50%	7.00%	7.50%	8.00%	8.50%	0.00%	0.00%	0.00%	0.00%
Pennsylvania	18.00%	18.00%	18.00%	18.00%	18.00%	18.00%	18.00%	18.00%	18.00%	18.00%
Virginia (Phase I utilities)	6.00%	7.00%	8.00%	10.00%	14.00%	17.00%	20.00%	24.00%	27.00%	30.00%
Virginia (Phase II utilities)	14.00%	17.00%	20.00%	23.00%	26.00%	29.00%	32.00%	35.00%	38.00%	41.00%
Washington, D.C.	26.25%	32.50%	38.75%	45.00%	52.00%	59.00%	66.00%	73.00%	80.00%	87.00%
Jurisdiction with Voluntary Standard										
Indiana	7.00%	7.00%	7.00%	7.00%	10.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Jurisdiction with No Standard										
Kentucky	No Renewable Portfolio Standard									
Tennessee	No Renewable Portfolio Standard									
West Virginia	No Renewable Portfolio Standard									

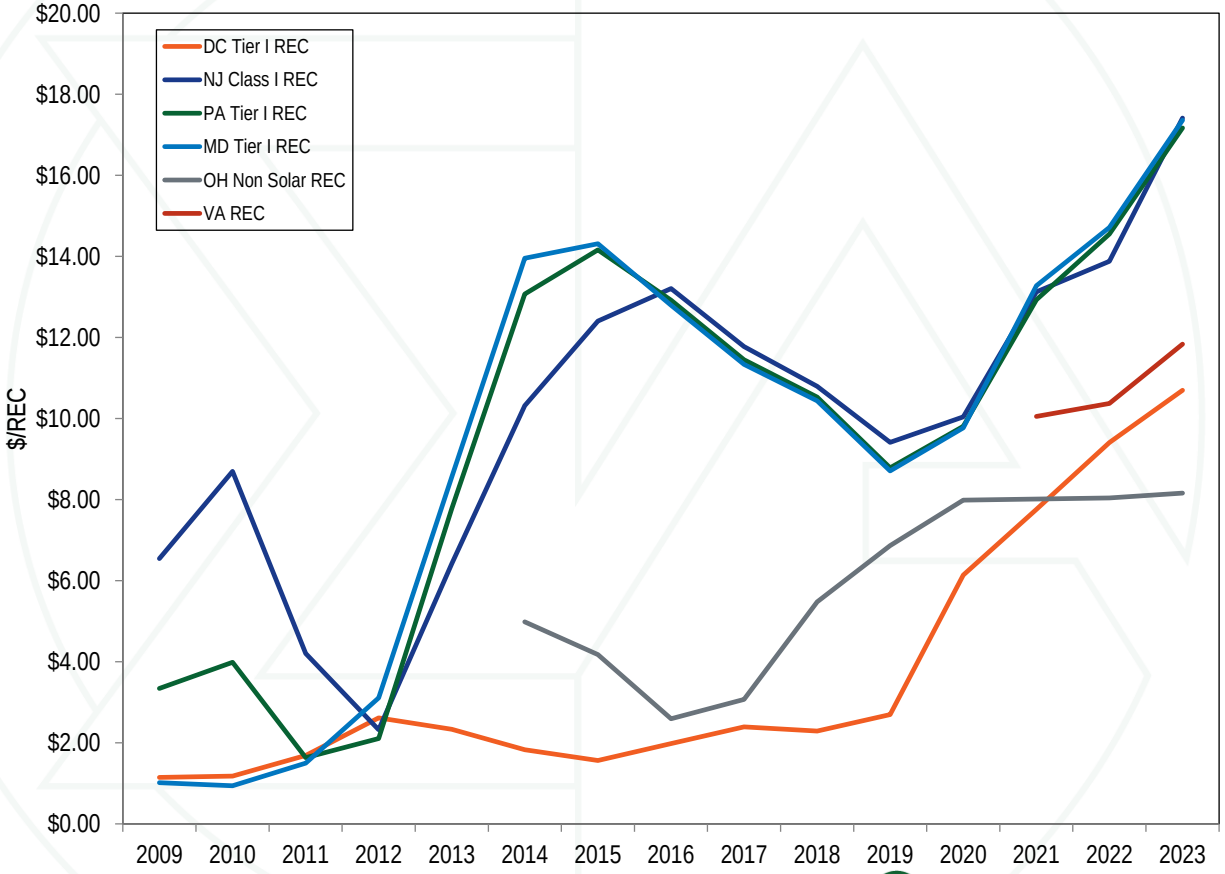
Sources of Tier I equivalent RPS

Year	REC Type	Carbon Free REC		Carbon Producing REC	
		In State	Import	In State	Import
2016	DE New Eligible	1.0%	99.0%	0.0%	0.0%
	DC Tier I	0.0%	40.5%	0.0%	59.5%
	OH Renewable Energy Source	12.3%	52.8%	8.7%	26.2%
	IL Renewable	27.1%	30.3%	0.1%	42.5%
	MD Tier I	0.8%	51.7%	12.5%	35.0%
	NJ Class I	0.0%	82.5%	4.5%	13.0%
	PA Tier I	15.1%	40.2%	11.1%	33.7%
2017	DE New Eligible	0.7%	99.3%	0.0%	0.0%
	DC Tier I	0.0%	77.2%	0.0%	22.8%
	OH Renewable Energy Source	15.6%	45.8%	8.1%	30.6%
	IL Renewable	22.5%	62.3%	0.0%	15.2%
	MD Tier I	6.5%	48.9%	10.7%	34.0%
	NJ Class I	0.1%	83.2%	3.9%	12.8%
	PA Tier I	19.6%	38.9%	9.4%	32.0%
2018	DE New Eligible	0.4%	99.6%	0.0%	0.0%
	DC Tier I	0.0%	76.5%	4.5%	19.0%
	OH Renewable Energy Source	15.4%	57.4%	8.3%	18.9%
	IL Renewable	26.1%	51.0%	0.0%	22.9%
	MD Tier I	1.9%	60.1%	9.6%	28.5%
	NJ Class I	0.0%	86.7%	2.3%	11.0%
	PA Tier I	18.7%	48.9%	10.9%	21.4%
2019	DE New Eligible	0.3%	99.7%	0.0%	0.0%
	DC Tier I	0.0%	81.5%	2.8%	15.7%
	OH Renewable Energy Source	14.7%	53.0%	7.3%	25.0%
	IL Renewable	70.5%	29.5%	0.0%	0.0%
	MD Tier I	0.7%	53.2%	8.4%	37.8%
	NJ Class I	0.1%	92.7%	2.8%	4.4%
	PA Tier I	17.0%	54.2%	7.2%	21.7%
2020	DE New Eligible	0.9%	99.1%	0.0%	0.0%
	DC Tier I	0.0%	80.1%	3.3%	16.6%
	OH Renewable Energy Source	10.5%	63.5%	5.5%	20.5%
	IL Renewable	78.3%	21.7%	0.0%	0.0%
	MD Tier I	4.1%	61.1%	5.3%	29.6%
	NJ Class I	0.1%	90.6%	4.0%	5.3%
	PA Tier I	13.9%	55.1%	6.2%	24.8%
2021	DE New Eligible	0.3%	99.0%	0.7%	0.0%
	DC Tier I	0.0%	72.9%	7.4%	19.7%
	OH Renewable Energy Source	9.6%	65.3%	4.4%	20.6%
	IL Renewable	81.0%	19.0%	0.0%	0.0%
	MD Tier I	1.0%	66.7%	6.1%	26.1%
	NJ Class I	0.1%	92.3%	2.0%	5.5%
	PA Tier I	14.4%	62.0%	4.6%	19.1%
	VA Renewable	10.1%	70.6%	9.7%	9.6%

RPS Requirements and Generation by RPS Eligible Resources: 2022

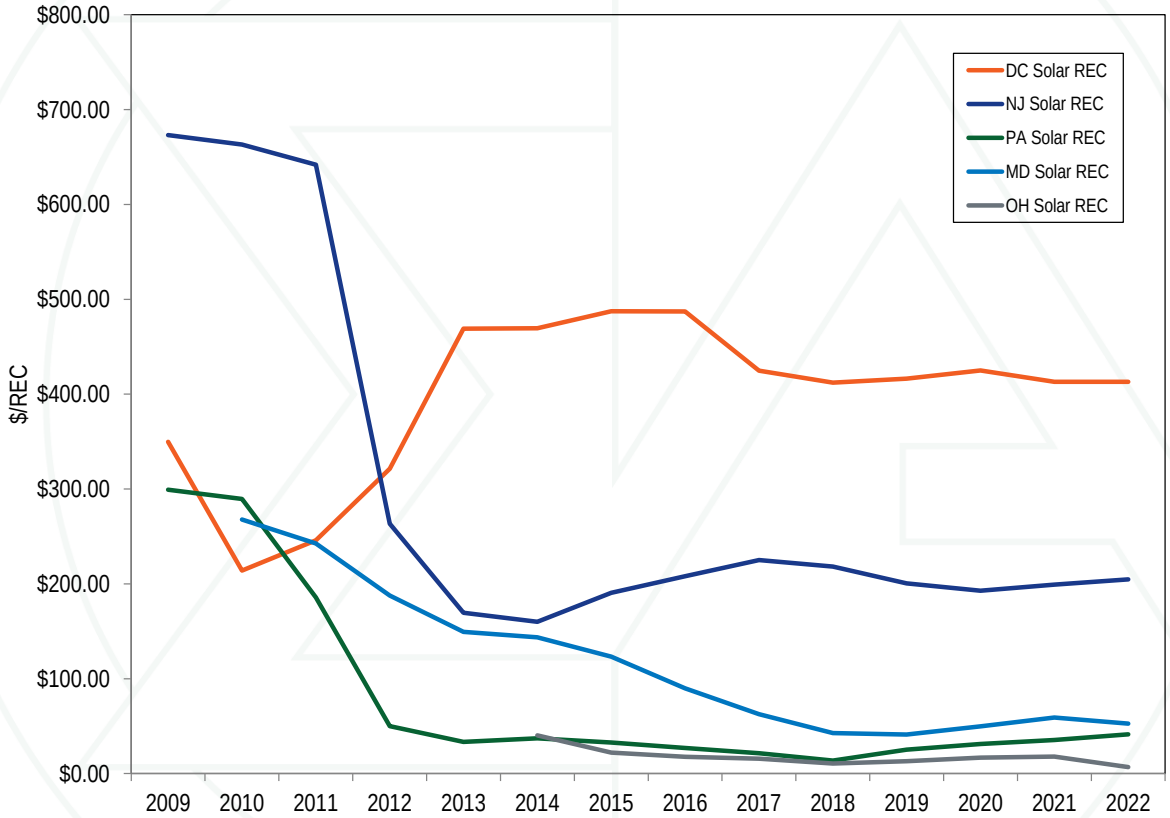
	Tier I			Tier II		
Jurisdiction	PJM Generation (GWh)	RPS Requirement (GWh)	Generation as Percent of RPS Requirement	PJM Generation (GWh)	RPS Requirement (GWh)	Generation as Percent of RPS Requirement
Delaware	45.2	2,673.3	1.7%	0.0	0.0	
Illinois	15,237.4	18,403.4	82.8%	0.0	0.0	
Indiana	7,204.8	0.0		0.0	0.0	
Kentucky	395.3	0.0		0.0	0.0	
Maryland	1,277.7	18,915.6	6.8%	542.6	1,571.1	34.5%
Michigan	121.1	676.3	17.9%	0.0	0.0	
New Jersey	1,050.8	16,465.5	6.4%	1,596.1	1,903.7	83.8%
North Carolina	3,055.6	561.3	544.3%	0.0	0.0	
Ohio	5,021.4	10,005.7	50.2%	0.3	0.0	
Pennsylvania	8,327.0	12,066.7	69.0%	9,784.3	15,083.4	64.9%
Tennessee	0.0	0.0		0.0	0.0	
Virginia	6,789.4	19,513.0	34.8%	5,862.5	0.0	
Washington, D.C.	0.0	2,936.8	0.0%	0.0	0.0	
West Virginia	2,767.9	0.0		605.0	0.0	
Total	51,293.6	102,217.7	50.2%	18,390.8	18,558.2	99.1%

Average Tier I REC price by jurisdiction



Monitoring Analytics

Average SREC price by jurisdiction



Monitoring Analytics

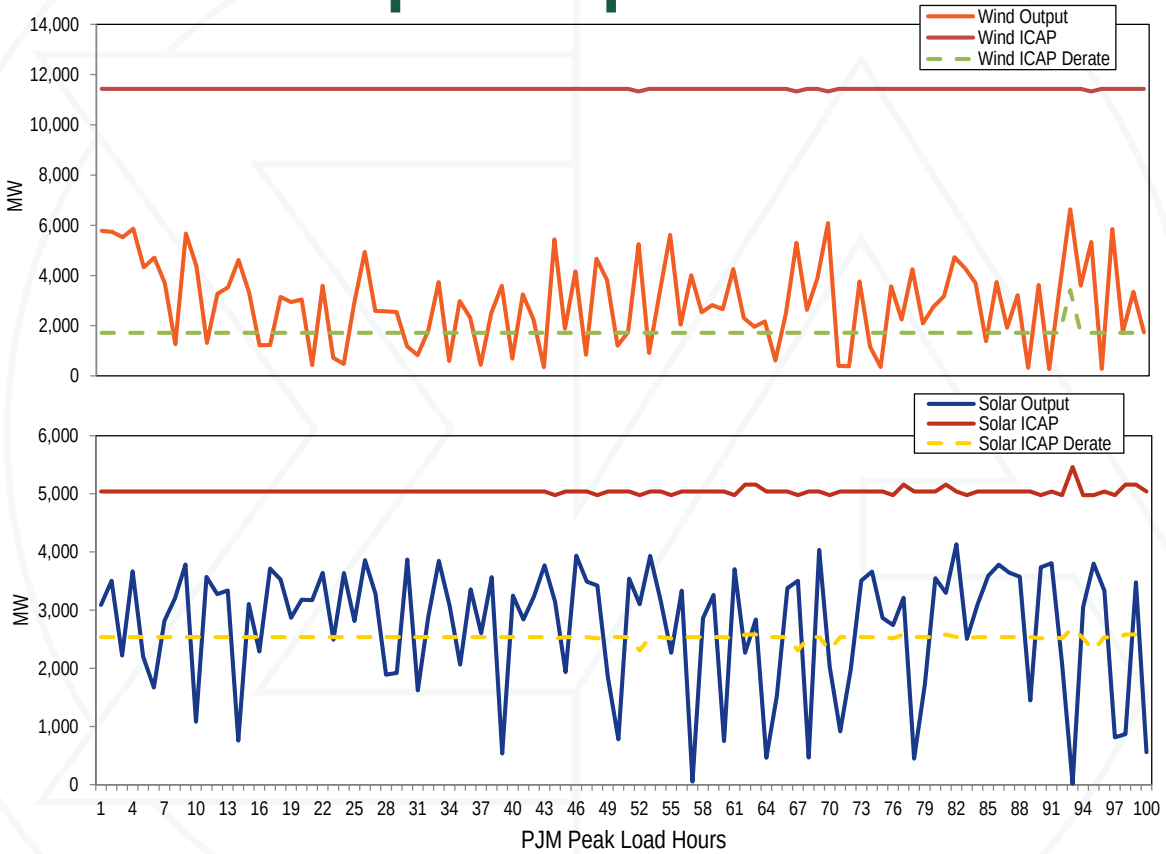
Implied carbon price from REC and SREC prices

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Jurisdiction with Tier I or Class I REC	Carbon Price ($ per tonne) Implied by REC Prices													
Delaware					$34.26	$35.28	$32.01	$33.01	$10.29	$11.60	$16.10	$19.94		
Maryland	$2.08	$1.93	$3.07	$6.36	$17.51	$28.54	$29.27	$26.17	$23.19	$21.35	$17.81	$19.98	$25.44	$28.18
New Jersey	$13.38	$17.79	$8.60	$4.75	$13.13	$21.10	$25.37	$27.01	$24.08	$22.08	$19.25	$20.54	$25.17	$26.65
Ohio						$10.19	$8.54	$5.30	$6.29	$11.21	$14.04	$16.33	$16.85	$16.87
Pennsylvania	$6.84	$8.16	$3.34	$4.31	$15.92	$26.74	$28.96	$26.43	$23.42	$21.53	$17.96	$20.06	$24.78	$27.85
Virginia													$18.77	$19.38
Washington, D.C.							$3.20	$4.05	$4.90	$4.69	$5.52	$11.90	$15.25	$18.55
Jurisdiction with Solar REC	Carbon Price ($ per tonne) Implied by Solar REC Prices													
Delaware						$117.60	$85.66	$86.75	$35.80	$17.38				
Maryland		$547.76	$496.04	$383.73	$305.46	$293.59	$251.99	$183.64	$128.05	$87.27	$84.19	$101.68	$120.84	$107.78
New Jersey	$1,376.52	$1,356.24	$1,312.96	$538.70	$346.98	$327.20	$389.91	$425.49	$460.60	$446.35	$410.31	$394.18	$407.57	$418.73
Ohio						$82.56	$45.25	$36.26	$31.92	$21.73	$26.65			
Pennsylvania	$611.89	$592.36	$379.82	$102.11	$68.55	$76.13	$67.09	$55.22	$43.97	$28.16	$51.65	$63.80	$72.56	$84.85
Washington, D.C.	$715.14	$437.60	$503.14	$657.50	$959.44	$960.35	$997.05	$996.49	$868.79	$842.89	$851.39	$869.41	$844.76	$844.56
Regional Greenhouse Gas Initiative	CO_2 Allowance Price ($ per tonne)													
RGGI clearing price	$3.06	$2.12	$2.08	$2.13	$3.22	$5.21	$6.72	$4.93	$3.77	$4.86	$5.98	$7.06	$10.59	$14.84

Factors Affecting Marginal Impacts

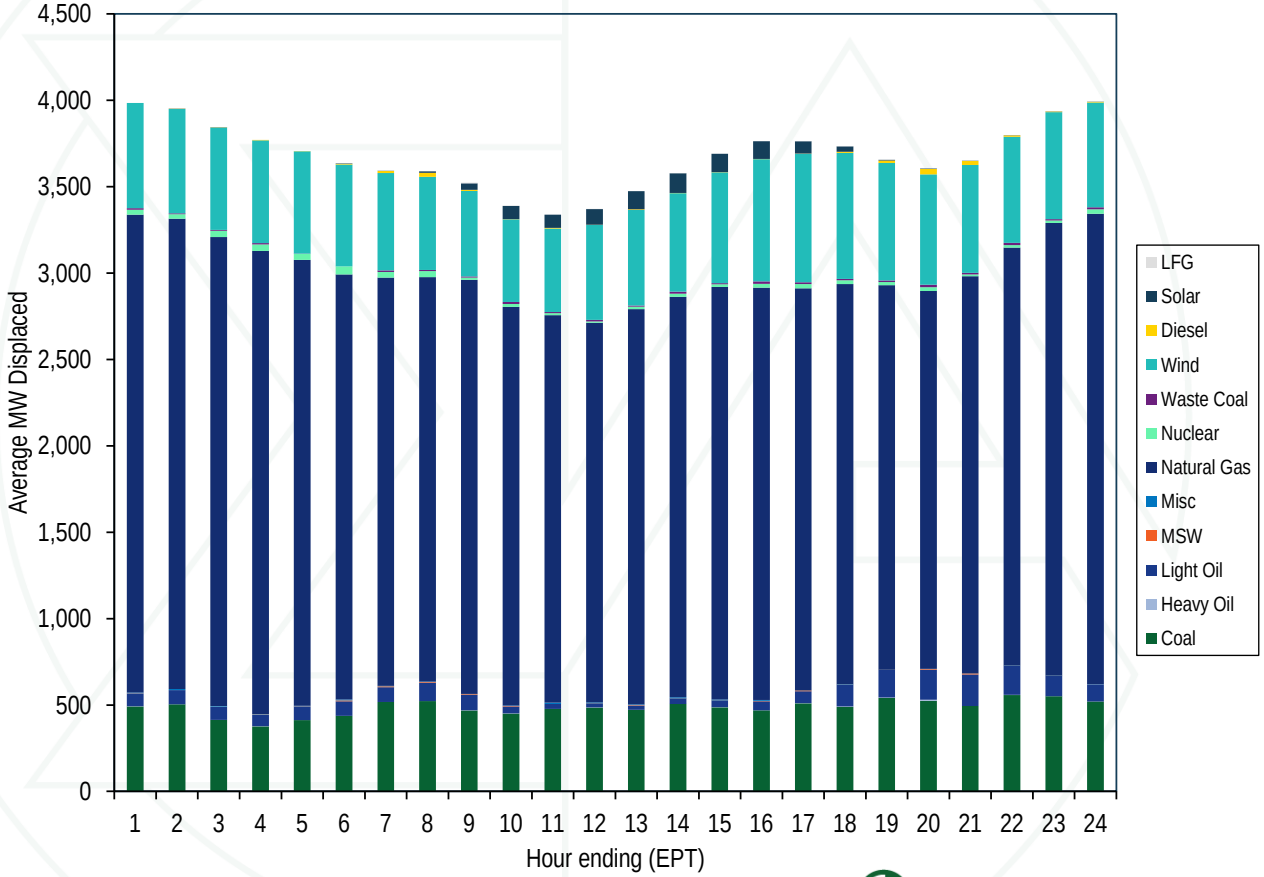
- Aggregate dispatch order
- Locational dispatch order
- Temporal dispatch pattern
- Relative fuel costs
- Unit specific factors
  - Operating at economic minimum
  - Power augmentation

Wind and solar output: top 100 load hours in 2022



Monitoring Analytics

Marginal fuel at time of wind generation: 2022

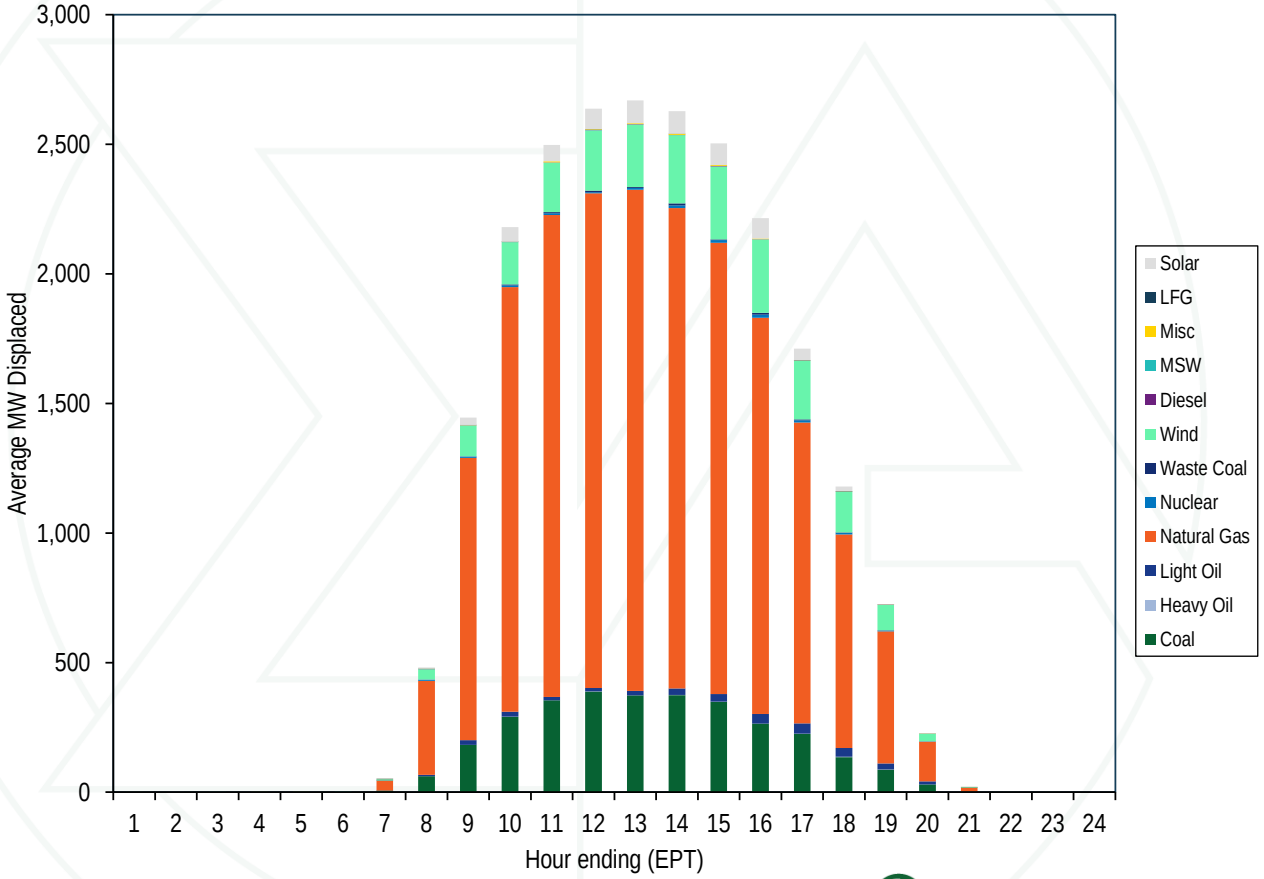


Monitoring Analytics

Marginal fuel MW at time of wind generation

Hour	Coal	Heavy Oil	Light Oil	MSW	Misc	atural Gas	Nuclear	Vaste Coal	Wind	Diesel	Solar	LFG	Total
0	491.9	0.7	74.6	0.5	4.4	2,766.4	27.7	9.6	609.2	0.0	0.0	0.0	3,984.9
1	504.6	0.6	80.4	0.0	7.0	2,722.6	25.5	5.7	602.8	2.0	0.5	0.0	3,951.8
2	413.4	0.5	75.3	1.3	4.0	2,714.1	36.2	4.8	593.0	1.0	0.7	0.0	3,844.4
3	376.6	0.4	65.5	2.6	2.3	2,680.5	37.8	7.2	595.6	2.2	0.0	0.0	3,770.7
4	413.2	0.0	79.0	0.8	2.6	2,580.4	34.9	2.4	592.0	0.7	0.0	0.0	3,705.9
5	437.1	0.0	84.6	4.6	5.1	2,461.2	46.0	0.0	589.5	4.6	1.5	0.0	3,634.2
6	517.1	0.0	85.8	4.8	2.6	2,363.6	32.6	8.3	563.7	11.5	1.9	0.9	3,593.0
7	522.8	0.0	105.8	4.5	2.8	2,340.8	35.3	6.7	537.8	23.4	9.0	1.2	3,590.2
8	469.0	0.6	89.6	3.3	2.0	2,395.9	13.3	7.0	494.5	7.0	37.0	3.5	3,522.8
9	450.7	0.2	41.0	2.5	2.2	2,307.8	17.2	11.8	476.9	1.8	75.8	0.8	3,388.8
10	478.0	0.0	27.3	1.3	6.7	2,243.4	11.6	6.8	482.5	4.8	75.6	0.0	3,337.9
11	484.9	1.0	23.4	0.5	4.7	2,197.7	8.0	8.7	549.4	1.2	91.3	0.2	3,371.1
12	472.3	0.0	25.0	2.7	3.7	2,288.4	13.2	6.5	553.5	3.3	105.0	0.0	3,473.5
13	505.5	0.4	32.7	0.3	5.8	2,317.5	18.6	11.8	569.5	1.8	113.6	0.5	3,577.9
14	486.4	0.8	39.5	0.4	4.7	2,388.1	15.9	5.5	641.2	1.7	107.0	0.0	3,691.1
15	469.6	0.5	51.7	3.0	4.6	2,387.0	21.9	13.9	707.8	0.6	102.9	0.0	3,763.3
16	510.1	1.2	68.1	5.2	0.7	2,326.6	25.2	10.1	743.6	1.6	71.3	0.5	3,764.1
17	488.5	3.0	126.6	0.6	3.1	2,315.0	21.2	8.4	729.8	6.5	30.8	1.3	3,734.7
18	541.0	3.1	158.1	0.6	1.6	2,225.5	17.6	9.5	679.7	15.1	4.2	0.1	3,656.2
19	524.3	5.6	173.6	3.9	2.0	2,187.0	21.7	13.9	639.8	30.3	3.0	0.0	3,605.1
20	494.5	0.0	182.3	6.5	0.4	2,298.2	10.5	9.0	624.1	23.2	0.1	0.0	3,648.8
21	558.1	0.6	166.9	0.8	2.6	2,418.7	14.4	12.6	613.7	8.0	0.1	0.0	3,796.6
22	550.8	0.5	116.0	0.7	2.5	2,619.8	14.3	7.3	619.2	3.4	0.3	0.2	3,935.3
23	520.6	0.0	98.2	0.0	1.4	2,723.7	25.5	11.3	606.0	5.0	0.4	0.7	3,992.7
Average	486.7	0.8	86.3	2.1	3.3	2,427.9	22.8	8.3	600.6	6.7	34.7	0.4	3,680.6

Marginal fuel at time of solar generation



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Marginal fuel MW at time of solar generation

Hour	Coal	Heavy Oil	Light Oil	atural Gas	Nuclear	Vaste Coal	Wind	Diesel	MSW	Misc	LFG	Solar	Total
0	0.1	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
1	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
2	0.1	0.0	0.0	0.2	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.4
3	0.0	0.0	0.0	0.2	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.3
4	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
5	0.1	0.0	0.0	0.8	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	1.0
6	6.1	0.0	0.1	38.9	0.4	0.1	4.8	0.0	0.3	0.1	0.0	0.3	51.1
7	61.6	0.0	5.4	362.3	4.8	0.3	40.5	0.8	0.9	0.0	0.1	4.4	481.3
8	182.3	0.1	18.4	1,089.1	5.1	1.3	117.6	0.8	0.9	1.2	0.7	27.5	1,445.1
9	290.9	0.4	19.0	1,638.3	7.2	3.3	163.1	0.9	0.6	0.8	0.1	55.9	2,180.4
10	354.6	0.0	12.6	1,860.1	6.3	4.5	190.0	1.5	0.7	4.2	0.0	62.7	2,497.2
11	387.9	1.0	12.8	1,909.6	4.2	5.7	232.6	0.4	0.8	3.0	0.5	78.5	2,637.1
12	373.5	0.0	17.2	1,933.6	7.3	3.5	240.0	1.6	1.3	2.9	0.0	88.2	2,669.2
13	374.5	0.5	25.4	1,853.2	10.4	7.9	263.4	0.9	0.4	4.3	0.5	86.9	2,628.3
14	348.1	1.1	29.3	1,741.9	9.6	3.1	281.8	1.2	0.1	3.8	0.0	83.5	2,503.5
15	264.6	0.3	36.6	1,529.4	11.9	6.9	282.3	0.7	1.5	2.1	0.0	78.8	2,215.1
16	225.3	0.7	39.3	1,161.2	8.8	3.6	225.9	0.9	0.6	0.2	0.9	43.7	1,711.1
17	135.5	1.6	33.5	824.0	5.9	1.9	156.8	1.1	0.3	0.7	0.9	17.0	1,179.3
18	87.1	0.1	23.7	509.9	2.9	1.3	97.3	1.4	0.0	0.1	0.2	1.3	725.1
19	30.1	0.0	11.5	153.1	1.0	0.4	28.8	0.9	0.1	0.0	0.0	0.4	226.4
20	2.8	0.0	0.6	13.8	0.0	0.0	1.8	0.0	0.0	0.0	0.0	0.0	19.1
21	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
22	0.1	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
23	0.1	0.0	0.0	0.5	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.7
Average	130.2	0.2	11.9	692.6	3.6	1.8	97.0	0.5	0.4	1.0	0.2	26.2	965.5

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