



Inside Energy

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RE: New evidence renewables don't reduce carbon dioxide emissions

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This comparison of actual regional grid carbon dioxide (CO₂) emissions between 2019 and 2021 shows increased use of wind and solar did not reduce emissions. Wind and solar electric generation are actually poor technologies no one would use without permanent government mandates and massive subsidies and taxes that are adding \$1 billion a year in power cost. They are also unreliable, non-recyclable, have negative environmental impacts¹, have shorter productive life spans than alternative power sources, and take up a lot of ground. If it doesn't reduce carbon dioxide emissions why are we using wind and solar?

The PJM regional electric grid serves over 65 million people in thirteen states. It is the largest such regional grid providing 22% of the countries electric power. Table 1 below shows how generation from various technologies changed from 2019 to 2021, Key changes are:

- Natural gas replaced coal almost one to one as it has been doing so for about the last decade
- Special oil based backup generators ran significantly more often
- Total carbon based generation stayed about the same at over 60% of total generation
- Zero emission nuclear generation fell over 2%, and hydro fell about 5%
- Combined wind and solar generation grew about 30% replacing lower nuclear and hydro generation plus covering a 0.2% increase in total regional generation, but still only equaled about 4% of total production despite over a decade of mandates and subsidies
- Overall the emissions fell 0.8%, a small improvement

Table 1: PJM electric generation by technology 2019 to 2021

Fuel	2019	2021	Change MWh	Change %
Coal	195,288,353	181,354,222	-13,934,131	-7.1%
Oil	833,249	1,469,140	635,891	76.3%
Natural Gas	299,925,492	313,750,191	13,824,699	4.6%
Other Gas	2,941,982	2,882,541	-59,441	-2.0%
Sub Total	498,989,076	499,456,094	467,018	0.1%
Hydro	11,047,831	10,509,639	-538,192	-4.9%
Nuclear	278,794,565	272,524,267	-6,270,298	-2.2%
Bio/wood/landfill	5,574,896	5,650,284	75,388	1.4%
Solar	2,734,753	7,336,368	4,601,615	168.3%
Wind	24,147,354	27,628,094	3,480,740	14.4%
Sub Total	322,299,399	323,648,652	1,349,253	0.4%
Total	821,288,475	823,104,746	1,816,271	0.2%
CO ₂ systems mix	851.1926	843.3056	7.8870	-0.9%

Source: PJM Systems Mix²



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Table 2 details the actual change in CO₂ emissions, but also considers how emissions may have fallen had the rate of emissions by megawatt-hour (MWh) remained the same as 2019. The key points are:

- Coal emissions should have fallen the same 7% generation did, but only fell about half as much as power plant efficiency fell
- Emissions from oil based backup generation grew 60%, but efficiency improved about 25%
- Natural gas generation grew 4.6%, but emissions only grew 3.6% as efficiency improved
- Overall emissions would have fallen 2.3% instead of the actual 0.8% mainly caused by falling coal generation efficiency

Table 2: PJM Carbon dioxide emissions by carbon based fuels

Fuel	2019 tons	2021 tons	Difference	% Change	2021 with 2019		
					Emission Rates	Difference	% Change
Coal	208,669,670	200,861,367	7,808,303	-3.7%	193,780,761	14,888,909	-7.1%
Oil	1,201,503	1,923,964	(722,461)	60.1%	2,118,426	(916,923)	76.3%
Natural Gas	132,674,207	137,397,814	(4,723,607)	3.6%	138,789,663	(6,115,455)	4.6%
Other Gas	7,063,985	6,653,028	410,957	-5.8%	6,921,261	142,724	-2.0%
Total	349,609,366	346,836,173	2,773,193	-0.8%	341,610,111	7,999,254	-2.3%

Source PJM Systems Mix²

Fuel switching from coal to natural gas would most likely have occurred even if no wind and solar power were available. Natural gas has about 60% lower emissions than coal for each MWh produced. Some of that fuel switching was caused by lower natural gas fuel prices, and part was simply replacing closed coal-fired power plants. As generation at coal plants falls the plants become less efficient actually increasing emissions per MWh as shown in Chart 1 below. Coal plants were not designed for frequent stops and starts and doing so can more than double emissions per MWh of production. Calculating from PJM Systems Mix data shows coal emissions grew 3.4%/MWh. Without that increase the actual total emission reduction may have fallen 2.3% instead of 0.8%.

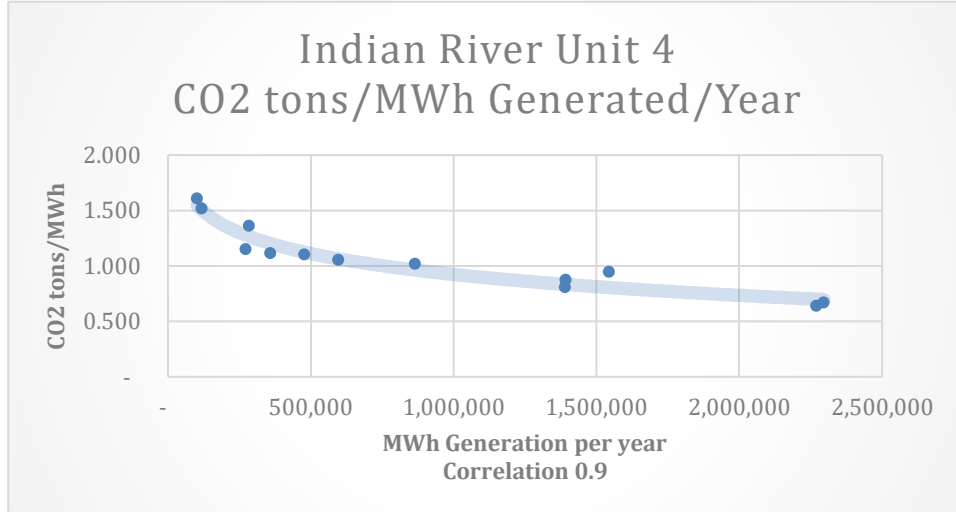
Solar and wind generation increased about 30%, or by 8.1 million MWhs. Nuclear power fell 6.3 million MWhs with 85% of that decrease related to the closing of the last unit at Three Mile Island. If you have been following the news many nuclear power plants are in financial trouble³ and some plants are closing. Nuclear power generation has to be continuous as there is limited ability to ramp a plant up and down so those plants largely follow prices set by other generation sources. Federal tax credits for wind power of over \$20/MWh⁴ are awarded based on the amount of power generated and were close to the PJM average wholesale energy price for 2021 of \$30.84/MWh⁵. So wind projects will bid low or even negative prices sometimes to reap those tax credits and nuclear plants follow even when losing money. Hydropower is very flexible and can be ramped down if the prices go too low.



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Chart 1: CO2 Emissions versus Annual Generation



Source: RGGI, Inc., RGGI COATS Platform, <https://rggi-coats.org/eats/rggi/>

There is more to the story. Electric demand and supply must be in absolute balance every second or there are brownouts and blackouts. To keep everything in balance PJM can call on fast reacting oil and natural gas-fired generators known as peaking generators. They meet the demand but are less efficient than regular equipment and increase emissions. The tables shows a large increase in oil-fired generation, and emissions. That increase is likely a direct result of wind and solar power ramping up and down as the wind and sunlight stopped or slowed. Without that extra peaking plant operation total PJM emissions may have fallen another 0.2%.

This lack of CO₂ reduction by wind and solar comes at a high cost. Tax payers and electric customers provide expensive subsidies totaling almost \$2 billion in the 2020-21 period, or \$1 billion a year;

- Besides selling power into the competitive PJM market wind generation receives \$18 to 23/MWh⁴ in federal Production Tax Credits paid by taxpayers depending on the year built for an average of \$20.50/MWh. With 54 million MWh produced in 2020 and 2021² the total cost was \$1,107 million
- PJM reports⁶ show from 6/1/2019 to June 1/2021, 1,077 MW of new solar capacity was added. Reports from the Solar Energy Industry Association⁷ indicate the average installed cost of utility scale solar with tracking over that period was \$0.96/Watt for a total investment of \$1,034 million. Solar projects received a 26% federal Investment Tax Credit⁵ from taxpayers, or \$269 million.
- Four states (NJ, DE, MD, VA) participated in the Regional Greenhouse Gas Initiative that requires carbon based generators to buy allowances to emit CO₂. The cost gets passed on in electric bills. For example Virginia, the only one of the four states with integrated generation and distribution, received \$228 million⁸ in RGGI taxes in 2021. Dominion Energy passed on \$6.67/MWh to ratepayers, or about \$80/year⁹. In deregulated states the RGGI cost (\$434 million⁸ in 2020-21) are passed on indirectly in higher average PJM energy prices.



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In summary, the minor reduction in emissions occurred because lower emission natural gas replaced coal. The emission reduction might have been as much as 2.5% instead of 0.9%. Increased reliance on intermittent wind and solar power increased the use of inefficient peaking power plants, and as generation volume at coal plants fell they became less efficient. Increases in wind and solar generation offset zero emission nuclear and hydro generation (84% of increase), with the balance going to higher overall PJM generation. The conclusion is wind and solar power are not yielding lower carbon dioxide emissions, but are adding \$1 billion a year in costs. Without lower emissions why are we mandating and subsidizing wind and solar power?

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