CARBON EMISSION PRICES AND ELECTRICITY MARKET SUBSIDIES

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Electricity market design depends on critical choices. There is no escape from the fundamentals. Under Order 888 the FERC recognized that a market based on tracing power flows between production and consumption was not viable.

> "A contract path is simply a path that can be designated to form a single continuous electrical path between the parties to an agreement. Because of the laws of physics, it is unlikely that the actual power flow will follow that contract path. … Flow-based pricing or contracting would be designed to account for the actual power flows on a transmission system. It would take into account the "unscheduled flows" that occur under a contract path regime." (FERC, Order 888, April 24, 1996, footnotes 184-185, p. 93.)

Why is this important?

- **Most electricity subsidy proposals assume facts not in evidence.** (Hogan, 2022) (Harvey & Hogan, 2023)
- **24x7 matching of individual generation and load is not workable.**
- **Marginal impact estimates depend on the details of economic dispatch.** (Rudkevich & Ruiz, 2012)
- **The details imply high locational differences that are neglected in aggregate and even regional analysis.** (He et al., 2021)

CLEAN ENERGY — Subsidies and Implied Carbon Prices

Subsidies are growing: RPS, RECs, PTCs, ITCs, DR, ZECs, zero emission targets and the IRA.

"Subsidies are contagious. Competition in the markets could be replaced by competition to receive subsidies." (Monitoring Analytics, 2017, p. 2)

"A typical finding is that using inefficient regulations or approaches will double the costs of meeting environment objectives." (Nordhaus, 2013, p. 179)

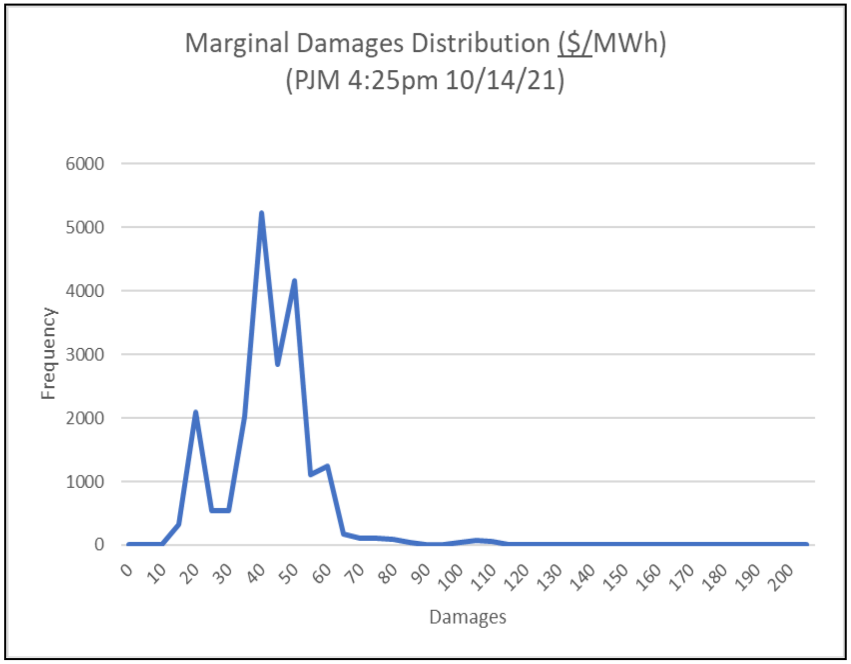
"Under IRA, clean energy that displaces zero-carbon energy such as hydropower is subsidized at the same rate as clean energy that displaces the dirtiest resources." (Bistline et al., 2023, p. 46)

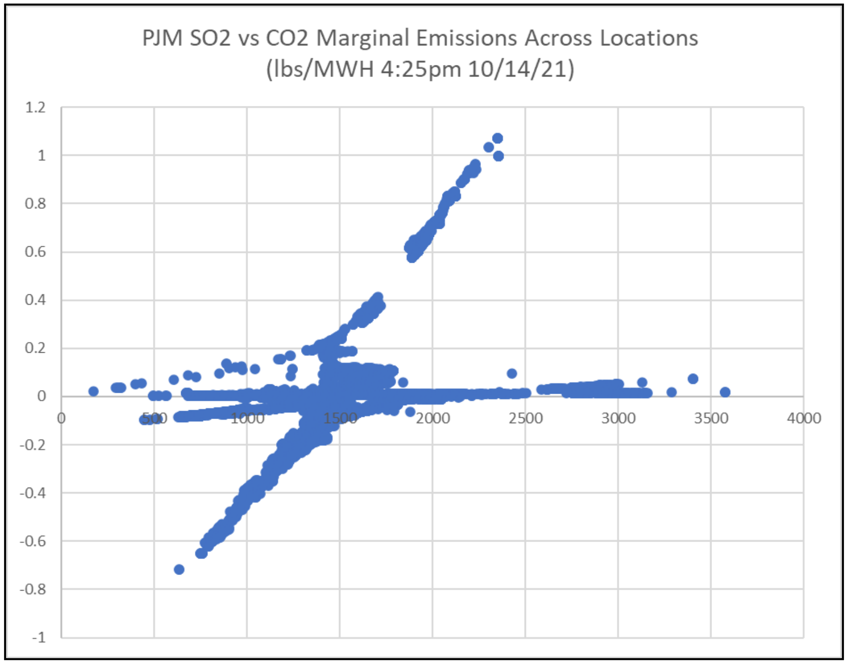
		IRA Scenario		**CO_2 Equivalent**		**Difference (p.p.)**	
Metric (units)	2021	2030	2035	2030	2035	2030	2035
Generation Share (%)							
Coal	22%	11%	8%	7%	4%	-4%	-5%
Coal CCS	0%	3%	3%	0%	0%	-3%	-3%
Gas	39%	20%	18%	35%	34%	15%	17%
Gas CCS	0%	0%	0%	0%	0%	0%	0%
Other	2%	9%	11%	7%	8%	-2%	-3%
Nuclear	19%	17%	14%	17%	16%	0%	2%
Hydro	6%	6%	6%	6%	6%	0%	0%
Wind and Solar	13%	33%	41%	28%	32%	-6%	-9%
CO_2 (% Drop from 2005)	35%	64%	68%	64%	68%	0%	0%
Generation Price ($/MWh)	$64	$56	$52	$65	$62	16%	20%
Abatement Cost ($/t-$CO_2$)	N/A	$83	$83	$12	$15	-85%	-82%

(Bistline et al., 2023, p. 49)

A typical assumption for implied carbon prices is that the subsidized entities are perfect or close substitutes for the carbon emitting and related activities[1]. However, transmission constraints and local conditions in the electricity system induce material differences across locations.

(across locations at the same time)

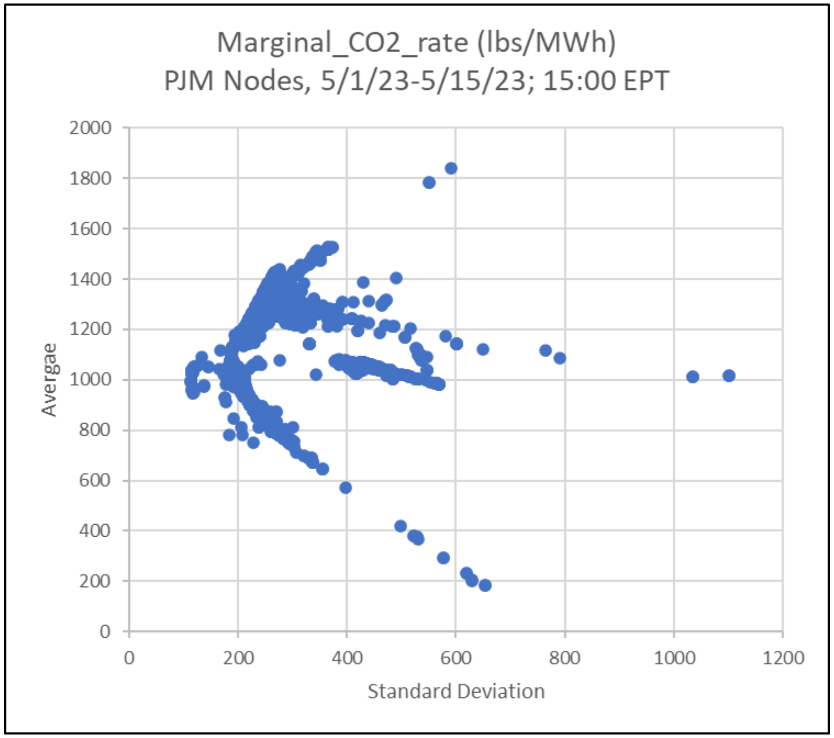


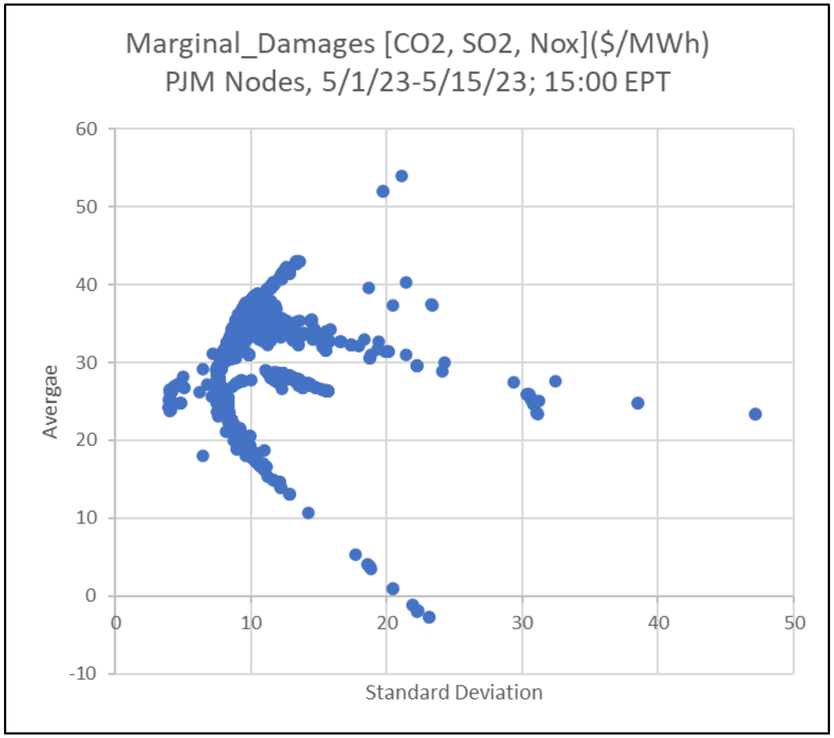


There can be a wide difference of impact on marginal emissions for different pollutants across the PJM footprint.

[1] \$50/ton CO_2; \$24,000/ton SOx; \$13,000/ton NOx (Goodkind et al., 2019)

The variations across space in the PJM balancing accompany significant variation across time. (across time at the same locations)





An important advantage of carbon emissions pricing, as opposed to subsidies, is the automatic ability to accommodate these wide variations and provide better incentives for operations and investments.

CLEAN ENERGY Supporting Materials

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On Federal policies: "…to calculate the carbon tax required to replace the major federal climate change policies that existed as of 2016: Corporate Average Fuel Economy (CAFE) Standards on light-, medium-, and heavy-duty vehicles; the Clean Power Plan (CPP); and the Renewable Fuel Standard (RFS). …the required carbon tax in 2020 is roughly $7 per tonne. In 2025, the required tax increases to roughly $22 per tonne; in 2030 the required tax is roughly $36 per tonne. These results underscore the economic power of a carbon tax, compared to the economically inefficient policies currently in place." (Knittel, 2019, p. Abstract) For examples from UK and Germany, see (Gugler et al., 2020).

On renewable portfolio standards (RPS): "…RPS policies' statutory requirements for renewable generation frequently overstate their net impact on generation, because they often include generation that existed at the time of the policy's passage… electricity prices increase substantially after RPS adoption… the estimates indicate that passage of RPS programs substantially reduces carbon emissions … putting together the findings on electricity prices and emissions implies that RPS programs achieve CO2 abatement at a relatively high cost. The cost to consumers per metric ton of CO2 ranges from $58 to $298 depending on specification and is above $100 in most specifications, suggesting that it is above conventional estimates of the social cost of carbon." (Greenstone et al., 2020, pp. 2–3)

Subsidies imply widely varying carbon prices.

The implied social cost of carbon from the PJM Market Monitor:

“For example, the average price of an SREC in New Jersey was $204.74 per credit in 2022. The SREC price is paid in addition to the energy price paid at the time the solar energy is produced. If the MWh produced by the solar resource resulted in avoiding the production of one MWh from a CT, the value of carbon reduction implied by the SREC price is a carbon price slightly more than $400 per tonne since the price of the SREC is slightly higher than the carbon price per MWh for a CT ($195.58). This result also assumes that the entire value of the SREC was based on reduced carbon emissions. The SREC price consistent with a carbon price of $50.00 per tonne, assuming that a MWh from a CT is avoided, is $24.45 per MWh.

Applying this method to Tier I and Class I REC and SREC price histories yields the implied carbon prices in Table 8-10. The carbon price implied by the average REC price during 2022 in Washington, DC is $18.55 per tonne which is $3.71 per tonne higher than the average RGGI auction price of $14.84 per tonne. The carbon price implied by the average price for Ohio RECs in 2022 is $16.87 per tonne and implied carbon price for Virginia RECs is $19.38 per tonne. The implied carbon prices for Maryland, New Jersey and Pennsylvania RECs are well above the RGGI clearing price, and well below the social cost of carbon which is estimated to be in the range of $50 per tonne.164 The carbon prices implied by SREC prices have no apparent relationship to carbon prices implied by the REC clearing prices. The carbon prices implied by the SREC prices [$107-$844] all exceed the carbon prices implied by the corresponding REC prices, and all exceed the social cost of carbon.” (Monitoring Analytics, 2023, pp. 451–452)

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