UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

Carbon Pricing in FERC-Jurisdictional Organized Regional Wholesale Electric Energy Markets	)))	Docket No. AD20-14-000

COMMENTS OF JOSEPH BOWRING, INDEPENDENT MARKET MONITOR FOR PJM

This Commission technical conference is to discuss considerations related to the adoption of carbon pricing by states within Commission jurisdictional organized wholesale power markets.[1] These comments focus on PJM.

If the PJM states decide that carbon is a pollutant with a negative value, a market approach to carbon is preferred to an inefficient technology or unit specific subsidy approach or inconsistent RPS rules that in some cases subsidize carbon emitting resources. Implementation of a carbon price is a market approach which would let market participants respond in efficient and innovative ways to the price signal rather than relying on planners to identify specific technologies or resources to be subsidized. The carbon price could be based on target emission quantities or be based on the choice of a preferred price. Implementation of a carbon price using RGGI or a similar market mechanism by the states would mean that the states control the carbon price and that no FERC approval would be required and no PJM rule changes would be required. The carbon price would become part of the marginal costs of power plants and the impacts on production and consumption

[1] Supplemental Notice of Technical Conference re *Carbon Pricing in Organized Wholesale Electricity Markets,* Docket No. AD20-14-000 (September 16, 2020).

decisions would be market based. States would control the resulting revenues. This is the case regardless of the number of PJM states that join RGGI or a similar market.

The IMM comments recognize the states' authority to implement environmental policies. The IMM comments include recommendations about how to improve the coordination of wholesale and retail power markets and how to improve the efficiency of wholesale power markets in light of state environmental policies as well as approximate quantification of the impacts of various options.

Environmental requirements and renewable energy mandates have had and continue to have a significant impact on PJM markets.

The investments required for environmental compliance have affected offer behavior in the capacity market. Expectations about the cost and life of such investments and about future capacity and energy prices have affected retirement decisions. The markets have also provided incentives for new, lower emission units to enter.

Environmental requirements and initiatives at both the federal and state levels and state renewable energy mandates and associated incentives have resulted in the construction of substantial amounts of renewable capacity in the PJM market, especially wind and solar resources. Renewable energy credit (REC) markets created by state programs, and federal tax credits have significant impacts on PJM wholesale markets.

But state renewables programs in PJM are not coordinated with one another, are generally not consistent with the PJM market design or PJM prices, have widely differing objectives, have widely differing implied prices of carbon and are not transparent on pricing and quantities. The effectiveness and efficiency of state renewables programs would be enhanced if they were coordinated with one another and with PJM markets, and if they increased transparency. States could evaluate the impacts of a range of carbon prices if PJM would provide a full analysis of the impact of carbon pricing on the economics of individual PJM generating units within each state and carbon pricing revenues to each PJM state in order to permit the states to consider a potential agreement on the development of a multistate framework for carbon pricing and the distribution of carbon revenues. A single

carbon price across PJM, established by the states, would be the most efficient way to reduce carbon output, if that is the goal.

The economic logic of RPS programs and the associated REC and SREC prices are not always consistent. The price of carbon implied by REC prices ranges from $6.31 per tonne in Washington, DC to $18.17 per tonne in New Jersey. The price of carbon implied by SREC prices ranges from $64.74 per tonne in Pennsylvania to $871.90 per tonne in Washington, DC.[2] The effective prices for carbon compare to the RGGI clearing price in June 2020 of $6.34 per tonne and to the social cost of carbon which is estimated in the range of $50 per tonne.[3] The impact on the cost of generation from a new combined cycle unit of a $50 per tonne carbon price would be $16.71 per MWh.[4] The impact of an $800 per tonne carbon price would be $267.30 per MWh. This wide range of implied carbon prices is not consistent with an efficient, competitive, least cost approach to the reduction of carbon emissions.

PJM markets provide a flexible mechanism for incorporating the costs of environmental controls and meeting environmental requirements in a cost effective manner. Costs for environmental controls are part of offers for capacity resources in the PJM Capacity Market. The costs of emissions credits are currently included in energy offers. PJM markets also provide a flexible mechanism that incorporates renewable resources and

---

2 See the *2020 Quarterly State of the Market Report for PJM: January through June*, Section 8: Environmental and Renewables (August 13, 2020).

3 "Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis – Under Executive Order 12899," Interagency Working Group on the Social Cost of Greenhouse Gases, United States Government, (Aug. 2016), <https://19january2017snapshot.epa.gov/sites/production/files/2016-12/documents/sc_co2_tsd_august_2016.pdf>.

4 The cost impact calculation assumes a heat rate of 6.296 MMBtu per MWh and a carbon emissions rate of 0.053070 tonne per MMBtu. The $800 per tonne carbon price represents the approximate upper end of the carbon prices implied by the 2019 REC and SREC prices in the PJM jurisdictions with RPS.

the impacts of renewable energy credit markets, and ensures that renewable resources have access to a broad market. PJM markets provide efficient price signals that permit valuation of resources with very different characteristics when they provide the same product.

PJM markets could provide a flexible mechanism to limit carbon output by incorporating a consistent carbon price in unit offers which would be reflected in PJM's economic dispatch. If there is a social decision to limit carbon output, a consistent carbon price would be the most efficient way to implement that decision. The states in PJM could agree, if they decided it was in their interests, with the appropriate information, on a carbon price and on how to allocate the revenues from a carbon price that would make all states better off. A mechanism like RGGI leaves all decision making with the states. Such a carbon price would not be FERC jurisdictional or be subject to PJM decisions. The IMM continues to recommend that PJM provide modeling information to the states adequate to inform such a decision making process. Such modeling information would include the impact on the dispatch of every unit, the impact on energy prices and the carbon pricing revenues that would flow to each state. This would permit states to make critical decisions about carbon pricing. For example, states receiving high levels of revenue could shift revenue to states disproportionately hurt by a carbon price if they believed that all states would be better off as a result. A carbon price would also be an alternative to specific subsidies to individual nuclear power plants and to the current wide range of implied carbon prices embedded in RPS programs and instead provide a market signal to which any resource could respond. The imposition of specific and prescriptive environmental dispatch rules would, in contrast, pose a threat to economic dispatch and efficient markets and create very difficult market power monitoring and mitigation issues. The provision of subsidies to individual units creates a discriminatory regime that is not consistent with competition. The use of inconsistent implied carbon prices by state is also inconsistent with an efficient market and inconsistent with the least cost approach to meeting state environmental goals. But it would be a positive step towards uniform carbon pricing if PJM states continue to join RGGI.

Complex rules addressing leakage issues are not necessary and can have unintended consequences.

The annual average cost of complying with RPS over the five year period from 2014 through 2018 for the nine jurisdictions that had RPS exceeded $873.1 million, or a total of $4.4 billion over five years.[5] The RPS compliance cost for 2017, the most recent year for which there is complete data, was $925.4 million.[6] RPS costs are payments by customers to the sellers of qualifying resources. The revenues from carbon pricing flow to the states.

The IMM has estimated the impacts on revenues and energy market prices of a range of carbon prices and participation levels. These are estimated impacts based on the stated assumptions and methods and are not based on a full redispatch of the PJM market. These estimates are included in order to provide a range of potential revenues and price impacts. PJM modeling with full redispatch provides a more precise basis for estimates of impacts.

If all the PJM states participated in a regional carbon market, the estimated revenue returned to the states/customers from selling carbon allowances would be approximately $2.1 billion per year if the carbon price were $5.75 per short ton and emissions levels were five percent below 2019 emission levels. If all the PJM states participated in a regional carbon market, the estimated revenue returned to the states/customers from selling carbon allowances would be approximately $18.0 billion if the carbon price were $50 per short ton and emission levels were five percent below 2019 levels. If only the current RPS states participated in a regional carbon market, the estimated revenue returned to the states/customers from selling carbon allowances at $5.75 per short ton would be about $1.2

---

[5] The actual PJM RPS compliance cost exceeds the reported $4.4 billion since this total does not include a value for Delaware in 2014 and does not include a value for Pennsylvania in 2018.

[6] See the 2*020 Quarterly State of the Market Report for PJM: January through June*, Section 8: Environmental and Renewables (August 13, 2020).

billion. The costs of a carbon price are the impact on energy market prices, net of the revenue returned to states/customers.

If all PJM states joined RGGI, the total RGGI revenue to the PJM states would be significant.[7] The estimated allowance revenue for PJM states based on 2019 CO_2 emission levels and the RGGI clearing price for the June 2020 auction ranges from $1.1 billion per year to $2.1 billion per year depending on associated reductions in carbon emission levels (Table 1).[8]

Table 1 shows the estimated carbon allowance revenue for each PJM state based on the latest RGGI auction price and reductions below 2019 CO_2 emission levels ranging from five to 50 percent. A power plant owner must acquire an allowance for each ton of CO_2 emissions and the revenue values in Table 1 are computed by multiplying the carbon price by the emission cap level which is expressed as a reduction below the 2019 actual emissions level. States that participate in RGGI choose their emission cap. For example, New Jersey chose an emission cap of 18,000,000 short tons for reentry into RGGI in 2020, 5.3 percent below New Jersey's 2018 CO_2 emissions level; the New Jersey emission cap will be reduced by 540,000 short tons each year through 2030.[9]

---

[7] The Regional Greenhouse Gas Initiative (RGGI) is a CO_2 emissions cap and trade agreement among Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont that applies to power generation facilities. New Jersey rejoined on January 1, 2020.[7] Virginia and Pennsylvania are preparing to join.

[8] This assumes that the PJM states would implement their RGGI rules consistent with the current RGGI states where owners of fossil fuel generators are required to purchase emission allowances in a regional centralized auction or purchase allowances in a secondary market.

[9] "Governor Murphy Announces Adoption of Rules Returning New Jersey to Regional Greenhouse Gas Initiative," State of New Jersey, Governor Phil Murphy Press Release, June 17, 2019 <https://nj.gov/governor/news/news/562019/approved/20190617a.shtml>.

Table 1 Estimated CO_2 allowance revenue at June 2020 RGGI price level[10] [11]

Jurisdiction	2019 power generation CO_2 emissions (short tons)	Estimated CO_2 allowance revenue ($ millions), carbon price $5.75 per short ton: 5 percent reduction below 2019 emission levels	10 percent reduction below 2019 emission levels	15 percent reduction below 2019 emission levels	20 percent reduction below 2019 emission levels	25 percent reduction below 2019 emission levels	50 percent reduction below 2019 emission levels
Delaware	2,007,608.3	$11.0	$10.4	$9.8	$9.2	$8.7	$5.8
Illinois	27,218,451.4	$148.7	$140.9	$133.0	$125.2	$117.4	$78.3
Indiana	39,583,687.7	$216.2	$204.8	$193.5	$182.1	$170.7	$113.8
Kentucky	27,571,710.2	$150.6	$142.7	$134.8	$126.8	$118.9	$79.3
Maryland	13,176,745.0	$72.0	$68.2	$64.4	$60.6	$56.8	$37.9
Michigan	0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
New Jersey	15,820,055.8	$86.4	$81.9	$77.3	$72.8	$68.2	$45.5
North Carolina	114,473.8	$0.6	$0.6	$0.6	$0.5	$0.5	$0.3
Ohio	79,400,173.0	$433.7	$410.9	$388.1	$365.2	$342.4	$228.3
Pennsylvania	82,719,699.4	$451.9	$428.1	$404.3	$380.5	$356.7	$237.8
Tennessee	0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Virginia	31,030,859.6	$169.5	$160.6	$151.7	$142.7	$133.8	$89.2
Washington, D.C.	0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
West Virginia	61,130,636.7	$333.9	$316.4	$298.8	$281.2	$263.6	$175.8
Total	379,774,100.9	$2,074.5	$1,965.3	$1,856.1	$1,747.0	$1,637.8	$1,091.9

The RGGI emissions cap is the sum of CO_2 allowances issued by each state. Compliance with the RGGI allowance obligation is evaluated at the end of each three year period which is called the control period. The first control period began in 2009. The 2020 compliance year is the third year of the fourth control period.

If higher carbon prices were implemented in PJM, the associated revenues flowing to states would also increase. Table 2 shows the estimated allowance revenue for PJM states for carbon prices ranging from $10 per short ton to $50 per short ton and for emissions reductions ranging from five percent to 50 percent. Allowance revenues to states would be $18.0 billion if the carbon price were $50 per short ton and emission levels were five percent

---

[10] The 2019 CO_2 emissions data is from the EPA Continuous Emission Monitoring System (CEMS) from generators located within the PJM footprint.

[11] Power generation companies subject to a RGGI emission cap can offset up to 3.3 percent of their allowance obligation by undertaking certain greenhouse gas emission reduction projects. The allowance revenue values in Table 2 do not reflect offset allowances.

below 2019 levels. Allowance revenues to states would be $1.9 billion if the carbon price were $10 per short ton and emission levels were 50 percent below 2019.

Table 2 Estimated CO_2 allowance revenue at various carbon prices

	Estimated CO_2 allowance revenue ($ millions)					
	5 percent reduction below 2019 emission levels	10 percent reduction below 2019 emission levels	15 percent reduction below 2019 emission levels	20 percent reduction below 2019 emission levels	25 percent reduction below 2019 emission levels	50 percent reduction below 2019 emission levels
Jurisdiction	Carbon Price ($ per short ton)			$10.00		
Delaware	$19.1	$18.1	$17.1	$16.1	$15.1	$10.0
Illinois	$258.6	$245.0	$231.4	$217.7	$204.1	$136.1
Indiana	$376.0	$356.3	$336.5	$316.7	$296.9	$197.9
Kentucky	$261.9	$248.1	$234.4	$220.6	$206.8	$137.9
Maryland	$125.2	$118.6	$112.0	$105.4	$98.8	$65.9
Michigan	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
New Jersey	$150.3	$142.4	$134.5	$126.6	$118.7	$79.1
North Carolina	$1.1	$1.0	$1.0	$0.9	$0.9	$0.6
Ohio	$754.3	$714.6	$674.9	$635.2	$595.5	$397.0
Pennsylvania	$785.8	$744.5	$703.1	$661.8	$620.4	$413.6
Tennessee	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Virginia	$294.8	$279.3	$263.8	$248.2	$232.7	$155.2
Washington, D.C.	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
West Virginia	$580.7	$550.2	$519.6	$489.0	$458.5	$305.7
Total	$3,607.9	$3,418.0	$3,228.1	$3,038.2	$2,848.3	$1,898.9
	Carbon Price ($ per short ton)			$25.00		
Delaware	$47.7	$45.2	$42.7	$40.2	$37.6	$25.1
Illinois	$646.4	$612.4	$578.4	$544.4	$510.3	$340.2
Indiana	$940.1	$890.6	$841.2	$791.7	$742.2	$494.8
Kentucky	$654.8	$620.4	$585.9	$551.4	$517.0	$344.6
Maryland	$312.9	$296.5	$280.0	$263.5	$247.1	$164.7
Michigan	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
New Jersey	$375.7	$356.0	$336.2	$316.4	$296.6	$197.8
North Carolina	$2.7	$2.6	$2.4	$2.3	$2.1	$1.4
Ohio	$1,885.8	$1,786.5	$1,687.3	$1,588.0	$1,488.8	$992.5
Pennsylvania	$1,964.6	$1,861.2	$1,757.8	$1,654.4	$1,551.0	$1,034.0
Tennessee	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Virginia	$737.0	$698.2	$659.4	$620.6	$581.8	$387.9
Washington, D.C.	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
West Virginia	$1,451.9	$1,375.4	$1,299.0	$1,222.6	$1,146.2	$764.1
Total	$9,019.6	$8,544.9	$8,070.2	$7,595.5	$7,120.8	$4,747.2
	Carbon Price ($ per short ton)			$50.00		
Delaware	$95.4	$90.3	$85.3	$80.3	$75.3	$50.2
Illinois	$1,292.9	$1,224.8	$1,156.8	$1,088.7	$1,020.7	$680.5
Indiana	$1,880.2	$1,781.3	$1,682.3	$1,583.3	$1,484.4	$989.6
Kentucky	$1,309.7	$1,240.7	$1,171.8	$1,102.9	$1,033.9	$689.3
Maryland	$625.9	$593.0	$560.0	$527.1	$494.1	$329.4
Michigan	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
New Jersey	$751.5	$711.9	$672.4	$632.8	$593.3	$395.5
North Carolina	$5.4	$5.2	$4.9	$4.6	$4.3	$2.9
Ohio	$3,771.5	$3,573.0	$3,374.5	$3,176.0	$2,977.5	$1,985.0
Pennsylvania	$3,929.2	$3,722.4	$3,515.6	$3,308.8	$3,102.0	$2,068.0
Tennessee	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Virginia	$1,474.0	$1,396.4	$1,318.8	$1,241.2	$1,163.7	$775.8
Washington, D.C.	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
West Virginia	$2,903.7	$2,750.9	$2,598.1	$2,445.2	$2,292.4	$1,528.3
Total	$18,039.3	$17,089.8	$16,140.4	$15,191.0	$14,241.5	$9,494.4

Table 3 shows the estimated impact of three different carbon prices on PJM load-weighted LMP. For example, if the carbon price were $5.00 per tonne, the PJM load-weighted average LMP in the first six months of 2020 would have increased by 6.8 percent.[12]

Table 3 Estimated impact of Carbon price on LMP: January through June, 2019 and 2020

		2019 (Jan - Jun)			2020 (Jan - Jun)		
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	$27.49	$28.46	3.5%	$19.40	$20.73	6.8%
Scenario 2	$10.00	$27.49	$29.55	7.5%	$19.40	$22.24	14.6%
Scenario 3	$15.00	$27.49	$30.63	11.4%	$19.40	$23.75	22.4%
Scenario 4	$25.00	$27.49	$32.11	16.8%	$19.40	$26.77	38.0%
Scenario 5	$50.00	$27.49	$36.84	34.0%	$19.40	$34.32	76.9%

Table 4 shows the impact of a range of carbon prices on the cost per MWh of producing energy from three basic unit types.[13] [14] For example, if the price of carbon were $50.00 per tonne, the short run marginal costs would increase by $24.52 per MWh for a new combustion turbine (CT) unit, $16.71 per MWh for a new combined cycle (CC) unit and $43.15 per MWh for a new coal plant (CP).

---

[12] LMPs are recalculated to account for the defined cost of carbon emissions on marginal units' offer prices. The LMP calculation is not based on a counterfactual redispatch of the system to determine the marginal units and the marginal costs that would have occurred if all units had made all offers at short run marginal cost. See Technical Reference for PJM Markets, "Calculation and Use of Generator Sensitivity/Unit Participation Factors," <http://www.monitoringanalytics.com/reports/Technical_References/references.shtml>.

[13] Heat rates from the *2019 State of the Market Report for PJM*, Volume 2, Section 7: Net Revenue, Table 7-4.

[14] Carbon emissions rates from: *Table A.3. Carbon Dioxide Uncontrolled Emission Factors*, Energy Information Administration, <https://www.eia.gov/electricity/annual/html/epa_a_03.html> (Accessed March 9, 2020).

Table 4 Carbon price per MWh by unit type

	Carbon Price per MWh						
Unit Type	Carbon $5/tonne	Carbon $10/tonne	Carbon $15/tonne	Carbon $50/tonne	Carbon $100/tonne	Carbon $200/tonne	Carbon $400/tonne
CT	$2.45	$4.90	$7.36	$24.52	$49.04	$98.08	$196.17
CC	$1.67	$3.34	$5.01	$16.71	$33.41	$66.83	$133.65
CP	$4.32	$8.63	$12.95	$43.15	$86.30	$172.60	$345.21

Table 5 also illustrates the effective cost of carbon included in the price of a REC or SREC. For example, the average price of an SREC in New Jersey was $181.18 per MWh for the first six months of 2020. 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 a MWh from a CT, the value of carbon reduction implied by the SREC price is a carbon price slightly less than $400 per tonne. 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 $24.52 per MWh.

Applying this method to tier I and class I REC and SREC price histories yields the implied carbon prices in Table 5. The carbon price implied by the average REC price for the first three months of 2020 in Washington, DC is $6.31 per tonne which is consistent with the average 2020 RGGI clearing price of $6.28 per tonne. All other carbon prices implied by renewable 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.[15] 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 all exceed the carbon prices implied by the corresponding REC prices, and all exceed the social cost of carbon.

---

15 "Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis – Under Executive Order 12899," Interagency Working Group on the Social Cost of Greenhouse Gases, United States Government, (Aug. 2016), <https://19january2017snapshot.epa.gov/sites/production/files/2016-12/documents/sc_co2_tsd_august_2016.pdf>.

Table 5 Implied carbon price based on REC and SREC prices: 2009 through 2020 [16]

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Jurisdiction with Tier I or Class I REC	Carbon Price ($ per tonne) Implied by REC Prices											
Delaware					$34.15	$35.17	$31.91	$32.91	$10.26	$11.57	$15.86	
Maryland	$2.07	$1.92	$3.06	$6.34	$17.46	$28.45	$29.18	$26.09	$23.12	$21.28	$17.68	$17.49
New Jersey	$13.34	$17.74	$8.58	$4.74	$13.09	$21.04	$25.29	$26.93	$24.01	$22.01	$19.20	$18.17
Ohio						$10.16	$8.52	$5.29	$6.27	$11.17	$13.22	$13.39
Pennsylvania	$6.82	$8.13	$3.33	$4.29	$15.87	$26.66	$28.88	$26.35	$23.35	$21.47	$17.84	$17.65
Washington, D.C.							$3.19	$4.04	$4.88	$4.68	$5.53	$6.31
Jurisdiction with Solar REC	Carbon Price ($ per tonne) Implied by Solar REC Prices											
Delaware						$117.25	$85.40	$86.48	$35.70	$17.33		
Maryland		$546.11	$494.54	$382.57	$304.54	$292.70	$251.23	$183.09	$127.67	$87.00	$78.94	$72.68
New Jersey	$1,372.37	$1,352.15	$1,309.00	$537.08	$345.94	$326.21	$388.73	$424.21	$459.21	$445.00	$406.85	$369.43
Ohio						$82.32	$45.12	$36.15	$31.82			
Pennsylvania	$610.05	$590.57	$378.67	$101.80	$68.34	$75.90	$66.89	$55.06	$43.84	$28.07	$50.79	$64.74
Washington, D.C.	$712.98	$436.28	$501.62	$655.52	$956.55	$957.46	$994.05	$993.49	$866.17	$840.35	$842.59	$871.90
Regional Greenhouse Gas Initiative	CO_2 Allowance Price ($ 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	$6.28

[16] There were no trades in 2018 and 2019 for Ohio SRECs available in the Evomarkets data.