ADVERSE CONSEQUENCES OF PRICING CARBON

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Putting a market price on carbon has become a major focus of initiatives to reduce carbon dioxide (CO2) emissions. Economic efficiency is touted correctly as a primary justification for putting a price on carbon. Pricing carbon would result in economic efficiency at the margin (for example, influencing what kind of new power plant to build or whether to replace a dirty power plant with a cleaner alternative).

However, pricing carbon would also affect the prices paid by consumers for the output of non-CO2 emitting technologies (such as existing hydro and nuclear). This infra-marginal effect would result in transfers of wealth from consumers to the owners of non-CO2 emitting technologies.

Economists often dismiss infra-marginal effects (or wealth transfers) since they have no effect on economic efficiency. But in fact real people care about wealth transfers, particularly when the transfers are from them to someone else. As such the political process must care about wealth transfers too.[2] But these wealth transfers have not been widely discussed.

A recent paper – "*Economics of Long-Distance Transmission of Wind Power*"[3] - found that the long-distance transmission of wind power from the Upper Midwest (North Dakota, South Dakota, Minnesota, and Iowa) to the Midwest and East made economic sense, if the value of the CO2 emissions reduced were about $50/ton.

One policy option would be to adopt a "market approach" – in the form of a carbon tax or a cap and trade system – that puts a market price on CO2 emissions. This paper assesses such a market approach.

After a brief Executive Summary, this paper describes the approach that was employed, the findings, and the policy implications of these findings.[4]

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[1] Hoff Stauffer is Managing Director of the Wingaersheek Research Institute, a not-for-profit corporation, focusing on the economics of global warming.

[2] Dr. Irwin Stelzer, an excellent economist with a wonderful quick wit, once retorted to a comment dismissing wealth transfers, something to the effect: "But the French Revolution was about wealth transfers!"

[3] "Economics of Long-Distance Transmission of Wind Power," by Hoff Stauffer of the Wingaersheek Research Institute, May, 2009, http://www.wingrg.com/Papers.html

[4] Thanks to Dan Klein, Pablo Paster, and Assef Zobian for their helpful comments. Of course, any inaccuracies are the responsibility of the author

EXECUTIVE SUMMARY

Putting a price on CO2 (with a carbon tax or a cap and trade system) would improve the market economics of projects like the long-distance transmission of wind economic (examined in the recent paper). If the price of CO2 were high enough, the cost savings would approximate (or exceed) the costs of the project.

But there would be adverse consequences as well. Oil and gas consumption would increase, electricity prices would increase, and consumer costs would increase a lot.

A small percentage of the increase in consumer costs would reflect real cost increases (such as the cost of substituting higher-priced natural gas for coal). All the rest of the large increase in consumer costs would be wealth transfers from consumers to the government (about half) and to generation margins (the other half).

APPROACH

As for the recent paper, this study used the DAYZER model developed by Cambridge Energy Solutions.[5] First, a base case (used in the recent study) was run with carbon priced at $50/ton. Then, the wind option – long-distance transmission of additional wind capacity in the Upper Midwest – was added to the base case with carbon priced at $50/ton of CO2. The difference between the two cases is the effect of the wind option given a price of $50/ton of CO2. Also, relative to the initial base case (without CO2 priced at $50/ton), these two runs show the effect of pricing CO2 emissions at $50/ton, with and without additional wind.

FINDINGS

There are two sets of findings reported below. The first set reports the effect of adding the long-distance transmission of wind, when the price of CO2 is $50/ton. The second reports the combined effect of pricing CO2 at $50/ton and adding the long-distance transmission of wind.

[5] This model is available from Cambridge Energy Solutions, 50 Church Street, Cambridge, MA 02138. www.ces-us.com. This model simulates the operation of electricity market and is widely used by electricity market traders and analysts. DAYZER is well-structured to assess the economics of long-distance transmission of wind power because it models the transmission system explicitly, the way electricity really flows in proportion to the impedance on each transmission line, rather than assuming incorrectly that electricity flows as if it were in a pipe between geographic regions. DAYZER represents each transmission line and the constraints thereon, plus each generator and load bus. Further, it operates on an hourly basis, enabling it to capture wind generation by hour flowing over transmission lines and constraints by hour given the generation of all generating units by hour.

Effect of Additional Wind and Long-Distance Transmission When CO2 Is Priced at $50 per Ton

In a market where CO2 is priced at $50 per ton, the generation cost savings approximate the annual costs of the additional wind generation and long-distance transmission. See Exhibit 1.

Emissions and fossil fuel use would be lower because the additional wind generation would substitute for generation from fossil fuels.

Exhibit 1

EFFECTS OF LONG DISTANCE TRANSMISSION OF ADDITIONAL WIND GENERATION IN THE UPPER MIDWESTWHEN CO2 IS PRICED AT $50 PER TON

		Base with $50 CO2	Wind with $50 CO2	Effect of Wind	%
Emissions	1000 tons/year				
	NOX	500	435	-65	-13%
	SOX	1,813	1,586	-227	-13%
	CO2	347,430	312,045	-35,385	-10%
Fuel Use	10^12 BTUs/year				
	Coal	2,691	2,362	-329	-12%
	Gas	1,416	1,383	-33	-2%
	Oil	15	16	1	4%
	Wind and Other	3,207	3,602	394	12%
	Total	7,329	7,362	33	0%
Prices	Average $/MWH				
	East	$83.4	$82.9	($0.5)	-1%
	West	$73.8	$71.7	($2.1)	-3%
	Total	$77.3	$76.4	($0.9)	-1%
Costs	$Billions/year				
	Consumer coats	$62.3	$61.6	($0.7)	-1%
	Generation costs	$43.8	$41.1	($2.8)	-6%
	Real Resource costs	$26.2	$25.2	($1.0)	-4%

Prices would be lower because the wind generation would substitute for the highest-priced generation in any hour, thereby reducing the market price. The prices would be lower and the price reductions would be greater in the West of the PJMRTO (Illinois, Indiana, Ohio, and West Virginia) than in the East of the PJMRTO (Pennsylvania, New Jersey, Maryland, Delaware, DC, and Virginia) because transmission constraints limit the flow of lower-priced electricity from West to East.

There are three measures of costs. Consumer costs are what consumers would pay for the electricity they would purchase (and what generators would get for the electricity they sell). Changes in consumer costs are driven by changes in the market price of electricity. Generation costs include the fuel, operations and maintenance, and emission allowance costs required to generate the electricity. Changes in generation costs represent changes in the costs of generating electricity. Real resource costs are the cost of producing electricity minus the cost of emission allowances, since these are a transfer from the producer (and consumer) to the government.

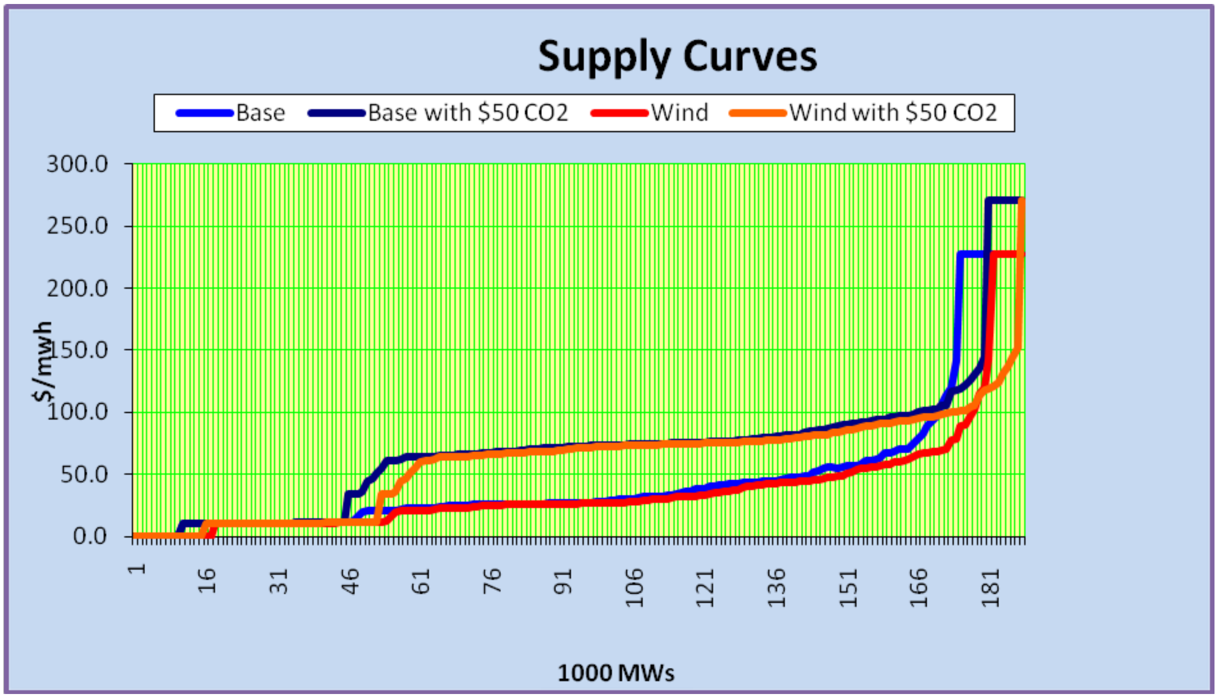
The generation cost savings ($2.8 billion) are greater when carbon is priced at $50 per ton of CO2 than when there is no price on CO2 ($1.1 billion). [6] This is because the CO2 emissions reduced by the additional wind generation are priced at $50/ton rather than zero. The real resource cost savings are about the same, because the value of CO2 emissions is not included in that measure.

The consumer cost savings ($0.7 billion) are less when CO2 is priced at $50/ton than when it isn't ($3.2 billion)[7] because the supply curves with and without wind are closer together. The cost of the previously lower cost coal-fired generation is increased a lot by pricing CO2 at $50/ton, from about $30/MWH to $75/MWH. The price of oil/gas generation is also increased, but by a lesser amount because CO2 emissions from oil/gas-fired generation are less than from coal-fired generation. The effect of wind is still to substitute for the higher-priced generation that was on the margin setting the price, but the cost of the lower-priced generation is much higher than it was, resulting in less of a market price decrease. See Exhibit 2 on next page.

[6] Reported in "Economics of Long-Distance Transmission of Wind Power," by Hoff Stauffer of the Wingaersheek Research Institute, May, 2009

[7] Ibid

Exhibit 2
PJMRTO SUPPLY CURVE



The $3 billion in generation cost reductions reported above is materially less than the $5+ billion reported in the CRA study.[8] Interestingly though, the 35 million tons of CO2 emissions reductions reported above is very close to the 34 million reported in the CRA study. CRA did not provide sufficient detail to sort out the reasons for this material difference in cost savings, but one of the reasons is no doubt the nature of the models employed to make the forecasts. Another may be that this study uses more recent wind data. Also, CRA uses an unusual measure of costs that is a combination of generation costs and consumer costs. Finally, CRA may have used higher prices for natural gas and CO2 emission allowances and lower prices for coal.[9]

The generation cost per ton removed would be close to zero, since the $50 per ton has been priced into the market. But consumer costs per ton removed would be higher since prices would not be affected as much as costs when CO2 is priced at $50 per ton. See Exhibit 3 on next page.

[8] See the direct testimony of Ira Shavel of CRA on behalf of the Green Power Express LP. See Exhibits GPE-400 and 401 of Green Power Express submission to FERC.

[9] A sensitivity analysis was performed that increased the price of natural gas by about 50%. However, there was no material change in the generation cost savings.

Exhibit 3

COST PER TON REMOVED
WHEN CO2 IS VALUED AT $50 PER TON

	Costs	Savings	Net Costs	Cost per ton of CO2 Removed
Consumer costs	$3.0	($0.7)	$2.4	$67
Generation costs	$3.0	($2.8)	$0.3	$8
Real Resource costs	$3.0	($1.0)	$2.1	$59

The cost per ton removed is higher for real resource costs because they do not include the market price of CO2.

Combined Effect of Pricing CO2 at $50 per Ton Plus Additional Wind and Long-Distance Transmission Relative to the Base Case

Relative to the Base Case, the combined effect of additional wind and long-distance transmission plus pricing CO2 at $50/ton would be lower emissions, since the additional wind generation would substitute for fossil generation. Also, gas-fired generation would substitute for coal-fired generation, since the costs of coal-fired generation with higher CO2 emissions would increase more than the costs of gas-fired generation with lower CO2 emissions, as a result of pricing CO2 at $50/ton.

But, there would be adverse consequences as well. Oil/gas use would increase, because of the substitution of gas-fired generation for coal-fired generation. Also, the price of electricity would increase, and both consumer and generation costs would increase a lot. See Exhibit 4.

Exhibit 4

COMBINED EFFECT

		Base	Wind with $50 CO2	Effect of Wind and $50 CO2	%
Emissions	1000 tons/year				
	NOX	771	435	-336	-44%
	SOX	2,598	1,586	-1,013	-39%
	CO2	438,240	312,045	-126,195	-29%
Fuel Use	10^12 BTUs/year				
	Coal	3,880	2,362	-1,518	-39%
	Gas	459	1,383	924	201%
	Oil	14	16	2	16%
	Wind and Other	3,366	3,602	235	7%
	Total	7,718	7,362	-357	-5%

Prices	Average $/MWH				
	East	$45.8	$82.9	$37.2	81%
	West	$33.9	$71.7	$37.8	114%
	Total	$42.9	$76.4	$33.5	78%
Costs	$Billions/year				
	Consumer costs	$30.6	$61.6	$31.0	101%
	Generation costs	$24.1	$41.1	$16.9	70%
	Real Resource costs	$23.4	$25.2	$1.8	8%

The substitution of gas for coal in electricity generation might turn out to be greater than reported above. The above substitution results from increasing generation from existing gas-fired generators to replace generation from existing coal-fired generators. This substitution does not account for the possibility of switching fuels, where an existing coal-fired generator would burn gas rather than coal.

Reducing emissions is clearly a good thing to do, but substituting gas fired-generation for coal-fired generation is not necessarily a good way to do it. Both oil and gas are imported at the margin, and such imports have adverse national security and macroeconomic implications. Also, increased natural gas consumption would result in higher natural gas prices, thereby inhibiting the use and environmental benefits of cleaner natural gas in other sectors.

The costs per ton removed would be high, except for real resource costs which do not include the price of carbon. See Exhibit 5.

Exhibit 5

COMBINED EFFECT

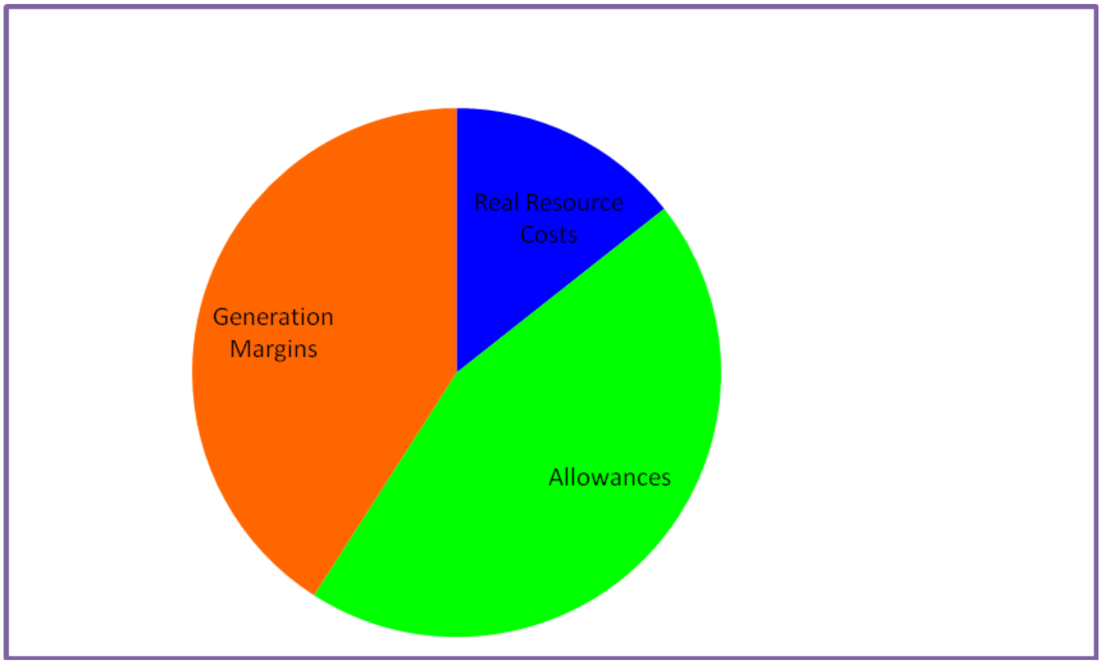
	Costs	**Negative Savings**	**Net Costs**	**Cost per ton of CO2 Removed**
Consumer costs	$3.0	$31.0	$34.1	$270
Generation costs	$3.0	$16.9	$20.0	$158
Real Resource costs	$3.0	$1.8	$4.9	$39

The increase in generation costs ($20 billion) has two components. One component is the real resource costs ($4.9 billion), which are the actual costs of the steps taken to reduce emissions, such as substituting natural gas-fired generation for coal-fired generation. The other component is the increased costs of allowances ($15.1 billion), which would flow to/thru the government.

The increase in consumer costs would be greater than the increase in generation costs. This is because the price effect is greater than the cost effect. As shown on Exhibit 2 above, the supply curve would shift up a lot, increasing prices in all hours, whereas costs are increased only for the generation with CO2 emissions. This means that generation margins would increase, by about $14 billion. See Exhibit 6.

Exhibit 6

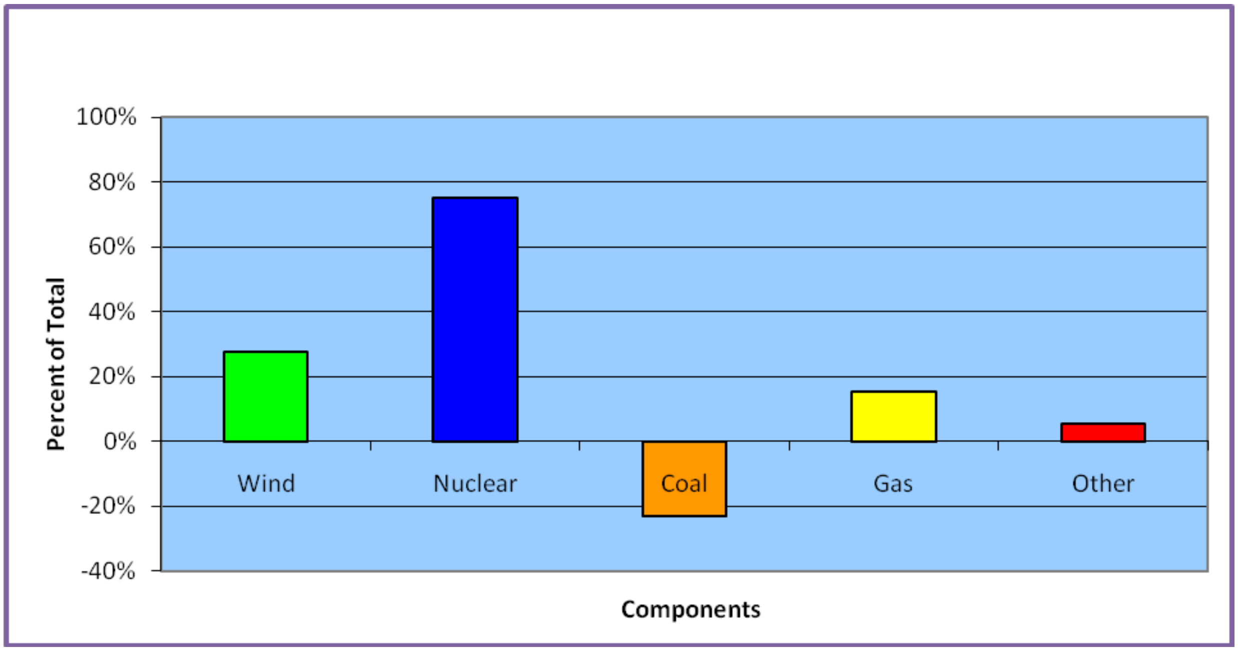
COMPONENTS OF CHANGE IN CONSUMER COSTS: BASE CASE VS CASE WITH ADDITIONAL WIND AND CO2 PRICED AT $50/TON



The generators with no CO2 emissions (wind, nuclear, and other which includes hydro) would capture most/all of the increase in generation margins. The increased margins of gas generation would be approximately offset by the decreased margins of coal generation. See Exhibit 7 on the next page.

Exhibit 7

CHANGE IN MARGINS BY TYPE OF GENERATOR: BASE CASE VS CASE WITH ADDITIONAL WIND AND CARBON PRICED AT $50/TON



Within the group with no CO2 emissions, the nuclear generators would capture about 75% of the increased margins.

POLICY IMPLICATIONS

The findings of the recent study[10] support the economics of long-distance transmission of additional wind generation in the Upper Midwest to the Midwest and East, if the reduced CO2 emissions were valued at about $50 per ton or more. Adopting a $50/ton market price for CO2 emissions is one way to encourage such a project.

But putting a price on CO2 emissions would have adverse consequences on other important measures.[11] The combined effect of such a project and a $50/ton market price on CO2 would result in a large increase in gas consumption and a doubling of consumer costs for electric generation. Since generation represents about 50% of a consumer's total bill for electricity, the total consumer bill would increase by about 50%.

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[10] Stauffer, op cit

[11] A higher market price for CO2 would further improve the economics of such a project, but the adverse consequences would increase as well.

The increase in gas consumption (likely imported on the margin) has clear adverse consequences (national security, macroeconomic, and environmental).

The effect on consumer costs is a political problem more than an economic problem. Only about 14% of the increase is consumer costs would be real resource costs. The rest would be wealth transfers from the consumers to the government and to generation companies.

The allowances or tax proceeds (about $15 billion per year) would flow from the consumers to the government. The government could use these in many ways. One way would be to mitigate the consumer cost increases.

However, the rest (about $14 billion per year) of the large consumer cost increase would flow to generation companies (particularly to nuclear generation companies) in increased generation margins. The political process would have to deal with the equity of this transfer of wealth.

These wealth transfers were not an issue when the acid rain legislation was enacted in 1990, because the electric utilities were regulated (and they still are in some parts of our country). There were no competitive electricity markets. Hence, cost increases resulted in regulated rate increases, but not in market price increases, because there was no market price. The only infra-marginal effect was the prices paid for allowances. Costs at the margin to reduce sulfur dioxide (SOx) emissions did not affect what consumers paid for generation with no SOx emissions (such as hydro and nuclear). There were wealth transfers (via the price of allowances) from consumers to government, but there were no wealth transfers from consumers to generators with no SOx emissions.

In order to reduce CO2 emissions in electricity markets, at least three major steps must be taken. First, economic projects such as the long-distance transmission of wind must be built, when the benefits (including the value of reduced emissions) exceed the costs. Second, uncontrolled new coal-fired power plants must not be built. Third, existing coal-fired power plants must be replaced with cleaner generation (and/or reduced consumption). Putting a price on CO2 emissions can create market incentives for all three of these steps. However, putting a price on CO2 emissions would have the adverse consequences described above.

Traditional regulation can ensure that these steps are taken. Wind/transmission projects could be approved by current regulatory processes and the costs could be borne by the consumers who would benefit. EPA could promulgate a performance standard that requires significant control of CO2 emissions for new coal-fired power plants. Also, EPA could set a mandatory retirement age for existing coal-fired power plants. If EPA set a retirement age at age 60 on existing coal-fired plants, CO2 emissions (in the electricity market assessed) would be reduced by about 45 percent in 2030 and by about 75% in 2040.

These new regulations would have costs, just as a pricing carbon would have costs, but the adverse consequences would be less. A big advantage of traditional regulation is that it works only at the margin, such as on new wind/transmission projects, new power plants, and existing power plants that are too old. The competitive markets would comply with the regulations in the most cost-effective way. All the rest of the generation - the infra-marginal generation - would not be directly affected. The shift from coal to gas would be much less, because the cost of existing coal-fired generation would not increase. The market price would eventually increase to cover the full costs of the best new generation option, but this increase would not occur until new generation capacity was required. Also, this increase would be less because no price would have to be paid on the residual carbon emissions from the new generation option. Hence, wealth transfers from consumers to generators with no CO2 emissions would be reduced.

Traditional regulation combined with less reliance on carbon prices could accomplish the same or more emission reductions with reduced adverse consequences. Also, traditional regulation could supplement low carbon prices to accomplish the carbon reductions that are needed. Finally, traditional regulation would help keep carbon prices lower than they would be without traditional regulation, thereby reducing the consumer cost increases and wealth transfers.