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Cap, Auction, and Trade

*Auctions and Revenue
Recycling under Carbon
Cap and Trade*

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Summary of Testimony

Cap, Auction, and Trade: Auctions and Revenue Recycling under Carbon Cap and Trade

A majority of economists favor the use of auctions over the free allocation of emissions allowances. One reason is that an auction satisfies the principle of simplicity and transparency. It is administratively simple and precludes regulated parties from seeking a more generous future allocation. The second and equally forceful reason is that it makes available funds that can be used to achieve related goals. Depending on how these revenues are used, they can help reduce the cost of policy significantly.

The harm to industry in the aggregate represents no more than 30 percent of the value of emissions allowances. Special attention is often focused on the electricity sector because it holds the potential for the largest emissions reductions in the first decades of climate policy. The harm in that sector in the aggregate is equal to only 6 percent of total allowance value. However, this statistic masks the fact that many firms are winners. Compensating firms is problematic because the delivery of compensation will be imprecise. Depending on the approach used and the compensation target, the opportunity cost of delivering compensation may be several times the amount of deserved compensation because much of the compensation will accrue to undeserving firms. Meanwhile, the harm to consumers in the electricity sector is eight times greater than that to producers. The best way to deliver compensation to consumers would be through broad-based approaches that preserve and enhance the efficiency advantages of an auction. Some leading possibilities would be revenue recycling to achieve broad-based reductions in preexisting taxes, investments in energy efficiency and research, and direct rebates of revenue to individuals.

Written Testimony of Dallas Burtraw

Cap, Auction, and Trade: Auctions and Revenue Recycling Under Carbon Cap and Trade

Mr. Chairman, thank you for the opportunity to testify before the House Select Committee on Energy Independence and Global Warming. My name is **Dallas Burtraw**, and I am a senior fellow at Resources for the Future (RFF), a 55-year-old research institution based in Washington, D.C., that focuses on energy, environmental, and natural resource issues. RFF is independent and nonpartisan and shares the results of its economic and policy analyses with environmental and business advocates, academics, government agencies and legislative staff, members of the press, and interested citizens. RFF neither lobbies nor takes positions on specific legislative or regulatory proposals. I emphasize that the views I present today are my own.

Over the past 18 years, I have studied the performance of emissions cap-and-trade programs from both scholarly and practical perspectives. I have studied the sulfur dioxide (SO₂) emissions allowance trading program created by the 1990 Clean Air Act Amendments and the nitrogen oxide (NO_x) trading program in the northeastern United States. I also have studied the European Union Emission Trading Scheme (EU ETS). I have conducted analysis and modeling to support the northeastern states in the design of the Regional Greenhouse Gas Initiative (RGGI). Recently I worked with a team of researchers to develop recommendations for the design of an auction in RGGI on behalf

of the New York State Energy Research and Development Authority.¹ I also worked with a team to provide guidance for the State of Maryland as it implements its plan to join RGGI.² Last year I also served on California's Market Advisory Board for implementation of the state's Assembly Bill 32, the centerpiece of the state's greenhouse gas initiative.³

I have been asked to comment generally on **how emissions allowances are allocated (i.e., initially distributed)** in the implementation of a cap-and-trade program. I will address six specific questions.

1. What are the efficiency benefits of robust auctions of allowances under a cap-and-trade system?

There are not many viewpoints you can get economists to agree on, but one exception is the role of an auction in the implementation of an emissions cap-and-trade program. The vast majority of public finance economists would recommend an auction as the most efficient way to allocate emissions allowances. There are several reasons for this. I will put them into two categories.

First, an auction satisfies the principle of simplicity and transparency. This is an important principle for the formation of a new market for an environmental commodity.

¹ Holt, C., Shobe, W., Burtraw, D., Palmer, K., and Goeree, J. 2007. *Auction Design for Selling Co2 Emission Allowances under the Regional Greenhouse Gas Initiative* (October 29).

² Center for Integrative Environmental Research, University of Maryland. January 2007. *Economic and Energy Impacts from Maryland's Potential Participation in the Regional Greenhouse Gas Initiative*.

³ *Recommendations for Designing a Greenhouse Gas Cap-and-Trade System for California*. 2007. Recommendations of the Market Advisory Committee to the California Air Resources Board, (June 20).

Compared with other approaches, an auction helps maintain transparency and the perception of fairness, and it leads to more efficient pricing of goods in the economy, which reduces the cost of the policy.

Generally speaking, auctions are viewed as more transparent than administrative approaches to the initial distribution of allowances. Parties have strong incentives to argue for an ever-increasing share of emissions allowances through free allocation, but the literature suggests that the use of auctions in telecommunications leads to less litigation.⁴ Many authors suggest that auctions reduce what economists call “rent-seeking behavior,” which is the incentive for regulated parties to invest resources in trying to affect the outcome of an administrative process that distributes allowances freely.⁵

One particularly insidious aspect of free allocation is the adjustment to allocation rules that are usually made for new emissions sources and for old sources that retire. The SO₂ trading program has no adjustments for these sources, which is a virtue because it does not create incentives that would entice investment behavior to deviate from what is otherwise efficient. However, most other trading programs have such adjustments. In the NO_x budget program, for example, individual states determine the allocation of allowances; most have set-asides for new sources, and sources that retire lose their allocations. Adjustments also are ubiquitous in the EU Emission Trading Scheme. The problem with such adjustments is that they alter the incentives for investment and retirement in a way that can lead to unintended consequences. For instance, there is evidence that as a result of adjustments to allocation rules for new sources in the EU, the

⁴ Binmore, K., and P. Klemperer (2002). “The Biggest Auction Ever: The Sale of the British 3G Telecom Licenses.” *The Economic Journal* 112: C74–C76.

⁵ Hepburn, C., Grubb, M., Neuhoff, K., Matthes, F., and Tse, M. 2006. “Auctioning of EU ETS Phase II Allowances: How and Why?” *Climate Policy* 6(1): 137–60.

value of emissions allowances can cause less economic and higher-polluting emissions sources to be a preferred investment relative to other technologies. This can result from the value of the subsidy that is received by those sources in the form of free allocations. Furthermore, the removal of allocations from sources that retire provides a financial incentive to continue the operation of existing facilities that are often inefficient and that otherwise would retire except for the value of the allowances that they earn by remaining in operation.⁶ The use of an auction avoids this predicament entirely.

Another reason that an auction has efficiency benefits applies specifically to the electricity sector. Compared with free allocation, an auction approach tends to reduce the difference between price and marginal cost for electricity generation—a source of inefficiency that is endemic to the electricity industry.⁷

The second and equally forceful reason that economists favor an auction is that it makes available funds that can be used to achieve other goals. Depending on how these revenues are used, they can help reduce the social cost of climate policy in an important way.

For the purposes of minimizing the cost of climate policy on the economy and promoting economic growth, economists would favor dedicating the use of revenue from an auction to reduce preexisting taxes. This is especially important in the context of

⁶ Åhman, M., Burtraw, D., Kruger, J., and Zetterberg, L. 2007. “A Ten-Year Rule to Guide the Allocation of EU Emission Allowances.” *Energy Policy* 35(3): 1718–30.

⁷ Beamon, J.A., Leckey, T., and Martin, L. 2001. “Power Plant Emission Reductions Using a Generation Performance Standard.” Draft. Washington, DC: U.S. Department of Energy, Energy Information Administration. Burtraw, D., Palmer, K., Bharvirkar, R., and Paul, A. 2001. “The Effect of Allowance Allocation on the Cost of Carbon Emissions Trading.” RFF Discussion Paper 01-30, Washington, DC: Resources for the Future. Burtraw, D., Palmer, K., Bharvirkar, R., and Paul, A. 2002. “The Effect on Asset Values of the Allocation of Carbon Dioxide Emission Allowances.” *The Electricity Journal* 15(5): 51–62. Parry, I.W.H. 2005. “Fiscal Interactions and the Costs of Controlling Pollution from Electricity.” *Rand Journal of Economics* 36(4): 850–70.

climate policy because it is likely to represent the most significant environmental initiative the country has ever pursued. Like any new regulation, climate policy imposes costs on households and firms, and that cost acts like a virtual tax, reducing the real wages of workers. This hidden cost can be especially large under a cap-and-trade program because the price placed on the scarcity value of carbon is reflected in the cost of goods that use carbon in their production. However, one of the most important findings in environmental economics and public finance in the past 15 years is that the use of revenue raised through an auction (or an emissions tax), if dedicated to reducing other preexisting taxes, can reduce this cost substantially. This so-called revenue recycling would have truly dramatic efficiency advantages compared with free distribution.⁸

Some portion of auction revenue could be used in several ways to help reinforce program goals and lessen the impact of climate policy. For example, the Model Rule for the 10 northeastern states participating in RGGI specifies that each state must allocate at least 25 percent of its budgeted allowances to a consumer benefit or strategic energy purpose account. These “consumer benefit” allowances are to be sold or otherwise distributed to promote energy efficiency, to directly mitigate electricity ratepayer impacts, or to promote lower-carbon-emitting energy technologies. (Six of the 10 RGGI

⁸ Bovenberg, A.L., and Goulder, L.H. 1996. “Optimal Environmental Taxation in the Presence of Other Taxes: General Equilibrium Analyses.” *American Economic Review* 86: 985–1000. Bovenberg, A., and de Mooij, R. 1994. “Environmental Levies and Distortionary Taxation.” *American Economic Review* 84: 1085–89. Goulder, L.H., Parry, I.W.H., Williams III, R.C., and Burtraw, D. 1999. “The Cost-Effectiveness of Alternative Instruments for Environmental Protection in a Second-Best Setting.” *Journal of Public Economics* 72(3): 329–360. Parry, I.W.H., Williams, R.C., and Goulder, L.H. 1999. “When Can Carbon Abatement Policies Increase Welfare? The Fundamental Role of Distorted Factor Markets.” *Journal of Environmental Economics and Management* 37(1): 52–84. Smith, A.E., Ross, M.T., and Montgomery, W.D. 2002. “Implications of Trading Implementation Design for Equity-Efficiency Trade-Offs in Carbon Permit Allocations.” Washington, DC: Charles River Associates.

states so far intend to auction 100 percent of their budgeted allowances.) In a study for the State of Maryland, we found that the dedication of 25 percent of the allowance value to investments in end-use efficiency could offset any increase in retail electricity price that would occur from the state's joining RGGI.⁹ This research indicates that investing just a portion of the allowance revenues can offset the impact of the policy on consumers while also advancing climate policy goals.

Auction revenue also can help support the attainment of efficiency in our energy infrastructure more broadly. A small sliver of auction revenues would provide a relatively substantial infusion of support for research and development of new technologies, or it could provide incentives for investment, such as an investment tax credit aimed at promoting innovative technologies or modernizing industries that are especially vulnerable to the policy.

Finally, a related issue involves adaptation to climate change. Atmospheric scientists tell us that we are already at the point where some climate warming is inevitable and that adaptation will be necessary. Adaptation to climate change will likely involve significant investment by the private and public sectors. An auction provides revenues that can be directed toward these adaptation activities.

2. Compared with a full auction of allowances, would free allocation of allowances significantly reduce economic impacts on consumers, and if not, why not?

⁹ Center for Integrative Environmental Research, University of Maryland. January 2007. *Economic and Energy Impacts from Maryland's Potential Participation in the Regional Greenhouse Gas Initiative.*

Our modeling indicates that the group most affected by climate policy will be consumers. The electricity sector has been studied in detail because it constitutes about 40 percent of the nation's CO₂ emissions, but it is expected to provide two-thirds to three-quarters of emissions reductions in the first decades of a policy. When 100 percent of CO₂ emissions allowances used by the electricity sector are auctioned, we find that although firms bear some cost, consumers of electricity bear an eight times greater cost. This results because firms in the electricity sector are able to pass costs along to consumers through increasing prices. The burden to consumers reflects the vast majority of the cost of climate policy to the electricity sector.

It is interesting to consider where impacts are felt by electricity consumers. Figure A illustrates the changes that would occur under a \$15 allowance price in the year 2015. Arrayed across the bottom is a sampling of regions of the country based on the share of coal-fired electricity generation, represented by the growing mountain from left to right. The dotted line across the graph represents the average electricity price that is expected nationally from the CO₂ price of \$15/ton. The lower part of each bar represents the electricity price in the base case with no federal CO₂ cap, and upper part represents the increase in electricity price that would result from the policy. There are two things to note from this figure. One is that those regions of the country that use the most coal use will experience the greatest change in electricity price. The second is that these regions will still have lower electricity prices than other parts of the country. In other words, the electricity customers who would bear the greatest change in costs due to climate policy still end up with prices that are lower than much of the nation.

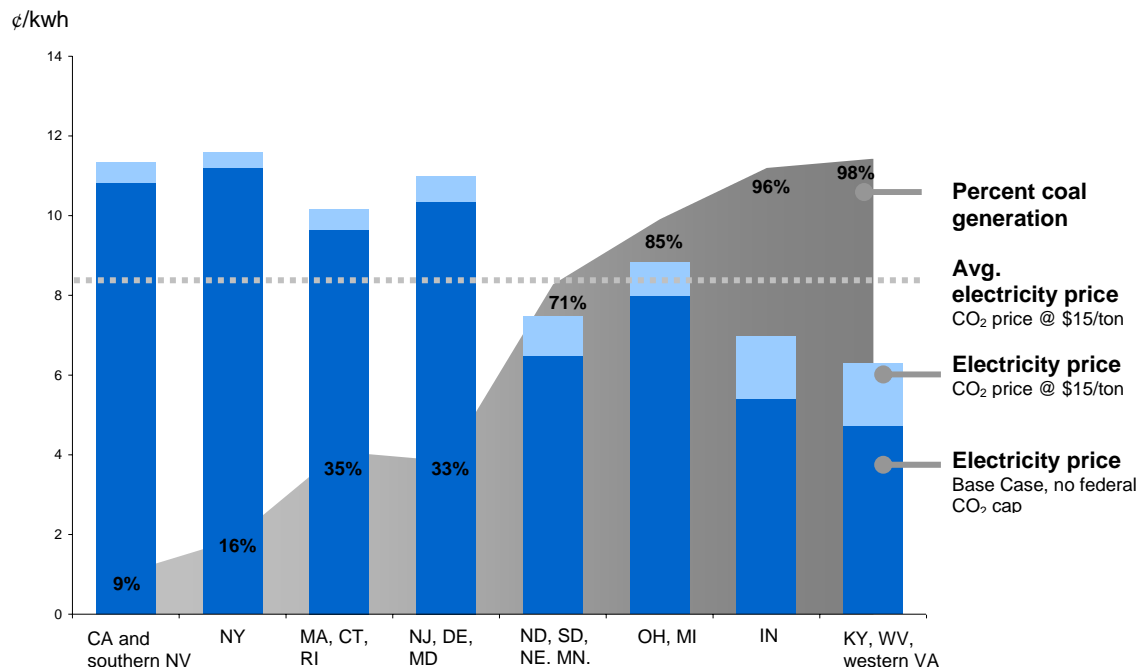


Figure A. Distribution of change in electricity prices by region (2015).

In some cases the free allocation of allowances can reduce economic impacts on consumers, but whether that occurs depends on how free allocation occurs and to whom it is directed. As a general principle, in competitive markets free allocation to firms will not benefit consumers because the economic value of a commodity in a competitive market is determined by its scarcity. Emissions allowances are a valuable asset, and as long as there is a liquid allowance market, a firm can sell allowances at the market price instead of using them for its own compliance responsibilities. Therefore, the firm will recognize the lost opportunity for revenue from the sale of an allowance each time it uses the allowance itself for compliance.

The fact that a firm in a competitive market will charge its customers for the use

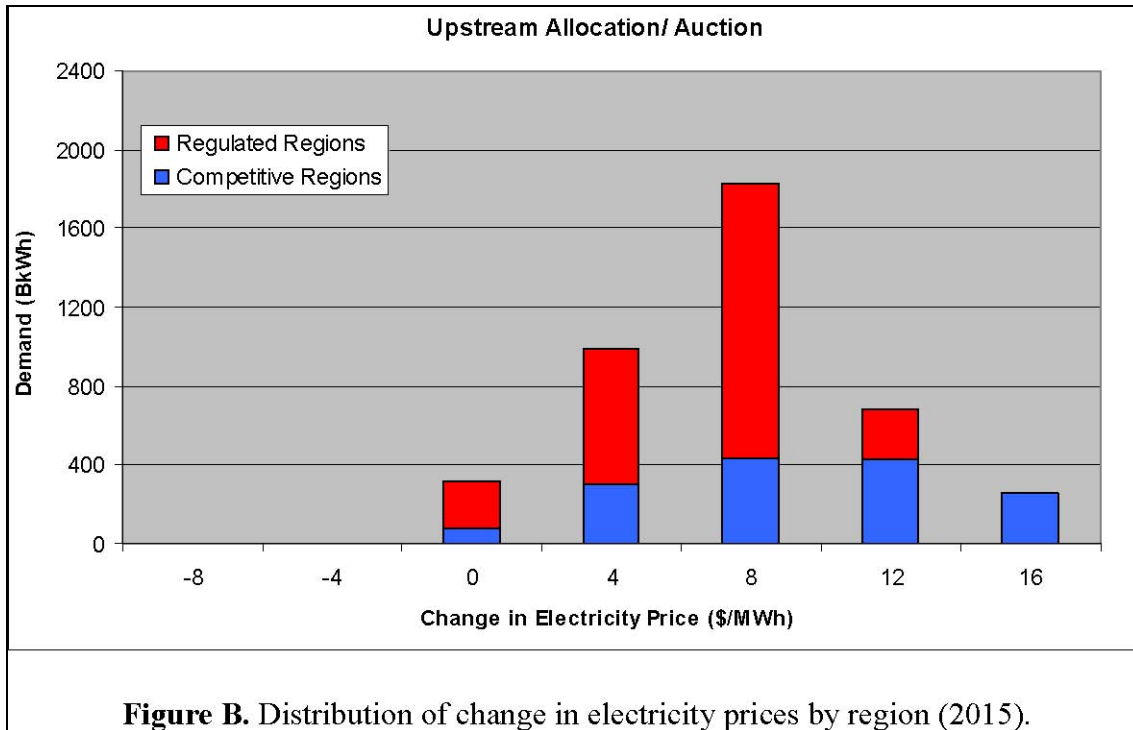
of an asset that the firm has received for free is often a difficult idea for people to grasp at first, but it is wholly consistent with economic theory and it is in general what is observed in empirical studies. Indeed, sometimes economists seek evidence of noncompetitive behavior and “market power” by looking for instances when the price of a good differs from the cost of factor inputs used in its production. An emissions allowance in a cap-and-trade program is one such factor. If a firm did not pass through the cost of an allowance in the pricing of its product, it would be *prima facie* evidence of a noncompetitive market—and of possible market manipulation.

In a recent project, we conducted laboratory economic experiments with human subjects to see how people actually behaved when faced with a pricing decision in the context of allowance trading. In the experiments, subjects were rewarded financially for how well they performed in the laboratory. Subjects were asked to determine the price for a good they were going to sell into a market, and production of that good required the use of an allowance along with other inputs. The subjects were sometimes given allowances for free, and sometimes they had to pay for them. In the laboratory we found a variety of behaviors; at first many subjects did not include the value of an allowance in setting their product price when they received the allowance for free. But subjects who did behave in accordance with economic theory had substantially greater earnings. Furthermore, we observed learning. Subjects who did not charge for the allowances they received for free learned quickly through trial and error that they could boost their earnings by doing so.

In a competitive market, the degree to which firms are actually able to charge customers for any change in cost depends on technical issues involving the relative elasticities of demand and supply, but theory clearly indicates that firms will charge

customers to the degree they are able to do so. The use of allowances constitutes a change in the cost of production. The important idea is that the ability of firms to pass on a change in the cost of production does not hinge on how they received the allowances initially. Sometimes one hears firms arguing to the contrary, saying, “We would not charge our customers for emissions allowances we received for free!” When one hears this, one might think that a different conversation needs to occur between those firms and their shareholders, because it is shareholder value that is being given away if such behavior is evident in fact.

Economists think most markets are fundamentally competitive, at least in the long run, so in most markets economists would not expect to see consumers receive the benefit from free allocation to firms. However, a substantial portion of the electricity market is not competitive, but instead operates under cost-of-service regulation. In these cases regulators set prices to allow firms to recover their costs, and costs are calculated on an original cost basis. If allowances are received for free by regulated electricity generators, then the addition to the cost basis for the purpose of cost recovery is zero. This is the one case where the benefit of free allocation to emitters or producers can be expected to be passed on to consumers. Roughly speaking, this situation applies to about half of the electricity customers in the country.



That some electricity consumers can be expected to benefit from free allocation to producers in regulated regions of the country but those in regions with market-based prices will not introduces a challenging dilemma to climate policy. Figures B and C illustrate this dilemma.¹⁰ Figure B shows the change in retail electricity price that could be expected from a modest climate policy that introduces a price on allowances of \$15/ton. The two colors in Figure B correspond to customers in regulated and competitive regions of the country. More or less, both sets of customers would experience a similar change in price under an auction; the difference would be driven primarily by the carbon intensity of electricity generation, which is consistent with the way a cap-and-trade program is expected to work.

¹⁰ Burtraw, D., and Palmer, K. 2007. "Compensation Rules for Climate Policy in the Electricity Sector." Resources for the Future Discussion Paper 07-41, and additional analysis.

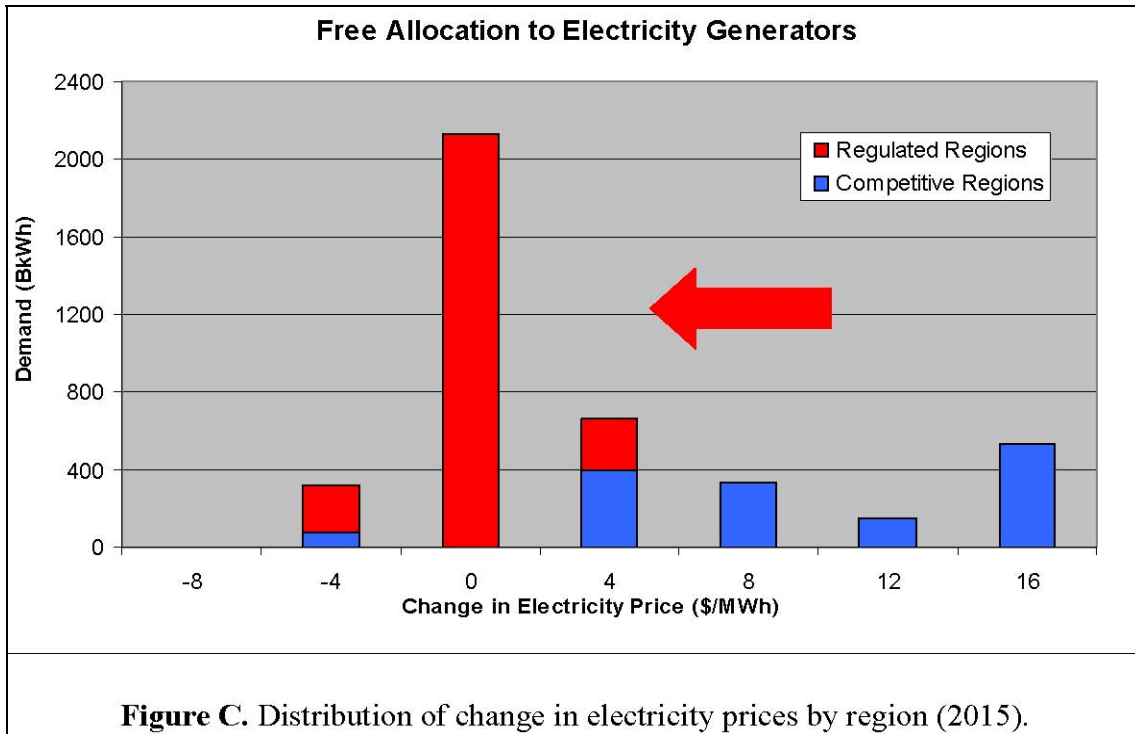
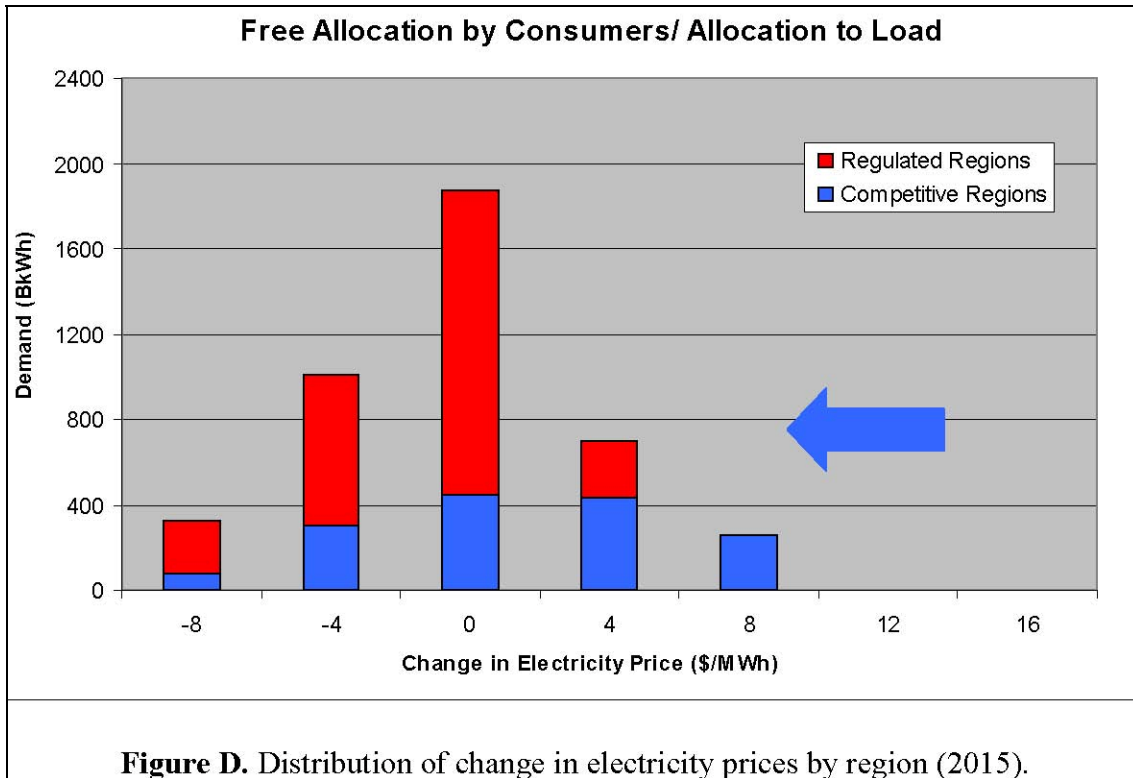


Figure C. Distribution of change in electricity prices by region (2015).

Figure C illustrates what would happen to electricity prices if there were free allocation to producers. In this case producers in regulated regions would be expected to allow their customers to receive the benefit of free allocation, but producers in competitive regions would not. The consequence is that an asymmetry emerges that is tied not to the amount of carbon emissions but rather to the nature of electricity sector regulation. For advocates of free allocation, this dilemma has been one of the most difficult stumbling blocks in thinking through how to craft climate policy: under free allocation, electricity customers in different regions are treated differently.



One other way that free allocation could directly benefit electricity consumers would be if that allocation were given to consumers directly, rather than to producers. This approach would allocate allowances to “load-serving entities,” the retail electricity companies that deliver electricity to customers. In general, the retail electricity distribution companies would be expected to share the value associated with free allocation with customers. Although retail companies would see the cost of power in the wholesale power market increase under a cap-and-trade program, they would have substantial allowance value to apply against that cost increase, and this would reduce the cost impact for their customers. The consequences of this type of policy are illustrated in Figure D: free allocation to retail electricity load-serving entities on behalf of their customers on the basis of consumption would tend to recover the symmetry in the impact of climate policy across regulated and competitive regions. For this reason, this approach

has gained some support as a potential path to compromise from surprisingly different types of firms in the electricity industry. Furthermore, it would soften the impact on electricity customers substantially. It begs the question of whether allocation to load should be on the basis of consumption, emissions, population, or some weighted average. Each approach produces a somewhat different result.

Unfortunately, free allocation to load-serving entities comes with an important efficiency cost. When electricity customers do not see the increase in retail electricity prices, they have no incentive to reduce electricity consumption: their electricity bills (and national climate policy) will play less of a role when it comes time to purchase a new refrigerator, so they will be less inclined to choose an efficient model. Across the sector, this effect would lead to more electricity consumption, and under an economy-wide program, it would lead to more emissions from the electricity sector. In the example we modeled, it leads to a 15 percent increase in allowance price under the cap-and-trade program and requires greater emissions reductions for the rest of the economy. Essentially, the free allocation to electricity customers is a subsidy to electricity consumption that is not received by users of natural gas or transportation fuels or by industry or commerce, except to the degree that they consume electricity. That means that more emissions reductions have to be achieved in these other sectors, which raises the cost of climate policy in an important way. Nonetheless, because free allocation to customers has the political virtue of lessening the price effect, it remains an idea for how to construct a transition path to phasing in a full auction in the electricity sector.

There is one other way that consumers can benefit from free allocation. That is if consumers, as citizens, receive allowance value directly. This approach has recently been

called “cap, auction, and rebate.” The idea is that allowance values from an auction could be returned directly to every individual who has a social security number. It would be the most progressive in its distributional consequences of all the approaches that have been suggested. Other than direct allocation on a per capita basis or some other formula that might take advantage of information about household income or some other criterion, the other way to achieve broad-based compensation for consumers is recycling the revenue raised in an auction to reduce preexisting taxes.

3. To what extent do full or robust auctions deprive polluters of the capital needed to invest in achieving substantial reductions in greenhouse gas emissions?

I have the most knowledge about the electricity sector. In this sector over the past 15 years, the major share of new investment in generation has come from nonregulated entities. As a change from the somewhat distant past, when projects were funded with corporate financing, today the industry generally relies on project-specific financing, meaning that each project is evaluated and financed independently with capital from outside the firm. This trend is likely to continue into the future. As a consequence, I believe, a change in the cost of operation is not likely to have a first-order effect on the availability of capital for financing new projects.

A different issue involves the cost of capital in the industry. Firms in regulated regions of the country enjoy a lower cost of capital because of the presumed lower risk associated with their investments. This is a separate issue but one that may be relevant in thinking about how to finance large investments in new technology in the future.

4. What proportion of allowance value is needed to compensate polluting firms for the economic impacts of climate change legislation?

The need to compensate firms depends on how the effect on firms is measured. Some previous studies have analyzed the effect at the facility level, which provide a high estimate. Effects at the facility level do not make sense because facilities do not have independent standing. Facilities are owned by shareholders, and shareholders own a portfolio of facilities, some of which may lose and others of which may gain value.

Another approach is to measure the effect on firms at the industry level, which yields a relatively low estimate. One general equilibrium study considered the effect of a constant \$25 allowance value sufficient to achieve emissions reductions of 18 percent in the long run.¹¹ Most of the economic effect would be felt in the oil, gas, and coal industries, which could be compensated with just 19 percent of allowance value. Compensating other downstream industries would require somewhat greater allowance value. The most important of these downstream industries is the electricity sector, but that would be much less affected than would the primary fuel sectors in the researchers' model. Another study using a general equilibrium model estimated the effects of a 14 percent decrease in emissions to be achieved by 2010, and a 32 percent decrease by 2030.¹² That study estimated that the reduction in equity value in the electricity sector would be equivalent to 6 percent of the total allowance value. In recent work, we reached a similar estimate using a detailed simulation model of the electricity sector. This value

¹¹ Bovenberg, A.L., and Goulder, L.H. 2001. "Neutralizing the Adverse Industry Impacts of CO₂ Abatement policies: What Does it Cost?" In C. Carraro and G. Metcalf (eds.), *Behavioral and Distributional Effects of Environmental Policy*. Chicago: University of Chicago Press.

¹² Smith, A.E., Ross, M.T., and Montgomery, W.D. 2002. "Implications of Trading Implementation Design for Equity-Efficiency Trade-Offs in Carbon Permit Allocations." Washington, DC: Charles River Associates.

appears relatively small, given that the electricity sector is expected to contribute substantially to emissions reductions throughout the economy. The reason the value is small is that firms own a portfolio of facilities. Although high-emitting power plants will suffer a decline in market value, low- and nonemitting power plants will experience an increase in value. As noted above, the effect at the firm level is the effect over a portfolio of assets. Furthermore, the effect on an industry-wide basis represents the effect over a collection of firms, each holding diverse portfolios.

Overall, one can reasonably conclude that the economy-wide harm, measured as a potential loss in the market value of industries most affected by climate policy, is likely to be equal to or less than 30 percent of the value of emissions allowances. It should be noted that this value masks some differences among firms, especially in the electricity sector, where important regional differences in the fuel and technology used for electricity generation would create winners and losers in the industry. The estimate that 6.4 percent would be sufficient for compensation at the industry level underestimates the cumulative losses for firms that lose value. We find losses at these firms cumulate to 10.6 percent of total allowance value, whereas the gains to firms that realize an increase in value cumulate to 4.3 percent of allowance value. These figures net out to arrive at the 6.4 percent value.¹³

5. Is it feasible to design an allocation formula that could efficiently target compensation to those firms adversely affected by climate change legislation and avoid windfall profits?

The award of free allowances is a blunt instrument for achieving compensation

¹³ Numbers do not add due to rounding.

for producers. This is especially true when implemented at the federal level. Free allocation tends to reward both winners and losers, thereby eroding efficiency and the ability to compensate other affected parties.

We have examined the role of simple decision rules in guiding the delivery of compensation to shareholders in the electricity sector. We examined a variety of approaches that would use publicly available information about facilities' fuel consumption and technology. The best approach was the use of emissions rates averaged across the firm.

If allocation remains a federal responsibility, full compensation could be achieved with 31 percent of allowances nationally. If we first apportion allowances by region, this constitutes 65 percent of the emissions allowances in the competitive regions. This approach still leaves a net gain in the industry equal to four times the harm to the industry in the absence of compensation. In other words, the opportunity cost is five times the magnitude of deserved compensation that is delivered successfully.

As an alternative to federal allocation, we also explored apportionment of allowance budgets to states and decentralized allocation to emitters. If regions or states were apportioned emissions allowances in a manner analogous to emissions budgets under the nitrogen oxide (NO_x) trading programs, compensation would be more efficient. If allowance budgets were implemented on a regional level, the same compensation target could be achieved with just 32 percent of the emissions allowances in competitive regions (15 percent of allowances nationally), leaving a net gain in the industry of 1.5 times the harm in the absence of compensation. This is the

most cost-effective strategy we discovered, and it would require an allowance value that is 2.5 times as great as the harm to the industry in the absence of compensation.

A key finding is that compensation has a significant opportunity cost, especially if the goal is to achieve full compensation. If free allocation to achieve compensation is implemented at the federal level, we find that the incremental cost in allowance value of compensating for the last increment of harm in the electricity sector would be 10 times the magnitude of that harm. Implemented at the regional or state level, that ratio falls, requiring the use of allowance value equal to about 4.5 times the harm. One way to improve the cost-effectiveness of compensation policy is to adopt relatively modest compensation goals. For example, one could fully compensate the firm that is midway between the firm that just barely loses from the policy and the firm suffering the greatest harm, allowing firms that are worse off than this one to continue to suffer some harm. This approach requires compensation equal to 11 percent of the allowance value nationally, or 22 percent in competitive regions. The magnitude of allowance value used for compensation would be 1.5 times the harm to the industry in the absence of compensation, still leaving many winners as well as some moderate losses. Nonetheless, under any strategy, there are important considerations regarding the difficulty of targeting compensation to its intended recipients and the opportunity cost of diverting allowance value from other purposes.

6. To what extent are the economic impacts of legislation on polluting firms likely to be spread among shareholders who hold diversified portfolios, and how does this affect the rationale for or against seeking to compensate firms?

Measuring the expected impact of climate policy in a granular way helps us

forecast what parts of the economy are vulnerable to the policy. In some cases, specific communities or groups of workers may be hard hit by climate policy, just as certain communities may be hard hit by a warming climate. This information can help policymakers craft compensation and other policies to soften the blow.

However, in this modern age the vast majority of shareholders hold few if any stocks in individual companies. Most assets are held in mutual funds. If most investment occurs not in the form of stock or bond holdings in individual firms but in a portfolio of firms captured in various industry indices held by mutual funds or large pension funds, then the industry-level measure might be the preferred measure of damage. A growing portion of the stocks on Wall Street are held by mutual funds or institutional investors, totaling \$9 trillion in 2005, suggesting that for many investors, the effect on the industry and the overall economy is more relevant than the effect on individual firms. For this reason, designing the policy as efficiently as possible to lessen its overall cost is perhaps the most effective way to minimize harm to the owners of equity in the economy. In effect, the way to deliver compensation to owners of equity is to design an efficient policy, which is precisely the virtue of the use of auctions.

Thank you for the opportunity to testify today.

Dr. Burtraw is a Senior Fellow at Resources for the Future. He holds a Ph.D. in economics and a master's in public policy from the University of Michigan. Dr. Burtraw has a longstanding interest in the design of incentive-based environmental policies in the electricity industry and has written extensively on the performance of emissions trading programs in the United States for sulfur dioxide and nitrogen oxides and the European Union's Emission Trading System for carbon dioxide. He also has advised on the design of climate policy for U.S. state governments. He currently serves on the EPA Advisory Council on Clean Air Compliance Analysis and on the National Academies of Science Board on Environmental Studies and Toxicology.