WORKING PAPER

Greenhouse Gas Allowance Allocation: Cost Pass-Through, Sector Differentiation and Economic Implications

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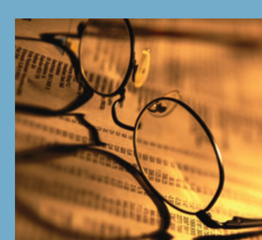

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1 Introduction

One of the most important decisions to resolve in implementing a cap-and-trade system is the question of how emission allowances are initially allocated to participants. As long as allowances can be freely traded, they can, in theory, be allocated to anyone and will find their way through the market to trading system participants willing to pay for them. Allowances can be given for free in various ways to participants and non-participants or auctioned to the highest bidders. Because allowances have significant monetary value, decisions regarding allocation methodologies are important for trading system participants and their customers.

> **Cap and Trade Mechanism**
> A cap-and-trade system sets a cap on overall emissions from companies that are required to participate in the trading system. For every ton of greenhouse gas (GHG) emitted, a participant in the trading system must own an allowance. At the end of the compliance period, a participant must verifiably demonstrate its GHG emissions and surrender an equal number of allowances to the program administrator. Those allowances are then retired.
>
> The cap itself is set simply by the number of allowances distributed to participants. Because the number of allowances available in the market is generally less than the number of tons that participants want to emit, the scarcity of allowances creates value, and a market price emerges that participants are willing to pay for allowances. If a company can reduce its emissions for less money than others are willing to pay for allowances, then it will do so. If a company can buy allowances for less money than it can reduce emissions, then it will buy allowances.

This paper is intended to provide a framework for policymakers to understand the options they have regarding allowance allocation and some of the tradeoffs they need to consider in choosing among these options. There are two basic approaches to allocating allowances: distribute them for free or auction them. If, for example, policymakers intend to distribute free allowances to companies in order to compensate them for some of the losses they may incur as a result of a cap-and-trade program, they should understand how many allowances are needed to accomplish the goal because providing a surplus of free allowances may result in windfall profits for some sectors of the economy. Overallocation of free allowances to certain sectors or entities would result in fewer allowances to accomplish other policy goals such as assisting low-income citizens with higher energy prices or funding research into advanced climate-friendly technologies like carbon capture and sequestration.

An allocation scheme need not be a one-size-fits-all distribution across sectors, as the new costs imposed by the cap-and-trade system will have different impacts on the sectors. A relatively simple criterion – ability to pass through costs to consumers – can provide some guidance for policymakers in deciding how many allowances a particular industry needs for free and how many it should purchase in an auction. If one industry is expected to be able to pass on relatively more costs than another industry, it needs fewer free allowances to compensate it for the new carbon price than would an industry that has to bear additional costs. For example, the iron and steel sector, which operates in a highly competitive global market, may have a very different ability to pass on extra costs than the cement industry, which is a less global market due to relatively high transportation costs per unit value. International competition and the response of customers to changes in the price of an industry's products largely determine the extent to which one country's industrial sector can pass carbon costs on to customers. Greater international competition (without explicit border adjustments to level the playing field) and a stronger reaction by customers to small price changes means that an industry will find it difficult to pass additional carbon price costs on to customers. On the other hand, an industry that faces little international competition and little consumer response to price changes can pass on more costs. The relative size of carbon costs compared to the value of goods and services an industry produces also affects how important an allocation of free allowances is. Free allocation is more important for industries with a relatively high exposure to carbon costs than for industries with a low exposure to carbon costs.

In the electric power sector, the patchwork quilt of regulated, partially restructured and fully restructured electricity markets presents unique challenges for allowance allocation and will affect how easily producers can pass through costs to customers. Regulated utilities will likely be required by regulators to pass on direct costs to customers. Under those conditions, if they receive allowances for free, they will not be able to incorporate the price of those allowances in the rates that customers pay, keeping rates lower but not giving utility customers the full price signal resulting from the cap-and-trade system that will encourage them to make investments in conservation and efficiency. On the other hand, electricity-generating companies in competitively restructured markets can pass on the full price signal to consumers even if the companies receive allowances for free; in other words, giving companies in restructured markets free allowances will *not* keep electricity prices lower for their customers in the same way that it will in regulated markets. The reasons for that outcome, and situations where this has occurred, are discussed further in the paper.

While price relief for electricity customers is important, so is the role that price signals play in inducing the type of efficiency responses that cap-and-trade programs are designed to produce. A full price signal to consumers is important so that they can respond with cost-effective energy efficiency investments and conservation. Policymakers will likely be concerned, however, with raising consumer energy prices too much and too quickly, before consumers can make those changes and investments. As an alternative to free allocation, policymakers could consider direct measures to address customer impacts through low-income assistance, demand-side management programs, or even direct payments. The advantage of these direct approaches to customer relief is that they do not distort prices. A cap-and-trade system, by its nature, is meant to provide the signal to the economy that GHG emissions have a real cost. Any measures that dampen that signal partly defeat the purpose of the policy.

If all sectors received the same allocation per current or historic emissions, some would profit because they would receive more value in the form of allowances than they need because they can pass on most carbon costs via higher prices, and some would incur losses because they would receive less value in the form of allowances than they need because they cannot pass on costs to customers.

This paper will explore allocation options, issues to consider with free allocations, and the possibility of differentiating allocation across sectors. The paper discusses the ability of major energy-intensive industries to pass through additional costs of carbon and the relative exposure of each industry to carbon costs. The paper then relates the experience in the SO_2 market and the European Union Emissions Trading Scheme and draws implications for carbon trading in the United States. It also explores the differences between regulated and restructured electricity markets and how they may affect cost pass through to customers. It does not advocate for any specific percentages of free allowances versus auctioned allowances for any sector, but merely provides policymakers with an understanding of cost pass-through and some of the issues related to over- or under-allocating to companies. Ultimately, as with any important public policy question, policymakers will consider a number of factors in their plan for allowance allocation, and cost pass-through may be one of them.

1.1 Equity Tradeoffs

Equity of burden is an important principle to consider in an allowance allocation decision. Two dimensions of the burden equity issue emerge: equity across different emitters of greenhouse gases ("producers") and equity between producers and their customers. Each form is addressed briefly here.

Equity across producers can entail two potentially competing perspectives. One is the "polluter pays" principle, implying simply that the costs are higher for producers who emit more. The other is based on whether high emitters had a "reasonable expectation" that they would have to face carbon-related costs when they made the fixed investments that forged their emissions profile. Although not everyone would agree on the date by which companies were on notice that climate policy is inevitable – some argue as early as the signing of the Rio Treaty in 1992 and others as late as the start of a mandatory federal cap-and-trade program that does not yet exist – the capital stock and infrastructure existing prior to that date was built without any expectation of a constraint on carbon emissions. One way to compensate companies for the burden imposed by this unexpected change is to allocate allowances for free to offset at least some of the hardship for those companies with highly carbon-intensive operations. Another approach to compensating companies is to focus on compensating shareholders directly.[1] Since stock ownership is increasingly shifting to mutual funds and retirement plans, ensuring that the economy as a whole faces the lowest possible cost may be an effective approach to compensating shareholders.

[1] Burtraw and Palmer, "Compensation Rules for Climate Policy in the Electricity Sector," Resources for the Future, January 2008

The initial burden may fall on entities who must submit allowances for the right to emit, but ultimately consumers will pay more for goods and services as a result of a cap-and-trade program. How much of the burden falls to consumers and how much falls to industry depends on a number of factors that will be discussed below. Consumers will certainly bear some burden, and equity suggests that they be considered for compensation as well.

1.2 Opportunity Cost Perspective

In principle, allocation should not affect the level of compliance each firm chooses because the opportunity cost of giving up an allowance to emit is the same regardless of allocation.[2] See text box for a simple example of opportunity cost. The number of allowances a company gets for free does not change its marginal cost of reducing emissions. A rational participant in a trading system would choose to emit the same number of tons whether given zero allowances or twice its current level of emissions.

Opportunity Cost Example
Imagine a motorcycle dealer operating in a town that requires it to include a helmet for every motorcycle it sold. Helmets are also sold by accessory shops for $50 each. The owner of the dealership knows that if he sells a motorcycle, he must include a $50 helmet, so he increases the price he charges for motorcycles by $50. People love motorcycles and are willing to buy them for an extra $50. Now let's say that the town gives the owner a bunch of helmets for free with no strings attached. He could lower his price and pass on the helmets for free, but he knows his customers will pay the extra money. He also knows that the accessory shop would be willing to buy his helmets for $50. For any motorcycle he did not sell, he could sell his extra helmet for $50. Being a good businessman, the owner continues to charge the extra $50 for every motorcycle because the value to him of each helmet is $50 regardless of whether he got it for free or paid for it.

1.3 Allocation, Revenue Recycling, and Economic Efficiency

The allocation of allowances can affect the overall economic impact of the trading system. One line of reasoning is that a full auction with revenue recycling is the most efficient alternative because some of the negative macroeconomic impact of the cap-and-trade system can be offset.[3] Such an allocation would result in more economic growth than would be the case with a free allocation because the disincentive of taxes would shift away from desirable productive activity to undesirable carbon emissions. If

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[2] There are two exceptions. With an updating output-based or input-based allocation, participants may have an on-going incentive to alter their investment decisions in order to increase their allocation, thereby resulting in a different outcome than would be the case with a non-updating allocation. In traditionally regulated electricity markets, utilities are obligated to select the least cost compliance strategy, but to the extent that costs are uncertain or equivalent, utilities have a greater incentive to invest in reductions in order to earn a rate of return rather than trade in the allowance market in which all revenues or costs would be directly passed through to consumers.
[3] Lawrence Goulder, "Environmental Taxation and the "Double Dividend:" A Reader's Guide," National Bureau of Economic Research Working Papers, October 1994
Ian Perry, "Revenue Recycling and the Costs of Reducing Carbon Emissions," RFF, June 1997

revenues are not recycled through marginal tax rate reductions or other productive uses the potential for efficiency gains may be diminished; however, the economic efficiency in this case would be no worse than with free allocation.

2 Allocation Mechanisms

A carbon price will not affect all sectors of the economy in the same way. Some sectors will be able to pass most or all of the cost of complying with a cap-and-trade system on to customers, while other sectors facing international competition or high elasticities of demand may be limited in the extra costs that can be passed through to customers.

Policymakers can design an allocation scheme, including allocating some or all allowances for free, to address transitional issues for participants in a cap-and-trade system and give assistance to those most affected by a carbon cap. On the other hand, giving a generous allocation to sectors with the ability to pass most costs through would likely result in unexpected profits for the sector and fail to provide the intended compensation to those parties who cannot effectively pass on costs or who are otherwise burdened by high costs passed on to them, such as energy-intensive manufacturing and low income households.

Rather than adopting a uniform approach to allowance distribution, policymakers could limit the number of free allowances per sector to a level that is sufficient to cover the costs that each sector cannot pass through to customers. This individualized methodology could be an effective approach for compensating sectors and garnering political buy-in without generating windfall profits for sectors with a greater ability to pass costs through to customers. One of the downsides to using cost pass-through as a metric for allowance allocation is that pass-through can only practically be estimated by program administrators on an industry or market segment basis, not on a company by company basis. If all companies in the same industry receive free allowances based on estimated pass-through for the industry, some companies will be winners and others losers.

2.1 Allocation Options

In addition to determining whether and to whom to allocate any free allowances, policymakers will also be faced with the decision of which allocation method(s) to use. Allocation can be administered in many different ways:

- **Auction**: allowances are sold in a periodic public auction administered by the government or its agent
- **Emissions-based** (i.e. grandfathering or free allocation): available allowances are given to participants on the basis of historical emissions.

- **Historical generation**: available allowances are given to participants on the basis of historical generation. This allocation mechanism would apply primarily to the utility sector and to other owners of large generation facilities.
- **Output-based (updating)**: similar to above, an allocation in which the number of allowances given to each facility is determined based on the previous year's or period's output rather than one initial base year or years. In other words, allocation is continually updated, though the frequency of updating can be annual or over longer periods.
- **Generation Performance Standard (GPS)**: a variation of output-based allocation in which allowances are given out at a rate equivalent to a specific technology like natural gas combined cycle. Under a GPS approach, all available allowances are not necessarily divided up and given out. Facilities with lower emission rates than the GPS will get more allowances relative to need than facilities with higher emission rates. Like any generation-based allocation, this method applies primarily to electricity generators.
- **Input-based (updating)**: works in the same way as an output-based allocation except that allowances are given out based on energy input rather than generation output. An updating input-based allocation does not in itself provide an incentive to improve energy efficiency[4], but it does encourage fuel switching because low-carbon fuels would receive the same number of allowances for the same heat content as high-carbon fuels, but companies using high-carbon fuels need more allowances because they emit more.

Allowances can also be distributed differently for each sector. In fact, some allocation methods are appropriate for only one sector. For example, output-based allocation can work for the electricity sector, but not for industrial sectors – few sectors other than electricity have a uniform output on which to base allocation. Input-based allocation may work across all sectors, but has the drawback of only encouraging fuel switching to lower-carbon fuels without encouraging efficiency improvements (less fuel per unit of output). Sectors like transportation present unique challenges that make it difficult to treat them in the same way as other sectors; allowances cannot easily be allocated to emitters (vehicle owners) but can be allocated to fuel producers, importers, and refiners, or even to vehicle manufacturers, based on the carbon content of the fuel or the carbon intensity of vehicles.

If policymakers desire to have a single allocation mechanism for all sectors, there are two primary options: an auction and emissions-based free allocation (or a combination of the two). However, if policymakers choose to give sectors different proportions of free allowances, there is no particular reason to use the same allocation mechanism for each sector. Even if policymakers choose to give sectors the same proportion of free allowances, they can be allocated using different mechanisms for each sector.

[4] Less efficient plants consume more fuel and therefore get more allowances.

2.2 Considerations with Free Allowance Allocation

Free allowances could play an important role in assisting sectors that cannot easily pass carbon costs on to customers. At the same time, as described above, distributing allowances for free could also provide certain sectors with an unfair advantage if they are given an allocation that has a greater value than the costs they incur from the cap-and-trade system. Because allowances are finite and limited, giving one sector more than it needs means that other sectors may get less than they need or consumers may get less assistance. This issue could be resolved by treating allocations to sectors differently according to their ability to pass on costs.

If a decision is made to treat sectors differently, then free allowances may need to be divided according to sector prior to allocation to individual entities. In other words, a separate pool of allowances could be designated to each sector covered in the trading system, including electricity, other industrial stationary sources, (perhaps even separate pools for industry subsectors), transportation, and agriculture/forestry.

The question of how to divide free allowances among sectors raises a number of competing principles.

- **Cost pass through**: If a particular sector enjoys a low elasticity of demand for its product and limited international competition, it can pass through more of its costs of compliance and, arguably, needs fewer allowances than a sector with a high elasticity of demand and extensive international competition.
- **Secondary impacts**: Some sectors or industries will face market changes apart from their direct emissions and participation in the trading system. Secondary impacts, both positive and negative, may factor into allocation to the sector.
- **Ability to reduce**: Certain sectors, such as airline travel, may have few options to reduce their own emissions and must purchase allowances. A sector's inability to reduce emissions may be considered in allocating to that sector.

Distributing free allowances can provide partial compensation to specific industries that may be adversely affected by a cap but are not large direct emitters. For example, if coal companies participated in a downstream emissions trading system they would receive few allowances under a grandfathering allocation because they emit little compared to the emissions embodied in their product. In fact, in a downstream system, coal companies may face much greater economic impact than some sectors that emit far more greenhouse gases directly because the demand for coal may decline. Whether or not coal companies are required to participate in a cap-and-trade system, policymakers can give them allowances apart from their direct emissions as a form of compensation to soften the impact of a climate policy that would lead to reduced coal consumption. Similarly, auto manufacturers emit little compared to the emissions generated by their products and may be adversely affected by a cap-and-trade system. There may be other industries that are not large direct emitters but consume large amounts of electricity purchased from the grid. These industries would not be compensated under a simple grandfathering allocation because they emit little directly, but they will face higher electricity prices and bear part of the burden of a cap-and-trade system.

Policymakers can also choose to allocate directly to consumers or to an agent for consumers. Alternatively, policymakers can choose to auction a portion of allowances and transfer the revenue to consumers as partial compensation for the costs of the cap-and-trade system.

Load Serving Entities (LSEs) may be a possibility to serve as an agent for consumer allocation; LSEs would receive allowances or auction revenue and pursue activities like demand-side efficiency programs that would help consumers. If LSEs use allowances to lower electricity rates rather than fund efficiency programs, consumers would have less incentive to invest in efficiency because of the lower electricity prices, leading to greater overall costs to the economy because of this price distortion (See Section 3.2.2.1 for a related discussion).

One approach to an auction and revenue transfer to consumers is the Cap and Dividend proposal put forth by Boyce and Riddle in which auction revenues would be distributed to all citizens on a per capita basis. Boyce and Riddle find that if all allowances are given to emitters, nine out of ten income deciles would be worse off. But if the Cap and Dividend approach is used, the poorest six deciles would positively benefit while the next three deciles would see losses, but less than if allowances were given to emitters. Only the highest earning decile would be worse off under the Cap and Dividend proposal.[5]

Allowances can be given to states for them to allocate to companies or consumers within the state. Allowances or auction revenue can also be given to a technology fund established by the government with the mission to help develop and commercialize new climate-friendly technologies.

3 Sector Differentiation

3.1 Industrial Sectors

Because industrial sectors face drastically different market forces, policymakers must consider the impacts that a carbon price will have on the sectors' competitiveness. Factors to consider include the degree to which an additional carbon cost represents a significant portion of value added[6], foreign competition from firms that do not face similar carbon costs, and elasticities of demand. For example, some industries face significant oversees competition from suppliers that do not face similar carbon

[5] Boyce and Riddle, "Cap and Dividend: How to Curb Global Warming While Protecting the Incomes of American Families," Political Economy Research Institute, University of Massachusetts Amherst, November 2007

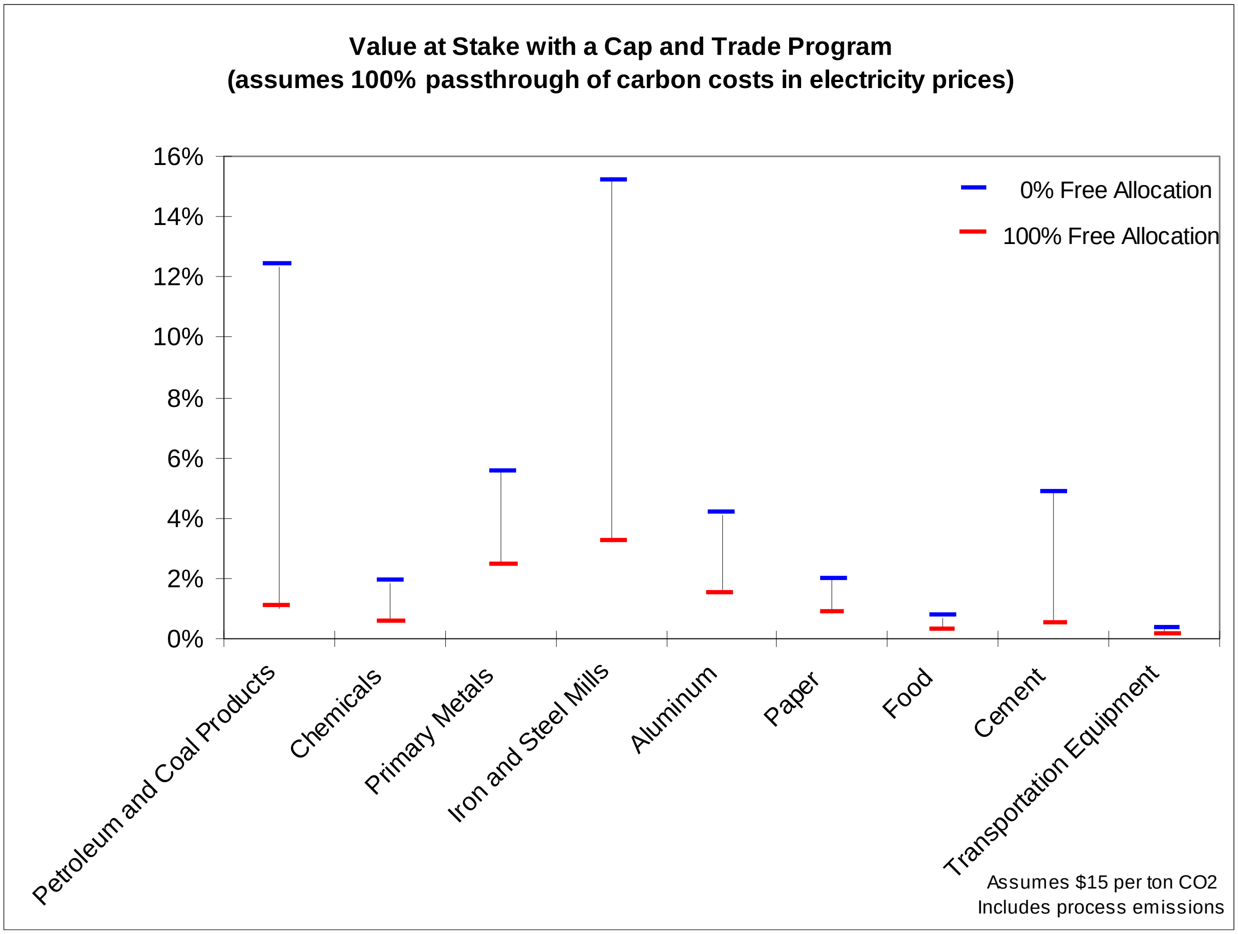
f[6] "Allocation and competitiveness in the EU Emissions Trading Scheme: Options for Phase II and beyond," Carbon Trust, June 2006 constraints. To the extent that this disparity harms domestic producers, a more generous allocation could compensate them if other mechanisms (*e.g.*, trade provisions) are not put into place. Conversely, industries that face low carbon costs relative to value added and have a greater ability to pass costs through to customers may need little free allocation of allowances to remain competitive.

3.1.1 Factors to Consider

3.1.1.1 Value at Stake

The potential exposure to a carbon price that several industries face is shown in the figure below. The blue marks represent the full opportunity cost – no free allowances – of each industry's direct and indirect GHG emissions as a share of the industry's value added, assuming $15 per ton CO_2e. Indirect emissions costs – the red marks – represent the increased cost of electricity purchases assuming 100% pass through of carbon costs by electricity generators. If no free allowances are given, industries would face exposures corresponding to the blue marks, but if allowances are given for free to cover 100% of direct emissions, the exposure would be represented by the red marks. Even with a 100% allocation, industries still face some exposure because of cost pass through by electricity generators. This figure does not reflect actual carbon costs faced by each industry, but only the opportunity cost without taking into account pass through to the industries' customers or potential for lower cost reductions within industries.

Figure 1: Value at Stake with a Cap-and-trade Program[7]



In the above chart, the blue marks represent the full opportunity cost of carbon emissions, at an assumed $15 per ton, as a percentage of value added for each industry, plus the indirect cost from electricity price increases, which are represented by the red marks. We assume 100% pass through of carbon costs from electricity to these industries. This chart does not reflect actual costs faced by each industry, but only the opportunity cost without taking into account pass through to the industries' customers or potential for lower cost reductions within industries.

As is clear by the above figure, different industries face different exposures to carbon costs. Some industries like iron and steel face potential carbon costs that represent a significant share of value added. Even if the iron and steel industry receives a 100% allocation for its direct emissions, it faces higher costs from increased electricity prices that are a significant share of value added. On the other hand, the food processing industry faces a relatively small share of its value added in potential carbon costs, both directly through its own emissions and indirectly through electricity prices.

[7] Value added data from the US Census *2005 Annual Survey of Manufacturers*. Emissions data from *Industry – related Carbon Dioxide Emissions from U.S. Manufacturing*, EIA.

3.1.1.2 Elasticity of Demand

Elasticity measures the responsiveness of quantity demanded to a change in price, with all other factors held constant, and is computed as the ratio of percent change in quantity demanded to the percent change in price. More elastic demand (>1 in absolute value) means consumers can more easily do without the good or switch to alternative goods, which makes it more difficult for companies to pass along a price increase without losing customers. Less elastic demand (<1 in absolute value) means that consumers cannot easily do without the good or switch to alternative goods, making it easier for companies to pass along a price increase.

Factors That Affect Elasticity

Substitutability: The more readily available substitutes for a commodity, the greater the elasticity of demand. This factor depends on the broadness of the definition of 'substitute.'

Necessary vs. Luxury Good: A luxury good is a commodity in which an increase in income increases proportional demand for that good. Luxury goods tend to have a larger degree of elasticity. A good that is 'necessary' has a demand that is more inelastic because consumers need to purchase it.

Short Run vs. Long Run: In the long run, consumers have time to adjust their behavior to increases or decreases in price so that elasticity tends to be greater in the long run. Conversely, in the short run consumers have less time to adjust their consumption behavior so demand is less elastic.

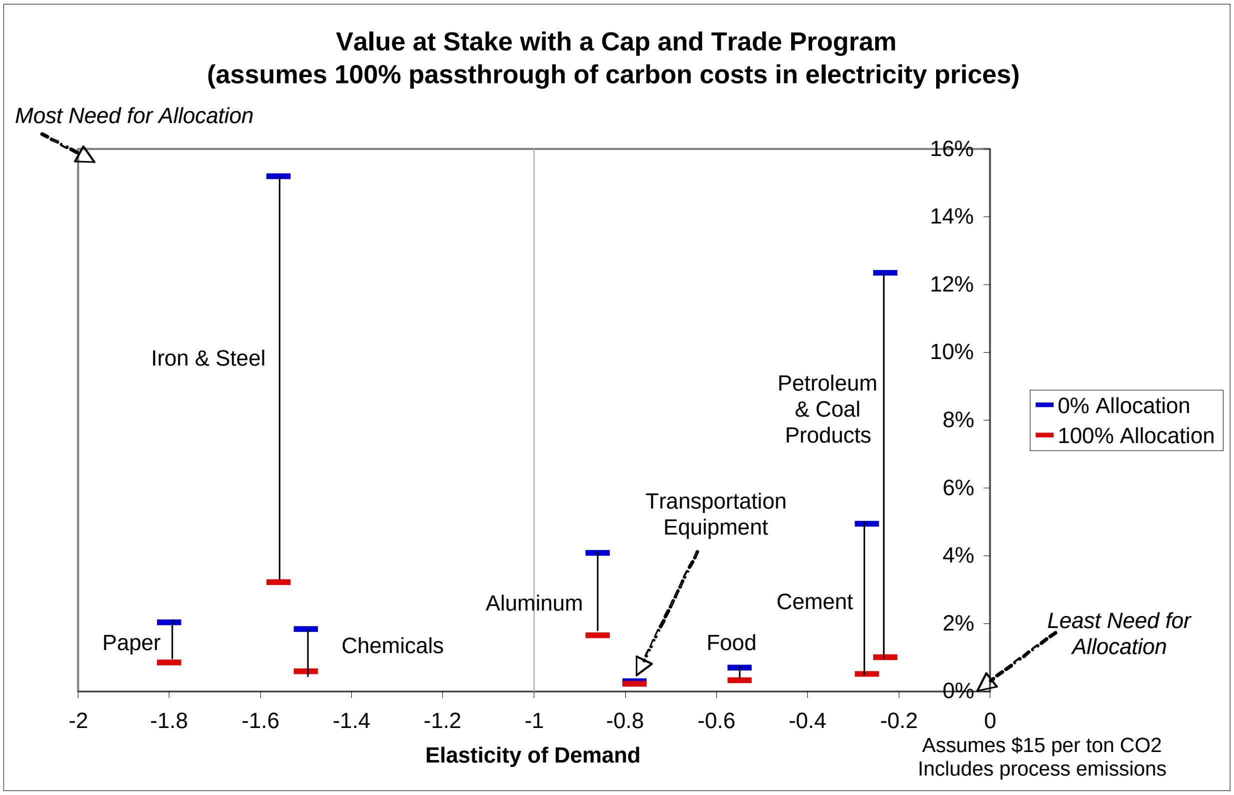
Proportion of Income: Commodities that account for a large portion of a consumer's budget tend to have greater elasticity.

Temporary vs. Permanent: A price change that occurs over a limited period of time will tend to be more elastic than a permanent price change.

3.1.1.3 Cost Pass Through

The following figure presents the same information as the figure above but combined with demand elasticities, which in themselves also reflect the level of international competition each industry faces. As such, they are a good indicator of ability to pass through costs. The industries toward the left have higher elasticities and less ability to pass on costs. Industries in the upper part of the graph face significant potential carbon costs relative to value added. Industries in the upper left are in most need of allocation; industries in the lower right have the least need for allocation

Figure 2: Value at Stake with a Cap-and-trade Program & Elasticity of Demand[8]



Note: the vertical line separates relatively elastic demands from relatively inelastic demands.

3.1.2 Discussion

The iron and steel sector faces a relatively high elasticity of demand and significant costs relative to value added. Clearly, the iron and steel sector is one of the most vulnerable sectors within a comprehensive GHG cap-and-trade system. The paper and chemicals industries also face high elasticities of demand; although their value at stake is much lower, these industries will find it difficult to pass costs on to their customers. Aluminum faces a slightly inelastic demand and has some ability to pass on costs, though not as much as the food, cement and petroleum products sectors, which have rather inelastic demands and the ability to pass on most costs. For these latter sectors, their customers may need compensation since most costs are passed to them.

The above analysis represents recent available elasticities of demand and provides a good framework for how to understand cost pass through in the near term. But

[8] Value added data from the US Census *2005 Annual Survey of Manufacturers*. Emissions data from *Industry – related Carbon Dioxide Emissions from U.S. Manufacturing*, EIA. Elasticities from the EPA Elasticity Databank (http://www.epa.gov/ttn/ecas/Elasticity.htm)

industries change over time. Industries that once had little international competition are facing growing competition from abroad. Similarly, substitutes for an industry's products may only now be coming to market. Both of these factors may lead to changes in the elasticity of demand and the ability to pass through costs.

Given the potential for fundamental change in industry, the process of allocating allowances would ideally incorporate a provision for reevaluation and updating as necessary to ensure that industries get no more or no less than needed in order to maintain competitiveness. Once a cap-and-trade system is underway, an econometric analysis can illuminate the extent to which various sectors actually pass costs through to customers. Such an analysis could be used to adjust free allocation in case certain industries that were expected to be able to pass most costs through turned out not able to do so or to do so to a lesser extent.

3.2 Electricity Sector

Allowance allocation to the electricity sector is in some ways more complicated than with other sectors. The U.S. Acid Rain Program and the European Union Emissions Trading Scheme can shed some light onto the complexity of regulated and unregulated electricity markets in a cap-and-trade system as well as some of the other issues associated with allocation. Because some states have traditionally regulated markets and some have restructured markets with varying degrees of market competition and marginal cost pricing, different states will have different pass through of allowance trading revenues/costs and compliance costs. Different electricity market structures have implications for the distribution of costs and benefits with free allocation, as well as implications for the overall cost of a cap-and-trade program.

A traditionally-regulated market is regulated by a state agency, typically a Public Utility Commission (PUC). A PUC determines the rates a utility is allowed to charge its customers. Rates are typically calculated on an average cost basis, and the PUC must agree that a cost is just and reasonable before allowing utilities to recover the cost in its rates. Electricity restructuring was an attempt to move away from a regulated rate structure to market competition and marginal cost pricing. Some states were more successful with this transition than others. A number of states have fallen in between a restructured and traditionally-regulated market, having initiated some restructuring measures but pulling back in the face of California's botched restructuring efforts and the realization that even in states that successfully restructured, the anticipated cost savings were not realized.

3.2.1 Lessons Learned from Emissions Trading Markets

3.2.1.1 SO2 Cap-and-trade Market

A prime example of how the treatment of allowances by regulators affected investments and allowance trading can be seen in the early years of the SO_2 allowance market that came into effect in 1995 as part of the 1990 Clean Air Act. The following table provides an overview of some of the similarities and differences in the SO_2 and CO_2 markets from the perspective of the electricity sector. Although many options to reduce emissions can apply to either SO_2 or CO_2, one of the main options for SO_2 abatement – "end of pipe" control technology – is not available yet for CO_2 emissions. Although the size of a future U.S. CO_2 market is not clear at this point, the closest comparison is the EU ETS, which is over 7 times as large as the U.S. SO_2 market.

	SO_2 Market	CO_2 Market
Scope of Market	Utilities	Major-emitting sectors Offset markets International markets
Size of Market	$41 billion* in market capitalization	N/A. e.g. EU ETS is $285 billion* in market capitalization
Electricity sector abatement options**	**Purchase allowances**	**Purchase allowances**
	Invest in "end of pipe" capture	*Post-combustion capture and storage (long-term)*
	Switch to low sulfur fuel More efficient generation Demand-side energy efficiency Renewable generation Nuclear generation	**Switch to low carbon fuel** **More efficient generation** **Demand-side energy efficiency** **Renewable generation** **Nuclear generation** *Pre-combustion capture and storage (mid-term)*

* from "A Trillion-Dollar Marketplace," *Environmental Finance*, http://www.environmental-finance.com/2007/0702feb/Sindicatum.htm, accessed November 5, 2007

** Bold indicates primary options; italics indicates options that are not yet commercially available

At the outset of the SO_2 program, state Public Utility Commissions (PUCs), which regulate rates that utilities charge customers, generally did not create clear guidelines up-front for how the costs or revenues associated with trading SO_2 allowances would be treated. Rules for cost-recovery for the installation of SO_2 scrubbers were clearer – a utility could expect that scrubber investments be recovered in their rate base and provide a return. In the beginning of the SO_2 program, many utilities perceived that there was less risk associated with switching to low-sulfur coal and installing SO_2 scrubbers than with trading allowances, resulting in less inter-utility allowance trading than was predicted in least-cost compliance models.

Bohi and Burtraw note that all 26 generating units that installed SO_2 scrubbers as a result of the SO_2 cap-and-trade program during the mid-1990s were located in six states that showed a regulatory bias towards the installation of scrubbers.[9] In addition, Arimura notes that the vast majority of the power plants that were outfitted with SO_2 scrubbers would not have had scrubbers installed under a least-cost compliance strategy.[10] Finally, Sotkiewicz concludes that state-level PUC regulations increased the cost of compliance anywhere from 4.5% to 88% above the least-cost option.[11] However, the wide-scale adoption of control technologies drove down their cost through learning by doing, ultimately resulting in significantly lower costs of abatement than were projected by analysts prior to the implementation of the Clean Air Act.[12]

After a few years of experience with the SO_2 trading program, most PUCs demonstrated either through rate cases or through specific rules that they require that any direct revenue or expenses incurred from the sale or purchase of allowances be passed through to customers by raising or lowering electricity rates. However, PUCs have not allowed the full opportunity cost of allowances to be passed through to customers. The reassurance that direct emissions trading costs can be recovered led to more trading than in the first years of the program. Nevertheless, the prospect that trading revenues will also be transferred to customers dampens a utility's incentive to engage fully in trading if, all other things being equal, it can earn a rate of return on investments that reduce emissions.

In contrast to most states, Connecticut encouraged the trading of emission allowances by allowing utilities to retain 15% of the revenue generated from the sale of allowances. This policy provided a strong incentive for utilities within the state to participate in the market for SO_2 allowances. See the Appendix for a table that describes how a number of traditionally regulated, partially restructured, and fully restructured states have dealt with SO_2 allowance trading revenues and costs.

Implications of the SO_2 experience for carbon trading are that PUCs can be expected to require that utilities pass through direct costs or revenues stemming from allowance allocation, trading or GHG reductions, but not for the opportunity cost of free allowances. Changing PUC rules to allow utilities to retain profit from allowance trading and to earn returns from energy efficiency investments would help put a utility's demand, supply and allowance trading options on a more equal footing. If PUCs were required to pass through the opportunity cost of free allowances, customers would

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[9] Bohi, D., Burtraw, D. *"SO2 Allowance Trading: How Experience and Expectations Measure Up."* Resources for the Future, February 1997.

[10] Arimura, Toshi. "An Empirical Study of the SO2 Allowance Market: Effects of PUC Regulations." *Journal of Environmental Economics and Management.* 2002, Vol. 44, Iss. 2.

[11] Sotkiewicz, Paul. *"The Impact of State-level Public Utility Commission Regulation on the Market for Sulfur Dioxide Allowances, Compliance Costs, and the Distribution of Emissions."* Working paper, Univ. of Minnesota, January 2003.

[12] Ellerman et al, "Emissions Trading Under the U.S. Acid Rain Program: Evaluation of Compliance Costs and Allowance Market Performance," Center for Energy and Environmental Policy Research, MIT, October 1997

Rubin et al, "Experience Curves for Power Plant Emission Control Technologies," Int. J. Energy Technology and Policy, Vol 2, Nos. 1/2, 2004 respond with a desire for more energy efficiency, much of which could be invested in by utilities if allowed to earn a return equivalent to (or even better than) supply investments.

3.2.1.2 The European Union Emissions Trading Scheme

The other major example of real world allowance allocation is from the European Union. Building upon the success of cap and trade as a policy instrument in the U.S. Acid Rain program, the European Union designed and implemented the first large scale mandatory greenhouse gas cap-and-trade system. The EU launched the European Union Emissions Trading Scheme (EU ETS) in 2005 in order to prepare for the Kyoto compliance period from 2008 to 2012.

Each Member State must comply with its target under the Burden Sharing Agreement or Kyoto Protocol.[13] One of the tools for meeting this target is the EU ETS, which covers electricity generation and several energy-intensive industrial sectors. Member States can decide how they plan to meet their emission goals through a combination of the EU ETS, other policies for sectors not covered in the EU ETS, and the purchase of international offset credits. Within the rules of the EU ETS, a Member State can allocate all the allowances that its industry would need to cover emissions as long as it plans to meet its target through other sectors. Most Member States chose to give participants most (in some cases all) the allowances they needed.

The electricity sector was a huge winner with free allowance allocation in the EU ETS. Many countries within the EU have moved toward competitive electricity markets. Electricity generating companies in competitive markets can pass on the opportunity cost of carbon quite easily to consumers. Sijm et al. found through empirical analysis that cost pass through in German and Dutch electricity markets in 2005 was between 60% and 120% of carbon costs and that electricity prices increased 50% to 60%.[14] In an ongoing modeling study of carbon cost pass through in the EU, Sijm has preliminarily found that the average pass through rate for the EU-20 is 174%; the marginal pass through rate is 89%.[15] The average pass through rate can exceed the marginal rate and go beyond 100% if the overall generation portfolio is low-carbon but the generation at the margin, which sets the price of electricity, is carbon-intensive.

These findings show that companies can and will pass through opportunity costs to consumers even when they receive allowances for free. Utilities in the EU ETS were

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[13] The Burden Sharing Agreement pools the total emissions budget from EU15 countries so that the EU collectively meets the same emission target as its Member States would individually under Kyoto, but redistributes the burden so that wealthier countries with slower growth rates must reduce emissions and poorer countries with higher growth rates can increase emissions. Each new Member State that joined the EU after the Burden Sharing Agreement was formed must meet its Kyoto Target individually.

[14] Sijm et al, "CO2 Price Dynamics: A follow-up analysis of the implications of EU emissions trading for the price of electricity" Energy Research Centre of the Netherlands, March 2006

[15] Jos Sijm, "Options to address EU ETS induced increases in power prices and windfall profits" IEEE PES General Meeting Conference, Tampa, June 25, 2007

given most allowances they need for free, yet still passed on the cost of allowances (based on the market price) as if they had purchased them. In hindsight, giving utilities free allowances in the EU ETS was not necessary to compensate them for increased costs because they could, in effect, cover those costs by charging their customers more.

Because they were given allowances for free and also charged their customers for them, utilities made windfall profits – profits that are "earned unexpectedly, through circumstances beyond the control of the company."[16] In published results for Germany and the Netherlands, Sijm found, using the COMPETES model, that the electricity sector enjoys substantial windfall profits, equal to an additional 8% to 88% of baseline profits, as a result of price changes due to the EU ETS and free allowance allocation.[17] The range of windfall profits depends on different assumptions about market structure, demand elasticity, and carbon price. Sijm distinguishes windfall profits that result from changes in production costs, electricity prices, and sales from windfall profits that result from free allocation. Windfall profits from market responses to the EU ETS in Germany and the Netherlands range from additional profits equal to -1.6% to 42% of baseline profits. Windfall profits from free allocation range from additional profits equal to 9.6% to 46% of baseline profits.[18] Preliminary results for the EU-20 are that windfall profits resulting from market response are an extra 4% to 21% of baseline profits, while windfall profits from free allocation are are an extra 11% to 27% of baseline profits. Total windfall profits for the EU-20 amount to an extra 15% to 48% of baseline profits.[19]

This example is instructive as U.S. policymakers consider the appropriate design for a federal cap-and-trade system. The EU ETS experience demonstrates that companies will pass both direct costs and opportunity costs through to consumers when it is possible to do so. Policymakers designing a cap- and- trade system cannot expect that consumers will have lower prices by giving free allowances to companies that can easily pass on additional costs in competitive markets. Similarly, giving free allowances to companies that can easily pass on extra costs in competitive markets can be expected to result in windfall profits. One option to avoid this result while also minimizing the impacts on vulnerable industries is to put a limit on free allocations to sectors that can easily pass on costs and to target allocations to sectors that cannot.

3.2.2 Regulated versus Restructured Markets

Because state regulation of the electricity sector ranges from full, traditional cost of service regulation to full retail competition, with many variations and degrees of regulation in between, the question of cost pass-through in the electricity sector is not a simple one. The significant differences between electricity markets argue for a flexible

[16] Economist On-line Dictionary, http://www.economist.com/research/Economics/alphabetic.cfm?letter=W, Accessed November 12, 2007.
[17] Sijm et al 2006
[18] Sijm et al 2006
[19] Sijm 2007

approach to allowance allocation for electricity generating companies in the different markets.

3.2.2.1 Traditionally-Regulated Markets

A 100% free allocation may promise to compensate electric utilities for the cost of reducing their emissions of carbon with valuable emission allowances, but a 100% free allocation may not be the most economically efficient approach. State PUCs typically do not let utilities incorporate the opportunity cost of emission allowances that were received for free into the rate base; they only allow for direct costs of purchasing allowances or for investments in environmental compliance to be passed through to customers. While this practice benefits ratepayers by keeping electricity rates lower than they would otherwise be when allowances are given to utilities for free, such policies perpetuate the separation between the marginal cost of electricity production and the electricity prices charged to customers. Without seeing the full opportunity cost of allowances, customers will not take as many cost-effective actions, such as energy efficiency investments, to reduce electricity consumption (and therefore emissions). Without this consumer response, a low-cost option for reducing emissions is lost, and emission reductions must occur elsewhere in the economy to meet the cap.

Basic economic theory tells us that when supply is reduced and demand stays the same, prices go up. In this case, the cap, which is the demand for emission reductions, must still be met, the supply of emission reductions is reduced, and the price of allowances that everyone pays goes up. Because utility customers in traditionally-regulated markets do not see the full market price of allowances, the participants in the trading system must make more expensive reductions. Of course, those utility customers in regulated states will pay less in electricity prices with a 100% free allocation, but those lower prices will come at a greater overall cost to the economy. Ultimately, utility-invested carbon abatement will increase the cost of electricity to utility customers, spurring energy efficient behavior, but only after participants in the trading system invest in more expensive carbon abatement options than it would have if electric utility customers could respond to the right price signal.

Nevertheless, a political decision may deem that lower electricity prices in regulated states is more important than a least-cost mitigation strategy. Over time, if allocation shifts from a free distribution to an auction, regulated utility customers will gradually see the correct price signal even if that price signal is muted at the beginning of the trading system.

3.2.2.2 Restructured Electricity Markets

Electricity generating companies that operate in restructured states with at least wholesale competition can freely pass on the opportunity cost of allowances through marginal pricing in the electricity market because of the relatively inelastic demand for electricity.[20] This ability has been demonstrated in the EU ETS, as discussed above. Examples of how opportunity cost can influence the market can also be seen in the U.S. SO_2 program, where the opportunity cost of freely distributed emissions allowances was incorporated into the price for electricity in restructured markets.[21] The price of electricity in deregulated states will be the same whether allowances are distributed freely or auctioned since the opportunity cost will be passed through either way. Electricity customers in restructured markets will see the full price signal and respond accordingly with energy efficiency investments and conservation. Because electricity generators in restructured markets can pass on the opportunity cost of allowances, they can recover a significant portion of their costs of compliance. For some companies, the value of free allowances may exceed their costs. This allowance value, along with their ability to raise prices to cover the higher costs, can generate windfall profits. Other companies will face lower profits or even losses if the electricity price rises less than their cost of compliance.

3.2.3 Implications of Free Allocation in Electricity Markets on Retained Profits

If an allocation to the electricity sector gives enough allowances for free to regulated utilities to diminish the price signal to their customers, it would likely result in windfall profits for many electricity generators in restructured states. As discussed previously, because electricity customers in traditionally regulated states will not see the full price signal based on the opportunity cost of allowances, everyone else in the system will face higher allowance prices. Therefore, customers in restructured states will pay more than customers in regulated states. As a result, all other things being equal, electricity customers in restructured states will bear a greater burden under a cap-and-trade system than customers in traditionally regulated states under a full free allocation to electricity generating companies.

The ability to pass through all costs may not be possible in some restructured markets, though a significant portion of costs will likely be passed through in all restructured markets. The increase in prices will be less in areas where natural gas sets the market price for electricity than in areas where coal sets the market price because natural gas has a lower carbon content than coal. For areas with natural gas on the margin, the pass through of costs may be less than 100% if coal units remain below marginal natural gas units in the dispatch order. For example, if a market consists of only coal and natural gas, and the cost of coal increases by 20% but the cost of natural gas increases by 10%, and natural gas continues to set the price of electricity because it is the marginal supply source, then coal units will get 10% more revenue for the electricity they generate but will have 20% higher costs to operate. Since these coal units would still be getting a price higher than their costs (if they did not, then they would not still fall below gas in the dispatch order), they will continue to operate and potentially earn a

[20] Martinez, K., Neuhoff, K. "Allocation of Carbon Emission Certification in the Power Sector: How generators profit from grandfathered rights" Cambridge Working Papers. Sept. 2004.
[21] Congressional Budget Office. "Tradeoffs in Allocating Allowances for CO2 Emissions" April 2007.

profit, but the owners would have to absorb the cost increase resulting from the cap-and-trade system. If the increase in the cost of coal units causes them to be on or above the margin, then those coal plants may suffer a loss or even shut down.

In markets with coal already on the margin, the expected increase in electricity prices will be greater, and generators can pass on the full cost to consumers; the increase in prices should be sufficient to cover all of the inframarginal generation's carbon cost increases. No matter whether the marginal unit is coal or natural gas, though, low- or zero-carbon generators stand to make a windfall profit even without receiving an allocation of allowances. These units would receive a higher price with little or no increase in costs. In areas where natural gas is on the margin, the windfall for low- or zero-carbon generators would be smaller than in areas with coal on the margin.

3.2.4 Allocation Options for the Electricity Sector: Free Allocation, Auctions, and Revenue Recycling

Even within a given sector, the best approach may be to differentiate allocation. Implementing a uniform allocation scheme or methodology for the entire electricity sector, apart from an auction, may not be ideal given the sector's complexity, both in terms of diverging state regulation and resource mixes. Free allocation would ideally vary according to whether a state's electricity market is subject to traditional regulation or to competitive market forces. If PUCs were required to pass on the opportunity cost of allowances to utility customers in regulated states, then many of the issues of free allocation to regulated utilities can be overcome. Additionally, if regulated utilities were allowed to earn a rate of return on energy efficiency investments the same way they earn a return for supply or even an enhanced return, utilities could profit from demand reduction driven by the carbon market and have an added incentive to help consumers respond to higher electricity prices, lowering the overall cost of the cap to the economy. If a free allocation to electricity generators in restructured markets takes into account the actual ability of generating companies in a given state or market to pass through costs based on the market resource mix, giving out only enough allowances to cover costs that those companies cannot pass through, then many of the issues around free allocation in restructured markets can be addressed.

Another way to avoid a lack of consumer response in traditionally-regulated states and the potential for windfall profits in restructured states is to allocate allowances via an auction. By incurring a cost for the allowances up-front, utilities will be permitted by PUCs to roll the cost of acquiring the necessary allowances into their rate bases, increasing the price of electricity and spurring energy efficient behavior from utility customers. Competitive generators would only buy the allowances they need and would pass on the costs to their customers.

An alternative way to soften the impact of higher prices resulting from a cap-and-trade system without affecting consumers' response to the price signal is an auction with revenues recycled back to consumers. Auction revenues can be distributed to consumers via lump-sum payments or tax cuts, can be used to provide incentives to invest in energy efficiency, or can be used to support the development of advanced climate-friendly technologies that will ultimately lower costs to consumers.

4 Conclusion

- Allowance allocation can have a tremendous impact on companies that participate in a cap-and-trade system, as well as on their customers and those indirectly affected by a cap.
- A carefully crafted allocation scheme can promote equity of burden by helping those who need it most while minimizing unnecessary gains by others.
- Economic theory suggests an auction with revenue recycling is the most efficient option.
- There are valid reasons for free allocation: equity/compensation and political buy-in.
- Allocation methodology and allotment of free allowances can and should vary by sector.
- In the absence of border adjustments on goods from countries without mandatory climate policies, some industries may need a substantial free allocation because they are unable to pass carbon costs on to customers and still compete in global markets. Other industries are much better suited to pass on costs.
- Some industries also face a much greater exposure to carbon costs as a percentage of annual value added and are therefore at greater risk under a cap and trade system than other industries.
- Free allocation to industrial sectors should vary and take into account cost pass-through and carbon cost exposure.
- Giving companies too many allowances can produce windfall profits, especially if companies can easily pass on the higher costs to consumers via prices.
- Companies will be able to pass on the opportunity cost (i.e. market price) of allowances to consumers even if companies are given allowances for free.
- Cost pass-through in regulated and restructured electricity markets differs considerably and leads to different prices and overall costs if these two kinds of markets are allocated allowances in the same way.
- If allowances are allocated for free to the electricity sector, policymakers can distinguish between regulated and deregulated states/markets
- Free allocation in the electricity sector can be more economically efficient and lead to lower costs for everyone if policymakers:
    - require that the opportunity costs be passed through to customers in regulated states;
    - give regulated utilities an equal or greater profit incentive to trade allowances and invest in energy efficiency as to invest in new supply;
    - allocate allowances based as much as possible on actual pass through ability by market structure;
    - or simply auction allowances;
    - then use revenue to assist affected customers, fund technology development etc.

Appendix

Table: Treatment of SO_2 Trading by State

State	SO_2 Pass Through	CO_2 Pass Through	Notes
Traditionally Regulated States			
AL[1]	100% pass through via the stat's fuel cost recovery clause		No accelerated cost recovery for environmental compliance
CO[2]	No formal policy for SO_2 cost pass through -- utilities are not trading SO_2 allowances. But CO has a cost adjustment factor to true-up costs if revenue or expenses are incurred from future SO_2 trading.	Unknown how CO_2 allowance revenues or costs would pass through to customers	Considering adders for CO_2 in planning for new plants; program may expand to a trading system later.
FL[3]	100% pass through of financial costs and benefits. Result of an official commission order. Environmental cost recovery mechanism allows for expedited, "automatic" cost recovery for the installation of emissions abatement equipment.	Cost pass through for CO_2 unlikely to be different than with SO_2. Current legislation being considered to make available some cost-recovery and prudence reviews during the construction of new carbon capture ready plants.	
IN[4]	Informal policy of 100% pass through of SO_2 revenues and expenses; dates to settlement agreement in the 1990s and has been the accepted method.	100% revenue and cost pass through expected for CO_2.	Incentives for installing SO_2 controls through expedited cost recovery that begin during construction
IA[5]	SO_2 financial costs and benefits are passed through to ratepayers		No PUC power to enact orders pertaining to the environment. PUC does not oversee Munis and Coops. Mid-American in rate freeze to 2014

State	SO_2 Pass Through	CO_2 Pass Through	Notes
MO[6]	100% of costs and revenues placed into credit account, then passed through at next rate case. Based on an agreement between utilities and commission staff	SO_2 pass-through mechansim would be the starting point for CO_2	Legislation allows for accelerated cost recovery for environmental projects deemed prudent; recovery can begin without a rate case
NC[7]	Revenue generated from SO_2 speculative trading is allowed to be retained by utilities. Likewise, utilities must bear any losses. Revenue and costs generated for use of SO_2 allowances are passed through 100%. True-up is through fuel cost adjustment in rate cases. One utility can retain revenue in a deferred account that must be passed through at a later date. A draft bill would allow revenues and costs to be trued-up annually without a rate case.	Not clear how the Commission would address costs and revenues from CO_2 trading	North Carolina Clean Smokestacks Act allows for some accelerated approval of SO_2 and NOx compliance costs. Uncertain if CO_2 would fall under this provision.
ND[8]	No formal policy for SO_2 cost and revenue pass through	Commission limited by law in its ability to take into account the potential future cost of CO_2 emissions	
WV[9]	100% pass-through of cost and revenue from the "prudent" trading of SO_2 allowances through the Expanded Net Energy Costs (ENEC) clause.	Cost pass through of CO_2 compliance would likely be done in a way to help ensure that the stat's coal industry would continue to thrive	ENEC originally created to adjust rates for changes in fuel costs; it has been expanded to include environmental compliance and purchased power costs. Accelerated cost-recovery for environmental compliance is allowed in specific instances, such as during installation of an SO_2 scrubber for utilities with below investment-grade credit

Partially Restructured States

State	SO_2 Pass Through	CO_2 Pass Through	Notes
CA[10]	No formal procedures in place since SO_2 emissions are so low	Discussion has begun for how to pass through CO_2 allowance costs and revenues for California AB 32 (California's cap-and-trade program) but nothing has been determined	
NV[11]	No official policy for SO_2 allowance costs or revenues, but costs are passed through via base rates. No revenue has been generated to date, but 100% pass through is likely.	Likely for 100% cost and revenue pass through	
OR[12]	Inconsistent treatment for SO_2 pass through. Pacificorp was required to pass through 100% of revenues from allowance sales. Idaho Power was allowed to keep 10% of the revenue from allowance sales. The commission supports revenue sharing on a 90/10 split	The commission would establish an official rule or order regarding how CO_2 allowance revenues would be treated, likely with a 90/10 split. The commission would not treat CO_2 allowances costs as an investment that a utility could earn a return on; all costs would be passed through to ratepayers.	
VA[13]	Orignally restructured with a rate cap on non-fuel costs, including SO_2 allowances. Commission has no oversight in this regard, BUT VA is re-regulating so that the commission will have weak oversight through a biannual rate review starting in 2009. A utility being overcompensated must return revenues via a complicated formula	Uncertain how CO_2 costs and revenues would be passed through to consumers given new regulatory structure	
Fully Restructured States			

State	SO_2 Pass Through	CO_2 Pass Through	Notes
CT[14]	Market driven; before restructuring, CT had an innovative revenue sharing rule that allowed utilities to retain 15% of SO_2 trading revenues, but this no longer applies post-restructuring	Market driven	
IL[15]	Market driven	Market driven; coal is on the margin, so price increases may be significant, but the threat of imports may put pressure on utilities not to pass on the full cost of compliance in their bids	
MD[16]	Market driven	Market driven	MD has the Healthy Air Act that is more stringent than CAIR. Utilities have opted to install new scrubbers to meet the requirement and can sell CAIR allowances and retain the revenue
NY[17]	Market driven	Market driven	
PA[18]	Market driven	Market driven	
TX[19]	Market driven	Market driven; natural gas is on the margin, so CO_2 may have only a small increase prices as long as natural gas continues on the margin	

[1]Personal communication with John Free, Alabama Public Service Commission, May 2007
[2]Personal communication with Jeff Hein, Colorado Public Utilities Commission, May 2007
[3]Personal communication with Bob Trapp, Florida Public Service Commission, May 2007
[4]Personal communication with David Johnston, Indiana Utility Regulatory Commission, May 2007
[5]Personal communication with Jeff Kaman, Iowa Utilities Board, May 2007
[6]Personal communication with David Elliott, Missouri Public Service Commission, May 2007
[7]Personal communication with Mike Manus, North Carolina Utilities Commission, May 2007
[8]Personal communication with Jerry Lein, North Dakota Public Service Commission, May 2007
[9]Personal communication with Ed Oxley, West Virginia Public Service Commission, May 2007
[10]Personal communication with Matthew Layton, California Energy Commission, May 2007

State	SO_2 Pass Through	CO_2 Pass Through	Notes

[11]Personal communication with Mark Harris, Public Utilities Commission, May 2007

[12]Personal communication with Judy Johnson, Public Utility Commission, May 2007

[13]Personal communication with William Stephens, Virginia State Corporation Commission, May 2007

[14]Personal communication with David Goldberg, Connecticut Department of Public Utility Control, May 2007

[15]Personal communication with Thomas Kennedy, Illinois Commerce Commission, May 2007

[16]Personal communication with Duane King, Maryland Department of the Environment, May 2007

[17]Personal communication with John Roberts, Public Service Commission, May 2007

[18]Personal communication with Cal Birge, Pennsylvania Public Utility Commission, May 2007

[19]Personal communication with Ken Donahoo, Electric Reliability Council of Texas, May 2007

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