

CLIMATE CHANGE 101

Cap and Trade



There are a variety of policy tools to reduce the greenhouse gas emissions responsible for climate change. This installment of the Climate Change 101 series explains how a cap-and-trade program sets a clear limit on greenhouse gas emissions and minimizes the costs of achieving this target. By creating a market, and a price, for emission reductions, cap and trade offers an environmentally effective and economically efficient response to climate change.

WHAT IS “CAP AND TRADE”?

Policymakers have many options as they consider how to achieve greenhouse gas (GHG) reductions, but two approaches are most prominent: traditional command-and-control regulation, in which regulatory authorities direct how emissions limits will be achieved, and market-based approaches, which harness the forces of supply and demand to change behavior and achieve environmental goals. One proven market-based approach is cap and trade.

In a cap-and-trade program, the government determines which facilities or emissions are covered by the program and sets an overall emission target, or “cap,” for covered entities. This cap is the sum of all allowed emissions from all included facilities. Once the cap has been set and covered entities specified, tradable emissions allowances (rights to emit) are distributed (either auctioned, or freely allocated, or some combination of these). Each allowance authorizes the release of a specified amount of greenhouse gas emissions, generally one ton of carbon dioxide equivalent (CO₂e).¹ The total number of allowances is equivalent to the overall emissions cap (e.g., if a cap of one million tons of emissions is set, one million one-ton allowances will be issued). Covered entities must submit allowances equivalent to the level of emissions for which they are responsible at the end of each of the program’s compliance periods.

Allowance trading occurs because firms face different costs for reducing emissions. For some emitters, implementing

new, low-emitting technologies may be relatively inexpensive. Those firms will either buy fewer allowances or sell their surplus allowances to firms that face higher emission control costs. Since a ton of carbon dioxide (CO₂) emitted from one source has the same warming effect as a ton emitted from any other, the location of a given emissions reduction does not matter. By giving firms a financial incentive to control emissions and the flexibility to determine how and when emissions will be reduced, the capped level of emissions is achieved in a manner that minimizes overall program costs.

Although a critical and effective component of any comprehensive solution to climate change, cap-and-trade programs alone cannot achieve the GHG emission reductions required to stabilize the climate. Addressing climate change requires a combination of market mechanisms with other policy measures, including incentives and standards. For example, in order to begin rapidly cutting emissions, certain technologies may require additional supportive policies to push them to their full potential. In addition, some emission sources of GHGs cannot easily be covered by a cap-and-trade program and will need to be addressed using other policies.

Figures 1 and 2 illustrate the economic benefits of trading by means of a simplified example.

Emitter A (a power plant) and Emitter B (a manufacturing facility) emit a combined total of 900 tons of CO₂ a year.



The government decides that these total emissions must not exceed 600 tons a year. As can be seen in Figure 1a, the cost of reducing a given amount of emissions for Emitter A is greater than the cost for Emitter B (Emitter A's first 100 tons of reductions cost \$2,000, while Emitter B's first 100 tons of reductions cost \$1,000, etc.). Under traditional environmental regulation, regulators might direct each facility to

cut its respective emissions to 300 tons. Emitter A would spend \$5,000, while Emitter B would spend \$1,000; the 600 ton goal would be reached at a total of \$6,000, or \$20 per ton reduced (Figure 1b).

Alternatively, the government could establish a cap-and-trade system, setting an overall emissions cap of 600 tons

Figure 1

Command and Control

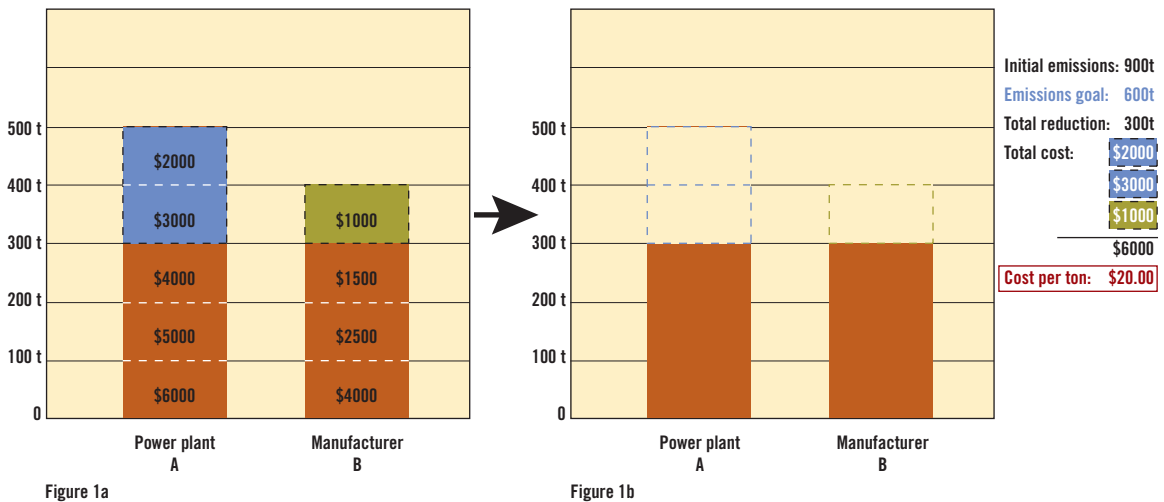
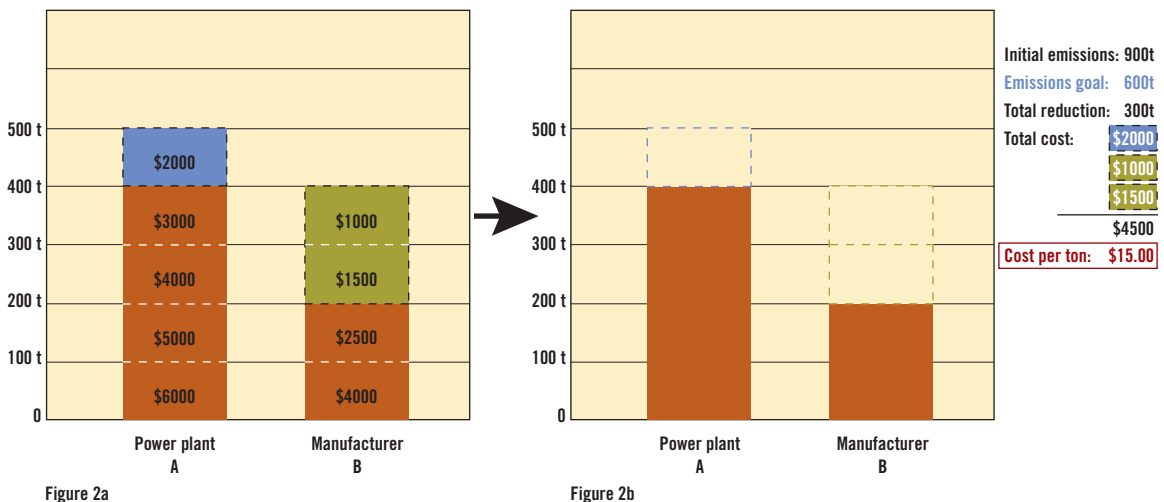


Figure 2

Cap and Trade



and then issuing 600 emissions allowances. If allowances were evenly distributed, both emitters would have an incentive to trade because emissions reduction costs are higher for A than for B (Figure 2a). Emitter B might cut emissions by 200 tons and sell its excess allowances to Emitter A for less than it would have cost Emitter A to make the reductions itself (for example, \$2,500 for 100 allowances). In this scenario, the desired level of emissions is reached at a lower total cost of \$4,500 and a lower cost per ton of \$15 (Figure 2b). The total cost is lower, as is the cost for each regulated facility.

DRIVING INNOVATION

A key advantage of cap and trade (and market mechanisms in general) is that it provides an incentive for continuous innovation in emissions reduction.² Under traditional command-and-control regulation, there is no incentive to go beyond the regulatory standard. In fact, there may actually be a disincentive to do so because demonstrating the feasibility of additional effort may result in more stringent future regulation. In a cap-and-trade program, a firm that can reduce emissions at a cost lower than the allowance price either reduces its compliance cost (because fewer allowances need to be purchased) or frees up allowances that can be sold to others. This financial incentive drives the private sector to continually innovate and seek new emission-reducing technologies that regulators might not anticipate under more prescriptive command-and-control regulations. In a market system, such emission-reducing innovation can set the stage for deeper emission cuts over time. This is particularly important because meeting the challenge of climate change will require new technology to achieve the very deep emission cuts that are necessary.

CAP AND TRADE MARKET DESIGN

Important decisions have to be made about what a cap-and-trade program will look like, including

- what emissions will be capped by the program (*scope of program*), and what entities will be required to hold allowances equivalent to emissions (*point of regulation*)
- the level of the emissions cap (*stringency*)

Emissions Trading: A Homegrown Approach

Emissions trading programs have been used to reduce pollution in the United States since the 1970s, when the Environmental Protection Agency introduced trading as a compliance option for meeting certain requirements under the U.S. Clean Air Act. The 1990 Clean Air Act Amendments established the U.S. Acid Rain program for sulfur dioxide (SO₂), a cap-and-trade system for SO₂ emissions from electric power plants that proved enormously successful, achieving its pollution reduction goals at approximately half the cost of traditional regulation.³ Moreover, the program has proved administratively efficient, requiring a staff of approximately 50 people to track all emissions data, allowance transfers, and compliance.⁴

- whether provisions will be included to help ensure the costs of the program do not get too high or volatile (*cost containment mechanisms*)
- whether the program should be linked with similar trading programs (*linkage*)
- how allowances are to be distributed (*allowance distribution*)

Scope and Point of Regulation. The first step in setting up a cap-and-trade program is deciding which greenhouse gases and emissions sources are covered and who is responsible for holding allowances. Some sectors that might be included under the cap are electric power, manufacturing, transportation, or fossil fuel use. In theory, market-based programs are most cost-effective if they cover all GHGs in all major emitting sectors because including more sources and greenhouse gases offers a broader range of opportunities for low-cost reductions. However, including sources that are small or difficult to monitor can make the program too administratively complex; these sources may be addressed more efficiently through other regulatory mechanisms.

After deciding which emissions are covered by the program, policymakers must decide who is responsible for surrendering enough allowances to match their emissions every compliance period. This is known as the “point of

regulation,” where compliance is demonstrated by submitting allowances. Which entities are required to submit allowances to cover emissions determines whether a cap-and-trade system is defined as an upstream, downstream, or a product- or load-based program (or some combination of these).

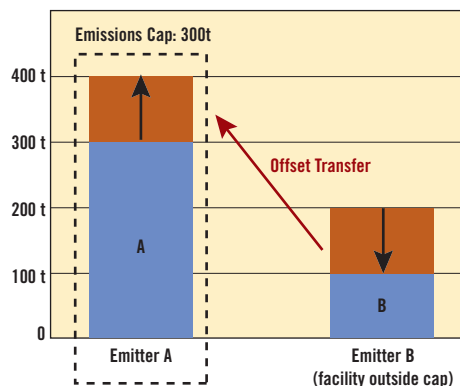
- **Upstream:** A pure upstream, economy-wide system for CO₂ would place a cap on the total amount of carbon contained in fossil fuels and other products used in the economy. It would require importers or suppliers of fossil fuels to submit allowances to cover the carbon in the products they sell. The key argument made in favor of an upstream approach is that one can achieve greater coverage of emissions at a smaller number of sources.
- **Downstream:** Under a downstream, source-based system, the covered entities are direct emitters of greenhouse gases (generally large emitters such as power plants or manufacturing facilities). The key arguments in favor of a downstream approach are that (1) to date, most experience with cap and trade has been based on downstream regulation, and this institutional familiarity makes such an approach less risky; and (2) downstream sources generally have more emission reduction options available, and are thus in a better position to respond to the requirements.⁵
- **Product- or Load-Based:** In a product- or load-based cap-and-trade system, the covered entities are responsible for all the emissions associated with the production of electricity, natural gas, or other product that they provide to customers.⁶

Many argue that, regardless of which entities are covered, an effective cap-and-trade program should follow some basic design criteria:

- Simple, consistent, and transparent rules
- Accurate emissions measurement, monitoring, and reporting, preferably done electronically and including public access to emissions data
- Sound auditing practices to ensure that emissions are being accurately reported
- Consistent enforcement with real penalties for non-compliance and inaccurate reporting
- Unrestricted trading of allowances and minimal transaction costs⁷

Figure 3

Offsets



An offset represents an emissions reduction credit generated by an entity not included under a cap that can be sold to capped entities and used in the same manner as an allowance. In Figure 3 above, Emitter A is included under a cap-and-trade system with an overall cap of 300 tons. If offsets are permitted under the program, an entity outside of the cap (Emitter B) can make an emissions reduction of 100 tons, creating 100 reduction credits that can be purchased by Emitter A to offset a 100 ton increase in its own emissions. Although emissions from the capped entity total 400 tons, Emitter B offsets 100 of those tons, so that, on net, the same emission reductions are achieved.

COST CONTAINMENT MECHANISMS

There are a variety of cost containment mechanisms that can help manage the cost of compliance for covered entities in a cap-and-trade program.

Offsets. Offsets are emission reduction projects undertaken at sources outside a cap-and-trade program. An offset mechanism enables covered entities to offset their own emissions by purchasing emission reduction credits generated through projects at facilities not covered by the cap (Figure 3). Offsets lower the overall cost of the program by bringing in low-cost emission reduction opportunities from outside the cap.

Offset projects may include landfill methane capture, afforestation, or other types of projects. Offsets should be measurable, real, additional,⁸ and have clear ownership. Regulators must also be able to verify such projects. Through the Clean Development Mechanism of the Kyoto Protocol, developed countries can use offset projects in developing countries to comply with their targets.⁹ The northeast Regional Greenhouse Gas Initiative allows certain types of offsets as well.¹⁰

Temporal Flexibility: Borrowing, Banking and Compliance Period. Markets can also be designed to include mechanisms for inter-temporal trading, allowing firms greater flexibility in compliance. Such flexibility can reduce allowance price volatility. Regulators can decide to let firms either “bank” or “borrow” their allowances. Banking allows firms to save, or “bank,” any excess allowances for future use or to sell later on, encouraging early or over-compliance.¹¹ Borrowing allows program administrators or covered entities to use in the current year allowances that will be issued in a future year, under the condition that they will “pay back” these allowances (perhaps with interest) by reducing emissions more in the future. Borrowing entails the risk that program administrators or firms will fail to pay back the borrowed allowances and the emission cap could thus be exceeded.

Longer compliance periods also provide some temporal flexibility. A “compliance period” is the length of time for which covered sources must submit allowances equivalent to their level of emissions, or face a penalty for failing to do so. A cap-and-trade program can have several compliance periods, especially if the cap is ratcheted down over time. The length of compliance periods determines how often covered emitters must submit allowances, and has important implications. Longer compliance periods are essentially the same as short-term banking and borrowing.

Safety valves. The term “safety valve” can have many meanings. Generally, it is a mechanism that triggers a change in the cap-and-trade program if compliance costs are higher than expected. The mechanism is often a pre-determined allowance price which triggers additional cost containment measures. The safety valve may allow emitters greater flexibility in how they comply with a cap, for example by increasing the availability of offset credits, changing the timing of program compliance,¹² or expanding the use of “borrowing” allowances (described above).

A safety valve may or may not affect the environmental integrity of the program. One version of a safety valve sets an allowance price cap that triggers the issuance of additional allowances to ensure that the price stays below a certain threshold. Since these additional allowances enable the emissions cap to be exceeded, this type of safety valve

does not ensure that environmental goals will be achieved. Another disadvantage of an allowance price cap is that it can inhibit linking or trading with market systems that do not have such a price cap (see below).

Choosing the price at which additional cost containment measures are needed is difficult. If set too high, the price can have little actual effect on costs. If set too low, it can diminish the economic incentive for technological innovation created by a cap-and-trade system.

Linkage. Cap-and-trade programs can be designed to link with other similar trading systems in other regions. Linking to other programs has the advantage of effectively expanding the market, leading to even more opportunities for low-cost emissions reductions and a larger market for new technologies. There are few hard-and-fast barriers to linking, but it is more easily achieved if certain structural elements are comparable in both programs.¹³

ALLOWANCE DISTRIBUTION

Once the cap has been set and the overall design of the cap-and-trade program established, choices have to be made about the best way to distribute emissions allowances.¹⁴ In general, how allowances are initially distributed does not affect the emission reductions achieved by a cap-and-trade program.¹⁵ However, it does affect how the program’s costs are distributed and can sometimes affect overall program costs.¹⁶ There are two basic approaches to allowance distribution: some form of free allocation, or some form of auction. A combination of auctioning and free allocation, or a shift from one to the other over time, is also possible. Regardless of which method is favored, either allowance allocation or auction revenues can be used to mitigate economic impacts (e.g., by granting allowances to emitters who are competitively disadvantaged by emission caps) or drive innovation (e.g., by using allowances or auction revenues to fund or incentivize research, development, demonstration and deployment of low-carbon technologies).

Several types of free allocation exist. Allowances can be given away for free based on participating entities’ historical emissions (a method also known as “grandfathering”). Output-based methods of allowance allocation are based

on the output of a product in a given sector. For example, allowances might be distributed based on megawatt-hours generated or tons of a product manufactured. Benchmarking, or setting a level of emissions (in the form of allowances) per unit, can be applied based on input or output. Allowance allocations may also be “updated” over time as input, output or emissions change. In the case of free allowance allocation, it is important to bear in mind that the point of regulation described above (where compliance is demonstrated by submitting allowances) does not necessarily need to be the same point at which allowances are initially distributed.

There are tradeoffs between simplicity and equity if allowances are distributed for free. For example, basing allocation on historical emissions is relatively simple. However, it means that some form of credit for early action would be needed to ensure that firms who took voluntary measures to reduce their emissions before the base year are not penalized for doing so. Updating has the advantage of adjusting allocation to changing circumstances. However, while fixed allocations will not affect firms’ future behavior, updating encourages firms to behave in ways that will maximize their future allocation. For example, if firms believe that allowances will be distributed based on future emissions, they may try to increase their emissions in order to receive more allowances.

As an alternative to free distribution, allowances can be auctioned. Auctioning generates revenue that the government can use to provide relief for compliance or higher energy costs. The government can also use the auction revenue to reduce other taxes that may be discouraging economic growth, or to fund complementary policies. However, as with the various forms of free allocation, there are tradeoffs involved with auctioning allowances. The impact of costs on a given firm depends on the competitiveness of the industry in which the firm operates as well as that industry’s regulatory environment. In some cases, auctioning may unfairly hurt participants lacking the funds to purchase enough allowances from outside the covered region. This is especially true for firms who cannot pass on some or all of the costs of their allowances to consumers. However, firms in other industries might be able to pass on their compliance costs under a cap-and-trade system. In these cases, firms would be over-compensated if most or all allowances were given away for free, which might lead to windfall profits for these firms.

Tax or Trade?

In addition to cap and trade, another type of market mechanism sometimes discussed as a means of reducing GHG emissions is a carbon tax, which would require emitters to pay a tax for every ton of GHGs they emit. The key difference between the two approaches is that cap and trade provides environmental certainty, since the quantity of total allowable emissions is set, while a tax provides price certainty, since the cost of emitting a given amount of GHGs is set. In response to a tax, many emitters will reduce their emissions, but others might simply accept the additional cost and continue to emit. Determining the correct level at which to set a tax in order to drive any given level of emissions reductions is difficult.

Cap and trade and a tax have to address many of the same issues. Both cap and trade and a carbon tax use economic incentives to promote least-cost emission reductions and drive climate-friendly innovation. Both approaches would require careful monitoring and enforcement, and both must address the question of how to distribute costs and benefits. For cap and trade that means figuring out how to distribute and/or auction emission allowances; under a tax that means figuring out who pays the tax and what to do with the tax revenue.

Auctioning some or all allowances could help avoid such windfalls. Auctioning can also help address concerns about crediting early action by firms, as it rewards those who have already reduced emissions by investing in lower-carbon technologies.¹⁷

Either allowances themselves (in the case of free allocation) or auction revenues (in the case of auctioning) can be used to advance program goals under a cap-and-trade system. For example, if regulators want to promote end-use energy efficiency programs among consumers, they could either use proceeds from auctioning allowances to support efficiency projects, or distribute allowances for free to entities undertaking efficiency projects. Similarly, just as auction revenue can be used to help offset program costs, free allocation can also be used to deal with high compliance costs which might be passed

on to consumers. The key difference between auction revenue and allowances is that auction revenue can more easily be used to adjust other taxes, and allowances are more easily limited to purposes more closely tied to the cap and trade program itself.

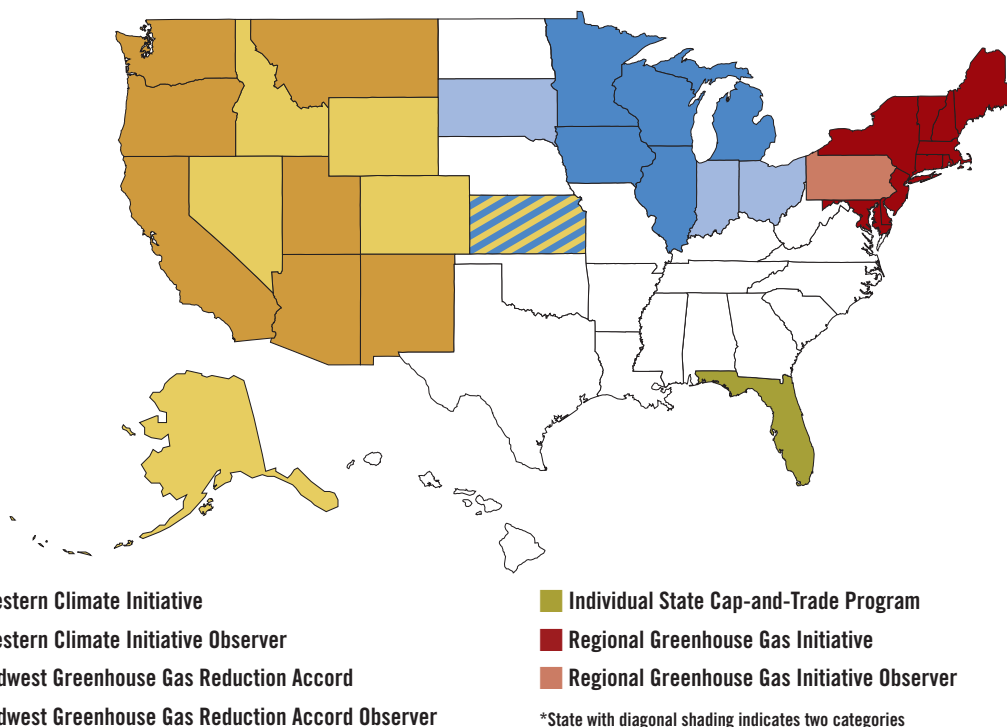
GREENHOUSE GAS TRADING IN PRACTICE

Emissions trading systems are already proving their value as tools to address climate change by reducing emissions of greenhouse gases throughout the world, and other markets are under development.

EU Emissions Trading System. The world's most ambitious and far-reaching example of greenhouse gas emissions trading is the European Union's Emissions Trading Scheme

(ETS), which limits CO₂ emissions from approximately 12,000 facilities in the 27 EU member states. Launched in 2005, the ETS covers power plants and five major industrial sectors (including oil, iron and steel, cement, glass, and pulp and paper) that together produce nearly half the EU's CO₂ emissions. An initial "learning phase" (phase I) ran through 2007; a second coincides with the Kyoto Protocol compliance period (2008-2012). Excess emissions incur a penalty (40 Euros/tonne in phase I, 100 Euros/tonne in phase II) and must be made up in the next phase. During the learning phase, ETS allowance prices fluctuated due to weather (affecting energy demand), shifts in energy prices, and initial over-allocation of allowances as a result of incomplete historical emissions data. Many regard these

Figure 4
States Establishing **Regional Cap-and-Trade Programs** for Greenhouse Gases



Three regional cap-and-trade programs are currently in development within the United States. A total of 23 states (accounting for 36 percent of total U.S. emissions) are full participants in these programs, and an additional nine states are participating as observers. Florida is developing its own trading program.

fluctuations as characteristic of a new compliance market. The EU ETS plans to adjust its allocations in the next phase and is also considering auctioning a significant portion of the allowances.

The ETS is the first program of its kind and size, and has established a functioning market in a relatively short span of time. Volume of allowance trading reached over 100 million allowances per month in early 2007, and rates of compliance with the program are high. In general, the EU ETS promotes innovation and is seen as flexible and cost-effective. European Union policymakers have said the ETS will continue beyond 2012 with or without a new international climate agreement. In January 2007, the EU commission released its proposal to commit the EU to a GHG reduction target of 20 percent below 1990 levels by 2020 and suggested that if other industrial countries follow suit—namely the United States—the EU will commit to 30 percent.

Regional Greenhouse Gas Initiative. The Regional Greenhouse Gas Initiative (RGGI) is the first mandatory U.S. cap-and-trade program for carbon dioxide. Currently, ten Northeastern and Mid-Atlantic states are participating: Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, and Vermont.

RGGI sets a cap on emissions of carbon dioxide from power plants in the region, and allows sources to trade emission allowances. The program will begin by capping emissions at current levels in 2009, and then reducing emissions 10 percent by 2019. Sources will continuously monitor and report their emissions, and penalties for non-compliance will be enforced according to each state's rules. Member states agree to each set aside at least 25 percent of their emission allowances for public benefit purposes, such as promoting renewable energy and energy efficiency or mitigating possible increases in consumer energy prices. Many of the RGGI states have committed to or are considering setting aside a greater portion of allowances for such purposes. RGGI also allows the use of offset projects for compliance, but these projects will need to meet strict standards and will be limited to ensure that significant reductions occur at electric generators.¹⁸ The RGGI states began trading in January 2009.

California and the West. In September 2006 Governor Schwarzenegger signed AB 32, the Global Warming Solutions Act. The Act caps California's greenhouse gas emissions at 1990 levels by 2020 and represents the first state-wide program in the United States that caps all GHG emissions from major industries and includes penalties for non-compliance. California is currently in the process of designing a comprehensive program to meet its goals under AB 32. The state is considering using market mechanisms, including a cap-and-trade program, as part of AB 32 implementation, and may try to link its program to RGGI and the EU-ETS markets.

California is also part of a larger, regional cap-and-trade program that is likely to emerge in the West. In February 2007 the Governors of Arizona, California, New Mexico, Oregon, and Washington signed an agreement establishing the Western Climate Initiative (WCI), a joint effort to reduce greenhouse gas emissions and address climate change. The states of Utah and Montana as well as the Canadian Provinces of British Columbia and Manitoba joined the Initiative in the following months. Under the agreement, the states and provinces jointly set a regional emissions target in August 2007 of 15 percent below 2005 levels by 2020. In September 2008, the WCI partners released their final recommendations for the design of a regional cap-and-trade program covering multiple economic sectors and nearly 90 percent of regional emissions to aid in meeting this target.

Midwestern Accord. In November 2007, six states and one Canadian Province established the Midwestern Regional Greenhouse Gas Reduction Accord, under which members agree to establish regional greenhouse gas reduction targets, including a long-term target of 60 to 80 percent below current emissions levels, and develop a multi-sector cap-and-trade system to help meet the targets. Participants will also establish a greenhouse gas emissions reductions tracking system and implement other policies, such as low-carbon fuel standards, to aid in reducing emissions. Members of the Accord include Illinois, Iowa, Kansas, Michigan, Minnesota, and Wisconsin, as well as the Canadian Province of Manitoba. The Accord partners will release their final design recommendations for a regional cap-and-trade system in early 2009.

THE BENEFITS OF CAP AND TRADE

Cap-and-trade programs offer significant advantages over traditional regulatory policies, particularly in the effort to address climate change. Unlike traditional regulation, cap and trade constrains emissions but lets market forces set a price on greenhouse gas emissions and helps minimize the cost of making substantial reductions in those emissions. Rather than mandating a specific technology, the flexibility afforded by emissions trading markets helps identify where emission reductions can be achieved most cost-effectively. Cap and trade stimulates the development of new technological solutions that can enable much deeper cuts at lower cost in the future—technologies that regulators simply cannot anticipate. Furthermore, emissions trading programs can be designed to cover a wide variety of emissions sources and sectors and serve as the core of an economy-wide GHG reduction program.

Despite its strengths, cap and trade alone cannot achieve the GHG emissions cuts necessary to address climate change, but, combined with other regulatory measures and incentives, can be a key part of the solution. In order to achieve the necessary reductions, certain technologies may need to be targeted by specific supportive policies in order to reach their potential, and some sources of emissions may not be easily covered through cap and trade. A solution to climate change will require a comprehensive approach, combining market mechanisms with more traditional standards and incentives.

Ultimately, cap-and-trade programs offer opportunities for the most cost-effective emissions reductions. Deciding on the most equitable method of initial allowance distribution, what trading rules should be, and other design features is challenging. Once established though, a well-designed cap-and-trade market is relatively easy to implement, can achieve emissions reductions goals in a cost-effective manner, and drives low-greenhouse gas innovation.

ENDNOTES

1. Carbon dioxide equivalent is a metric used to compare the amounts and effects of different greenhouse gases. It is determined by multiplying the emissions of a gas (by mass) by the gas' "global warming potential" (GWP), an index representing the combined effect of the length of time a given greenhouse gas remains in the atmosphere and its relative effectiveness in absorbing outgoing infrared radiation. CO₂ is the standard used to determine the GWPs of other gases. CO₂ has been assigned a 100-year GWP of 1 (i.e., the warming effect over a 100-year time frame relative to other gases). Another greenhouse gas, methane (CH₄), is 21 times more potent than carbon dioxide, and nitrous oxide (N₂O) is roughly 310 times more potent a GHG than CO₂.
2. *An Emerging Market for the Environment: A Guide to Emissions Trading*. United Nations Environment Programme and United Nations Conference on Trade and Development, 2002, p 8.
3. Ellerman et al. *Emissions Trading in the U.S.: Experience, Lessons, and Considerations for Greenhouse Gases*. Pew Center on Global Climate Change, 2003.
4. See *Recommendations for Designing a Greenhouse Gas Cap-and-Trade System for California*. Recommendations of the Market Advisory Committee to the California Air Resources Board, June 2007, p. 99. Available online at http://www.climatechange.ca.gov/documents/2007-06-29_MAC_FINAL_REPORT.PDF
5. For more on the respective advantages of upstream and downstream approaches to regulation, see *Recommendations for Designing a Greenhouse Gas Cap-and-Trade System for California*. Recommendations of the Market Advisory Committee to the California Air Resources Board, June 2007.
6. A load-based system is an example of a product-based cap-and-trade system, in which entities that sell products are responsible for the emissions associated with the products that they provide to customers, and demonstrate compliance with the cap. The term "load-based" is used because gas or electric demand is often referred to as load, and the entities meeting this demand are referred to as load-serving entities. In California and Oregon, where an emissions market is currently being discussed, "load-based" is used to describe a cap on the electricity retailers instead of the power generators, although electricity retailers and generators can be the same entities.
7. Ellerman et al. 2003.
8. "Additional" means that the emissions reductions achieved are in addition to those that would otherwise have occurred in the absence of the project under a business-as-usual scenario.
9. The CDM is designed to promote sustainable development in developing countries. It enables industrialized countries to invest in emission reduction projects in developing countries and to receive credits for reductions achieved. For more information, see the United Nations Framework Convention on Climate Change site at http://unfccc.int/kyoto_protocol/mechanisms/clean_development_mechanism/items/2718.php.
10. For additional information, see the RGGI final model rule, available online at http://rggi.org/docs/model_rule_corrected_1_5_07.pdf.
11. Banking allows firms to better cope with uncertainties and unexpected circumstances that may lead to high allowances prices at a future date, and has proved important to the success of past emissions trading programs, such as the Acid Rain Program in the U.S. See Ellerman et al. 2003.

12. In California's AB 32 legislation, "safety valve" was also used to describe the provision that allows the Governor to delay compliance deadlines by a year under extraordinary circumstances. The Regional Greenhouse Gas Initiative uses price triggers to allow more offsets for compliance purposes.
13. For a detailed discussion on linkage considerations, see *Recommendations for Designing a Greenhouse Gas Cap-and-Trade System for California*. Recommendations of the Market Advisory Committee to the California Air Resources Board, June 2007, p. 69.
14. For a more in-depth discussion of allowance distribution, see *Greenhouse Gas Emissions Allowance Allocations*, prepared by the Pew Center on Global Climate Change, 2008. Available online at <http://www.pewclimate.org/brief/allocation>
15. Ellerman et al. 2003.
16. United Nations Environment Programme and United Nations Conference on Trade and Development, 2002.
17. For more on the relative merits of auctioning versus free allocation of allowances, see *Greenhouse Gas Emissions Allowance Allocations*, prepared by the Pew Center on Global Climate Change, 2008. Available online at <http://www.pewclimate.org/brief/allocation>
18. Specifically, RGGI will initially set standards for offset projects in five categories: forest sequestration, sulfur hexafluoride (SF₆) leak prevention, landfill gas capture and destruction, methane capture from animal operations, and oil and gas efficiency improvements. RGGI will also allow international offset projects under certain circumstances. Sources will initially be allowed to cover up to 3.3% of their emissions using offset allowances, an amount on average equal to approximately half of a covered source's emissions reduction obligation. However, if average allowance prices rise above \$7 per ton, sources will be allowed to cover up to 5% of their emissions using offsets. If allowance prices rise above \$10 per ton, RGGI will allow sources to cover up to 10% of their emissions with offsets, and will allow offset projects outside the U.S. as well as allowances from the EU Emissions Trading Scheme and the Kyoto Protocol's Clean Development Mechanism.

CAP AND TRADE KEY TERMS GLOSSARY

Additionality: Emissions reductions achieved through a given project (or class of projects) over and above those that would otherwise have occurred in the absence of the project(s) under a business-as-usual scenario. Additionality is a criterion for approval of project-based activities (offsets) under the Clean Development Mechanism of the Kyoto Protocol as well as offset projects allowed for credit under other emissions trading programs.

Allowance: A government-issued authorization to emit a certain amount. In greenhouse gas markets, an allowance is commonly denominated as one ton of CO₂e per year. The total number of allowances distributed to all entities in a cap and trade system is determined by the size of the overall cap on emissions.

Allowance distribution: The process by which emissions allowances are initially distributed under an emissions cap-and-trade system. Authorizations to emit can initially be distributed in a number of ways, either through some form of auction, free allocation, or some of both.

Auctioning: A method for distributing emission allowances in a cap-and-trade system whereby allowances are sold to the highest bidder. This method of distribution may be combined with other forms of allowance distribution.

Banking: The carry-over of unused allowances or offset credits from one compliance period to the next.

Baseline: The target, often the historical emissions from a designated past year, against which emission reduction goals are measured.

Benchmarking: An allowance allocation method in which allowances are distributed by setting a level of permitted emissions per unit of input or output.

Borrowing: A mechanism under a cap-and-trade program that allows covered entities to use allowances designated for a future compliance period to meet the requirements of the current compliance period. Borrowing may entail penalties to reflect a programmatic preference for near-term emissions reductions.

Cap and Trade: A cap-and-trade system sets an overall limit on emissions, requires entities subject to the system to hold sufficient allowances to cover their emissions, and provides broad flexibility in the means of compliance. Entities can comply by undertaking emission reduction projects at their covered facilities and/or by purchasing emission allowances (or credits) from the government or from other entities that have generated emission reductions in excess of their compliance obligations.

Carbon Tax: A surcharge on the carbon content of fossil fuels that aims to discourage their use and thereby reduce carbon dioxide emissions.

Circuit Breaker: A threshold or circumstance which, if met, would require suspending further tightening of the program until the circumstances change.

Command and Control: A system of regulation that prescribes emission limits and compliance methods on a facility-by-facility or source-by-source basis and that has been the traditional approach to reducing air pollution.

Cost Containment Mechanisms: Design elements in a cap-and-trade program that reduce the risk of high or volatile compliance costs for affected facilities or industries.

Credits: Credits can be distributed by the government for emission reductions achieved by offset projects or by achieving environmental performance beyond a regulatory standard.

Downstream (source-based) System: Also known as a source-based system, a downstream cap-and-trade system is one in which the point of regulation coincides with the point of emission of covered greenhouse gases. Examples of this approach include the Regional Greenhouse Gas Initiative's cap on power plant CO₂ emissions or the cap on large industrial and utility sources in the European Union's Emissions Trading Scheme.

Emissions Cap: A mandated constraint in a scheduled timeframe that puts a "ceiling" on the total amount of anthropogenic greenhouse gas emissions that can be released into the atmosphere.

Emissions Trading: The process or policy that allows the buying and selling of credits or allowances created under an emissions cap.

Grandfathering: A method by which emission allowances are freely distributed to entities covered under an emissions trading program based on historic emissions.

Greenhouse Gases (GHGs): Greenhouse gases include a wide variety of gases that trap heat near the Earth's surface, slowing its escape into space. Greenhouse gases include carbon dioxide, methane, nitrous oxide and water vapor and other gases. While greenhouse gases occur naturally in the atmosphere, human activities also result in additional greenhouse gas emissions. Humans have also manufactured some GHGs not found in nature (e.g., hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride) that slow the release of radiant energy into space.

Linking: Authorization by the regulator for entities covered under a cap-and-trade program to use allowances or offsets from a different jurisdiction's regulatory regime (such as another cap and trade program) for compliance purposes. Linking may expand opportunities for low-cost emission reductions, resulting in lower compliance costs.

Offset: Projects undertaken outside the coverage of a mandatory emissions reduction system for which the ownership of verifiable GHG emission reductions can be transferred and used by a regulated source to meet its emissions reduction obligation. If offsets are allowed in a cap and trade program, credits would be granted to an uncapped source for the net emissions reductions a project achieves. A capped source could then acquire these credits as a method of compliance under a cap.

Point of Regulation: The point of program enforcement, or where specific emitting entities covered under a cap and trade program are required to surrender enough allowances to match their actual emissions within a compliance period.

Price Trigger: A general term used to describe a price at which some measure will be taken to stabilize or lower allowance prices. For example, RGGI uses price triggers to expand the amount of offsets that can be used for compliance.

Product- or Load-Based System: A system in which the covered emitters are responsible for all the emissions associated with the generation of the electricity, natural gas, or other product that they provide to customers.

Safety Valve: Generally, an optional design element of a cap-and-trade program that seeks to provide cost containment by triggering certain actions if costs turn out to be higher than expected. One form of a safety valve is a price cap, which makes allowances available at some threshold price to ensure that the allowance price does not rise above a certain level.

Scope: The coverage of a cap-and-trade system, i.e., which sectors or emissions sources will be included.

Source: Any process or activity that results in the net release of greenhouse gases, aerosols, or precursors of greenhouse gases into the atmosphere.

Updating: A form of allowance allocation in which allocations are reviewed and changed over time and/or awarded on the basis of changing circumstances rather than historical data. For example, updating can be based on megawatt-hours generated or tons of a product manufactured.

Upstream system: An upstream approach to a cap-and-trade system places the point of regulation with the point of entry of fossil fuels into commerce within the covered region.

ADDITIONAL RESOURCES

An Emerging Market for the Environment: A Guide to Emissions Trading. United Nations Environment Programme and United Nations Conference on Trade and Development, 2002.

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