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Cap and Trade Programs

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Cap and Trade Programs

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The course is based on a United States Environmental Protection Agency Office of Air and Radiation document, Tools of the Trade: A Guide To Designing and Operating a Cap and Trade Program For Pollution Control, June 2003.

Introduction

To ensure a cleaner, healthier environment, governments are increasingly using market-based pollution control approaches, such as emission trading, to reduce harmful emissions. The theory of emission trading and the potential benefits of market-based incentives relative to more traditional environmental policy approaches are well established in economic and policy literature. Until recently, however, practical applications of emission trading programs have been relatively limited. In 1990, the United States enacted legislation to implement a comprehensive national sulfur dioxide (SO₂) program using a form of emissions trading called “cap and trade.” The U.S. SO₂ cap and trade program has proven to be highly effective from both an environmental and an economic standpoint. The success of this program and others that followed has spurred interest from policymakers, regulating authorities, and business and environmental organizations. Today, emission trading mechanisms are increasingly considered and used worldwide for the cost-effective management of national, regional, and global environmental problems, including acid rain, ground-level ozone, and climate change.

Cap and trade is a market-based policy tool for environmental protection. A cap and trade program establishes an aggregate emission cap that specifies the maximum quantity of emissions authorized from sources included in the program.

The regulating authority of a cap and trade program creates individual authorizations (“allowances”) to emit a specific quantity (e.g., 1 ton) of a pollutant. The total number of allowances equals the level of the cap. To be in compliance, each emission source must surrender allowances equal to its actual emissions. It may buy or sell (trade) them with other emissions sources or market participants. Each emission source can design its own compliance strategy – emission reductions and allowance purchases or sales – to minimize its compliance cost. And it can adjust its compliance strategy in response to changes in technology or market conditions without requiring government review and approval.

Cap and trade programs offer a number of advantages over more traditional approaches to environmental regulation. First and foremost, cap and trade programs can provide a greater level

How a Cap and Trade Program Works

1. The regulating authority sets a cap on total mass emissions for a group of sources for a fixed compliance period (e.g., 1 year).
2. The regulating authority divides the cap into allowances, each representing an authorization to emit a specific quantity of pollutant (e.g., 1 ton of SO₂).
3. The regulating authority distributes allowances.
4. For the compliance period, each source measures and reports all of its emissions.
5. At the end of the compliance period, each source must surrender allowances to cover the quantity of the pollutant it emitted. If a source does not hold sufficient allowances to cover its emissions, the regulating authority imposes penalties.

of environmental certainty than other environmental policy options. The cap, which is set by policymakers, the regulating authority, or another governing body, represents a maximum amount of allowable emissions that sources can emit. Penalties that exceed the costs of compliance and consistent, effective enforcement deter sources from emitting beyond the cap level. In contrast, traditional policy approaches such as command-and-control regulation generally do not establish absolute limits on allowable emissions but rather rely on emission rates that can allow emissions to rise as utilization rises.

With cap and trade programs, even new emission sources may not increase the limits on emissions. The regulating authority may require new entrants to purchase or receive allocated allowances from the total allowable emissions set by the cap. Thus, the emissions target is maintained and the price of an allowance can adjust to reflect the increased demand for allowances.

A cap and trade program may also encourage sources to pursue earlier reductions of emissions than would have otherwise occurred, which can result in the earlier achievement of environmental and human health benefits. This is a result of two primary drivers: first, the cap and associated allowance market creates a monetary value for allowances, providing sources with a tangible incentive to decrease emissions. Second, a cap and trade program can incorporate the flexibility of banking to provide sources with an additional incentive to reduce emissions earlier than required. *Banking* allows sources to carry over unused allowances for use in a later compliance period when there might be more restrictive requirements or higher expected costs to reduce emissions. Essentially, banking gives sources some flexibility in the timing of emission reductions. This is in addition to flexibility given to sources in the location at which they make emission reductions.

Another environmental advantage of cap and trade is improved accountability. Participating sources must fully account for every ton of emissions by following protocols to ensure completeness, accuracy, and consistency of emission measurement. This system contrasts with most environmental programs that base compliance on periodic inspections and assumptions that equipment is functioning and the source is in compliance between inspections.

Accurate measurement of emissions and timely reporting are critical to the success of a cap and trade program and the integrity of the cap. After emissions data and allowance transaction information are reported, the regulating authority can provide detailed or summary information to the public. This transparency, or access to information, can provide confidence in the effectiveness of the program.

In addition to the environmental benefits of adopting a cap and trade program, significant economic benefits also support the use of such a mechanism. Cap and trade programs provide

sources with flexibility in how they achieve their emission target, which is uncommon under traditional environmental policy approaches.

The cap establishes the emission level for emission sources; the sources, however, are provided with the flexibility of choosing how they want to abate their emissions. Each source can choose to invest in abatement equipment or energy efficiency measures, to switch to fuel sources with no or reduced emissions, or to shutdown or reduce output from higher emitting sources. The regulating authority does not need to approve each source’s compliance choices because the cap, accompanied by emission measurement and reporting requirements, enable the regulating authority to focus on assessing compliance results (i.e., ensuring that each source has at least one allowance for each unit of pollution emitted). Cap and trade programs also allow sources to trade allowances, providing an additional option for complying with the emissions target. Sources that have high marginal abatement costs (i.e., the cost of reducing the next unit of emissions) can purchase additional allowances from sources that have low marginal abatement costs. In this way, both buyers and sellers of allowances can benefit. Sources with low costs can reduce their emissions below their allowance holdings and earn revenues from selling their excess allowances – a reward for better environmental performance. Sources with high costs can purchase additional allowances at a price that is lower than the cost to reduce a unit of pollution at their facility (see Figure 1). This outcome is consistent with the “polluter pays” principle.

Cost Minimization with Trading

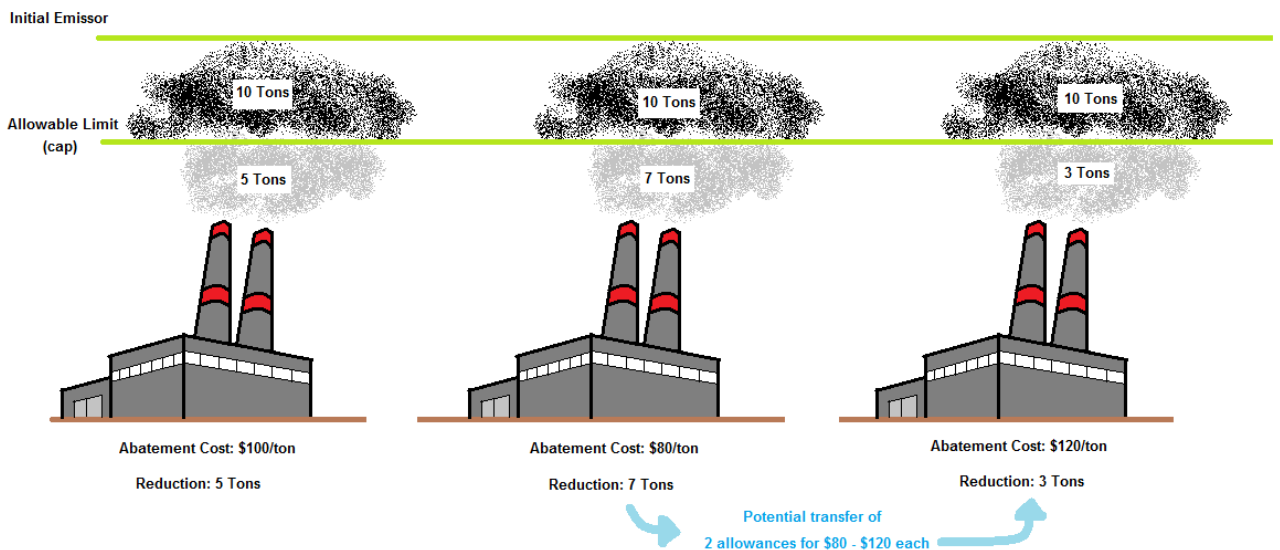


Figure 1

A well designed cap and trade program can also provide continuous incentives for innovation in emission abatement. Because of the value attached to allowances. The value creates an economic

incentive to invest in research and development for emission abatement options that can further reduce the costs of attaining compliance.

Finally, the cost-minimizing feature of cap and trade has long-term environmental benefits. Driving down the cost of reducing a unit of pollution means that policymakers and regulating authorities can set targets that reduce more pollution at the same cost to society. This system makes it economically and politically feasible to achieve greater environmental improvement.

Chapter 1

Is Cap and Trade the Right Tool?

Cap and trade can be an effective tool to address air pollution. However, it is not appropriate in all situations or for all environmental problems. Policymakers should consider a number of important issues before deciding whether cap and trade is appropriate. Prior to developing a cap and trade program, policymakers and other experts should determine whether the nature of the environmental problem, as well as the institutional capacity and political situation, is conducive to the successful establishment of such a program.

This chapter begins with a brief discussion of some of the general issues that must be assessed for any type of emission reduction program. Next, we examine whether cap and trade can address a particular environmental problem. Finally, we compare cap and trade to other types of policies including different forms of emission trading.

General Assessment Issues

Before making a decision about an emission reduction program, policymakers should assess a number of science, technology, and other issues. For example, regardless of the type of program chosen, policymakers must understand the nature of the environmental or health problem of concern, the pathways of exposure, the location and magnitude of the sources that contribute to the problem, and the emission reductions necessary to address the problem. Similarly, policymakers should have answers to technical and economic questions such as the cost, availability, and performance of control technologies.

Once policymakers have a thorough understanding of these issues and questions, they can determine whether cap and trade is an appropriate tool to address the problem. The following sections outline some of the key considerations used to determine whether cap and trade will be an effective program for a particular situation.

Is Flexibility Appropriate?

Cap and trade is premised on the notion that regulators do not need to direct the type or location of specific emission reductions within a region. Instead, these programs set an overall target and let “the market” determine where to make the most cost-effective reductions. In some cases, however, it does matter where an emission reduction is made. For example, some toxic emissions may have primarily local health impacts in the area immediately surrounding a facility. Allowing such a facility to buy allowances from other similar facilities in the area may not fully address the risks caused by its emissions. It may make a situation worse by causing a “hotspot” if the cap does not require sufficient reductions to minimize or prevent local impacts.

In such a case, it may be necessary, from a public health standpoint, to impose source-specific controls and limit the flexibility inherent in an emission trading program.

In general, the more a pollutant is uniformly dispersed over a larger geographic area, the more appropriate it is for the use of cap and trade.

Even when the location of emissions does matter, cap and trade may be effective if the environmental goal can be met through emission reductions in a general region. For example, a cap and trade program can reduce total loadings of a pollutant into the atmosphere, particularly if these pollutants are emitted by many sources and transported over a large geographic region. This was the case in the United States with the SO₂ Allowance Trading Program, which is intended to reduce acid deposition in the Eastern United States and Canada. Similarly, cap and trade programs can address ambient air quality problems by reducing background levels of pollution that contribute to adverse air quality. For example, if there are prevailing winds, it may be necessary to include emission sources upwind of the polluted area that could prevent downwind areas from meeting their ambient air quality standards. The NO_x cap and trade programs in the Northeastern United States were designed to reduce long-range transport of NO_x emissions that lead to the formation of ground-level ozone.

Before designing cap and trade programs to address emissions that are not uniformly mixed, it is necessary to conduct an assessment of the possibility of hotspots. In such cases regulating authorities may need to limit emissions at specific sources or limit trading to ensure that the program does not create hotspots and that it achieves the environmental objectives. It should be noted, however, that if a program requires too many trading restrictions to avoid hotspots, a more conventional regulatory approach to address the problem might be preferable.

Do Sources Have Different Control Costs?

Cap and trade programs make the most sense when emission sources have different costs for reducing emissions. These cost differences may result from the age of the facilities, availability of technology, location, fuel use, and other factors. In the U.S. SO₂ Allowance Trading Program, there was considerable diversity in emission reduction costs because of differences in the age of power plants and the proximity to low sulfur coal supplies. Where costs are different, there is “room for a deal,” because sources with high marginal abatement costs have an incentive to buy allowances from sources with low marginal abatement costs. Conversely, if affected sources tend to be relatively homogenous, their marginal abatement costs may be approximately equal and there is little incentive for trading. In this case, a cap and trade program is not likely to yield a significantly more cost-effective outcome than more traditional types of regulation.

Are There Sufficient Sources?

In general, cap and trade programs should include enough sources to create an active market for allowances. If there are too few sources, there may be few opportunities for trading. In addition, even if there are cost-effective trading opportunities in a program with few sources, a market with few transactions could make potential sellers reluctant to part with their excess allowances. These potential sellers could be concerned that if business conditions change and they need more allowances in the future, they will have difficulty purchasing them. They may instead hoard excess allowances even though it might not appear to be in their economic interest to do so. Additionally, with fewer sources, there may be a concern that larger sources may exert market power and withhold allowances from the market to drive up prices of allowances.

There is a tradeoff, however, in that the more numerous the sources, the more complex and costly the cap and trade program may be to establish and operate. For example, a cap and trade program for vehicles could be administratively costly if there was a need to measure and report emissions and enforce compliance at the vehicle level.

Comparison of Cap and Trade and Other Policy Options

A number of different policy tools can be used to address environmental concerns. These include:

- Economic-incentive approaches, such as environmental taxes and emission trading.
- Command-and-control approaches, such as technology mandates or emissions rate standards.
- Non-regulatory approaches, such as voluntary agreements and eco-labeling.

Ultimately, the policymaker's objective should be to achieve the optimal level of pollution control to adequately protect human health and the environment at a minimum cost to society.

Command-and-Control Regulation

For many air pollution problems, command-and-control (or direct regulation) may be the best course. For example, where regulating authorities can identify a specific facility as the source of a public health problem, limiting its emissions may be the simplest and most effective solution. Also, in the transportation sector where fuel characteristics can have a direct impact on the effectiveness of engine technology, it may be best to directly specify fuel parameters, such as sulfur content, to permit firms to design engines in the most cost-effective way to reduce harmful emissions of particulates or other pollutants such as NO_x, hydrocarbons, and carbon monoxide.

Command-and-control regulations often work best when:

- Emission reduction experience is limited and expertise is concentrated among regulators.
- Solutions are clear or there are few options for reducing emissions.
- Monitoring total mass emissions is not feasible.
- Emissions have serious local health impacts, and trading might make such hotspots worse.
- Emissions are toxic, and the desired emissions level might be zero.

With command-and-control, the regulating authority typically establishes a requirement to install a specific type of emission reduction technology. Although sources may achieve a certain level of emissions per unit of heat input or product output using the technology, increased utilization and new emissions sources can threaten the ability to achieve and maintain an emissions target. Older sources that have been exempted or “grandfathered” from strict emissions controls might also threaten the ability to achieve and maintain an emission target. This threat can affect the ability to achieve an environmental and/or human health goal.

For some environmental problems, however, specific requirements may cost more than flexible policy approaches and inhibit innovation. These types of environmental problems may work well for a transitional application of incentive-based approaches or economic instruments, such as taxes or a cap and trade program. Such programs may be preferred to encourage more economically efficient solutions. If properly designed, economic incentives can harness market forces to work toward environmental improvement. By internalizing pollution control costs they can make pollution reduction in the economic interest of the firm and promote innovation.

It is also possible and, in some instances, beneficial to use a hybrid approach where command-and-control policies are implemented side-by-side with a cap and trade program. Command-and-control policies, if not overly restrictive, can establish a backstop or safety net to adequately protect human health and the environment (see Chapter 3).

Environmental Taxes

Environmental taxes are another significant market-based instrument for reducing pollution. The major difference between cap and trade and environmental taxes is that cap and trade imposes an absolute restriction on the quantity of emissions allowed (i.e., the cap) and allows the price of emissions to adjust to the marginal abatement cost (i.e., the cost of controlling a unit of emissions). An environmental tax sets a price for a ton of emissions and allows the quantity of emissions to adjust to the level at which marginal abatement cost is equal to the level of the tax (See Figure 2).

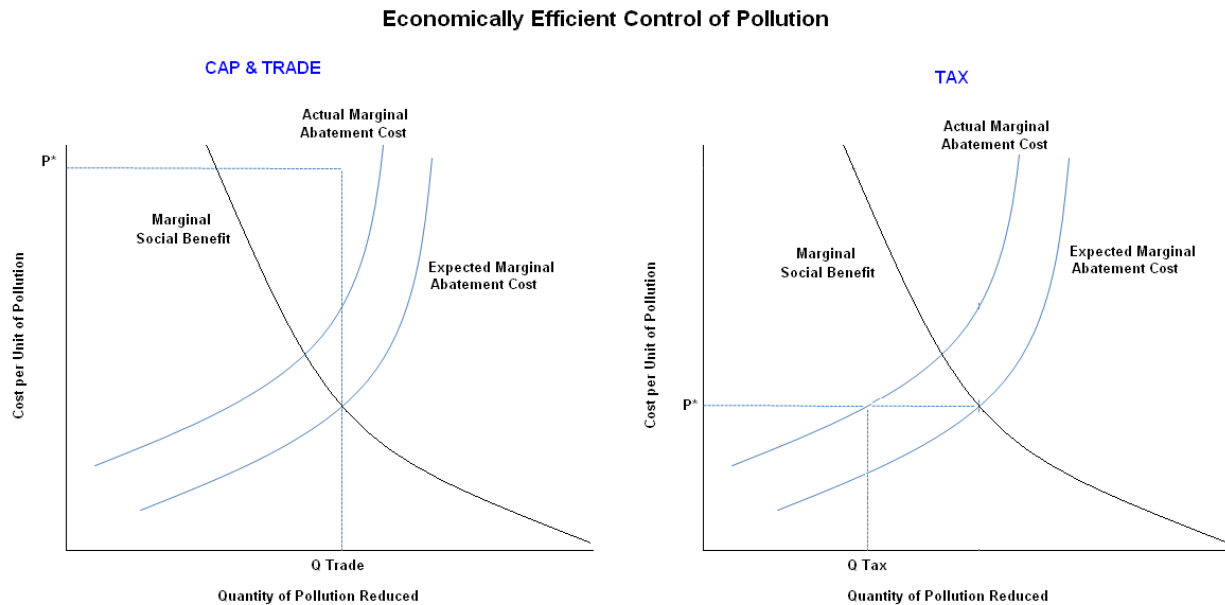


Figure 2

In situations where greater environmental certainty is needed, cap and trade programs are preferable because the cap sets an emission goal that sources must meet. With taxes, the regulating authority must establish a tax per unit of emissions. However, due to imperfect information (e.g., regarding marginal abatement costs and price sensitivities) and technological changes, setting the tax at the level required to attain the emission target becomes difficult and uncertain. Moreover, under a regime of environmental taxes, new entrants into the polluting activity will lead to increased emissions. With cap and trade, regulating authorities can require new entrants to purchase allowances directly from the market or the regulating authority can provide allowances from set-asides that are within the cap. Thus, the emission goal can be maintained.

In situations where price certainty is needed, tax programs are preferable because the tax per unit of emissions limits the cost to firms. For example, where the costs of achieving a level of emission reductions are uncertain, policymakers may decide to set an emissions tax rather than taking a chance that an allowance price will rise to a level that is economically or politically unsustainable.

Administrative costs are similar for both environmental taxes and cap and trade. Each approach requires sources to keep records of fuel consumption or emissions and to report this information to the regulating authority. The regulating authority's administrative costs include processing this information, reviewing it for completeness and accuracy, and recording it. The regulating authority could also conduct detailed audits of selected submissions.

With both instruments the regulating authority must decide the rigor of emission measurement and reporting requirements. For example, Sweden's NO_x tax and the U.S. SO₂ Allowance Trading Program require the use of continuous emission monitors. Similarly, the regulatory authority's review of data can be more or less rigorous depending on the level of review necessary. Under the U.S. SO₂ Allowance Trading Program, emission data review is rigorous. Although it is highly automated, more than 75 percent of staff resources at the federal and state level are associated with the measurement, processing, and tracking of emissions data.

Under a cap and trade program, a small amount of additional resources are necessary to process allowance transfers and reconcile emissions and allowances at the end of a compliance period. A tax program will require resources to collect and manage tax receipts. Some fiscal institutions, however, may already have the resources in place to collect and manage receipts from other tax schemes.

Some regions have a history of implementing environmental tax programs. In these regions environmental taxes may be easier to implement because they are already understood and accepted and much of the infrastructure may already exist. In other regions, there may be political reasons to opt for a cap and trade program. Emission sources may prefer a system in which allowances are allocated without charge rather than a system of environmental taxes in which a source has to pay for emissions. The initial allocation of allowances reflects a transfer to sources of an asset that is scarce and therefore has economic value. Recognizing this, sources are often more supportive of this market-based incentive program than they are of environmental taxes. In some circumstances, policymakers might use both policies, environmental taxes and cap and trade. A low tax can generate revenue for the regulating authority while still offering emission sources the benefits of a cap and trade program. Alternatively, the regulating authority could generate revenue with a cap and trade program by distributing some or all allowances through an auction.

Project-Based Trading

Project-based trading, otherwise known as credit trading or offset trading, is generally not used as a standalone program. It can be used to offer emission sources the flexibility to seek lower cost emission offsets from sectors outside a regulatory program. Historically in the United States, these types of credits or offsets have been used to meet rate-based emissions limits for conventional pollutants. More recently, there has been considerable international interest in using project-based trading as a complement to cap and trade to meet voluntary or mandatory greenhouse gas emission targets.

Emission offsets, or credits, are typically calculated by comparing actual emissions against a baseline. The baseline is an estimate of what emissions would be in a hypothetical situation (e.g.,

if the project had not been created). Determining the baseline is often the biggest challenge with project-based trading. Designing effective protocols to verify offsets is difficult because it requires making a determination about whether the emission reductions from an offset project would have occurred anyway. This type of test is known as *additionality*. If emission reductions from a project are not “additional,” there is a risk that these reductions could dilute an emissions goal and lead to increased emissions compared to a case in which no offsets are allowed.

A similar concern in some situations is “paper credits.” These are created when a source uses its legal allowable level of emissions (e.g., its maximum potential to emit) as its baseline rather than what emissions would have been in the absence of the project. These paper credits are the difference between what a source is allowed to emit and what a source actually emits. These credits increase allowable emissions without generating any real emission reductions.

Two issues must be addressed for project-based trading—the effect on total emissions from *non-additional* offsets and *leakage*, which is an increase in emissions or decrease in sequestration caused by the project but not accounted for in the emission baseline for that project activity. The underlying concept is that a particular project can produce offsetting effects that fully or partially negate the benefits of the project. For example, a project that protects a forest tract slated for deforestation may simply accelerate logging of the next most suitable location.

Projects that temporarily sequester emissions (e.g., forestry projects that sequester carbon dioxide) also raise issues of *permanence*. If the emission reductions from the project are used to offset other emissions, and the project subsequently releases the sequestered emissions, not only is the environmental benefit lost, but the credits may allow emissions to increase.

As with cap and trade, project-based trading can reduce the economic costs of achieving an emission goal by adding flexibility for sources to develop appropriate compliance strategies. For example, a polluting facility may invest in an offsite emission abatement project to earn emission reduction credits. If approved, these credits may be used to offset emissions from the facility.

A key difference between cap and trade and project-based trading is the way that emission reductions are verified and the implications for administrative involvement. A cap and trade program requires preliminary analysis to establish an emission cap for regulated sources. Depending on the method of allowance distribution, additional work may be required to allocate emission allowances to the regulated sources. Due to the emission cap and measurement requirements, there is no need for the regulating authority to review each emission reduction activity or to calculate an emission baseline for each activity. Instead, each regulated source measures and reports its total emissions, and the regulating authority focuses on ensuring emissions are measured accurately and an allowance is turned in for each unit of emissions.

In contrast, project-based trading often requires that project participants develop a project specific emission baseline for review by the regulating authority or other authorized experts. Review of such baselines can be contentious and resource intensive because it is extremely difficult to define with certainty what would have happened in the absence of a project.

To reduce administrative and transaction costs and address additionality concerns, the regulating authority may establish multi-project baselines. Multi-project baselines use performance standards or benchmarks for a type of project. If the project results in emission rates lower than the standard, the project automatically receives credit equal to the difference between the baseline and the actual emissions. Standardizing baseline methodologies in advance can significantly reduce administrative costs and reduce the subjectivity inherent in the review of a project baseline. They may not, however, always be a perfect test for whether emissions are below the levels that would have occurred otherwise. Also, multi-project baselines may be difficult to develop for some types of projects.

Project-based trading can reduce the costs of attaining an emission goal, but the administrative and transaction costs per unit of emission reduction are often higher than cap and trade programs; there is greater uncertainty and risk associated with an offset than an allowance (e.g., due to baseline, permanence, and leakage issues); and extensive involvement and oversight by the regulating authority are required to ensure environmental integrity. These transaction complexities vary depending upon project type. Project-based trading can be an effective way to introduce some sectors to market-based incentive programs. In addition, it can be effective for sectors in which it is easier to measure an emission reduction (e.g., the quantity of gas captured from a landfill methane recovery project) than total mass emissions.

Rate-Based Trading

Under a rate-based trading approach, the regulating authority determines a performance standard (e.g., an amount of emissions allowed per unit of output) for a sector (e.g., tons of a pollutant per kWh of electricity generated). Sources with emission rates below the performance standard can earn credits, whereas sources with emission rates above the standard must obtain credits for their excess emissions to remain in compliance.

Sources with low cost opportunities to improve their emissions rate have an incentive to operate at rates below the performance standard. They can then sell the resulting credits to sources that have higher costs to attain the performance standard. Rate-based trading programs have been used in the United States to phase out lead in gasoline and control mobile source emissions.

One consideration when evaluating rate-based trading is that if the activity level increases at a rate faster than the emission rate declines, sources can earn credits while total emissions increase.

Perhaps the most important measure of a regulatory approach is whether it can produce the desired environmental improvement. Emission caps set the total emission level, in effect, constructing a program from the environmental goal back to the sources. In contrast, rate-based trading attempts to establish an emission rate standard for each source that will, in aggregate, produce the desired environmental improvement. However, under a rate-based program, emissions and the pollution load on the environment can increase if sources increase their utilization or if new sources are built.

This situation raises a distinction between cap and trade programs and rate-based programs regarding industrial growth. Both types of programs accommodate growth. The responsibility for addressing growth, however, falls upon the sources in a cap and trade program while it falls on the regulating authority in a rate-based program. More specifically, under a cap, sources must determine how to operate new facilities or increase utilization of existing facilities and still comply with the emission cap. This approach encourages industry to innovate and find lower-cost approaches to reducing emissions. In the U.S. SO₂ Allowance Trading Program electricity production and economic growth increased while SO₂ emissions decreased significantly (see Figure 3). In a rate-based program, as with an environmental tax program, the regulating authority must periodically impose new rate standards to achieve and maintain an emission target and prevent additional emissions that may result from increased production. This cycle of revising regulatory programs can create a less certain regulatory environment for sources to conduct compliance and business planning.

Decoupling Economic Growth and Environmental Protection

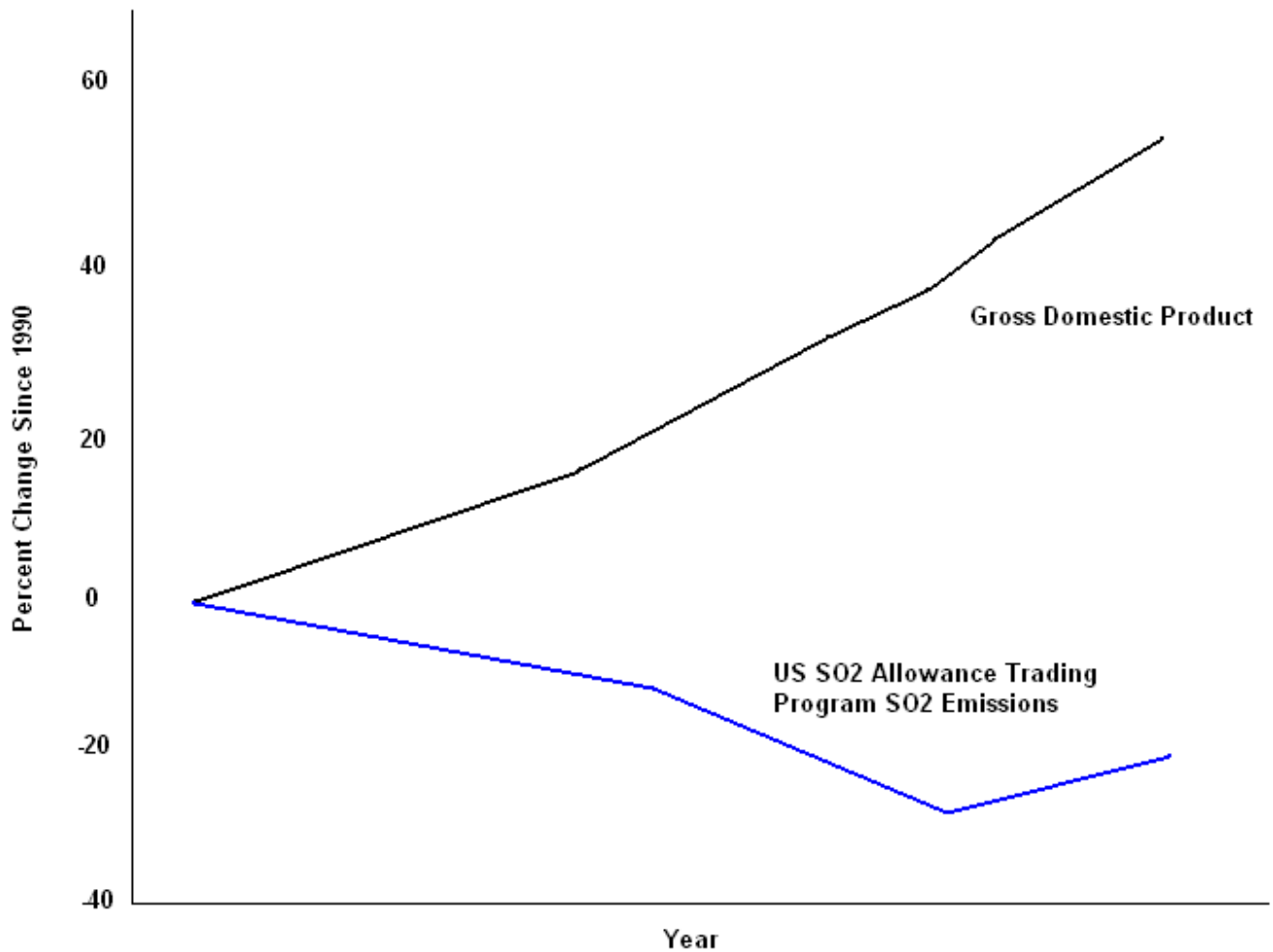


Figure 3

As with cap and trade, the fact that sources can trade their credits under the rate-based approach implies that the performance standard could be achieved at a lower economic cost. This is because sources with high marginal abatement costs will choose to purchase credits from firms with lower marginal abatement costs.

Under a rate-based system, the regulating authority converts each source's emission rate and activity level to credits. Because the regulating authority must collect activity level data, the data requirements may be greater for rate-based trading. Such data may also include commercially sensitive data that could be difficult to obtain. This information, however, may be useful for other types of trading programs as well. The regulating authority can use the information to verify measured emissions.

Like cap and trade, rate-based approaches do not necessarily require that the regulating authority approve each trade (in contrast to the project-based trading described earlier). Because some additional steps for government approval may be required, the level of administrative involvement and costs could be the same or slightly greater than those of a cap and trade program.

Each of the three forms of emission trading is appropriate in certain situations. When achieving and maintaining an absolute emission goal is important, a cap and trade program can provide more certainty about total emissions. Administrative and transaction costs for cap and trade programs are often lower than for project-based trading, which is burdened by higher uncertainty and risk and the need for extensive regulating authority involvement.

Project-based trading programs have historically evolved from the introduction of limited flexibility in traditional command-and-control programs. Because project-based programs usually do not require net emission reductions, they are not effective as standalone programs. However, a well designed project-based trading program may complement a command-and-control program that establishes emission or concentration limits. It may also complement a cap and trade program in sectors for which accurate emission measurement of entities or activities may not be as well developed.

Rate-based trading can be an effective way to promote efficiency if circumstances do not require an absolute cap on emissions. The administrative and transaction costs for rate-based trading programs are likely to be the same or similar to cap and trade. (See Table 2 for a summary of the forms of emission trading.)

Table 2			
Three Forms of Emissions Trading			
Program	Limit Total Emissions	Cost Minimization	Administrative and Transaction Costs
Cap and Trade	High	Yes	Low
Project-based Trading	Low to Medium	Yes	High
Rate-based Trading	Medium	Yes	Low to Medium

Chapter 2

Developing a Cap and Trade Program

Prior to implementing a cap and trade program, policymakers should examine various design options, decide which features to employ, and ensure that there is adequate legal authority. Key decisions include determining which sources to include in the program (i.e., applicability), the level of the emission reduction or limitation (i.e., cap), and the timing when reductions will be required. In addition, policymakers should determine requirements for measuring and reporting emissions, methods of distributing allowances, rules governing allowance use, compliance and enforcement provisions, and provisions for integrating cap and trade with existing policies. Before design work can proceed, it is critical to have information on the potentially affected sources, such as their emissions, utilization, and control options. All of these issues are discussed in this chapter.

Guiding Principles

Several overarching principles can guide the development of a cap and trade program. Adhering to these principles—simplicity, accountability, transparency, predictability, and consistency—can promote environmental compliance and efficient markets.

Simplicity

Simplicity is an important goal when designing an effective cap and trade program. Program operation for both emission sources and regulating authorities can be less costly and time-consuming if the rules are not overly complex or burdensome. Markets function better when the rules are simple and easily understood by all participants. Moreover, the environment is more likely to be protected when rules are clear and easily enforced. In contrast, complexity often requires more decisions, debate, and information collection. This situation, in turn, can create uncertainty and unnecessary burden that may lead to delays, opportunities foregone, and ultimately higher costs. In some countries, complexity may also make it more likely that there will be litigation over contentious issues.

Another aspect of simplicity that will increase the economic effectiveness of a cap and trade program is the *fungibility* of allowances (i.e., an allowance is a standardized unit of trade that is interchangeable with other allowances). Fungibility is highly desirable to minimize transaction costs in the program and to maximize the efficiency of the cap and trade program to lower costs. Simplicity is enhanced by avoiding the creation of different categories of allowances with different attributes, unless it is absolutely necessary to maintain the environmental integrity of the system. For example, discounting the use of certain types of allowances based on their

geographic origin or on their ability to be banked complicates transactions and reduces the cost effectiveness of allowance trading and may not have significant environmental benefits.

More broadly, the principle of simplicity can be applied to all elements of the program, including:

- Applicability thresholds (determining which facilities are affected)
- Allocation formulas
- Trading rules and/or restrictions
- Measurement options and rules
- Reporting requirements
- Penalty assessment

Accountability

A cap and trade program must create a framework of oversight and enforcement that will hold participants accountable for their emissions and ensure compliance with the program's requirements. The basis of accountability is the accurate measurement and verification of emissions and the rigorous and consistent enforcement of penalties for fraud or noncompliance. The regulating authority can facilitate accountability through clear and simple rules.

Transparency

Transparency refers to the full and open disclosure of relevant public and private decisions, such as establishing the rules and regulations for a trading program and determining if an emission source is in compliance. Transparency is important to a well-functioning cap and trade program, both in terms of its design and its operation. Transparency of the design process can promote public acceptance and confidence in the cap and trade program.

Information transparency is also important to the effective operation of an emission trading program. Providing public access to source-level emission and allowance data promotes confidence in the program and provides an additional level of scrutiny to verify enforcement and encourage compliance. In some jurisdictions these data are classified as confidential and may require legal changes to make them publicly available.

Advances in information technology and the Internet have made it possible to provide interested parties with timely and useful information about emissions, allowances, and program results.

Predictability and Consistency

Predictability and consistency in the design and application of program rules are important principles for an effective cap and trade program. They help create the right circumstances to encourage innovation and lower costs. With a cap and trade program, emission sources have an incentive to find better and lower-cost opportunities to reduce emissions. This incentive depends upon long-term, predictable, and consistent rules that affect the economic value of emission reductions. This arrangement does not mean, however, that rules cannot change in response to new information. Rather, it means that the framework must include the possibility for change and a clear explanation of the process for changing the rules.

Establishing Legal Authority

As discussed earlier, there must be legal authority to establish a cap and trade program. Although policymakers can include many components in authorizing legislation, the basic components are listed below.

- Setting the emission cap
- Sources covered
- Distributing tradable allowances
- Banking
- Trading procedures
- Emission monitoring and reporting
- Compliance
- Establishing and enforcing penalties for non-compliance

In addition to establishing this new authority, a cap and trade program may require appropriate amendments to existing legislation. For example, fundamental legal issues (e.g., existing technology standards or taxes) may hinder the development of a cap and trade program if not properly addressed. There may already be some regulations that are related to environmental performance. If existing regulations are simply in place to collect revenues for the government, then a cap and trade program can likely be added. If there are technology standards, it may be necessary to make certain adjustments in existing legislation.

Creating an Emission Inventory

An important step in the development process for a cap and trade program is the creation of an adequate source-level emission inventory. The types of data and appropriate level of detail for

the emission inventory will depend upon the intended use of the data. The emission inventory is likely to be useful in analyzing and making the following design decisions:

- **Program applicability:** The regulating authority may use inventory data to make decisions about which sectors to include, where to apply the obligation to hold allowances (e.g., at the fuel distributor or the emission source), and what thresholds should be set to determine if a source is affected by or exempted from the program (e.g., production capacity).
- **Allowance allocations:** The regulating authority may use inventory data to analyze the effects of different allocation options on emission sources and to decide on a method for distributing allowances.
- **Aggregate cap:** The regulating authority will need the inventory data for the affected emission sources to analyze the potential costs and benefits of different emission caps, as well as to assess the performance of the program once implemented. In some cases, the emission inventory is used to project future emissions, either using a sophisticated computer model or using simple assumptions about projected emission growth.

Minimum data requirements for the emission inventory include: individual emission source characteristics (e.g., size, location, nameplate capacity, process type, boiler type, fuel type); and emission levels for individual sources based on output, fuel use, and/or emission data. These data requirements will vary depending upon: the types of sources to be regulated under the cap and trade program; the pollutant; the choice of allowance distribution method; and the method for setting the overall cap.

Inventory Level of Detail

For cap and trade programs that require emission sources to hold allowances, sources can be inventoried at five different levels of detail: the company level; the plant level, which denotes a plant or facility that could contain several emitting activities; the point/stack level, where emissions exit to the ambient air from stacks, vents, or other points; the process/segment level, representing the unit operations of specific source categories (e.g., a single boiler that burns both coal and gas would count as two segments); and the unit level (e.g., each individual boiler).

The most significant factors in making this decision are:

- **Program design considerations:** The level of detail needed for the emission inventory is often determined by program design considerations. For example, if the program applicability threshold is based on the size of a combustion unit, then an inventory created at the plant level will not provide sufficient detail; additional information at the

unit level will be necessary. Similarly, allowance allocation formulas may require a certain level of inventory data.

- **Cost of data collection and availability of data:** Some options may make it easier to collect necessary data. For example, fuel purchase records may be kept only at the plant level rather than for each individual unit. Although data can be apportioned when necessary, it may be more cost effective to collect data at more aggregated levels of detail, such as the plant level.
- **Completeness:** Inventorying emissions at the unit level avoids many of the complications that may arise with other inventory levels (e.g., complex configurations of production units and stacks) and provides the most detailed information about the emission sources. However, this arrangement requires more data that may be more difficult to compile.
- **Measurement Method:** It is important to consider whether the data gathered for the program development stage will need to match the level used to assess compliance once the program is in place. If so, the regulating authority should evaluate issues related to emission measurement for the various levels of detail. For example, if in-stack measurement such as continuous emission monitors (CEMs) is used for compliance with the program, a stack-level inventory would be an advantage because it would include all of the emissions from each stack. However, for alternative measurement methods (e.g., fuel-based mass balance approaches), using stack level data for compliance might complicate emission measurement, particularly if several units share fuel supplies but exhaust through different stacks.

Program Design Elements

In developing a cap and trade program, the regulating authority should consider a number of design elements. Each design decision affects other aspects of the program. Although these elements are discussed in a specific order, the interrelationships between all the design elements should be considered together when making program decisions.

Applicability

After deciding that cap and trade is the preferred approach to reducing the emissions of a particular pollutant, policymakers must determine which emission sources to include in the cap and trade program. Ideally, all sources, sectors, and emissions would be included for full coverage and maximum environmental effectiveness and economic efficiency. However, measurement capabilities and costs, available control options, administrative burdens, political considerations, and other constraints may limit participation to a subset of emission sources.

When determining the applicability of a cap and trade program, there are several important considerations:

- **Contribution to emissions:** Included sources should represent a substantial portion of emissions in order to appropriately address the environmental issue of concern. To determine whether to include sources or sectors in a program, the regulating authority should perform an analysis using the existing emission inventory (as discussed in the previous section), as well as an analysis of how future growth will change the existing emission patterns. In this analysis, it is important for the regulating authority to acknowledge and, if necessary, address emission sources that they cannot feasibly include, but that could receive shifts in production from emission sources constrained by the cap. Such shifts of production from affected sources to other non-affected sources (“leakage”) could undermine the environmental benefits of the cap (See Figure 4). Maximizing the coverage of emissions in a cap and trade program can optimize both the environmental effectiveness and the economic efficiency of the program. Conversely, the environmental effectiveness of a cap and trade program is diminished if a large percentage of emissions are outside the cap. Although the regulating authority can implement other policies for emissions outside the cap, the level of these emissions is not guaranteed. Also, because sources outside the cap do not benefit from the economic efficiency of the trading program, the policies to control their emissions may be relatively more costly.
- **Availability of cost-effective control options:** Some sources included in the program should have a range of cost-effective abatement options to ensure the ability to achieve the reduction goal. Variation in abatement costs promotes competition among control options, stimulates innovative technologies, and helps lower compliance costs.
- **Ability to measure emissions:** As discussed further in this chapter, sources that participate in a cap and trade program must have the ability to account for their emissions accurately and consistently. Alternatively, a regulating authority may involve independent parties to measure and report emissions. If independent parties are involved, the regulating authority should have oversight, certification, and review procedures in place to promote accountability. Because each allowance has economic value, it is important to ensure that emissions are quantified accurately and consistently.
- **Number and size of sources:** The number and size of sources participating in the cap and trade program may affect the regulating authority’s ability to manage the program. The regulating authority must balance the desire to maximize the coverage of the program to increase the environmental effectiveness and efficiency against the ability to operate the program and enforce compliance. If sources responsible for a significant portion of the total emissions are not included in the program, the program may be less environmentally effective and less economically efficient. In addition, excluding some significant sources within an industrial sector can cause sources to shift activity to those sources outside the cap, thereby reducing the environmental effectiveness of the program. It might not, however, be necessary to include all small sources. Excluding some small sources may

help keep the total number of sources to a level that is manageable for the administration of the program.

- **Simplicity:** It is important to avoid overly complex applicability criteria. Complex criteria make it more difficult and costly for sources and for the regulating authority to determine which sources the program covers. Complex criteria also increase the likelihood of loopholes that allow significant sources in the same industrial sector to avoid inclusion in the program. To this end, the threshold for determining source applicability should be based on source characteristics that remain constant, such as capacity or potential to emit, rather than characteristics that could vary from year to year, such as mass emissions or fuel use. This will ease administration of the program, provide greater certainty to sources, and avoid frequent changes in an individual source's applicability status.
- **Equity:** The regulating authority should give careful consideration to the economic competitiveness of businesses and the effect on markets that could result from including or excluding certain industries from a trading system. Fairness relative to emission reduction potential is another consideration for the regulating authority.

Leakage

Plants within capped area reduce pollution by decreasing production, but import power from a source outside of the cap. This source increases its production and pollution and sends electricity into the capped area, so there is no benefit to the environment. This is known as "leakage".

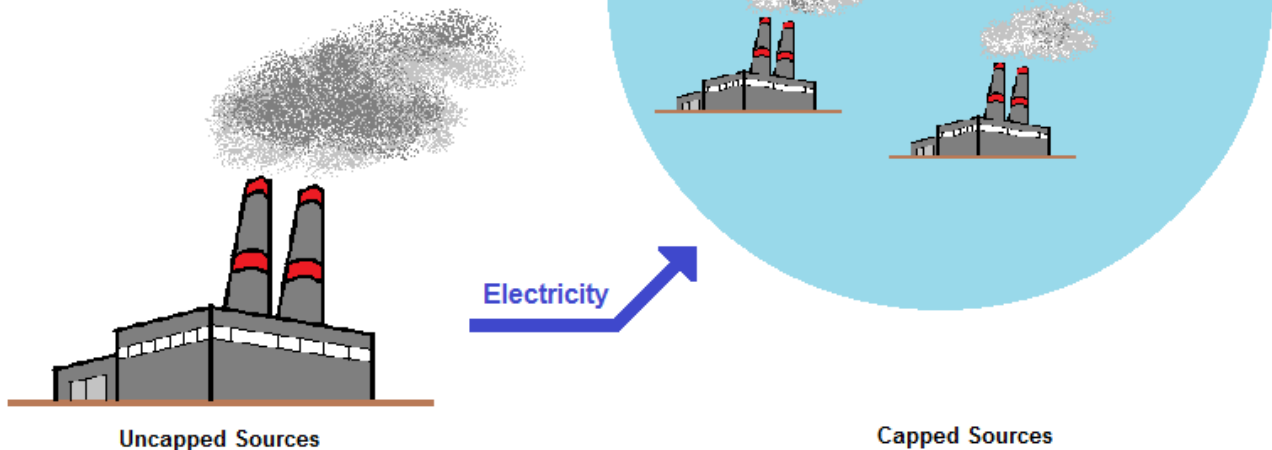


Figure 4

Closely related to the questions of which sources and sectors are covered in a cap and trade program is the question of where there is an obligation to hold allowances (See Figure 5). There

is a growing literature discussing how this would apply to emissions that can be capped at several different points in an economy, including:

- **Point of emissions (Direct emitters):** A point of emission program focuses on direct emission sources (e.g., electricity generators and large industrial sources) where the pollutant are released to the atmosphere. This approach works well if the production or combustion process affects emissions (e.g., NO_x from industrial boilers) or there are available end-of-pipe controls (e.g., SO₂ from electricity generators).
- **Upstream (Potential emitters):** An upstream program focuses on any point prior to the emission source (e.g., fuel producers and processors such as coal mines or oil refineries). An upstream program does not have a direct cap on emissions. Rather, the cap is set on the emission potential inherent in the fuel. The restriction at the fuels level restrains supply and can cause fuel prices to increase relative to alternatives. This “price signal” encourages fuel consumers to reduce demand for the fuel, either by finding more cost-effective alternatives or creating new technologies that use the fuel more efficiently. In this way, it operates much like a pollution tax, but has the benefit of a cap on total emission potential.
- **Hybrid:** A hybrid approach could be used to cap some entities upstream and some entities at the point of emissions. For example, large emitters such as electricity generators might be capped at the point of emissions, while emissions from transportation might be capped upstream.

Point of Obligation

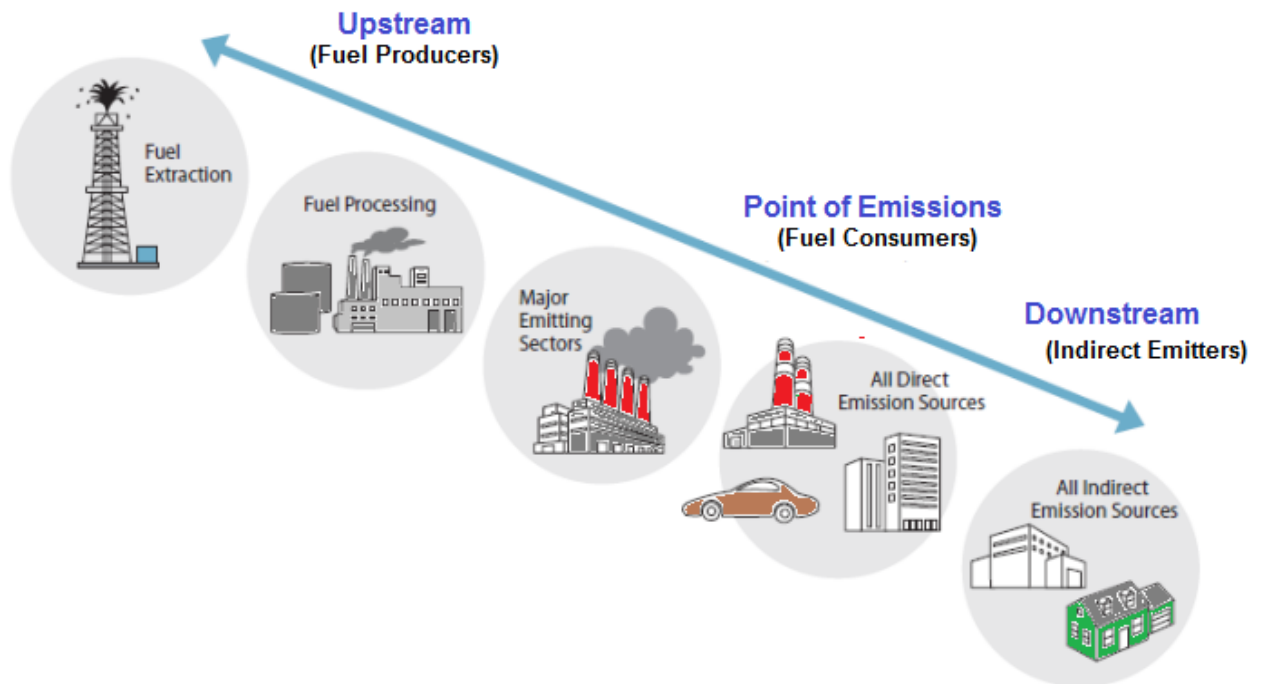


Figure 5

Some analysts argue that a hybrid system may be an acceptable compromise. These analysts contend that such a design would be desirable because it would provide similar coverage of emissions to an upstream system, while allowing the program design to focus on the types of emission sources that have been successfully included in past cap and trade programs. Potential downsides to such an approach include a larger number of sources than an upstream program and added complexity from the need to avoid double counting emissions at both upstream and point of emissions sources. For example, policymakers may include natural gas-fired electric generators (point of emissions) and natural gas distributors (upstream) in a hybrid cap and trade program. The regulating authority would have to deduct fuel used by the included electric generators from the amount of natural gas distributed by upstream sources to ensure that emissions are not counted by both sectors.

Some sectors may not meet the above criteria for inclusion in the cap and trade program but have individual sources that can meet the criteria. In such cases, it may be desirable to allow these sources to voluntarily “opt-in” to (participate in) the program. These sources receive an allowance allocation and are subject to the same requirements as sources under the cap. Theoretically, these sources will have cost-effective emission reduction opportunities that

warrant the expense of meeting the monitoring and other requirements associated with the cap and trade program. If policymakers allow opt-ins, sources that choose to opt-in should be subject to all the terms of the program. It is imperative that any sources opting in employ a measurement protocol that is equivalent in consistency and accuracy to the methods used by the affected sources. This ensures that the reductions achieved are real, verifiable, and comparably valued. Although voluntary opt-in provisions may reduce costs to affected sources, they raise some of the same issues associated with project-based credits. Sources may decide to opt-in and take advantage of allowance allocations that are above what their emissions would have been if they were not participating in the cap and trade program. In some cases, they may opt-in and then take measures to reduce emissions that would have occurred anyway, regardless of participation in the program. Unless the regulating authority can make an allowance allocation at a level that equals “business as usual,” extra allowances will be introduced into the system and will undermine the environmental effectiveness of the cap and trade program. Research on the U.S. SO₂ Allowance Trading Program has shown that many of the sources that voluntarily joined the program under opt-in provisions were spurred by overly generous allowance allocation formulas. Opt-ins using these provisions achieved very few additional emission reductions.

Setting the Level of the Cap

Setting the level of the emission cap is one of the most important decisions for policymakers and the regulating authority. In theory, the most economically efficient level for the emission cap is where marginal abatement costs are equal to marginal benefits from the reduced emissions. However, this level is often difficult to determine due to uncertain information. More generally, the cap should be set at a level that is expected to address the environmental and health problems of concern at an acceptable cost.

As with other types of policies to reduce emissions, it is desirable to use atmospheric and ecological or health effects models to assess the impacts of different levels of emission reductions. Models range from those that describe links between one receptor area and one source, to others that describe complex regional-scale relationships. Models also can project a wide variety of impacts throughout the region. Some models address changes over short time periods, such as episodes, while others focus on longer time periods, and some attempt to do both. Usually, models focus on one part of the overall assessment and should be linked to produce a truly integrated assessment. Emission models develop emission data for input into air quality models. The output of the air quality models is then translated into impacts using a variety of models characterizing human health and ecological welfare and other effects. Ultimately, selection of the best model framework or best set of models depends on the question being asked.

In practice, policymakers will determine the cap by considering a combination of science, economics, and political feasibility. One approach that policymakers sometimes use to determine the aggregate emission cap is finding the “knee in the cost curve” (i.e., the point before costs per unit of emission reduction begins to rise rapidly (see Figure 6)). Policymakers may also want to ensure that costs are within an acceptable range. To estimate costs and benefits, policymakers may use economic modeling to depict optimal control decisions.

Knee of Marginal Abatement Cost Curve

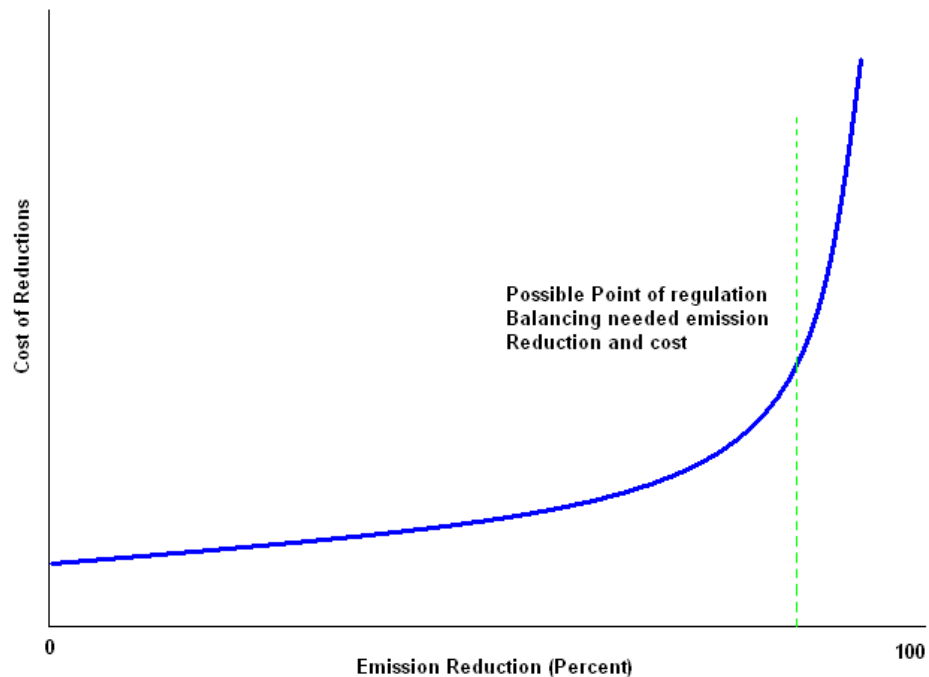


Figure 6

The decision of when to implement the cap is integral to the decision on the level of the cap. Policymakers may need to weigh the pros and cons of opting for a tighter cap with a later implementation date versus a less aggressive cap with an earlier implementation date. For example, it may not be feasible to set the cap at the optimal level for the initial stage of implementation. However, rather than delay implementation until a later date when the optimal level may be more achievable, it may be advantageous to begin the program as soon as possible to encourage advances in control technology and influence investment decisions. Under such a scenario, policymakers may establish a cap that declines over time to ultimately achieve the environmental goal. This is one of the advantages of allowing emission sources to bank excess allowances. It encourages early reductions, advances control technologies, and reduces the economic effect of the declining cap. For predictability, it is important that policymakers or the

regulating authority define the decline in allowances in advance to provide sources sufficient time to adjust to new cap levels.

The level of the cap will also depend on applicability decisions about which sources and sectors to include in the program. In the case where policymakers establish a national emission goal and develop a cap and trade program in conjunction with other regulatory tools, they must determine what portion of the goal should come from sources in the cap and trade program (the cap) and what portion from other sectors and sources. Ideally, a cap and trade program should include as many sectors as possible to maximize the cost savings from trading between sources with different marginal abatement costs. If it is not possible to include certain sectors under the cap and trade program, then alternative policy instruments may be used to reduce emissions in sectors outside the cap. Where possible, however, these instruments should be used to reduce emissions to levels where marginal abatement costs in the uncapped sector are roughly equivalent to the marginal abatement costs in the sector participating in the cap and trade program.

Length of Compliance Period

The length of the compliance period should be linked to the environmental problem and reflect operational considerations. If the environmental problem is continuous and long-term, as in the case of acid rain or climate change, the compliance periods should be continuous, covering all months of the year. If the problem is seasonal, the decision of whether to assess compliance quarterly, annually, or less frequently should also take into account the administrative burden imposed. A short compliance period puts a larger administrative burden on both the regulating authority and emission sources but allows for swifter action to correct a case of noncompliance. A longer compliance period allows more flexibility for the sources to achieve compliance and reduces the administrative burden for the regulating authority. By lengthening the period between compliance assessments, however, cases of noncompliance can persist for longer periods of time, possibly increasing the difficulty of correcting those problems. Most cap and trade programs determine compliance on an annual basis.

Quantifying Emissions from Sources in the Program

One of the most important features of a cap and trade program is that sources measure total mass emissions (as opposed to emission rate or concentration) as accurately and consistently as possible. Because the emission measurements are the “gold standard” underlying the traded allowances, it is important that a ton of emissions at one source is equal to a ton of emissions at any other source. This creates a level playing field for participants in the program and a strong foundation upon which a market can operate.

Table 3	
Emissions Monitoring Priorities	
Purpose	Priorities
Cap and Trade	<ul style="list-style-type: none">• Complete and consistent accounting of total mass emissions• Accurate and consistent measurement among sources• Conservative emission estimates (not under-estimated)
Command and Control	<ul style="list-style-type: none">• Accounting of emission rate or technology installation
Project-based Trading	<ul style="list-style-type: none">• Reasonably accurate estimate of baseline (what emissions would have occurred in the absence of the project)• Accurate accounting of emission rate and activity level
Research Inventory	<ul style="list-style-type: none">• Best available emission data, regardless of consistency among sources or sectors• Consistent emission measurement methodologies over time

The emissions monitoring priorities for a cap and trade program differ from other types of environmental regulations (see Table 3 for emission monitoring priorities of different types of programs). In considering potential emission measurement regimes for a cap and trade program, the following monitoring objectives may be useful as a guide:

- **Consistency:** The regulating authority should create clear and consistent protocols for sources to determine emissions. This means employment of standard procedures and the use of sound engineering practices. This arrangement can be particularly challenging if the cap and trade program includes sources from a variety of industrial sectors.
- **Accuracy:** For a cap and trade program, accurate measurement is more important than consistency over time. Policymakers should consider enhancements to measurement methods or using different methods if better approaches are available and practical. The monitoring program can also be designed to include performance standards that reward sources that achieve better accuracy than required. For example, for less accurate approaches, sources should use more conservative estimation methods that are not biased toward underestimating emissions. Ultimately, it is most important to avoid systematic underestimation of emissions.

Considerations in Choosing a Measurement Approach

Pollutant. The pollutant to be measured, the conditions under which it is created, and the mode in which the emissions enter the atmosphere will affect the types of emission measurement techniques available. For example, measurement issues related to emissions of SO₂, NO_x, and CO₂ from stationary source combustion will vary because emissions of SO₂ and CO₂ are directly linked to the combusted fuel, while emissions of NO_x also depend on the combustion conditions. Therefore, an appropriate measurement method for CO₂, such as mass balance based on carbon content in the fuel will not be appropriate for NO_x. Instead, accurate measurements of NO_x emissions from stationary source combustion must be taken from exhaust gases.

How Emissions Enter the Atmosphere. How emissions enter the atmosphere can limit the choice of methodology. For example, continuously measuring actual emissions is an option only if emissions are vented through a stack or other contained area where measurement equipment can be located. In contrast, measuring *fugitive* emissions (i.e., emissions that escape directly into the atmosphere in a diffuse manner) may depend on estimation techniques based on inputs and defaults.

Emissions Abatement Options. The abatement options available for sources to reduce their emissions are also a factor in the choice of measurement method. It is important that the measurement method be able to accurately capture the reductions made. For example, measurement methodologies based on fuel inputs (e.g., mass balance) may be appropriate for sources that reduce emissions by switching or conserving fuels, but it would be much less appropriate for sources that use reduction technologies such as combustion modification or post-combustion control. In choosing a standard measurement approach, it is important to allow sources full flexibility of compliance/mitigation options. It is also important to consider potential technological innovations in mitigation approaches. Thus, it is useful to choose a method that can measure the reductions achieved through various reduction strategies or to specify multiple measurement options, some of which may be allowed only for certain mitigation options.

Point of Obligation. The point of obligation will influence where and how emissions, or their proxy, are measured. Similarly, measurement constraints will influence where and how the emissions are regulated. If the regulation is directed at upstream sources, such as fuel suppliers, it is not appropriate to measure combustion emissions using an in-stack monitor at the power plant where the fuel is burned. Instead, the fuel supplier's compliance with the cap and trade program should be judged based on the amount and characteristic of each type of fuel sold, and the monitoring method would focus on determining the total amount of each type of fuel sold.

Frequency of Measurement. Although a cap and trade program requires a complete accounting of each unit of emissions, the minimum frequency of measuring emissions or the parameters

used in calculating the quantity that is emitted will need to be determined (e.g., continuous emission monitoring, periodic monitoring, or the use of emission factors). The nature of the problem to be solved, the potential variability of the measured parameters, and the length of the compliance period will influence the appropriate frequency. For a cap and trade program aimed at solving a problem caused by a total accumulation of emissions in the atmosphere, such as acid rain, the frequency will be dictated by the ability to capture variations in emissions and contribute to an accurate estimate of total emissions. For an episodic problem, such as ground-level ozone, more importance will be placed on the frequency of measurement because aggregation of emission measurements must be at frequent enough intervals to investigate individual episodes. Furthermore, greater frequency of measurement is warranted when emissions, or the parameters used to calculate emissions, have the potential for high variability (e.g., for units that use fuels with varying characteristics or for units in which emissions can be affected by the way the unit or control devices on the unit are operated).

Frequency of Reporting. In addition to deciding upon the frequency of measurement, the regulating authority should consider how often to receive the data. The U.S. SO₂ Allowance Trading Program, which requires sources to record hourly data, requires sources to compile and send emission reports to EPA on a quarterly basis even though compliance is determined on an annual basis. Factors to consider when setting the frequency of reporting include: allowing enough staff time to review the data (e.g., not waiting until the end of the year to review all data at once); giving time to sources to correct any errors found during review; and providing timely, reviewed data summaries to the public.

Cost and Feasibility. Within a cap and trade program, there may be sources that emit small quantities of emissions because they are small, clean, or operated infrequently. Alternative and less costly methodologies may be appropriate for such sources due to the high cost of the standard methodology. It is important to the integrity of the trading system to ensure that less accurate methodologies are conservative in nature (i.e., the methods overestimate rather than underestimate emissions), as well as to keep the number of sources treated in this fashion relatively small. It is also important to keep in mind that the cost of accurate emission monitoring should be considered in light of the cost savings afforded by the cap and trade approach over traditional approaches to environmental protection. The added cost of accurate measurement may be a small percentage of the savings achieved by implementing a cap and trade program versus another form of regulation, and the resulting accuracy and confidence in the emission data may be well worth the expense.

Quality Assurance and Quality Control (QA/QC)

Simply requiring the most accurate emission measurement methodology will not ensure an effective trading system. Effective implementation is critical. It is essential that the measurement techniques are standardized, commonly applied to program participants,

implemented properly, and validated for individual applications. In addition, regardless of what measurement systems are used to quantify emissions, it is imperative that any system be subject to a well-defined and continuous quality assurance and quality control (QA/QC) program. These QA/QC programs should be based on national or international standards (e.g., International Standards Organization) and must be documented with records that can be audited.

Missing Data Substitution

It is essential to account for each unit of emissions from a source because cap and trade programs assess compliance by comparing the total emissions and the total number of allowances held. In real-life situations, however, monitored data may be unavailable because monitoring equipment occasionally functions improperly or is being tested or maintained. Therefore, there is a need for rules to provide a standard methodology for substituting for missing data periods.

This standard methodology should provide incentives for regulated sources to keep records in good order, to keep measurement equipment well maintained, and to have procedures that ensure that faulty equipment will be replaced or repaired in a timely fashion. To accomplish this most simply, the rules could require a very conservative substitute value (e.g., a value that would result in the maximum potential emissions) to be used for any hours of missing data. Another option, which is more complex, would be to consider the frequency and length of the missing data periods in determining a substitute value. This way, an average or slightly conservative value is used for short and infrequent periods of missing data and a very conservative value is used for long or frequent missing data periods.

Allowance Distribution

The distribution of allowances may be one of the most difficult issues for policymakers when developing a cap and trade program. Distribution decisions have economic, equity, and political ramifications. Cap and trade programs create a valuable asset for those who own or control the authorizations to emit. If emission sources receive allowances through a no-cost allocation, they capture the gains from these valuable assets. Under an auction, the government captures the value of these assets in the form of increased revenues. Some analysts have argued that the revenues from allowance auctions can have economy-wide efficiency or equity benefits if they are distributed in certain ways (e.g., used to reduce distortionary taxes or distributed in lump sums to households or other groups.)

Different types of allocation formulas can create “winners” and “losers” among sources participating in a cap and trade program. It is important to note, however, that the method for distributing allowances will not affect the environmental integrity of the program if the program is properly enforced.

The first major step in the allowance distribution process is to decide whether the allowances will be allocated at no cost to the emission sources (usually based on some form of operating data), sold by the regulating authority through an auction or a direct sale, or distributed by some combination of these systems. To date, existing cap and trade programs have allocated allowances at no cost to sources.

Whatever allowance distribution method is selected, policymakers can include set-asides or pools of allowances from within the cap. Existing cap and trade programs utilize set-asides to provide allowances for new sources or to provide an incentive or compensation for certain types of behavior (e.g., early reductions, energy efficiency measures, or renewable energy generation). This section explains the incentives and decisions associated with allocations, auctions, and direct sales.

Allocations

If policymakers decide that allowances will be allocated free of charge, many different methods can be used to distribute the allowances. The regulating authority will need to consider the following issues:

- **Path Foundation:** In general terms, there are three different aspects of a unit's operation that may be measured and used (individually or in combination with performance standards) as a basis for allocating allowances: mass emissions, fuel (or heat) input, and production output (e.g., quantity of electricity produced). The measures of input and output will vary by sector, but any of these processes could be used as a basis for the allocation of allowances. Policymakers should consider the character and quality of existing data (e.g., it may be difficult to base allocations on historic output if multiple sectors with different products are included in the cap and trade program) and the behavior they want to reward (e.g., allocations based on historic emissions benefit the largest and least-efficient emitters, whereas allocations based on historic input or output benefit those that used the most fuel or produced the most product). Additionally, allocations could be based on the above information in conjunction with a performance standard, control measures, or existing control technology requirements, again depending upon the resources available and the desired effect.
- **Reference Period:** The reference period for allocations could be historic, current, or even projected. Though an important decision in any allocation scheme, the relative importance of the reference period decision increases with the length of the allocation, as further explained below. Allocations using historic reference periods are attractive to firms that typically have been big emitters, or in the case of input or output approaches, near their maximum capacity in the past (whether they have subsequently reduced these activities or not) because they are guaranteed a relatively large allocation under the new cap and trade regime. Using the average of several years' data can smooth out possible

irregularities (e.g., extreme weather conditions, plant shutdowns for maintenance). An important issue to consider when determining the reference period is how the choice will affect sources that implemented emission reduction measures prior to the start of the cap and trade program. For example, if the allowances are allocated based on historic emission levels, choosing a recent year for the reference period will penalize those sources that voluntarily reduced emissions early. If emission sources predict that such a choice may be made in the design of the program, it could provide a disincentive for sources to take early actions beneficial to the environment and human health. One way to avoid this problem is to choose an earlier year as the reference period. However, this may have a negative impact on the availability or quality of the data used. Another option is to choose an allocation method that is not based on historic emissions, but one that may still be based on some historic information. In the U.S. SO₂ Allowance Trading Program the allocation method uses a performance standard applied to historic utilization (i.e., heat input). This heat input data was readily available and did not reward plants with high emission rates.

- **Allowance Period:** Policymakers must decide whether allocations will be permanent or updated periodically. Because updating systems change allowance allocations at periodic intervals, entities may have an incentive to do more of the activity that will earn them more allowances. Therefore, updating allocations can influence future behavior. The time period of the interval will affect the level of influence updating has on future behavior. For example, if updating is done annually based on output, it could provide a strong incentive to increase output in order to receive additional allowances. If, however, the time period is longer (e.g., 10 years) the effect will be considerably less. Permanent allocations, on the other hand, provide no such incentive because changes in behavior will not affect future allocations.
- **Length of allocation:** The regulating authority may decide to allocate allowances to emission sources in advance of the allowance vintage period (i.e., the period in which the allowance can be used for compliance). Having allowances allocated in advance can add liquidity to the market because sources and other market participants can trade future allowances. This also helps emission sources develop and implement compliance strategies in advance of the compliance period (e.g., a source that installs an emission control device can sell future excess allowances to generate revenue to help offset the cost of the control).
- **Preserving the cap:** Once policymakers determine the method for distributing allowances and calculate the sources' allocations, policymakers should compare the resulting total allocations and the size of the cap. If too many or too few allowances were created while calculating sources' allocations, policymakers can employ a ratchet (i.e., a formula that adjusts each source's allocation proportionately). The resulting total allocation will then match the number of allowances in the cap. This ensures that the cap is not inflated through the allocation process.

- **Incorporating new sources:** Policymakers must decide how new entrants into the program will obtain the allowances needed to operate. In some systems with updating allocations, new emission sources may receive some allowances. In the case of permanent allocations, new units may obtain needed allowances from the market. In a permanent allocation system, facilities that are shutdown continue to receive allowances indefinitely. These allowances may then be used by the owners of the shutdown facility to cover emissions at new or other existing facilities that they own, or they can sell the allowances in the market. This system works well when there are many facility and allowance owners and no monopoly exists on current allowance holdings. Alternatively, an allocation set-aside could be created for new entrants. The set-aside could hold a specific percentage of the overall cap to cover growth in new sources.

Finally, some analysts have noted that both economic theory and empirical experience suggest that there is not a competitive barrier to new entrants that do not receive no-cost allowance allocations in cap and trade programs. These analysts argue that emission sources that receive no-cost allowances allocations have the same marginal “opportunity cost” for every ton emitted as the marginal cost paid by the new entrant. In support of this argument, there is no evidence of entry problems for new electric power plants under the U.S. SO₂ program, which requires new power plants to purchase allowances from the market. There has been significant entry by new units, even coal-fired units that do not receive a no-cost allowance allocation.

Auctions

Auctions are an alternative approach to distributing allowances. Under this approach, sources are required to bid for the number of allowances they would like to purchase (i.e., as opposed to receiving an initial amount of allowances free of charge via allocations). There is considerable research in economic literature that supports the view that auctions are more economically efficient than allocations. Supporters of auctions argue that auctions:

- Create a source of revenue that can be used to offset administrative expenses or distributed to affected groups. If the revenue is used to replace existing distortionary taxes (e.g., labor taxes) it can create additional economic benefits. Distributing auction revenues, however, may be politically contentious and there is no guarantee that revenues will be used for economically beneficial purposes.
- Collect “windfall” profits that might otherwise accrue to emission sources if allowances are allocated at no charge.
- Avoid politically contentious issues regarding allocation methodology and lead to an efficient distribution of allowances.
- Provide an immediate price signal in the allowance market.
- Create an equal opportunity for new entrants into the allowance market.

In establishing the design of an auction, the regulating authority will need to consider the following issues:

- **Frequency of auction:** The following are factors to consider when determining the frequency of conducting auctions (e.g. annually, semi-annually, quarterly and biannually): the lifetime of an allowance and the length of the compliance period; the administrative burden of conducting auctions; and other methods of distributing allowances. If the auction is used in conjunction with other allowance distribution methods and is intended as a means to provide an early price signal to the allowance market it may not be necessary to conduct auctions as frequently.
- **“Spot” and “Advance” auctions:** Spot auctions refer to allowances that are sold for current use. Advance auctions refer to allowances for a future compliance period that are auctioned in the current year, even though they cannot be used for compliance until the future compliance period. Early auctions can facilitate development of an active future and options market, thus improving risk allocation.
- **Bidding procedures:** There are many approaches to conducting auctions. The auction can be designed so that all successful bidders pay the same price or the price they bid. Bidding options for conducting the auctions can be categorized as either, sealed bid, ascending bid, or declining price auctions. Generally, with *sealed bid* auctions, potential buyers submit bids for a specific quantity of allowances. The auctioneer ranks the bids by price and, starting with the highest bids, tallies the requested allowances until it is equal to or greater than the number of available allowances. The price of the last winning bid is called the clearing price. Those who bid at least as much as the clearing price receive allowances at that price (i.e., uniform pricing methodology) or the price they bid (i.e., “pay-your-bid” methodology.) With *ascending bid* auctions, potential buyers have the opportunity to increase their bids, changing losing bids into winning bids. When there are no more bids, the allowances are distributed to the highest bidders. *Descending price* auctions, also called Dutch auctions, are the reverse of ascending bid. Generally, the auctioneer starts with a high price for each allowance. Potential buyers can accept the price for a specific number of allowances. The auctioneer decreases the price until all allowances are sold.

The different auction approaches have different effects on bidding behavior, which can thus influence the efficiency of the allowance distribution. With “pay-your-bid” pricing, potential buyers try to bid slightly above the estimated clearing price. Ascending bid auctions reveal greater information about what a potential buyer is willing to pay for allowances. This improves a bidder’s value estimates and, as a result, the efficiency of the final allowance distribution.

Auctions may also be used to distribute only a portion of allowances with the remainder distributed by an allocation method. Some analysts have proposed beginning with an allocation system and transitioning to an auction-based system over time. This would increase economic efficiency over time and decrease political opposition from emission sources worried about the cost of allowances.

Set-asides

Another tool that can be used in allowance distribution is an allowance set-aside. Under a set-aside, the regulating authority withholds a certain number of allowances from within the cap for a specific purpose. The set-aside can be a fixed number of allowances or a percentage of the total amount of allowances.

The regulating authority can distribute the set-aside allowances for purposes such as an incentive for certain technologies, as a way to address equity issues, or as a reserve for new units as explained in the earlier section. Policymakers can create set-asides that last for a fixed period, such as five years, after which the set-aside expires, or it can last in perpetuity.

Policymakers or the regulating authority should also address how excess allowances from the set-aside will be managed if they are not distributed. Options for managing excess set-aside allowances include canceling the allowances, saving them for future use, and distributing them to sources through an allocation or auction. Canceling decreases the quantity of allowable emissions (i.e., the cap) and may therefore increase compliance costs for sources. Saving excess allowances for the future can provide flexibility in the future for unforeseen circumstances (e.g., many new emission sources in the cap and trade program) but it reduces the number of available allowances in current years and can lead to increased compliance cost for current emission sources. Distributing excess allowances through an allocation or auction is perhaps the most common approach for existing cap and trade programs, but policymakers must address the same issues discussed earlier in the sections for allowance allocation and auction.

The most important aspect of set-asides is that the allowances come from within the cap so that new allowances do not inflate the cap and undermine the ability to achieve the environmental goal. If a set-aside will be used, policymakers will need to decide the basis for awarding allowances from the set-aside and the size of the set-aside allowance pool that will be awarded.

Allowance Use

Policymakers or the regulating authority must create rules governing the use and trading of allowances. These rules should be neutral (i.e., favoring no particular individuals or groups of market participants) and provide for low-cost exchange among participants.

Accounting for allowances works like a banking system. Each affected emission source should have an allowance account for holding their allowances. Transfers of allowances between these accounts should be made as simple as possible, with few limits or restrictions to impede the market. There are, however, two possible categories of restrictions on allowance trades that may be considered — temporal and spatial.

Temporal Considerations

Allowances are typically allocated for use in a specific compliance period. Policymakers might consider whether current allowances can also be used for compliance in future periods, referred to as “banking” (see Figure 7). Allowing banking in a cap and trade program creates additional flexibility for sources, encourages early emission reductions, can reduce compliance costs, and, partly for these reasons, can increase economic and political support for the program.

Although the ability to bank allowances in a cap and trade program can provide significant reductions early in the program, policymakers must recognize that banking can also delay the achievement of the emission target if banked allowances are used. Because banking does not delay achievement of cumulative reductions, this tradeoff does not represent an environmental concern for problems such as acid deposition and climate change, where the environmental problem is caused by total accumulation of a pollutant in the atmosphere. However, for problems such as ground-level ozone, where the environmental problem is caused by short-term episodes of high emissions, analysis should be undertaken to weigh the potential effects of banking. Nevertheless, the experience with limits on banking has shown that such limits complicated or hindered the operation of cap and trade programs and failed to provide apparent benefits.

Banking Emissions

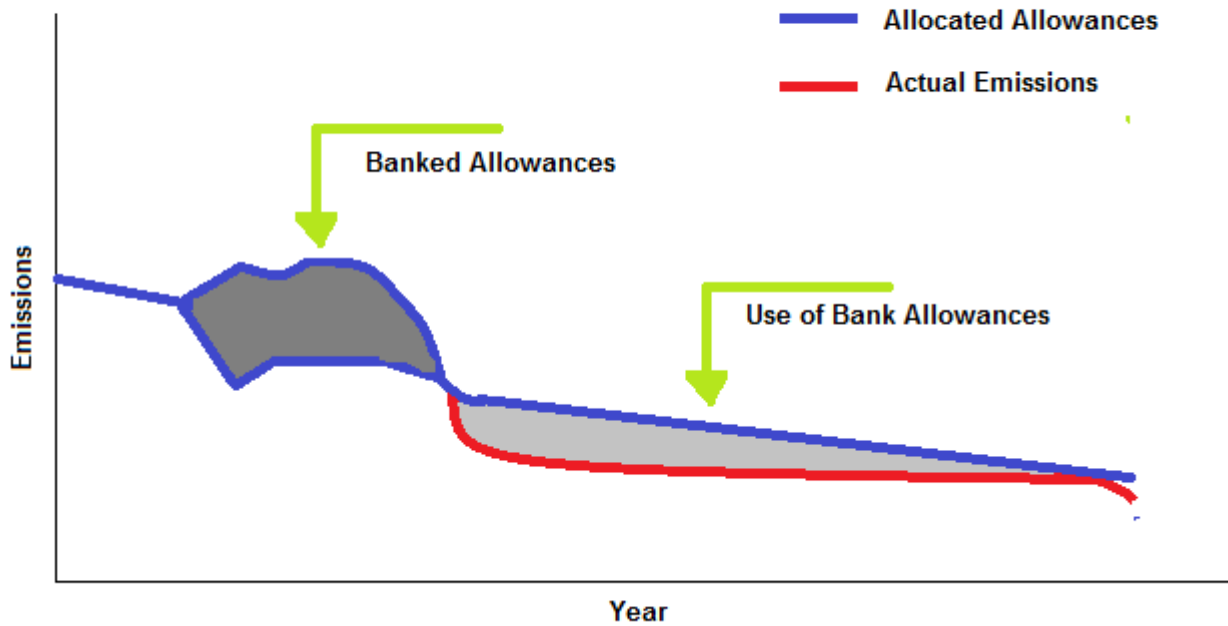


Figure 7

Borrowing is another form of temporal flexibility. With borrowing, allowances from a future compliance period are brought forward to meet a compliance obligation in an earlier period. As with banking, borrowing provides compliance flexibility and can be helpful in smoothing out spikes in allowance prices.

For example, if prices reach a certain level, sources might be allowed to buy allowances from the government that would be deducted from allowances available in future compliance periods. The potential downsides of borrowing are that emission reductions are delayed and there is a greater risk of future non-compliance if an emission source cannot “repay” the borrowed allowances. In addition, borrowing can create an incentive for emission sources to act to disrupt the cap and trade program’s performance and longevity in order to avoid “repayment” of allowances. Furthermore, the health and environmental benefits of emission reductions today are delayed until the future. All else being equal, benefits in the near term are better than benefits in the future.

There is little experience with borrowing, so policymakers should carefully assess the potential environmental and programmatic effect of delaying some emission reductions and weigh these effects against the potential flexibility and cost savings of borrowing. In addition, policymakers should apply a discount, or interest, rate on borrowed allowances that is at least as high as the

discount rate applied to the capital the source saves by not undertaking the abatement or purchasing allowances. In lieu of this discount rate, sources will find it less expensive to delay abatement, invest the capital saved, and borrow allowances.

Spatial Considerations

Because a cap and trade program allows for the flexible use of allowances across the geographic scope of the trading program, a common concern for a cap and trade program aimed at reducing emissions with localized impacts (e.g., SO₂ and NO_x) is that hotspots may occur.

Assuming that a firm's objective is to maximize profits, those with low marginal abatement costs will offer to sell their allowances to firms with higher marginal abatement costs. If sources with high marginal abatement costs (i.e., net buyers of allowances) are congregated in specific areas, those areas are likely to experience less environmental improvements than others (depending also on meteorology and wind patterns). Furthermore, such areas could experience increased emissions and harmful local environmental or human health effects, even as the larger goal of aggregate emission reductions is achieved.

For pollutants with localized impacts, an evaluation of potential trading patterns may be useful. Potential trading patterns can be assessed with economic models or with less resource-intensive methods such as spreadsheet analysis. If the results indicate that geographic trading patterns will arise, it may be necessary to assess where the largest emission reductions are likely to take place compared to where the most sensitive environmental areas are, and whether the program will adequately address the environmental problem (see Figure 8) or be less effective than direct controls on sources. This involves an analysis of the source-receptor relationship and includes predicting changes in concentrations or deposition resulting from changes in precursor emissions, the influence of emission sources in one region on concentrations or deposition in other geographic regions, and the levels of concentrations or deposition in certain sensitive receptor regions.

If spatial issues are likely to arise, then the cap and trade program will need to be designed accordingly.

Spatial Considerations

Where are emission reductions most likely to occur?

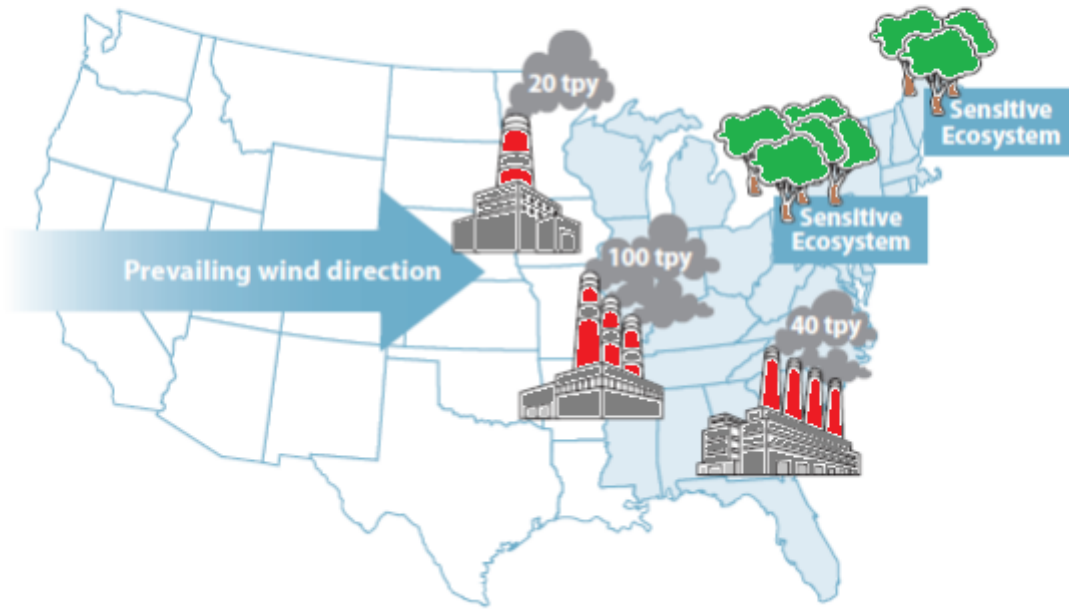


Figure 8

Generally, there are three approaches for addressing this issue. The first is the possibility of introducing spatial restrictions on trading. For example, if unacceptable concentrations or deposition are expected to arise in a particular area, trading restrictions could be imposed by introducing “zones” where net flows of allowances into the sensitive area are prohibited or discounted by an appropriate amount (see Figure 9). A drawback of trading restrictions is the effect on fungibility of allowances and market efficiency. Spatial restrictions on the use of allowances mean that an allowance is not a standard commodity that is fully interchangeable with all other allowances. This lack of full fungibility can diminish the economic efficiency of the cap and trade program and can complicate the allowance market (e.g., lead to price stratification between allowances of different zones).

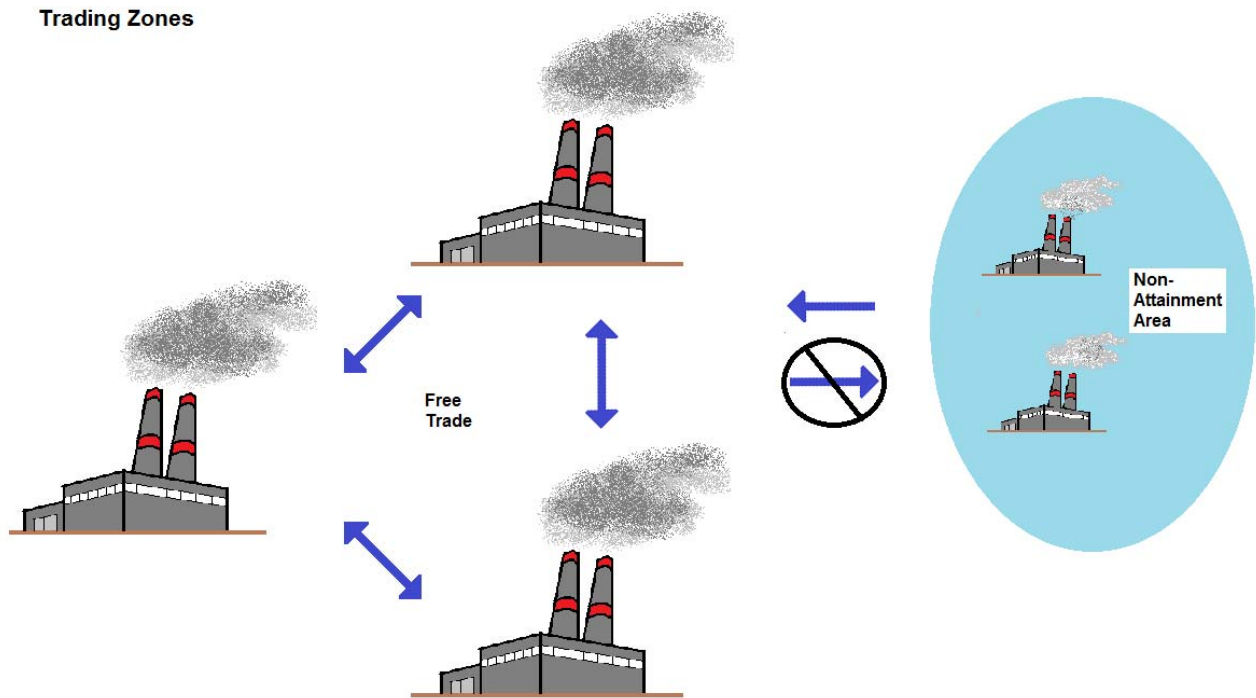


Figure 9

A simpler way of achieving the same effect as discounting without affecting fungibility is to have a higher retirement rate (e.g., 1.5 allowances per ton of emissions) in the zone of concern. This does not prohibit trading or differentiate among types of allowances; it simply makes it more expensive in such zones.

The second approach is to restrict trading between different categories of emission sources. This approach can be effective if the cap and trade program includes sources with different characteristics that influence the local effect of the sources' emissions (e.g., stack height). For example, the regulating authority may restrict a tall-stack source from trading allowances to a short-stack source because the shorter stack will likely have a greater impact on local air quality.

The third approach is to adopt a "tiering" of environmental policies, requiring sources to comply with local environmental quality provisions as well as those imposed by the cap and trade program. In its simplest form, this allows the appropriate regulatory authority to limit emissions of the sources identified as contributing to the local air quality problem, while not tampering with the allowance program. This third approach is the one employed by the U.S. SO₂ Allowance Trading Program.

Allowance Accounting

Each source that is responsible for compliance should have an allowance account. These accounts are the official records for allowance allocations, holdings, and transfers and can be

used to track compliance. Initial allocations (or initial winning bids in an auction) provide the beginning balance for the allowance accounts.

Policymakers might also consider whether the program will allow other interested parties to have allowance accounts and hold allowances. These non-source accounts provide the vehicle through which organizations, such as brokers or environmental groups, can hold and trade allowances. Brokers, investors, and other market makers may play a crucial role in facilitating allowance trades. Because the allowance brokering and pooling functions are intended to facilitate sources' efforts to maximize the cost savings of their compliance strategies, these non-source accounts should be integrated with the account system for emission sources.

Allowance Serialization

Allowances can be serialized to facilitate tracking the allowance from creation to use for compliance. There are a number of benefits to identifying allowances by serial number. Although tracking serial numbers increases the administrative burden to both regulators and industry, it provides additional transparency and protection against accounting discrepancies. The use of serial numbers could also facilitate record keeping so allowance holders can track the different costs incurred in acquiring allowances. This may be necessary for tax purposes. Finally, the inclusion of serial numbers in the allowance tracking system provides the opportunity to analyze trading patterns and the movement of allowances over time. This may be useful for assessing the impacts of the trading program. At a minimum, allowances should be identified by vintage (i.e., the compliance period for which they are issued) to identify when the allowances are authorized for compliance use.

Property Rights

The program rules must clearly define the legal rights and responsibilities of emission sources and the nature of allowances. Because allowances can be traded, the rights and responsibilities of ownership must be established so that these rights and responsibilities can be transferred from one participant to another.

When addressing allowance use, the regulating authority might want to consider certain property rights issues, namely entitlements and takings. For instance, sources that have historically polluted with limited or no restrictions might argue that they have an implied right to allowances based on their historical emissions levels. If the implementing institution reduces the number of allowances at a later date, participants might argue that they are entitled to compensation from the regulating authority based on the value of the lost allowances. Both can be addressed in the implementing legislation or program rules.

Compliance Determination

The compliance determination process for a cap and trade program should be simple and straightforward. Prior to implementation, the rules should clearly specify the deadlines for reporting and for holding sufficient allowances to cover emissions. At the end of the compliance period, the emission sources should be given enough time to verify emission data for the period and to submit them for compliance. This verification period should not be so short as to cause the emission sources to submit data that has not been properly quality assured, but not so long as to unreasonably delay compliance assessment. It should also allow enough time for the regulating authority, once it receives the data, to finish conducting the compliance determination well before the end of the subsequent compliance period, when the process will begin again. At the end of each compliance period and during the time when sources are assuring the quality of their emission data, the rules should provide for a short grace period (e.g., 60 days) so that sources can make final allowance trades. This will allow sources to assure that their account has allowances equal to or greater than their emissions. The regulating authority should specify an allowance transfer deadline—the final date for sources to trade allowances for use in the compliance year—in advance.

It may be advisable to freeze allowance transfers into or out of accounts after the transfer deadline until the regulating authority completes the compliance determination and deducts allowances for compliance.

Enforcement

Stringent penalties for noncompliance are an integral feature of a well-functioning cap and trade program. These should be applied automatically in cases where a source does not have sufficient allowances to cover mass emissions during the compliance period. In cases where there is noncompliance with requirements of the cap and trade program (e.g., measuring emissions, reporting, and other requirements), the penalties should be determined based on the nature and severity of the violation. The penalties should be sufficiently high to provide the appropriate incentives for compliance and can take the form of allowance, financial, and/or criminal penalties.

Excess Emission Offsets

In cases where a source does not have sufficient allowances to cover its emissions, an allowance restoration rate of at least one-to-one should be applied to maintain the environmental integrity of the program. Under a one-to-one rate, one allowance from the next compliance period would be retired for every unit of excess emissions in the current compliance period. Alternatively, the shortage of allowances can be purchased from the allowance market.

Aside from the one-to-one allowance restoration rate to maintain environmental integrity, the regulating authority should apply financial penalties for noncompliance if the goal is to deter such behavior. The existence of a one-to-one restoration rate without other accompanying punitive measures for noncompliance implies that sources can, in effect, use allowances from future compliance periods to attain their emissions reduction target. This can result in a scenario in which the emission cap is never attained. Hence, it is very important that the incentives deter noncompliance.

Financial Penalties

Deterring noncompliance can either take the form of allowance or financial penalties. With allowance penalties (i.e., where a source would have to turn in a multiple of its allowance shortfall at a ratio greater than one-to-one) the aggregate cap of emissions in the next compliance period is reduced. The environmental benefits of the program increase due to the allowances that are deducted as a penalty, but this could lead to further noncompliance because the necessary reductions are greater in the following compliance period.

Alternatively, market volatility may tempt some to speculate and intentionally be in noncompliance if they believe the market price for allowances will drop in the future. Furthermore, taking allowances out of the market reduces the supply and raises the price of allowances for all participants, not just those that are out of compliance. However, this should not be a significant factor unless there is large-scale noncompliance.

For these reasons, a financial penalty (in addition to the one-to-one offset) may be preferable to deter noncompliance. Policymakers or the regulating authority should set the level of the financial penalties significantly higher than the expected marginal abatement cost—the expected market price of allowances—to create an effective deterrent for noncompliance. Policymakers could also create a graduated financial penalty to reflect the severity of the violation or the length of delay in making payment. For example, if a source exceeded its emission cap because of an accounting error, the penalty might be twice the price of allowances, payable in 30 days. For a more serious violation or if the penalty is not paid in 30 days, it could grow to several times the price of an allowance. If the penalty is in dispute, the source could put funds into an escrow account awaiting adjudication.

The allowance price from which the penalty is calculated can be based on a projection of the allowance price (established during the development of the program) and adjusted for inflation. Alternatively, it can be based on a multiple of either the actual average price or the highest monthly price of allowances for the preceding year in which the program was in operation. Establishing the penalty based on a multiple of the projected market price of allowances can be

difficult because different economic models often yield substantially different estimates. However, indexing the compliance penalty to actual prices can also be difficult without a liquid market/exchange. In some cases, a periodic, government-run auction can reveal price information that the regulatory authority can use to set the penalty level.

If a source is out of compliance with the monitoring, reporting, and/or other requirements specified by the regulating authority, financial penalties should also be applied. These also can be graduated depending on the nature of the noncompliance (or “degree of fault”), with higher penalties for repeat. To maintain consistency, the penalty levels should, to the extent possible, be defined in advance. Finally, to ensure that the penalties are enforced in a timely manner, the penalty rate might increase if the source does not pay the penalty within a specified period of time.

The revenues from these penalties might be collected and redistributed in several ways. For example, they can be collected by the national treasury and redistributed in the same way as income taxes or they can be paid directly to the regulating authority to offset program costs. The revenues may also be collected in a special fund to provide resources for research and development into abatement technology and/or environmental purposes related to the pollutant being regulated.

Regardless of the type and severity of penalties, they should be objective and automatic. Eliminating penalty negotiations between regulating authority and emission source promotes impartiality and equity and reduces opportunities for dishonest behavior. In addition, it sets clear expectations so that sources know the consequences for noncompliance.

Criminal Penalties

The regulating authority might also impose criminal penalties on individuals who knowingly violate any requirements, with maximum sentences for first-time and repeat offenders. Criminal penalties provide direct incentives for the legally responsible individuals (“designated representatives” or owners and operators) at the affected sources to behave responsibly. Owners, operators, and designated representatives should be required to sign each form that is submitted to the regulating authority for the source (e.g., allowance transfers or emissions reporting) indicating that they are liable for acts and omissions within the scope of their responsibilities under the cap and trade program.

Other Design Considerations: Integration of Cap and Trade with Other Approaches

There are a number of ways in which policymakers can integrate cap and trade programs with other approaches for environmental policy. Command-and-control approaches can be compatible

with cap and trade, but policymakers should identify the relationships between the different policies and ensure there are no contradictions or duplications. With command-and-control, the regulating authority specifies sector-wide technology and/or performance standards that each of the affected sources must meet, whereas cap and trade provides sources with the flexibility to choose the technologies that minimize their costs.

Depending on the type of pollutant that is being regulated by cap and trade, integration with command-and-control approaches can aid in the prevention of hotspots that may result from the use of allowances. For example, additional reductions through a cap and trade program could be layered on top of existing requirements.

Finally, with regard to integrating alternative forms of emission trading, if the regulating authority decides to establish more than one type of emission trading program, each should affect distinct sectors. If desired, allowances from a cap and trade program could, in theory, be fully interchangeable with offsets from project-based mechanisms or credits from a rate-based program. However, the regulating authority must ensure that project-based mechanisms do not undermine the environmental integrity of the cap. Stringent oversight, verification, and conservative crediting methodologies need to be established to account for uncertainties and to avoid the creation of “anyway” tons, paper credits, leakage, or double counting.

Chapter 3

How to Implement and Operate

The credibility of the cap and trade program and confidence in the market depend on the accuracy of emission measurement and enforcement by the regulating authority. Because allowances, and therefore emissions, have an economic value, sources might misrepresent emission data if there are no consequences or low probability of discovery. The regulating authority must ensure that enough resources are dedicated to verifying emission reports and auditing affected sources.

The regulating authority must also ensure that allowance accounting is undertaken with the appropriate scrutiny and security to avoid errors and fraud. Computerized accounting systems for emissions and allowances can facilitate the management of these responsibilities.

This chapter describes the functions necessary to implement and operate a successful cap and trade program including tracking information on emissions, allowances, and compliance; auditing and verifying emissions reports; providing technical support and policy guidance to regulated sources; and costs and resources necessary to operate a cap and trade program.

Integrated Information Systems

Perhaps one of the most important lessons learned from existing cap and trade programs is the need for comprehensive, accurate, transparent, and timely information about emissions and allowances. The regulating authority that operates the program must collect, verify, maintain, and disseminate the data if the program is to operate with environmental integrity, economic efficiency, and public credibility. Computerized information systems are the most effective method available today to process and disseminate these data.

Using an information system to collect and manage large amounts of data on emissions and allowances can provide numerous benefits, including:

- **Increased data accuracy:** Electronic reporting and automated data quality checks reduce errors and eliminate redundant data entry.
- **Reduced time and costs:** Electronic reporting and automated data quality checks reduce the time and costs required to complete, process, and review paper forms.
- **Enhanced Access:** Electronic data storage makes it easier and faster to retrieve, analyze, and evaluate relevant data on demand.

- **Improved consistency and comparability:** Electronic reporting and electronic data storage encourage consistency by requiring all emission sources to report the same information in a common reporting format.

This consistency promotes comparability across time and among program participants, leading to a fully fungible tradable commodity and efficient market.

A comprehensive information system should include modules to collect, review, and manage data on emissions and allowances and a module to determine compliance.

Emissions Tracking Module (ETM)

The most data-intensive component of the information system may be the *emissions tracking module*, or ETM. The purpose of the ETM is to collect, review, and maintain relevant emission-related data from each source. The type and quantity of data collected will depend on the measurement requirements for the cap and trade program. For example, a program that relies on emission factors to calculate emissions from combustion sources might require participants to report data on the type and amount of fuel consumed, the combustion technologies installed, and the emission factors used. A cap and trade program requiring continuous emission monitoring systems might collect data on measured pollutant concentration and volumetric flow of exhaust gas. Although the frequency of reporting will depend upon the calculation method, the length of the compliance period, and administrative requirements, it should be frequent enough to supply sources, the regulating authority, other market participants, and interested parties with timely information about emissions and facilitate compliance determination.

Regardless of the method used to calculate emissions, the data must be consistent, accurate, and objective if sources, market participants, and the public are to have confidence in the program. To facilitate access to the data, the regulating authority can make the emission data from the ETM available to interested parties through a publicly accessible interface (e.g., the Internet). The data are useful to market participants who can use them, along with allowance data, to gauge potential supply and demand for allowances. The public, interest groups, and academics can use the data to evaluate the effectiveness of the cap and trade program. However, simply making data available may not be sufficient. True transparency necessitates making the data available in a useful and usable format. Determining the appropriate format will depend on the type and quantity of data collected, as well as their end use.

Due to the potentially large volume of data, the regulating authority operating the program might benefit by requiring all sources to submit emission-related data electronically. Electronic submissions improve accuracy and reduce the burden on sources and the regulating authority by eliminating the need for redundant data entry, facilitating automated data quality checks, and providing immediate feedback about data quality. If the ETM uses electronic reporting, it can

acknowledge the submission and report the results of the quality check directly to the sources. The ETM can also perform in-depth analysis and quality assurance checks. For example, the system might compare the submitted data to historical data from the source and similar facilities to search for inconsistencies. Potential problems that the ETM identifies might be reported to the regulating authority so an auditor can check the data and, if necessary, request additional information from the source. In the absence of a computerized information system, the regulating authority should oversee these functions.

Once the data passes the data quality check, it can be recorded in the ETM and made available to interested parties. An automated data quality check reduces the time and cost of data review in two ways. First, the ETM identifies minor errors immediately and reports to the source so they can correct the errors. Second, the regulating authority can focus on problems identified by the second stage of the review in order to prioritize in-depth reviews. The automated data quality check can also reduce processing delays and provide interested parties with faster access to emission data.

Allowance Tracking Module (ATM)

The *Allowance Tracking Module*, or ATM, is the accounting system for the trading program, keeping track of account information, account holdings, and transactions. As with other components of the system, public access to the data is important. Market participants, including sources, brokers, and other allowance owners, can use the data to verify transactions and monitor holdings. The public, interest groups, and academics can use the data to evaluate the effectiveness of the cap and trade program, identify barriers to cost-effective trading, assess overall market activity, identify trading trends, and analyze the emission implication of trades.

The potentially large volume of transactions in a trading program may necessitate electronic submission of transactions. As discussed earlier in the section on submissions of electronic emissions data, electronic submissions have many benefits, including improved accuracy, reduced burden on the regulating authority, immediate feedback and transaction confirmation to participants.

The ATM can play a critical role in all allowance transactions, including the issuance, transfer, retirement, and cancellation of allowances. The regulating authority can use the ATM to issue and distribute allowances according to a prescribed method (e.g., allocation formulas, auctions, sales). A computerized ATM can also ensure that trades are valid by reviewing the data to verify that account numbers are correct, the seller owns the allowances being transferred, and the allowances are still valid (i.e., they have not been retired for compliance or cancelled). Once the information is verified, the ATM can deduct the traded allowances from the seller's account and add them to the buyer's account. If the transaction is not valid, the ATM should notify the buyer

and seller and, if appropriate, record the failed transaction as an acknowledgement that the transaction was submitted.

The ATM, in conjunction with the Reconciliation and Compliance Module, can facilitate compliance assessment by retiring the appropriate number of allowances from each account. In addition to issuance, transfers, and retirement, the ATM can facilitate canceling allowances for environmental or other reasons (e.g., administrative penalties, purchases by environmental groups).

Reconciliation and Compliance Module (RCM)

The *Reconciliation and Compliance Module* (RCM) is the vital link between the ETM and ATM to determine compliance. At the end of each compliance period, the RCM compares a source's allowance holdings against the total emissions from the period. If the source's emissions are equal to or less than their allowance holdings, the source is in compliance. Conversely, if emissions are greater than the allowance holdings, the source is not in compliance and is subject to any noncompliance consequences and penalties.

The RCM, in conjunction with the ATM, should deduct the appropriate number of allowances from each source's account. The deductions might be made on a prescribed basis (e.g., first in, first out) or by specific instructions as to which allowances are to be deducted. The latter approach may be desirable for a variety of reasons (e.g., tax consequences, forward trade contracts).

If the source is not in compliance, the RCM should:

- Instruct the ATM to deduct all allowances from the source's account and withhold future allowances equal to the overage penalties.
- Report the noncompliance and emissions overage to the regulating authority for enforcement.

Auditing and Verification

Auditing and verification of emission data can take several forms. If data submitted by sources are required in a standard electronic format, regulating authorities can use software to audit the data and identify potential discrepancies or issues to investigate. The regulating authority can use these electronic "desk" audits to target more in-depth audits. If sources submit emission data using paper forms, the audit and verification will be more resource intensive. For this reason, requiring sources to submit emission data in standard electronic format is strongly recommended.

When sources use measurement devices, either to measure actual emissions or to measure some other parameter involved in calculating emissions, such as fuel flow, the regulating authority should review data collected from measurement devices for reasonableness. In addition, the audit should review results of any quality assurance and quality control tests performed on the measurement equipment to ensure that the equipment is operating properly. If possible, the regulating authority should compare submitted data to independently obtained data.

Verification of submitted emission data should also involve field audits — visits to the emission sources — especially when sources use measurement equipment. Such field audits can include observing quality assurance tests, reviewing on-site records, inspecting measurement equipment, and/or comparing installed measurement equipment to independent reference methods. Such field audits can be performed on a random sample of all sources, and/or field audits can be performed on sources identified with potential measurement or data problems during the electronic desk audits.

Technical Support for Regulated Sources

An important element of implementing and operating a cap and trade program is the ongoing technical support for sources. The program is more likely to be successful if the regulating authority and emission sources keep open lines of communication on the rules and procedures of the program. Before implementation of the program begins, sources may benefit from workshops that explain and clarify the rules of the program. In addition, throughout the life of the program, as new issues arise, new sources and new employees enter the program, and revisions are incorporated into program rules, a continued dialogue between the regulating authority and the sources will facilitate the smooth operation of the program.

It is wise for the regulating authority to plan workshops for sources after the rules of the program have been publicly disseminated but prior to the beginning of the program. The workshops can address all aspects of implementation for which the sources are responsible, and should inform them about the role of the regulating authority. For example, the workshops could:

- Explain the applicability criteria of the program and address questions about which sources are and are not affected.
- Explain the allocation process, including when and how each source will know its allocation or the procedures for participating in an auction, if applicable.
- Address source responsibilities, such as the procedure for identifying the person who will be responsible for making submissions and demonstrating compliance for each source.

- Discuss the requirements for measuring emissions and reporting to the regulating authority.
- Outline the procedures for reporting allowance trades to the regulating authority.
- Answer any questions related to the determination of compliance and potential enforcement actions.

During implementation of the program, it might be necessary to supplement the initial published rules of the program with guidance documents that focus on specific questions or clarifications regarding the rules. It is likely that the initial rules of the program will not cover all of the situations that actually arise.

Sources may need interpretations of the rules by the regulating authority to help apply the rules to the source's unique circumstances. This may be particularly true for emission measurement and reporting.

The more individualized the measurement methods and the more options available, the more questions are likely to arise. For consistency in the program, it is important that sources receive the same guidance. One option to ensure consistency is for the regulating authority to create a guidance document that includes answers to both commonly asked questions and unique questions. The regulating authority can modify the document as new guidance is created. Such a document is useful as an internal reference to help maintain consistency over time, as well as to provide information to the public and sources.

Administrative Costs Associated with Cap and Trade

Although cap and trade programs can cost significantly less than more traditional policy options, the programs require resources to operate efficiently and effectively. Regulating authorities should consider these costs when designing the program so they can identify appropriate funding sources and budgets.

The smaller a cap and trade program is, the more likely it can operate effectively and efficiently with a simple spreadsheet or paper-based system. However, as the number of participants or data requirements increase, a computer-based system with automated data processing becomes necessary. The costs of designing and developing such a system can be considerable, but the savings in staff time and error reductions can help offset some of the expense. Additionally, the system may undergo modifications as program rules change, automation is enhanced, or technologies improve.

Oversight and enforcement assure that sources are accountable for their emissions and compliance with the program requirements. The functions of oversight and enforcement include the verification of emissions and the enforcement of penalties for fraud or noncompliance.

Other costs associated with cap and trade programs may include:

- General administration.
- Recording allowance trades.
- Providing public access to program information (e.g., emission reports, allowance holdings and trades).
- Monitoring program results.
- Responding to questions from program participants and the public.

Chapter 4

Assessment and Communications

This chapter describes how outreach and communications can facilitate a credible and successful cap and trade program and discusses some of the communication issues that are unique to emission trading programs. The chapter emphasizes the importance of transparency for cap and trade programs. Finally, the chapter discusses ongoing data collection and assessment recommended for cap and trade programs to determine whether they are delivering the desired environmental and economic results and to identify potential improvements. These include environmental, economic, and market assessments.

Communicating Status and Results

Research has shown that public acceptance of a government policy is critical to ensure successful implementation; keeping stakeholders informed and involved helps build trust in both the policies themselves and in the regulating authority. In addition to simply conveying information, communication and outreach activities can help generate public support for cap and trade programs. This support is particularly important in the case of environmental issues, which frequently engender considerable public debate between competing interest groups with differing values and objectives. Because there are many misconceptions about cap and trade, regulating authorities implementing cap and trade programs need to provide complete, accurate, and balanced information on how the program works and how it will help achieve environmental objectives. It is also important to engage in communication and outreach activities in the beginning of the policymaking process and use these activities throughout implementation to develop credibility for the new approach to emission control.

Multiple Audiences for Outreach

The audience for most outreach activities is highly varied, and each constituency has a unique set of concerns. For example, the general public and the environmental community may be primarily interested in learning how the trading program affects human health and ecosystems, particularly in and around their own communities. The affected emission sources, on the other hand, may need access to account information or guidance on how to measure and report emissions. The academic community might show a preference for technical information, such as data on long-term emission trends or prices. Policymakers might be interested in whether program goals are being met (e.g., whether emissions are decreasing, by how much, and where). Policymakers might also be interested in the program's overall cost-effectiveness. The needs of each of these stakeholder groups can be met through a well-designed monitoring, assessment, communication, and outreach program.

Information for the Market

Another important role of a communication program is to provide information to the emission sources to help facilitate market operation. Sources need to know what their reporting requirements are under the system, how to comply with program rules and regulations, and whom in the regulating authority to contact regarding questions. Moreover, for a cap and trade system that relies on trades recorded in near real time, it is necessary for the regulating authority to provide data on allowance availability and individual accounts.

Fortunately, recent advances in information technology are making it possible to provide data relevant to cap and trade programs in real time and in many highly useful forms. For example, before an allowance trade is completed and money changes hands, the party acquiring allowances may want to know that the ATM has recorded the transaction. Availability of this information helps keep the program running smoothly and efficiently without long lag times. Ultimately, transparency of information makes the market more efficient by letting those who wish to buy and sell allowances know who is trading and what volume of allowances are being traded. This information allows participants to make trading and compliance decisions more easily and quickly than if critical information was not available.

Communication Issues Unique to Emission Trading Programs

There are some unique communication issues associated with cap and trade programs. These programs are sometimes met with skepticism from the environmental community and the public. Unique concerns or misconceptions about emission trading are summarized below.

- **“Emission trading is immoral.”** Some critics of emission trading start with a philosophical opposition to what they call “the right to pollute.” Even under conventional regulation, however, permitting establishes the “right” to emit pollution at a certain level. Sometimes this right is in the form of an emission rate and sometimes it is in the form of the emissions that result from specific, mandated pollution control technologies. Unlike cap and trade, most of these traditional mechanisms do not limit the total tonnage of pollutants from each plant (i.e., plants can emit more when they operate more).
- **“Emission trading is unfair.”** A second misperception of emission trading is that it is unfair because companies can buy their way out of their responsibilities to reduce emissions. Similarly, some have argued that emission trading favors large companies at the expense of small companies. These arguments ignore the fact that under a cap and trade system, companies that buy allowances are essentially paying for emission reductions at other companies. Moreover, small companies often benefit the most from cap and trade because they may have fewer internal options for emission reductions and

they may benefit from the flexibility of buying allowances. In addition, the largest and highest emitting facilities often have the lowest cost per ton for reducing emissions.

- **“Companies will cheat.”** Some believe cap and trade will allow companies to avoid their obligations because enforcement and oversight is left to “the market.” In fact, if programs are properly designed, accountability can be better under a cap and trade program than under conventional approaches. Cap and trade programs require the creation of compliance structures that are useful regardless of whether any trading occurs. Participating sources must fully account to the government for each ton of emissions according to stringent emission measurement protocols to ensure completeness, accuracy, and consistency of emission data. Automatic financial penalties can be used that are set at levels that discourage noncompliance. The regulating authority’s role in the program is to ensure emissions are measured accurately and that all participating sources are in compliance. Finally, reported information on emissions can be made available to the public on the Internet or through other means. This transparency can help build the necessary confidence in the efficacy of the cap and trade approach.
- **“Trading doesn’t clean the air.”** Critics of emission trading sometimes argue that trading does not reduce emissions; it merely shifts the location of existing pollution. However, this argument fails to account for the cap. Under a cap and trade system, the overall level of emissions is reduced and capped. The environmental objective is embodied in the cap and the economic objective in the trade. Moreover, the larger the overall reduction reflected in the cap, the less concern there is about the environmental impacts of any individual trade or group of trades. This point is particularly relevant in addressing concerns about hotspots that may arise due to trading. Economic and atmospheric modeling done in conjunction with an EPA study of the U.S. SO₂ Allowance Trading program showed that in the Eastern United States, the difference in acid deposition with and without trading was less than 5 percent. Differences in deposition of less than 10 percent are not expected to measurably change the acidification of lakes and streams.

Independent analysis also shows that emission trading can lead to greater human health and environmental benefits than non-trading policies.

Modes of Communication

By far the most effective means of communication and outreach is the Internet. Electronic information can reach a vast audience at low cost. A well-designed Web site should be user-friendly, rely on intuitive navigation, and, ideally, undergo usability testing before it is made available to the public. It should also be regularly updated to reflect the latest program data and

developments. An up-to-date Web site can greatly add credibility to the trading program and can be used to provide information that builds confidence in the cap and trade program.

Information can also be made available to the public via print media. Depending on available budget, a regulating authority may prepare and distribute fact sheets, brochures, and topical reports that can be distributed by mail. Periodic newsletters are another effective means of keeping the public informed of the program's status and results, including emission reductions to date, auction results, and allowance prices. Similarly, information can be conveyed at workshops and conferences.

Regardless of the mode of communication, it is important to bear in mind that keeping the public informed about the status and results of the cap and trade program can help ensure the program's success by highlighting its environmental and economic benefits, facilitating market operation, and building public and decision maker support. To ensure that adequate resources are available to meet public demand for information throughout a program's lifetime, a communication function should be designed at the program's outset, rather than on an ad-hoc basis after results are available. Consistently available, up-to-date information will help build public confidence in the cap and trade program.

Environmental Assessment

A cap and trade program, by setting a quantifiable emission goal and using accurate and consistent emission measurement, lends itself well to periodic assessment. Reviewing emission levels will help determine how effectively the program is operating and whether the emission cap level has been achieved. Equally important to program success is determining how the environment is responding to emission reductions and whether over-arching objectives for environmental protection are being met. Periodic measurement of these environmental endpoints will help provide information on how well the cap level is protecting the environment.

The scope of the assessment is determined, to a large extent, by the specific policy questions being addressed. Continued assessments can include evaluation of emission data, ambient air concentrations monitoring data, and pollutant deposition monitoring data. Assessment may also include an evaluation of end-point parameters or receptors, such as changes in surface water chemistry resulting in decreases in acid deposition. Examples of environmental endpoints include acidic levels of rainwater and sulfate deposition levels for acid rain, and ground-level ozone levels for NO_x emissions.

In order to evaluate the effectiveness of environmental policies and programs, a strong commitment to long-term monitoring programs is critical. Effective assessment requires a full suite of monitoring capabilities, including tracking stack emissions, analyzing atmospheric

concentrations of pollutants, measuring wet and dry deposition to land and water surfaces, and evaluating environmental impacts through surface water chemistry and biological monitoring. These programs not only help in evaluating environmental compliance and progress towards program goals (e.g., through tracking emissions reductions), they also enable assessment of the effectiveness of emission controls in addressing human health and environmental concerns. Over the long term, investment in such program accountability mechanisms will yield great benefits through their contribution to the credibility of the policy.

Economic Assessment

Economic assessments are useful to evaluate whether the cap and trade program is delivering the expected economic benefits. Assessments include a comparison of the environmental and human health benefits (or damages avoided) as a result of the program, and the total costs of compliance. These types of analyses can be used for a more comprehensive cost-benefit analysis to evaluate whether further emission reductions and/or additional control programs are warranted.

Market Assessment

Market assessment (i.e., tracking allowance trading activity and prices) is another important aspect of a cap and trade program. The volume of activity (i.e., the number of transactions that occur) indicates whether the market for allowances is liquid and whether it is working effectively to minimize the economic costs of achieving the emission reduction target. Of particular importance is a measure of the number of allowances traded in “arm’s length” transactions, or trades that occur between unaffiliated companies. It is these trades that have market significance and demonstrate that an allowance market has developed.

Program Refinement

Once a cap and trade program has been implemented, assessment of the program is valuable to ensure its effectiveness. It is important not only to assess the environmental and economic effectiveness of the program, but also to assess the implementation. Policymakers should consider whether these procedures could be improved or if they could be more cost-effective.

After gaining some experience of program implementation, policymakers should consult with the emission sources, as well as use the experience from the sources to assess whether changes are warranted in the implementation rules and procedures. In addition, input should be solicited from other stakeholders. Based on such input, it can be determined whether the program would benefit from refinement and if so, a process and timetable can be established. It is important to minimize disruption in the program and realize that some changes, even if they would have been a better

choice from the start, are not worth implementing because of the disruption they would cause. The sources, as well as the regulating authority, have learned the rules and any changes, even improvements, might require more time on their part to learn and implement. On the other hand, it is very possible that there will be changes where the benefits will outweigh the disruption caused by change.

Summary

How the U.S. decides to implement additional emission controls on the energy sector will have a profound impact on the future economic vitality of this country. This course has given you a detailed overview of how these programs work and should provide an understanding of the advantages and risks of implementing a cap and trade program.

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