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Using Emissions Trading to Combat Climate Change: Programs and Key Issues

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Editors' Summary: Emissions trading has emerged as the major policy instrument to address climate change, as evidenced by programs and proposals in Australia, Europe, the United States, and elsewhere. A host of choices need to be made to design and implement a greenhouse gas emissions trading program, choices that are important both to the performance of the program and to the many private firms and groups that are affected. In this Article, David Harrison Jr., Per Klevnas, Albert L. Nichols, and Daniel Radov investigate these alternatives. They explain that private firms and sectors need to understand how their costs and revenues might be affected—including differences depending upon various policy alternatives—and to determine how to take advantage of the flexibility provided by emissions trading. The development of a carbon market as well as the other market effects of a climate change program also will affect key decisions such as the development of new capacity or the retirement of existing plants and equipment. Understanding these influences will help firms and sectors to respond effectively and, in the process, allow the trading programs to achieve goals of meeting key climate change objectives at lowest cost to society.

I. Introduction and Background

Emissions trading has emerged as a major tool for combating climate change. The European Union Emissions Trading Scheme (EU ETS) for carbon dioxide (CO_2) launched in January 2005 now involves nearly 30 countries and has provided important experience and visibility for the emissions trading approach and highlighted its applicability to climate change policy. In the United States, which has had extensive experience with emissions trading for other pollutants for more than a decade, virtually all of the major proposals to control CO_2 and other greenhouse gases (GHGs) are based upon the emissions trading approach. Australia and New Zealand are developing emissions trading programs to deal with climate change, and the approach is now being considered in Canada, Japan, and other countries. Moreover, many developing countries are participating in the Clean Development Mechanism (CDM) program, one of the trading programs (flexibility mechanisms) established under the Kyoto Protocol to reduce the global cost of meeting the Kyoto Protocol targets.

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Compared to the alternative command-and-control approach, in which inflexible emission standards are set for various emitters, emissions trading is attractive for two major reasons. First, trading lowers the cost of meeting key climate change objectives. Providing sources with the flexibility to trade the right to emit, rather than requiring all sources to meet a given emission standard, means both that the allowance market can be used to determine the least-costly means of achieving objectives and that firms have continuing incentives to find cheaper means of reducing emissions. The second reason, and one less generally discussed, is that emissions trading can provide environmental gains relative to a command-and-control approach—it can provide greater certainty that targets will be met and can avoid the environmental effects of giving exemptions to firms that find it difficult to meet the command-and-control standards. Extensive experience with emissions trading programs for other air emissions over the last decade provides strong evidence that the theoretical economic and environmental gains can be achieved in practice.

This Article summarizes the major existing programs and proposals to use emissions trading to deal with climate change and discusses key issues for the future. These future issues include both the policy issues that decisionmakers face in developing an effective and efficient emissions trading program to combat climate change as well as the private issues that corporations and sectors face in response to a mandatory emissions trading program. Indeed, far more than prior emissions trading programs for air emissions, trading programs to deal with climate change have the potential to impact companies/sectors in major ways. Responding to these challenges requires that companies understand these impacts and adapt their decisions to the new realities of a carbon-constrained economy.

We first provide an overview of the concept and the three major types of emissions trading programs that have been put in place. In Part II, we summarize the previous experience with emissions trading for air emissions in the United States and the lessons this experience provides. Part III provides a summary of the existing emissions trading programs and proposals to deal with climate change, including the Kyoto flexibility mechanisms, the existing European cap-and-trade program, and various proposals in the United States and elsewhere. Parts IV and V build upon these specific policies and proposals to identify the key future issues for policymakers and companies, respectively. The final part provides brief concluding remarks.

A. Concept of Emissions Trading

The concept of emissions trading is simple.[1] A cap-and-trade program sets an aggregate cap on emissions that defines the total number of emissions allowances, each of which provides its holder with the right to emit a unit (typically a ton) of a particular type of emission. The allowances are initially allocated in one of several ways, usually directly to participating sources, although allowances may be allocated to others or auctioned. Each source covered by the program must surrender enough allowances to cover its emissions, with sources free to buy or sell allowances among themselves.

1. Economic and Environmental Gains

Giving regulated facilities the flexibility to trade emissions allowances reduces the compliance costs of achieving an emissions target, while the overall cap on the level of emissions provides certainty that the emission target will be achieved. Although it is not possible to provide precise measures of cost savings compared to hypothetical control approaches that might have been applied, the available evidence suggests that the increased compliance flexibility of emissions trading can yield costs savings of as much as 50% or more.[2]

Some skeptics have suggested that emissions trading is a way of evading environmental requirements, but experience to date with well-designed trading programs indicates that emissions trading helps achieve environmental goals in several ways. First, emission reductions may begin sooner, taking advantage of the fact that some facilities can control more quickly than others, whereas the timing of command-and-control requirements often must be keyed to the slowest facilities. Second, giving firms with high abatement costs the flexibility to meet their compliance obligations by buying emissions allowances eliminates the rationale underlying requests for special exemptions from emissions regulations based on hardship and high cost. Third, reducing compliance costs has resulted in tighter emissions targets, in keeping with efforts to balance the costs and benefits of emissions reductions. Finally, properly designed emissions trading programs appear to provide other efficiency gains, such as greater incentives for innovation and improved emissions monitoring.

2. Simple Example to Illustrate the Cost Savings From Emissions Trading

Although actual programs are more complex, a simple numerical example illustrates how emissions trading can reduce control costs compared to a traditional approach based on setting uniform command-and-control standards. Typically, the marginal cost per ton of reduction rises as the level of reduction required increases and also varies widely across affected plants. Assume then that to reduce emissions to meet the standard, Plant A incurs a cost of $1,500 for the last ton of emissions reduced, while Plant B spends $3,000 for the last ton it reduces.

The same overall reduction in emissions could be achieved at lower cost by tightening controls at Plant A by one ton, which costs $1,500, and relaxing them at Plant B by one ton, which saves $3,000, for a net decrease in total compliance costs of $1,500. Under a cap-and-trade program, each source would compare its own emissions control costs with the market allowance price and determine whether it is profitable to control more and sell allowances to others or to control less and buy allowances to cover the additional emissions. For example, in this case if the market price were $2,000, Plant A could gain $500 by controlling another ton and selling the allowance, while Plant B could gain $1,000 by buying that allowance and relaxing controls by one ton. The total compliance savings of $1,500 are thus divided between the buyer and seller.

B. Broad Types of Emissions Trading Programs

Three broad types of emissions trading programs have emerged: (1) cap-and-trade programs; (2) credit-based programs; and (3) averaging programs. Although all share the feature of tradability, the three differ in important respects. The bulk of climate change programs are cap-and-trade programs, but the other two types of programs are also relevant.

1. Cap-and-Trade Programs

A cap-and-trade program is the "classic" emissions trading program summarized above. An aggregate cap on emissions is set that defines the total number of emissions allowances, each of which provides its holder the right to emit a unit of emissions. Each source covered by the program must submit allowances to cover its emissions, with sources free to buy and sell allowances among themselves. In most programs, allowances have been allocated initially to covered sources free of charge, based on emissions during some historical period before the program's commencement. However, initial allocations may be made to other parties or

1. *See, e.g.*, David Harrison Jr. & Daniel Radov, *Carbon Emission Trading: Creating a New Traded Commodity Market in Europe*, World Power, Oct. 2002, at 1-4.

2. A. Denny Ellerman et al., Emissions Trading in the U.S.: Experience, Lessons, and Considerations for Greenhouse Gases iv (Pew Center on Global Climate Change 2003), *available at* http://www.pewclimate.org/global-warming-in-depth/all_reports/emissions_trading.

through auctions. The keys to smooth functioning of cap-and-trade programs are that the total number of allowances is fixed and their initial distribution is clearly specified. As a result, trading does not affect overall emissions and it is clear what participants have available to sell, so that individual trades do not require detailed scrutiny.

2. Credit-Based Programs

The earliest emission trading programs were developed in the United States in the late 1970s and early 1980s for conventional pollutants. These were based on "credits" granted to sources that reduced their emissions below a "baseline."[3] This baseline typically was set at the emissions level that would have been required by preexisting regulations. Credits could be traded to other sources (sometimes limited to other sources owned by the same company). Problems arose because baseline emissions could not be defined with certainty, both because the command-and-control regulations from which the credits were measured generally did not establish clear emission rates, and because future activity levels affect the future level of emissions. For example, an emission standard for a boiler might specify an emissions rate per unit of heat input, with different limits depending on the type of fuel and whether the boiler is an existing or new one and with different credits depending upon the future level of heat input. It was very difficult to decide when emissions were reduced because of the trading program as opposed to falling for other reasons. For example, if a plant switched the boiler's fuel from coal to gas, emissions might fall substantially, but it would be unclear whether the source should receive credit, because it might have switched fuels even if the credit-trading system did not exist.

Because of these problems, the U.S. credit-based systems of the 1970s and early 1980s included many provisions designed to minimize the risk of "paper credits." Those provisions sharply raised transactions costs and blocked many potential trades, with the result that these early programs yielded few cost savings.[4] As discussed below, these same issues arise in the context of the CDM and other "offset" programs designed for climate change.

3. Averaging Programs

Averaging programs involve setting an average emission rate, i.e., emissions per unit of input or output, that participating facilities must achieve and allowing the participants to buy and sell emissions credits in order to achieve the required rate. The best-known examples include the lead-in-gasoline trading programs developed in the United States in the 1980s[5] and the current U.S. Corporate Average Fuel Economy standards, which allow manufacturers to average fuel economy across different models in order to determine compliance.

Like reduction-credit programs (and typical command-and-control standards), averaging programs do not explicitly limit overall emissions. However, unlike credit-based programs, they do not raise the issue of determining the appropriate "baseline" for trades. In practice, averaging programs can work much like cap-and-trade systems, although the implicit allowances are distributed based on the relevant measure of production, e.g., gallons of gasoline or number of cars, and thus the overall cap can vary with that measure.[6] Indeed, if there is no provision to modify the number of allowances in response to changes in output levels, an averaging program would be equivalent to a traditional cap-and-trade program.

4. Combinations of Types

Trading programs may include more than one type of mechanism. The most common is a cap-and-trade program that includes credits (sometimes called offsets) that can be earned through actions by sources not covered by the basic cap. Early reduction credits, which allow covered sources to earn credits by reducing emissions before the formal cap applies, are one example. As noted below, the programs and proposals for climate change include this combination as well. In some cases, emission trading programs are combined with, and limited by, more traditional regulations. For example, under all of the U.S. trading programs, new sources must meet very stringent new source performance standards and have sufficient allowances for the emissions that remain to comply with the emissions trading program.[7]

II. Experience With U.S. Cap-and-Trade Programs for Conventional Air Pollutants

Emissions trading has been used extensively over the past 20 years to regulate conventional air emissions in the United States, and this experience is an important reason that the emissions trading approach—particularly that exemplified in the cap-and-trade method—is so prominent for climate change. Indeed, many of the supporters and developers of the "flexibility mechanisms" in the Kyoto Protocol and the EU ETS pointed to the U.S. experience as evidence that the approach would work to lower costs and achieve key climate change objectives. This part provides an overview of the major U.S. cap-and-trade programs and the lessons their experience provides.

Table 1 summarizes the five major cap-and-trade programs that have been established in the United States. As noted below, in February 2008, the mercury trading program was found by the U.S. Court of Appeals for the District of Columbia (D.C.) Circuit to be impermissible under the relevant part of the Clean Air Act (CAA). The U.S. Environmental Protection Agency (EPA) has administered all these programs except for the Regional Clean Air Incentives Market (RECLAIM), the Los Angeles air basin program administered by the South Coast Air Quality Management District (SCAQMD).

3. David Harrison Jr., *Tradable Permit Programs for Air Quality and Climate Change*, *in* International Yearbook of Environmental and Resource Economics, Volume VI 311, 314-18 (Henk Folmer & Thomas Tietenberg eds., 2002).

4. *Id.*

5. *See* Albert Nichols, *Lead in Gasoline*, *in* Economic Analyses at EPA: Assessing Regulatory Impact 49, 49-86 (R. Morgenstern ed., 1997).

6. In the context of GHG emissions, averaging programs sometimes are referred to using other terms, including "intensity-based programs," "rate-based programs," and "relative targets."

7. *See* Harrison, *supra* note 3, at 311-33.

Table 1. Summary of Major Cap-and-Trade Emissions Trading Programs

Program	Agency	Pollutant(s)	Sector(s)	Scope	Years
RECLAIM	South Coast Air Quality Management District	NO_x, SO_2	Multiple	Los Angeles Basin	1994-Present
Acid Rain Trading Program	U.S. EPA	SO_2	Electricity Generation	U.S.	1995-Present
Northeast NO_x Budget Trading	U.S. EPA; 12 states and D.C.	NO_x	Stationary	Northeast	1999-Present
Clean Air Interstate Rule (CAIR)	U.S. EPA	NO_x, SO_2	Electricity Generation	East (28 states)	2009-
Clean Air Mercury Rule (CAMR)	U.S. EPA	Mercury	Electricity Generation	U.S.	2010-

A. Acid Rain Trading Program

The largest and best-known cap-and-trade program in the United States is the program for sulfur dioxide (SO_2) created by Title IV of the 1990 CAA Amendments.[8] It is often referred to as the Acid Rain Trading Program because the major motivation for the program was to reduce damage from acidic deposition. The law specified two phases. Phase I (1995-1999) covered a high-emitting subset of power plants. Phase II (2000-) broadened coverage and tightened the cap to require roughly one-half the average emission rate as the cap in Phase I. The Phase II cap reduced total SO_2 emissions from electricity-generating units to about one-half of what they had been in the early 1980s. Participants were allowed to bank unused allowances from one year to the next, and large quantities were banked in Phase I by sources that reduced emissions more than required to have additional allowances to meet the more stringent Phase II cap. The allowances were allocated to owners of affected units free of charge, primarily based on each unit's average annual heat input during the three-year baseline period, 1985-1987. A small fraction of allowances (2.8%) is withheld and auctioned each year, but the revenues are returned on a pro rata basis to the original owners of the allowances withheld for the auction. The auction was intended to ensure liquidity for new sources, but has proved unnecessary as trading has been vigorous.

The Acid Rain Trading Program has proved very successful, with substantial trading across covered sources and across time through banking. An extensive study of the program by researchers at the Massachusetts Institute of Technology (MIT) estimated in 2000 that trading would reduce costs from 1995 through 2007 by just over $20 billion, a savings of about 57% compared to costs without trading.[9] Researchers at Resources for the Future estimated somewhat smaller, though still significant, savings on the order of 13% in Phase I (1995-1999) and 37% in Phase II (2000-).[10]

B. RECLAIM

Regulators in the Los Angeles air basin developed RECLAIM as an alternative means of achieving the emission reductions of nitrogen oxides (NO_x) and SO_2 mandated by the 1991 Air Quality Management Plan.[11] RECLAIM began operation in 1994, the year before the Acid Rain Trading Program. The declining series of caps were set higher than expected emissions in the earliest years, but by 2003, achieved levels that were roughly one-half of their 1990 levels.

Unlike the acid rain program, RECLAIM covers a heterogeneous group of industries and sources, not just electricity-generating plants. It also distinguishes emissions in two geographic zones, a coastal zone and an inland zone, with separate trading credits issued for the two zones. Reflecting the fact that prevailing winds drive pollutants inland, the coastal credits are usable in either zone, but the inland credits cannot be used in the coastal zone. The RECLAIM program does not allow banking, although it provides limited temporal flexibility by having two overlapping annual reporting periods that implicitly allow carrying allowances for six months beyond their nominal expiration date.

Studies done when the program was introduced estimated cost savings to be about 40%.[12] Retrospective studies have not been done, but the overall volume of trading has been high, each year exceeding the allocation for that year, re-

8. See generally Robert N. Stavins, *What Can We Learn From the Grand Policy Experiment? Lessons From SO_2 Allowance Trading*, 12 J. Econ. Persp. (1998) and A. Denny Ellerman et al., Markets for Clean Air: The U.S. Acid Rain Program (2000), for overall assessments.

9. *See* Ellerman et al., *supra* note 8, at 282-86.

10. Curtis P. Carlson et al., *SO_2 Control by Electric Utilities: What Are the Gains From Trade?*, 108 J. Pol. Econ. 1292-1326 (2000).

11. David Harrison Jr., Ex Post Evaluation of the RECLAIM Emissions Trading Program for the Los Angeles Air Basin 5 (2003).

12. David Harrison Jr. & Albert Nichols, An Economic Analysis of the RECLAIM Trading Program for the South Coast Air Basin 1 (National Economic Research Associates 1992).

flecting in part trading in future vintages.[13] The RECLAIM program ran into considerable difficulties during the California electricity crisis in 2000 and 2001, when the price of RECLAIM allowances for NO_x emissions increased dramatically—and overall NO_x emissions exceeded the cap—and the SCAQMD removed electricity-generating plants from the RECLAIM program. Although the effect on emissions would have likely been greater without RECLAIM, the large increase in prices does suggest the importance of including mechanisms to deal with price volatility, notably the ability to bank allowances.[14]

C. Northeast NO_x Budget Trading Program

The Northeast NO_x Budget Trading program covers 12 states in the northeastern United States and the District of Columbia. The trading program covers NO_x emissions from electricity-generating facilities and is intended to reduce the formation of ground-level ozone. In the first phase (1999-2003), the cap represented roughly a 60% reduction from uncontrolled levels. In the second phase (2003-), the cap reduced emissions about 75%. Covered sources are allocated allowances by the individual states, with different states using different criteria. The cap-and-trade system only applies for emissions from May through September because the ozone air quality standard is rarely violated in the region outside that period and the states did not want emission reductions in other months used to increase emissions during the ozone season. Early reviews of the performance of the NO_x Budget program indicate that it has operated effectively, with trading aided by the participation of marketing and brokerage firms.[15]

D. Recent Programs

In 2005, EPA established two new rules for fossil fuel-fired electricity generation units that include cap-and-trade mechanisms. The Clean Air Interstate Rule (CAIR) sets tighter limits for SO_2 and NO_x emissions in two steps, the first starting in 2009 for NO_x and 2010 for SO_2 and the second in 2015 for both pollutants.[16] It will cover 28 eastern states and the District of Columbia.

The Clean Air Mercury Rule (CAMR) promulgated by EPA on March 15, 2005, sets standards for mercury emissions from coal-fired generating units. It sets national mercury emissions caps, starting in 2010, with a further cut in 2018, and provides for interstate trading of emissions allowances.[17] Several states objected to interstate trading on the theory that trading might lead to "hot spots," i.e., elevated levels of local mercury concentrations.[18] In February 2008, a D.C. Circuit panel ruled against the trading program, finding that mercury emissions from power plants are covered by a section of the CAA that does not allow trading.[19]

E. Implications of U.S. Experience for GHG Trading

The U.S. experience with trading offers several lessons for trading in GHGs. The most important (and basic) of these is that trading, particularly of the cap-and-trade variety, can be both cost-saving and environmentally effective.[20] As discussed below, emissions trading seems even more attractive for GHGs than for most other pollutants. The impacts of GHG emissions do not vary by location or timing, except in the general sense that earlier reductions are more valuable than later ones. Thus, the concerns about local concentrations seen with mercury do not apply, nor do the concerns about short-term or seasonal timing seen with NO_x and other ozone precursors. On the other hand, GHG emissions come from a wide variety of sources, including small sources such as automobiles that would be difficult to monitor under a trading program, and thus at least in contrast to pollutants such as SO_2, designing a comprehensive program introduces additional challenges. Moreover, the scale of GHG emissions and the pervasiveness of these emissions as a byproduct of much of the world's economic activity mean that significantly higher values are at stake, and the absence of any commercially ready "end-of-pipe" technological abatement option makes the cost of reducing emissions potentially very high.

III. Major GHG Emissions Trading Programs and Proposals

The increased national and international interest in emissions trading is largely based on concern about climate change and a consensus that GHGs are well suited to a cap-and-trade program.[21] Once emitted, GHGs reside in the atmosphere for periods measured in decades and even centuries. Atmospheric currents ensure that emissions are dispersed quickly in the atmosphere so that atmospheric concentrations of GHGs are relatively uniform over the globe. Uniform mixing means that a ton of a given GHG will have the same effect on atmospheric concentration—and thus on climate change—regardless of whether the ton is emitted in London, New York, or any other place on the globe. Thus, trading can be national or even international in scope, with the potential cost savings increasing as the scope broadens.

The cumulative effect of GHGs and their long duration in the atmosphere also mean that variations in the timing of

13. *See supra* note 11, at 11.

14. *See* Ellerman et al., *supra* note 8, at 285-86.

15. A. Farrell, *Multi-Lateral Emission Trading: Lessons From Inter-State NO(x) Control in the United States*, 29 Energy Pol'y 1061-72 (2001).

16. Note that the number of states included in the program differs for the two pollutants. *See* U.S. EPA, *Clean Air Interstate Rule*, http://www.epa.gov/interstateairquality/basic.html.

17. U.S. EPA, Standards of Performance for New and Existing Stationary Sources: Electric Utility Steam-Generating Units (2005). *See* U.S. EPA, *Clean Air Mercury Rule*, http://www.epa.gov/air/mercuryrule/basic.htm.

18. It is not, however, clear that mercury would remain a primarily local phenomenon. *See, e.g.*, David Harrison Jr. & James Johndrow, *State Restrictions on Mercury Trading Could Prove Expensive, Ineffective*, 24 Nat. Gas Elec. 2, 1-6 (2007).

19. Daniel Cusick & Darren Samuelsohn, *Appeals Court Strikes Down EPA Cap-and-Trade Regulation*, Greenwire, Feb. 8, 2008.

20. See Ellerman et al., *supra* note 8, at 314-22, for a more detailed discussion of the lessons learned from the U.S. programs.

21. Many economists contend that in theory an emissions tax would be more appropriate for dealing with GHGs, although there is agreement that a tax is not likely to be politically feasible. *See, e.g.*, William Pizer, *The Optimal Choice of Climate Change Policy in the Presence of Uncertainty*, 21 Resource & Energy Econ. 3-4, 255-87 (1999); Michael Hoel & Larry Karp, *Taxes and Quotas for a Stock Pollutant With Multiplicative Uncertainty*, 82 J. Pub. Econ. 1, 91-114 (2001); and Willam D. Nordhaus, *Life After Kyoto: Alternative Approaches to Global Warming Policies* (Nat'l Bureau of Econ. Research, Working Paper No. 11889, 2005).

emissions are not important, because they will not have significant impacts on atmospheric concentrations or climate. As a result, there is no need to be concerned about seasonal variations in emissions (as there is with NO_x, for example) or annual variations due to banking. Although the specific nature of domestic and global measures to address climate change will evolve over time, few environmental problems appear so well suited to trading as global climate change.

The Kyoto Protocol is the major international agreement in place now, and the EU ETS is the most important trading program in place to meet commitments made by signatories to the Kyoto Protocol.[22] Indeed, these two programs are closely linked, as CDM projects allowed under the Kyoto Protocol are used extensively by participants in the EU ETS. Although the United States is not a signatory to the Kyoto Protocol, successor agreements are under development and various proposals in Congress would establish a cap-and-trade program for U.S. sources. As noted above and discussed in detail below, regions within the United States and other countries also are considering a cap-and-trade program for GHG emissions.

A. Flexibility Mechanisms Under the Kyoto Protocol

In December 1997, representatives from the developed nations of the world met in Kyoto, Japan, and devised a plan for reducing GHG emissions. Signatories to the Kyoto Protocol committed themselves to specific GHG emissions reduction targets with an average emissions reduction of 5.2%. The treaty came into force in February 2005, and the first commitment period is 2008-2012.

The Kyoto Protocol includes three emissions trading mechanisms that countries can use to achieve part of their emissions reductions: (1) trading of emission credits between governments; (2) participation in emissions reduction projects in developing countries (the CDM); and (3) participation in emissions reduction projects in industrialized countries with a GHG reduction commitment—joint implementation (JI).

CDM and JI projects are overseen and approved by the CDM Executive Board and the JI Supervisory Committee, which issue each project's emissions reductions credits, known as certified emission reductions (CERs) and emission reduction units (ERUs), respectively. Countries are using both project-based mechanisms to meet the Kyoto requirements because they can provide emissions reductions at a lower cost than domestic emissions abatement measures. CDM and JI credits also can be used by firms to meet obligations under the EU ETS. As discussed below, project credits are expected to account for a significant share of the emissions reductions required for compliance with the EU ETS during the 2008-2012 Kyoto period. Governments and private companies from Europe and Japan have either developed CDM/JI projects on their own or have taken part in carbon funds, funds created by various public and private institutions to invest in CDM/JI projects in order to deliver emissions reduction credits to the fund participants. In aggregate, these funds manage more than $5 billion in capital.[23]

As shown in Table 2, the total combined value of CDM and JI transactions of both types roughly doubled from 2005 to 2006, supporting the belief held by most observers that these project-based compliance mechanisms have successfully established a rough price signal to encourage GHG reductions in developing countries.

Table 2. Value, Volume, and Average Price of CDM and JI Transactions

	2005			**2006**		
	Value (Millions)	**Volume ($MtCO_2$)**	**Avg Price ($\$/tCO_2$)**	**Value (Millions)**	**Volume ($MtCO_2$)**	**Avg Price ($\$/tCO_2$)**
CDM	$2,638	351	$7.52	$5,257	475	$11.07
JI	$68	11	$6.18	$141	16	$8.81
Total	**$2,706**	**362**	**$7.48**	**$5,398**	**491**	**$10.99**

Source: World Bank & International Emissions Trading Ass'n, State and Trends of the Carbon Market: 2007 (2007).

22. EUROPA, Emission Trading Scheme (2008), *available at* http://ec.europa.eu/environment/climat/emission/ets_post2012_en.htm.

23. World Bank & International Emissions Trading Ass'n, State and Trends of the Carbon Market: 2007, at 26-27 (2007).

B. EU ETS

Under the Kyoto Protocol, the EU is committed to reducing its emissions of GHGs by 8% below 1990 levels over the period between 2008 and 2012. The EU ETS was established in 2003 as a cost-effective mechanism to comply with this commitment.

1. Overview of the EU ETS

The EU ETS is a cap-and-trade program, and it follows the general design outlined above.[24] Its rules identify the installations that are covered by the program, specify the process whereby the total quantity of allowances to emit CO_2 is determined and distributed to these installations, and stipulate an obligation on each installation to surrender allowances equal to its total emissions in each calendar year. This amounts to establishing a cap on CO_2 emissions from covered installations in the EU. In addition, allowances can be bought and sold, and the resulting market in EU allowances helps lower the overall cost of achieving the cap on covered emissions.

The first phase of the trading scheme ran from 2005-2007, while the current second phase runs from 2008-2012 coinciding with the first commitment period under the Kyoto Protocol. The trading scheme currently covers large installations in certain industrial sectors (including power generation, refining, iron and steel, cement, glass, lime, bricks, ceramics, pulp, and paper) and also all combustion activities with a rated thermal input exceeding 20 megawatts. The trading scheme covers almost the entire power generation sector, but coverage is lower in other sectors because smaller sources are more common. In total, the trading scheme includes over 11,500 installations, accounting for around 45% of CO_2 emissions in the EU, emitting around 2.1 billion tons of CO_2 per year. It does not currently cover households, agriculture, or transport, but the EU intends to bring aviation into the trading scheme in the next few years. Recent proposals published by the European Commission would further expand the scope, to include GHGs other than CO_2, more industrial activities, and domestic project credits.

Emissions allowances currently are issued and allocated by national governments (Member States), which are required to publish a national allocation plan (NAP) for each phase of the trading scheme.[25] In the first two phases, virtually all allowances have been awarded free of charge,[26] usually assigned first to sectors before being distributed to individual installations within each sector. Allocation typically has been done on the basis of historical emissions (or grandfathering) or using industry-specific benchmarks. Member States also have the option of reserving a portion of total allowances for new installations, and all Member States have made use of this provision. The Emissions Trading Directive requires that the total quantity of allowances allocated be consistent with each Member State's obligations under the EU Burden-Sharing Agreement[27] and the Kyoto Protocol, and the European Commission has reviewed Member State NAPs in light of these requirements. In addition to allowances allocated by each Member State, allowances may also enter the trading scheme through the "Linking Directive."[28] This allows emissions credits generated through the flexible mechanisms of the Kyoto Protocol—JI and CDM—to be valid for compliance within the EU ETS.

2. Experience With the EU ETS Thus Far

It is too early to provide a definitive assessment of the potential economic and environmental gains from the EU ETS.[29] One reason for this is the high volatility in allowance prices over the first phase, which may have reduced incentives to invest in lower emitting production technologies. Moreover, uncertainty about the design of the trading scheme in future phases may have encouraged a "wait and see" attitude among many covered installations. Effects have been observed, however, in the electric power sector. There has been extensive discussion of the effects of the program on electricity prices, and these discussions have expanded into more general discussions about the current and future effects of the EU ETS on the competitiveness of energy-intensive industries in Europe. We return to these issues in Part IV.

Figure 1 shows the prices of EU ETS allowances (EUAs) over time, split into Phase I and Phase II allowances, and the total volume traded each week. The graph shows wide fluctuations in the price of Phase I allowances. The large decline in prices in late April 2006, followed the publication of verified emissions data for the first time. In a number of Member States, 2005 actual emissions were considerably lower than had been expected and significantly lower than the total quantity of allowances that had been allocated. Because banking of allowances between Phases I and II generally has been prohibited, the "overallocation" of allowances has led to a steady decline in prices toward zero by the end of Phase I. Based on more reliable emissions data, Phase II caps have been set to be more stringent, and as Figure 1 indicates Phase II prices have so far remained at relatively high levels. The more stringent Phase II cap in part reflects demands by the European Commission that some Member States issue less generous allocations than initially proposed.

24. *See supra* note 22.

25. *See* A. Denny Ellerman & Barbara K. Buchner, *The European Union Emissions Trading Scheme: Origins, Allocation, and Early Results*, 1 Rev. Envtl. Econ. Pol'y 1, 66-87 (2007).

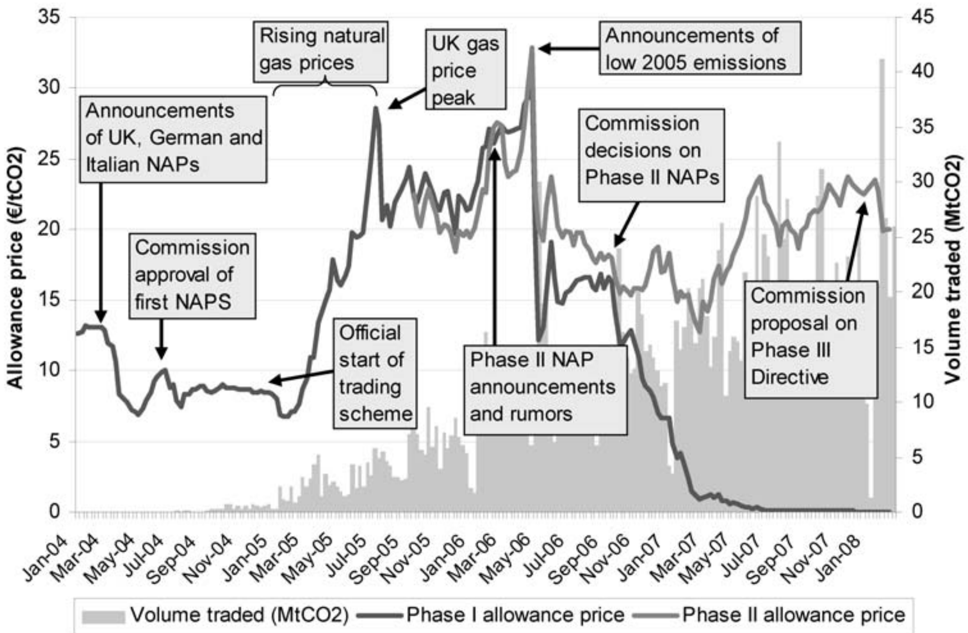
26. Auctioning was limited to a maximum of 5% for Phase I and 10% for Phase II, but the actual level of auctioning for both phases has remained far below these levels.

27. Council Decision 2002/358/EC (Apr. 25, 2002).

28. COM(2003) 403.

29. For assessments of individual NAPs and the NAP process in the first phase of the EU ETS, see Ellerman & Buchner, *supra* note 25, at 66-87 and Allocation in the European Emissions Trading Scheme: Rights, Rents, and Fairness 14-38 (A. Denny Ellerman et al. eds., 2007) [hereinafter Rights, Rents, and Fairness]. For information on the NAP in the United Kingdom, one of the earliest and most influential programs, see David Harrison Jr. & Daniel Radov, *Experience for Member States in Allocating Allowances: United Kingdom*, *in* Rights, Rents, and Fairness, *supra* at 41-70.

Figure 1. EU ETS Allowance Market



Source: Data from Point Carbon; commentary provided by the authors.

Experiences in the early years of the EU ETS and in the development of the Phase I and Phase II NAPs have led to considerable discussion regarding the post-2012 design of the EU ETS. The European Commission has completed an initial review of alternatives and in January 2008, it put forward proposals for changes to the directive that would result in a more centralized approach and greater use of auctioning to allocate allowances.[30] These commission proposals are preliminary and subject to negotiation and approval by the European Parliament and the European Council of Ministers.

C. GHG Trading Programs and Proposals in the United States

Various proposals have also been developed in the United States at the federal level as well as at the state and regional levels. This part provides brief overviews of the major proposals.

1. Regional Programs and Proposals

Several regional groups of U.S. states have developed, or are developing, emission trading plans. The Regional Greenhouse Gas Initiative (RGGI) is furthest along, with a mandatory cap-and-trade program covering CO_2 emissions from power plants in 10 northeastern states that is scheduled to start in 2009.[31] Under the plan, emissions would be stabilized at current levels through 2014 and reduced by 10% by 2018. The memorandum of understanding among the participating RGGI states calls for at least 25% of allowances to be auctioned. The program incorporates "safety-valve" mechanisms that would loosen limits on the use of project-based offsets (credits) or extend the 2018 deadline when the RGGI allowance price reached a certain level. Some of these safety valve provisions would apply if allowance prices exceeded \$7/ton of CO_2, while others would be triggered at \$10/ton.

California enacted the California Global Warming Solutions Act, often referred to as AB 32, in 2006.[32] The law calls for a cap on emissions in 2020 that is equal to the state's emissions in 1990. However, it leaves open how the cap will be achieved, specifying that by Jan. 1, 2009, the Air Resources Board (ARB) must adopt a plan indicating how reductions are to be achieved "via regulations, market mechanisms and other actions." In June 2007, an advisory committee issued recommendations for a cap-and-trade program, but it is not clear what sectors would be covered by this program or the extent to which covered sectors would also be subject to various other regulations.[33]

California is also part of the Western Climate Initiative, which in early 2008 included six states and two western Canadian provinces.[34] The group is holding various workshops and plans to issue a design by August 2008 for a market-based mechanism to reduce GHGs in the region.

30. *See supra* note 22.

31. *See* RGGI, *Homepage*, http://rggi.org (last visited Apr. 8, 2008).

32. *See* California Air Resources Board Climate Change, *Homepage*, http://www.arb.ca.gov/cc/cc.htm (last visited Apr. 8, 2008).

33. *See generally* Market Advisory Committee to the California Air Resources Board, Recommendations for Designing a Greenhouse Gas Cap-and-Trade System for California (2007).

34. *See* Western Climate Initiative, *Homepage*, http://www.westernclimateinitiative.org (last visited Apr. 8, 2008).

In November 2007, six states in the Midwest and the Canadian province of Manitoba agreed to establish long-term GHG reduction goals and to develop a multisector trading program.[35] Three other states also are currently signed on as observers. As in other programs, the public officials developing this program have established a process to develop details of the potential trading program.

2. Congressional Proposals

Interest in a federal cap-and-trade program for CO_2 and other GHGs has been growing in recent years, and it looks increasingly likely that some program will be enacted within the next few years. As of early 2008, a bill introduced by Sens. Joseph I. Lieberman (I-Conn.) and John W. Warner (R-Va.) is the most prominent proposal in Congress.

The December 2007 version of the Lieberman-Warner Bill would establish a declining cap that by 2050 would be about 70% below 2012 levels. Although earlier versions of the bill focused on larger stationary sources, the current version would achieve broad coverage (including motor vehicles) by extending the program to producers and importers of petroleum and natural gas, which would be required to cover the CO_2 emissions embedded in the fuel they sell. Emissions from coal would be covered by requiring coal-fired units to cover their coal-related emissions. The bill also includes a separate cap for hydrofluorocarbons. To broaden coverage further, the Lieberman-Warner proposal provides for the use of offsets obtained through projects that reduce emissions in uncovered sectors, e.g., capturing methane emissions from agricultural waste. The bill would allocate most allowances for free initially but would reduce the level of free allowances over time so that a majority would be auctioned in later years. There is of course substantial uncertainty about whether and when a federal cap-and-trade program might be enacted and come into force and, if it does, what provisions it would contain.

IV. Key Policy Issues for GHG Emissions Trading

The United States seems likely to develop a national cap-and-trade program for GHG emissions within the next several years, a program that might be accompanied by regional or state programs. As reflected by the recent European Commission proposal for the post-2012 period, the European program is likely to evolve as well. Moreover, as noted above, other countries, e.g., Australia, seem likely to develop their own cap-and-trade programs. There are numerous issues that arise in translating the relatively simple cap-and-trade approach into a workable, effective, and efficient program. In addition, as discussed in the subsequent section, such a program has important implications for private firms.

The public policy issues can be put into three categories: (1) basic program design elements; (2) methods of dealing with competitive and leakage concerns from the perspective of a single program; and (3) international considerations related to linking multiple programs and integrating non-participating countries. Although the nature of these issues differs between jurisdictions, generally these same issues arise in all programs.

A. Program Design Elements

Experience with cap-and-trade programs indicates the importance of several major program design elements. The following is a discussion of the important elements, including the key issues that arise as a cap-and-trade program for GHG emissions is developed.

1. Coverage of Sources

A GHG trading program has to determine which emissions should be subject to the program and the point(s) in the production chain at which allowances will be implemented. Both environmental benefits and economic efficiency typically are greater the more comprehensive the coverage. Prior emissions trading programs typically have involved regulating direct emitters (such as power plants)—a system referred to as "downstream" because these facilities are downstream in the chain of energy production, distribution, and end use. Trading for CO_2 also can be implemented "upstream," at the point of production or first sale of fossil fuels, e.g., coal mining and oil companies or importers. Assuming equal coverage, there is little difference in terms of potential environmental performance of downstream and upstream approaches because emissions vary little between different uses of each fuel.

The downstream approach has two main advantages. First, it makes possible the coverage of GHGs other than CO_2. Second, downstream schemes can include carbon capture and storage (CCS) as a permissible abatement method. This method of abatement currently is experimental, but some have noted it as a major potential method for future emissions reductions. Current discussions of changes to the EU ETS, which is a wholly downstream scheme, reflect both these considerations, and the European Commission has proposed the inclusion of both non-CO_2 GHGs and CCS in the EU ETS in 2013.[36]

Against these advantages, downstream schemes typically cannot achieve as comprehensive coverage as a pure upstream scheme. Where the number of downstream emissions sources is large, e.g., motor vehicles, it is not feasible to include the many smaller sources that cumulatively represent important emissions. This concern is reflected in recent discussions about changes to the EU ETS, where the draft commission proposal would remove small emitters on the grounds that the administrative and transaction costs incurred by these sources are greater than the gains of their continued inclusion. At the same time, there also are proposals to extend the EU ETS scope to additional sectors, including aviation. These developments highlight the trade off inherent in any downstream cap-and-trade program between achieving as comprehensive coverage as possible and avoiding excessive administrative costs.

An upstream program would avoid most of these potential problems, as the number of entities included would be small relative to the number of downstream emitters with

35. *See* Midwestern Greenhouse Gas Reduction Accord: 2007, 1-4 (2007), *available at* http://www.midwesterngovernors.org/resolutions/GHGAccord.pdf.

36. It would be possible to include CCS within an upstream program, but this would probably require treating the operation of CCS equipment as a credit-generating activity that could be used to offset emissions within the cap-and-trade framework.

corresponding emissions. An upstream program creates incentives for emissions reductions because fuel producers or suppliers attempt to pass on the costs associated with the need to cover emissions to their customers in the form of higher prices.[37] The higher prices diffuse throughout the economy and encourage all parties to reduce emissions to reflect CO_2 emissions associated with various types of fuels and the CO_2 emissions embodied in various products. All users of covered fuels thus are indirectly covered by the program, and the total emissions included typically can be greater than in a downstream approach.

Recent U.S. GHG trading proposals have sought to combine the upstream and downstream approaches into hybrid programs, with downstream implementation for large emitters such as electricity generators—potential candidates for CO_2-capture strategies—and upstream implementation for other categories, such as space heating, less energy-intensive industrial processes, and motor vehicles, for which the numbers of emitters are large and CO_2 capture unlikely. As noted earlier, the December 2007 Lieberman-Warner proposal, for example, covers coal downstream for large stationary sources, but covers emissions embedded in petroleum and natural gas upstream, at the point of production or import.

2. Cap Levels Over Time

The overall cap on emissions and its time path determines the environmental ambition of a cap-and-trade system and, to a large extent, allowance prices. Decisions therefore must take into account overall long-term climate policy aims, as well as the potential reductions achievable from emissions sources not included in the emissions trading program, such as transport in a downstream program or projects to increase sequestration in forests.

The experience with the EU ETS illustrates the importance of the process determining the cap. The cap for the first phase of the EU ETS, which was intended as a pilot program, was set on the basis of limited data on past and current emissions levels. Moreover, the total EU cap was determined in a decentralized process through the aggregation of individual Member State decisions about the quantity to allocate to their own industries, which created incentives to provide relatively high allocations to domestic facilities (leaving aside difficulties in judging business as usual emissions). When verified emissions data for 2005 were made public in 2006, it became clear that actual emissions were substantially lower than the total cap for all Member States. The impact on prices was immediate, and the remainder of Phase I saw prices drop practically to zero.[38]

Phase II of the EU ETS has seen a more stringent cap, after the European Commission insisted on substantial downward revisions of the amounts proposed by various Member States. While this has restored scarcity to the market and achieved relatively high allowance prices, this process has lead to legal action by some of the Member States. For the post-2012 period, the commission has proposed a fully centralized process, which would replace the system of NAPs with a single EU cap, set centrally for the period 2013-2020 to achieve emissions reductions from covered sources by just over 20% from 2005 levels.[39] The proposed cap trajectory is calculated to be consistent with the EU's recent commitment to reduce its total GHG emissions by at least 20% relative to 1990 (and by as much as 30% if other countries commit themselves to binding reductions).

Another motivation for the move to a predetermined and long-term trajectory is to provide more certainty about long-term allowance prices. Such price stability may be an important aspect of encouraging long-term abatement options, including research and development of new technologies and long-term investment. Although many other factors influence allowance prices, the total cap level arguably is the single most important factor and the one most directly under the influence of policymakers.

In contrast to the European system in its initial implementation, most U.S. proposals have specified a long-term (multiple decades) trajectory, although the implied level of stringency differs significantly between different proposals. In the United States, presumably the annual caps under a federal program would be established by Congress, either directly or through specified formulas to be implemented administratively. The December 2007 version of Lieberman-Warner, for example, would apply a cap starting in 2012 that would decline over time until 2050, at which point it would be about 70% below its 2012 starting level.[40] Because emissions would otherwise rise over time, the declining cap implies more dramatic reductions from business as usual (BAU); the 2030 proposed cap represents a 33% reduction in covered emissions from the 2012 cap, but a 48% reduction from projections of the Energy Information Administration of BAU emissions.[41] Even after only 10 years, in 2022, the proposed cap would require a 31% reduction from covered BAU emissions. Other congressional proposals (including earlier versions of Lieberman-Warner) set less stringent caps, but at least one from Sens. Bernie Sanders (I-Vt.) and Barbara Boxer (D-Cal.) (Sanders-Boxer) would set tighter limits.

In both the EU and United States, assessing the significance of proposed caps is complicated by the existence of several other climate policy targets and instruments. These include energy efficiency programs, various proposed technology standards, biofuels mandates, and renewable portfolio standards. Cumulatively, these targets and policies will result in emissions reductions undertaken both within and outside the scope of emissions trading. Decisions regarding these other programs thus will interact with the decisions taken by emissions trading participants and affected parties.

37. The extent to which product prices rise will depend upon supply and demand and other market conditions. The impacts of upstream and downstream programs on final product prices generally will be the same although effects on fuel prices would differ. With a downstream program, prices for CO_2-intensive fuels would decline, as demand falls. In contrast, with an upstream program, CO_2-intensive fuel prices would increase to reflect the need for fuel producers to cover the CO_2 emissions embedded in their products. Note, however, that the net prices recovered by the fuel producers would be similar in the two types.

38. In prior trading programs, emissions have also been well below annual caps in early years. The collapse of the allowance price in the EU ETS was due to the allowance surplus combined with a prohibition on the banking of Phase I allowances.

39. *See supra* note 22.

40. The business as usual (BAU) baseline from which this reduction is measured is based on the 2005 EPA Emissions Inventory.

41. U.S. Energy Information Administration, Annual Energy Outlook 2008, With Projections to 2030 (forthcoming 2008).

As a result, these other policies will affect how future caps translate into future allowance prices.[42]

3. Safety Valve

The concept of a safety valve is to provide a mechanism to protect against excessive GHG emission allowance prices. Under a pure safety valve, the government would agree to sell an unlimited number of allowances at the safety valve price. Thus, allowance prices would be capped at the safety valve, and the overall emissions cap would increase if the safety valve price were exceeded. The proposal from Sens. Jeff Bingaman (D-N.M.) and Arlen Specter (R-Pa.) (Bingaman-Specter), for example, set a safety valve price of \$12/ton of CO_2 for 2012, which would increase 5% per year in real terms thereafter.[43] If allowance prices exceeded those levels, the government would sell additional allowances. Assuming the cap trajectory is set to be binding in light of expected compliance costs, and if costs proved higher than anticipated, the cap effectively would be relaxed and the system would become more akin to a carbon tax. Support for a safety valve may be based on the belief that such relief is economically efficient[44] or a more pragmatic political judgment that tighter caps may be acceptable only if costs can be contained and the volatility of allowance prices limited.[45]

Other types of mechanisms may be used to address concerns about high allowance prices or adverse impacts on the economy.[46] Lieberman-Warner, for example, creates a Carbon Market Efficiency Board that is to monitor the market and take certain limited actions to provide cost relief if it determines that the program is causing "significant harm" to the U.S. economy. In particular, the board can loosen restrictions on borrowing and on the use of offsets or allowances obtained from trading programs in other countries. As noted above, the RGGI program incorporates a similar approach.

The economic case for safety valves may be relatively strong, but many observers object to the possibility of relaxing the cap. In the context of climate change, short-term relaxation of the cap is unlikely to be of significant environmental importance. Nonetheless, in a political context where credibility and commitment are signaled through the adoption and achievement of emissions reductions targets, the safety valve may be seen as a political drawback. Moreover, the presence of a safety valve in a program may make other countries or jurisdictions unwilling to allow cross-program trading, as a safety valve in one program will effectively apply to any program that links to the first.[47] As we note below, international trading has been identified as a major mechanism for reducing the cost of global emissions reductions, and the potential advantages of safety valves thus may have to be weighed against higher compliance costs because of less international linkage.

Even in the absence of explicit safety valves, however, national governments are likely to relax caps or modify rules if a program comes to be seen as a major drag on the economy. It is unrealistic to think that legislation with such a large potential economic impact will remain unchanged over the course of several decades. Current U.S. bills may set cap trajectories out to 2050, but it seems virtually certain that these will be modified in the future (either relaxed or tightened) as conditions change and more is known about both the costs and the benefits of reducing GHG emissions.

4. Banking

Experience from prior U.S. programs clearly shows that allowing banking increases cost savings from emissions trading.[48] Banking can also reduce the volatility of allowance prices because banked allowances provide a buffer against short-term changes in demand conditions.[49] Recognizing these advantages, both the EU ETS and virtually all U.S. proposals allow banking. As noted above, one exception was the transition between the first and second phases of the EU ETS, where banking was not allowed. This reflected the uncertainty that attached to the scheme in the first years, but also the importance of the second phase to political aims—as Phase II coincides with the first Kyoto Commitment Period, banking was seen as a risk to the attainment of the required emissions target for that period. However, banking is expected to be permitted under the EU ETS from Phase II to Phase III, and further in the future. Leading U.S. proposals generally allow unlimited banking.

The counterpart of banking is borrowing, which is more controversial for several reasons. Borrowing can delay achievement of emission reduction objectives. Moreover, as with ordinary loans, allowance borrowing raises questions about the borrower's ability to repay the loan. Borrowing allows firms to borrow allowances if their emissions exceed their holdings, on the understanding that the borrowed allowances would be repaid in the future by holding and surrendering allowances greater than their emissions. The EU ETS implicitly allows borrowing within each phase, because each year's allowances are issued two months before companies must surrender allowances to comply with the previous year. With more explicit borrow-

42. For evaluations of the interactions of the EU ETS with renewable and energy efficiency programs, see generally David Harrison Jr. et al., Interactions of Greenhouse Gas Emission Allowance Trading With Green and White Certificate Schemes (European Commission Directorate-General Environment 2005).

43. S. 1766, 110th Cong. (2007).

44. With uncertain costs, a cap fixes the quantity but lets the price rise or fall without limit, while a tax fixes the price and lets the quantity vary freely in response to actual marginal costs. Which is most efficient depends primarily on how rapidly marginal costs rise with control as compared to how rapidly marginal damages rise with higher emissions. *See, e.g.*, Martin L. Weitzman, *Prices vs. Quantities*, 41 Rev. Econ. Stud. 4, 477-91 (1974). Hybrid systems, of which cap-and-trade with a safety valve is an example, can perform better than either type of pure system. *See, e.g.*, M.J. Roberts & M. Spence, *Effluent Charges and Licenses Under Uncertainty*, 5 J. Envtl. Econ. Mgmt. 193-208 (1976); and William Pizer, Optimal Choice of Policy Instrument and Stringency Under Uncertainty: The Case of Climate Change (1997).

45. We distinguish between a safety valve, designed to allow emissions to rise if costs are high, and various penalty schemes that seek to make violations of the cap so expensive that no party would choose to emit more than its allowance holdings allowed.

46. *See generally* David Harrison Jr. et al., Interactions of Cost-Containment Measures and Linking of Greenhouse Gas Emissions Cap-and-Trade Programs (2006).

47. *Id.*

48. Ellerman et al., *supra* note 2, at vi.

49. Concerns that emissions will be too high during periods when a bank is drawn down have resulted in restrictions on banking in some programs for conventional pollutants where variations in emissions can lead to changes in ambient air quality. *See id.* at 20-21. Those considerations do not apply to CO_2, however, where atmospheric concentrations reflect emissions over decades and the current rate of emission thus is of lesser importance than the cumulative emissions over a longer time period.

ing arrangements, an interest rate typically is applied so that, for example, if the interest rate were 10%, as it is in the Lieberman-Warner bill, 100 allowances borrowed in one year would require repaying 110 allowances the next.[50]

5. Auctioning Versus Free Allocation of Allowances

The issue of whether allowances should be allocated for free or sold at auction has become significant in recent years. In most past emissions trading programs allowances have been allocated largely for free. Arguments for free allocation have included the grandfathering of past rights to emit, compensation for adverse impacts of emissions trading on companies or asset values, or pragmatic considerations of political support for emissions reductions.[51] As in past U.S. programs, free allocation was the approach taken in Phase I of the EU ETS, in which less than 1% of total allowances have been auctioned. During Phase II auctioning will be used more, but even so less than 5% of allowances are likely to be auctioned.

Auctioning is gaining more support, both in Europe and the United States. The recent commission proposal for post-2012 illustrates this shift. In contrast to the first two phases—in which auctioning was limited to 5% and 10%, respectively—the commission identifies auctioning as the default method for allocating allowances.[52] The commission would vary the amount of free allocation between sectors, eliminating it entirely in the electricity generation sectors while retaining some "transitional" free allocation in other sectors. This proposal to eliminate free allocation for electricity generators grows out of concerns about "windfall profits" to generators, based upon electricity price rises to reflect the opportunity cost of emissions allowances, leading to higher operating margins for some generators.[53] Moreover, the commission has proposed a gradual elimination of free allocation over time, with complete phaseout by 2020. This is likely to reflect a view that any stranded assets, i.e., reductions in asset values resulting from unanticipated introduction of emissions regulations, are likely to be less of a concern with the passage of time.

The current European proposals would link free allocation explicitly to leakage and competitiveness concerns. The European Commission proposes that free allocation be eliminated entirely in the event of an international agreement that resulted in emissions reductions commitments comparable to the EU ETS among major trading partners. Conversely, the commission's proposals hold out the possibility that some sectors would continue to receive free allocation above the default transitional level. This would be based on an in-depth economic assessment demonstrating the risk of carbon leakage, focusing on the ability of industries to pass through emissions costs without risking significant loss of market share. These proposals imply that outside the electricity sector at least, free allocation may continue to be important, albeit alongside a greater share of auctioning.

A similar shift away from the free allocation that has characterized previous programs can be seen in other areas. The most dramatic example has taken place in the U.S. RGGI program, with several states having announced their intention to auction all allowances. In Australia, one proposal would explicitly link free allocation to assessments of "compensation" for foregone profits and reduced asset values.[54] Most U.S. congressional proposals involve a mix of auctioning and free allocations, with the mix shifting to more auctioning over time. The December 2007 version of Lieberman-Warner, for example, starts by auctioning 27.5% of allowances in 2012, but by 2031 70.5% would be auctioned.

The share of allowances auctioned does not tell the whole story; another critical issue is how the revenues will be spent. Economists have identified the possibility of a double dividend, whereby an emissions tax (or, equivalently, allowance auction) could raise revenue that allowed for the reduction of other, distortionary taxes. In reality, however, this tax reform seems an unlikely outcome of allowance auctions. Current proposals in the United States typically earmark auction revenue for expenditures on programs related to climate change, such as ones that reduce the adverse impacts of climate change, encourage specific low-carbon technologies, or provide assistance to consumers and workers adversely affected by measures to reduce GHG emissions. The December 2007 Lieberman-Warner proposal allocates all auction revenues to 10 new programs designed to achieve those goals. Similarly, the European Commission proposes that auction revenue be used in part for redistribution between rich and poor Member States, and partly earmarked for programs to fund renewables and other climate initiatives.

6. Allocation Method for Free Allowances

Designers of emission trading programs also must decide how to distribute the free allowances. With some level of free allocation likely to continue, interest in the methodology for distributing allowances will remain high. The current implementation of allocation in the EU ETS and current proposals in the EU and the United States offer insight into the issues that have arisen when implementing allocation in practice.

One important decision is on what basis shares for sectors and individual emissions sources should be determined. Free allocation in the EU ETS has been dominated by approaches based on historical emissions, although allocations based on various forms of emissions benchmarking also have been used to different degrees, especially in the

50. The implicit financial interest rate may be significantly higher than the nominal rate applied to allowances, because allowance prices are expected to rise over time. If real allowance prices rose 5% per year, for example, a 10% borrowing rate would translate to a real financial rate of more than 15%.

51. David Harrison Jr. et al., Complexities of Allocation Choices in a Greenhouse Gas Emissions Trading Program (International Emissions Trading Ass'n Report No. E2-E3, 2007).

52. For details on the proposal, see *supra* note 22.

53. Changes in margins due to changes to input prices are a general feature of competitive markets. For example, in competitive electricity markets, operators of nuclear plants are likely to see their operating margins improve if gas prices rise. To the extent that the EU ETS leads to higher electricity prices but has a differential impact on the costs of different generation units, it too may benefit some operators while reducing the margins of others. Nonetheless, the issue of windfall profits for generators has strongly influenced European debates about allocation. *See generally* David Harrison Jr. et al., Effects of the European Union Emissions Trading Scheme on Electricity Prices (Electric Power Research Institute, Inc. 2005).

54. Australian Government, Report of the Task Group on Emissions Trading (2007).

power sector.[55] Critics of approaches based on historical information have argued that it is difficult to justify an approach that is based on increasingly outdated emissions data. Of course, benchmarks based on historical data suffer the same problem, and add concerns about commercial sensitivity of divulging past output or input use. Under simple theoretical conditions, there would be no difference among the basic approaches to allocations in terms of the way they provide incentives or influence decisions—provided they are based only on historical information.[56] For historical approaches, the choice therefore is one of distribution. When the complexities beyond these simple conditions are taken into account, however, the similarity of the major allocation methods disappears.[57]

In contrast to this historical approach, recently proposed allocation schemes often include elements that revise at least some allocations over time. For example, the December 2007 Lieberman-Warner proposal updates allocations to industrial sectors (other than electricity generation) based on emissions and then provides allocations to individual sources within a sector based on updated information on the numbers of production employees. Industry representatives in the EU have argued for allocations linked to actual output, while some Member States have proposed adjusting allocations ex post to match actual production or emissions levels. Updating of baselines and allocations in this way, so that they depend on future activity levels at individual sources, has the potential to reduce the cost-effectiveness of the trading program. For example, if producers know that their future allocations will fall if they reduce output, they will have diminished incentives to reduce output of energy-intensive products, undermining the role of lower consumption in reducing emissions and increasing the overall cost of meeting the cap. To the extent that updating leads to lower leakage, however, updating could on balance be more cost effective than relying only upon historical information.

Related to updating is the treatment of facilities entering and exiting the trading scheme over time. In the EU, allowances have been explicitly set aside for new facilities, and current proposals would likely continue this practice. Current outlines of the Australian emissions trading scheme also would include such new entrant allocations, and the leading U.S. proposals also allocate free allowances to new sources. The December 2007 Lieberman-Warner proposal, for example, gives free allowances to new fossil fuel-fired electric-generating plants based on average emission rates for new plants in the three years before the plant commences operation and the amount of electricity generated by the plant. As discussed below, a motivation for new entrant allocations has been to preserve investment within the regulated area in the face of international competition without corresponding emissions constraints.

Like other updated allocations, new entrant allocations carry the risk of undermining incentives for least-cost emissions abatement. This is particularly the case if (as has been the case in some EU Member States) higher emitting technologies are provided with more allowances than are lower emitting alternatives for the production of the same output. If current European Commission proposals for a centralized EU-wide approach to allocations are implemented, future allocations to new entrants may be based on technology-neutral allocations, e.g., based on capacity or output, regardless of technology.

A related issue is how to treat facilities that cease production. In the EU, both current implementation and proposals for future reform imply that shutdown leads to the forfeiture of future allowances. U.S. proposals include similar provisions. One possible motivation for such provisions is that they can help prevent the relocation of production to jurisdictions not covered by emissions regulations. However, shutdown provisions also reduce the incentive to close older, often high-emitting facilities, thus preventing what may be a low-cost way to reduce emissions.

In the EU ETS and in past U.S. trading programs, free allocations generally have been limited to sources covered by the trading program. There is no fundamental reason why allowances cannot be allocated to others, such as downstream producers and consumers who will face higher prices as a result of the program. Recent U.S. proposals include substantial allocations to entities not directly covered by the program. The December 2007 version of the Lieberman-Warner proposal, for example, allocates allowances to companies that distribute but do not generate electricity or natural gas, with the requirement that they use the proceeds from selling the allowances to provide financial relief to low- and moderate-income consumers. States and Indian tribes also receive sizable allocations under this proposal. In these cases, allocations are akin to recycled auctioned revenue, in that the distribution is unrelated to other trading scheme obligations.

Experience suggests that decisions regarding allocation are likely to be very contentious, as are all political decisions involving the implicit allocation of large amounts of money. However, experience also indicates that it is possible to develop an allocation approach that achieves political acceptance.[58] Indeed, the success of EU Member States in developing the NAPs for Phase I and Phase II of the EU ETS is evidence that acceptable allocation plans can be developed, even with the large amounts of money at stake—on the order of 15-60 billion euros in the case of the Phase I NAPs.[59]

B. Addressing Leakage and Competitiveness Concerns

One of the important ways in which a cap-and-trade program can reduce emissions is by raising the prices of products that are relatively GHG-intensive, thus providing incentives to use less of them. This is an intended consequence of cap-and-trade programs. Indeed, in the case of upstream programs it is the only way in which incentives for emissions reductions are created. When the program does not cover all producers in the market, however, the rise in prices risks shifting production to producers that are not covered by the program and that therefore do not face higher costs. Such producers could be located in other countries that do not have equivalent emissions regulations requirements, and the relocation of production raises two related concerns.

55. *See* Harrison et al., *supra* note 51, at 12.

56. *See id.* at E1.

57. For an assessment of the complexities of allocation choice and their implications for alternative approaches, see *id*. at E1-E4.

58. *See* Ellerman et al., *supra* note 2, at vi.

59. *See generally* Rights, Rents, and Fairness, *supra* note 29.

The first concern is that although the emissions reductions continue to take place in the jurisdiction with the trading program, the resulting global reductions are diminished by increases elsewhere. This phenomenon is commonly referred to as emissions leakage. In extreme cases, the leakage could be more than 100%, i.e., global emissions might increase beyond what they would be with no cap at all. This could happen, for example, if production of an energy-intensive product shifted from the United States or Europe to a less developed country that had older, less energy-efficient equipment and relied more heavily on coal to provide the energy used in the production process. As noted above, this leakage should be taken into account in assessing the cost-effectiveness of alternative allocation approaches.

The second issue raised by such shifts is the decline in international competitiveness of relatively energy-intensive industries in the countries imposing caps or other regulations, resulting possibly in losses of economic activity, including jobs and investment. These concerns have been a significant impediment to the development of a program in the United States. After the Kyoto treaty was negotiated, the U.S. Senate passed a resolution not to enter into any climate treaty that would adversely affect the U.S. economy.[60] As noted above, impacts on competitiveness are also major concerns in Europe and are figuring prominently in discussions about revising the EU ETS.

We discuss below four additional design issues that have arisen in discussions about how best to limit leakage and adverse competitiveness effects in the context of emissions trading. These include program scope, method of allowance allocation, border tax adjustments, and regulation of associated product markets.[61]

1. Program Scope

Leakage and competitiveness concerns are more important the smaller the area limiting emissions. Estimates suggest, for example, that a cap imposed only in the RGGI states would have a leakage rate of about 40%, i.e., for every 10 tons of CO_2 emissions reduced in the state, emissions would increase elsewhere (primarily in states without a cap) by 4 tons.[62] By contrast, leakage is likely to be significantly smaller for a U.S. national program. The most desirable way to reduce leakage and competitiveness concerns thus is to broaden coverage. Current international negotiations may provide some basis for future coordination of emissions reductions, at least among developed countries, and the prospect of emissions regulations in the United States has helped allay some concerns in the EU. It is clear, however, that for the foreseeable future, coverage will be far from complete on a global basis, so other approaches must be considered.

2. Allocation Methods That Reduce Price Effects

The de facto approach in the EU has been to accept some potential leakage and adverse competitiveness impacts, but to compensate through the provision of free allowances. As noted above, current Australian and European proposals make this relatively explicit, linking free allocation to exposure to international competition and the risk of leakage.

Traditional approaches to allocation are unlikely to succeed in addressing these concerns, except in the case of industries with regulated prices based on average costs. If the allocations are based on historical information, independent of a firm's future production level and other decisions, generally the impact on prices and production will be the same whether the allowances are auctioned or distributed free of charge. This is because the allowances have an opportunity cost equal to their market value, regardless of whether a firm receives them for free or has to pay for them. When the firm produces a unit of output, it needs enough allowances to cover the resulting increase in emissions. This represents a cost of production regardless of whether those allowances were originally obtained for free or purchased. Thus, the price of the output would tend to reflect the value of the needed allowances along with other costs that vary at the margin. Although fixed allowance allocations can offset a firm's losses associated with stranded costs or other factors, they are unlikely to reduce marginal costs or prices, and thus these allocations may have little impact on competitiveness or leakage.

By contrast, updating allowance allocations could possibly address competitiveness concerns. If the allocation of free allowances depends on production levels, the marginal costs faced by companies, and therefore product prices, would rise less than with fixed allocations. While the marginal cost of production increases by the number of allowances needed to cover current emissions, it is reduced by the value of whatever additional allowances are obtained free of charge as a result of producing another unit. As noted above, new entrant allocations can provide incentives for domestic investment, and forfeiture of free allocations upon shutdown can further prevent relocation to jurisdictions with less stringent emissions regulations.

The benefit of such allocation schemes is that they reduce concerns about leakage and reduced competitiveness for GHG-intensive products. The drawback is that they reduce the incentive consumers receive to shift purchases away from goods that are relatively GHG-intensive and toward those that have few emissions associated with their production.[63] Reducing those incentives means that other emissions reduction strategies must be implemented more intensively, which is costly. One consequence of updating allocations therefore is likely to be higher allowance prices. The trade off between the costs and benefits of updating will vary across different sectors, depending in large part on the extent to which price increases are likely to increase imports rather than reduce consumption of GHG-intensive goods.[64]

3. Inclusion of Imports and Border Tax Adjustments

Other potential approaches to addressing leakage/competitiveness issues relate to international trade, both including

60. S. Res. 98, 105th Cong. (1997).

61. Other design parameters, such as the cap or the inclusion of safety valve or other cost-containment features, can be modified to reduce costs and consequently competitive impacts. These have been discussed above and we do not consider them further here.

62. David Harrison Jr. et al., Effects of the Regional Greenhouse Gas Initiative on Regional Electricity Markets 15 (2007).

63. Some proposals attempt to reduce the tension between the two goals. As noted earlier, for example, the December 2007 Lieberman-Warner proposal allocates allowances to electricity distributors and requires that they spend the money generated to provide relief to low- and moderate-income consumers, but also prohibits them from issuing rebates that lower the marginal price of electricity.

64. For a treatment of the trade offs in these allocation choices, see Harrison et al., *supra* note 51, at 17-34.

imports in the cap system and imposing a border tax that reflects CO_2 emissions associated with production of the imported goods. Including imports is relatively straightforward for fuel imports covered under an upstream program, and proposals for upstream programs routinely include imports.[65] The system becomes much more complicated when the import in question is not a fuel and the attempt is to include emissions from the production process (both direct and indirect emissions). Determining the amount of GHG emissions that is embedded in a particular imported product is difficult given wide variation in production methods and fuel types used in production. It may be worth incurring these administrative costs for the most GHG-intensive products. Even for such products, however, the technical obstacles to designing an effective and fair tariff system are significant, and could prove insurmountable at a reasonable cost. Perhaps for these reasons, the EU Council of Ministers has stopped short of calling for border taxes, despite widespread concern about the prospect of leakage and adverse competitiveness effects.

The December 2007 Lieberman-Warner proposal includes a mechanism similar to a border tax starting in 2020 for certain energy-intensive goods; importers of such goods would have to purchase special international reserve allowances from the government at a price established by the Administrator if the country of origin had not taken comparable steps to reduce GHG emissions and its emissions exceeded a threshold. Many details of these proposals are left to administrative determination.

In addition to technical barriers, adjustments to border taxes based upon embedded GHG emissions may face legal hurdles. Current World Trade Organization rules allow for some tariffs to be imposed in lieu of domestic taxes, but it is unclear that this would extend to emissions trading or that the type of adjustments that have been proposed could be introduced without resulting in significant trade disputes.

4. Regulation in Electricity Markets

Increases in electricity prices have been a major focus of concern about competitiveness and leakage. As noted above, the impact of emissions trading on electricity prices or indeed on prices for any carbon-intensive product, and the resulting incentives for energy or other input efficiency, is an important mechanism by which emissions trading reduces emissions in an economically efficient way. Nevertheless, in the EU the resulting increases in electricity prices have attracted proposals for changes to reduce such impacts.[66] These proposals have included using competition law or other regulations to limit the pass-through of cost to prices in competitive markets.[67] Indeed, some of these proposals would amount to re-regulation of the electricity markets, despite the fact that Europe is committed to liberalizing energy markets to increase efficiency and competition.

C. Linkages Between Programs and Other International Considerations

As noted above, climate change is a global issue that ultimately will require international coordination. Until a comprehensive global regime is put in place, there are potential efficiency gains from linking programs. These gains arise because of potential cost savings and because linkage tends to reduce emissions leakage. However, linking different programs can pose difficulties, some of them subtle.

1. Program Linkage

As various carbon cap-and-trade programs are developed and proposed, the question naturally arises whether and how different GHG emissions trading programs might be linked with one another. The gains from linkage are clear: since gains from trade depend upon differences in costs, linking trading programs with different GHG emissions sources, and thus different GHG abatement costs, promises to increase the overall cost savings from trading. The available literature suggests that the gains from spreading emissions reductions efficiently globally could be very large.[68] Moreover, linkage can promote efficient emission reductions within and among companies with operations in multiple countries. Options include (1) allowing all market participants, e.g., facilities subject to the cap, brokers, etc., to trade in all markets, (2) providing specific exchanges/mechanisms for interprogram transactions, and (3) limiting cross-program exchanges to governments.

So far, linking of cap-and-trade programs has been limited. The EU ETS has been linked to similar programs in Iceland, Liechtenstein, and Norway, none of which are part of the EU. The recent proposals for changes to the EU ETS foreshadow further international linking, and various discussions are underway with regional programs in the United States as well as other international initiatives.

Proposals to link different state, regional, national, or international programs must deal with design features that reduce the compatibility of different programs. As noted above, one important design issue concerns the presence of a safety valve. If an emissions cap is exceeded in a program with a safety valve, this effectively leads to exceeding the caps in all other linked programs, absent special provisions.[69] Other design differences, for example, in monitoring and verification procedures, might also lead to difficulties.[70] Realistically, some harmonization of scheme design is likely to be required for linking to be desirable or politically feasible.[71]

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65. By symmetry, one can argue that exports should not be subject to the cap, but rather subject to the importing nation's cap.

66. *See* Harrison et al., *supra* note 53, at 53-60.

67. Indeed, in some Member States electricity companies have been challenged by competition authorities for passing through the opportunity cost freely allocated allowances, despite the fact that such pass-through is an expected consequence of emissions trading. *See, e.g.*, Daniel Radov & Per Klevnas, *CO_2 Cost Pass-Through: German Competition Regulators' Shaky Economics*, Energy Reg. Insights, Jan. 2007, at 1-7.

68. Jae Edmonds et al., International Emissions Trading and Global Climate Change: Impacts on the Cost of Greenhouse Gas Mitigation 2-8 (Pew Center on Global Climate Change 1999).

69. *See* Henry D. Jacoby & A. Denny Ellerman, The Safety Valve and Climate Policy (MIT Joint Program on the Science and Policy of Climate Change Report No. 83, 2002).

70. *See* Harrison et al., *supra* note 46.

71. Joseph Kruger et al., Decentralization in the EU Emissions Trading Scheme and Lessons for Global Policy 14-15 (2007).

2. Developing Countries and the Role of Credits

Virtually all commentators agree that involvement of developing countries in a global climate change regime will be critical, particularly in the longer term, for several reasons: (1) the rapid growth of emissions in developing countries means that long-run global targets cannot be met without the participation of those countries; (2) the leakage/competitiveness issues discussed above make caps in developed countries less effective; and (3) many of these countries offer some of the least expensive opportunities to reduce emissions. However, developing countries are reluctant to retard their economic growth by imposing stringent GHG restrictions. Various approaches have been proposed to encourage participation by developing countries, notably a growth target that would allow emissions to grow as countries developed and their economies grew,[72] but thus far no developing country has expressed a serious interest in participating in a specific program. It seems likely that for many years, obtaining reductions in developing countries will require making it economically attractive for them to do so.

The most obvious approach with a cap-and-trade system is to generate allowance credits by financing or otherwise participating in emission-reducing projects in countries without their own binding caps. As discussed above, the Kyoto Protocol offers the CDM mechanism, which provides this opportunity. Such projects offer potential for reducing costs (and benefitting both sides of the transaction), but as with all credit systems for emissions trading, they also pose the problem of defining baselines from which to measure credits and thus to ensure that credited emissions reductions are additional to what would otherwise have occurred. Like all credit-based emissions trading programs, this requires balancing the ability of the program to achieve the largest cost savings possible with the risk of generating paper credits rather than real reductions in emissions. If such credits are to play a significant role in a trading program, predictable rules are needed so that participants can anticipate the conditions under which their credits will have value.[73] Similar issues arise in addressing domestic credits for activities such as sequestration through forest management, which do not lend themselves to direct inclusion in the basic cap-and-trade program.

V. Key Issues for Companies

A cap-and-trade program for GHGs affects many companies, including those directly affected as participants as well as those indirectly affected through effects on energy and other prices. The effects of a GHG cap-and-trade program are likely to differ from other environmental programs for several reasons.

- *Market-based approach.* A cap-and-trade program differs from the conventional command-and-control approach, which requires compliance with more or less fixed emissions reduction requirements. In contrast, with a cap-and-trade program, firms have flexibility in compliance because they can decide how much to reduce their emissions based upon the relative costs of internal controls and purchasing allowances. Put another way, a cap-and-trade program shifts environmental decisions from compliance decisions to business decisions.
- *Pervasiveness and importance.* Carbon requirements are likely to affect many more companies than prior environmental requirements—including prior cap-and-trade programs—and to have more substantial impacts. Virtually every company produces and/or uses energy and thus would be influenced by a program to restrict carbon emissions. As one indication of the possible magnitude of a GHG cap-and-trade program, the value of the allowances in the EU ETS is on the order of 40 billion euros per year, and the value of allowances for a U.S. program is likely to be the same order of magnitude.
- *Opportunities as well as impacts.* Other environmental regulations have provided opportunities for some businesses. Manufacturers of catalysts and other products used to control air emissions represent one example. But the potential for new and modified technologies seems likely to be substantially greater in the case of carbon regulation. Examples of companies that might gain are those who provide renewable energy or energy efficiency services, both of which will be incentivised by a GHG cap-and-trade program.

This part discusses some of the issues that private firms should address in the context of a GHG cap-and-trade program.

A. Clarification of What Is at Stake for the Company Under a GHG Cap-and-Trade Program

In the first instance, it is important for companies to assess the potential impacts of a GHG cap-and-trade program on their costs and revenues, assuming initially that they would not make any changes in response to potential policies. The cap-and-trade program and other potential climate change policies will affect costs, either directly as a result of the need to cover emission or indirectly in the form of higher prices for fuels and other inputs. Revenues will be affected in complex ways depending upon domestic product markets, competitive conditions, and increased international competitive pressures.

Developing comprehensive assessments of what is at stake with a GHG cap-and-trade program involves developing four specific types of information.[74]

- *Company information.* The company should develop information on its carbon and other GHG emissions, its electricity and other energy inputs or outputs, and its product outputs. The information should be projected over at least a decade in order to provide estimates that take into effect potential changes over time.

72. Robert N. Stavins, *Forging a More Effective Global Climate Treaty*, Environment, Dec. 2004, at 23-30.

73. David Harrison Jr. et al., Critical Issues in International Greenhouse Gas Emissions Trading: Setting Baselines for Credit-Based Training Programs—Lessons Learned From Relevant Experience (2000).

74. For an illustration of how such analyses can be developed, see generally David Harrison Jr., Climate Change: What Every Company Should Do to Get Ready for a Mandatory Emissions Trading Program (2008).

- *Characterization of the GHG cap-and-trade program.* The discussion in the prior part makes it clear that a potential GHG cap-and-trade program could take many forms and that as in many programs, details matter. Key elements include cap coverage and stringency and the details of the allocations to be provided.
- *National and regional market effects.* A GHG cap-and-trade program will lead to impacts on many markets. In the first instance, the cap trajectory will lead to a price trajectory for CO_2 allowances. In response to CO_2 prices and requirements for participants to cover their emissions, prices for various fuels—coal, natural gas, and others—will be affected, with the nature of the price changes dependent in part on whether the program is upstream or downstream. Electricity prices also will be substantially affected. Prices for various products that use energy all will be affected by these changes.
- *Impacts on prices of firm's products.* The net impact of a cap-and-trade program on a firm's profits depends greatly on the extent to which its higher costs can be passed forward in the form of higher product prices. Estimating price impacts requires estimating how industry supply and demand will shift, and how responsive supply and demand conditions are to price changes. An important element in assessing the sensitivity of demand to price changes is the degree to which the industry faces competition from countries that do not impose similar obligations.

These various factors can be used to develop estimates of the effects of various potential cap-and-trade programs on a company's costs and revenues. This information also can be used to develop estimates of changes in asset values.

This basic structure also can be used to develop estimates of the implications of key elements of potential climate change legislation, such as the criteria for allocating allowances or the stringency of the cap. These assessments allow the company both to bound the potential impacts of the potential program as well as to clarify what features or factors are particularly important.

B. Incorporation of Carbon Considerations Into Investment Decisions

Firms should consider what investment decisions might be made in response to potential climate change policy as well as how intended investments would be affected. There are several types of decisions that can be identified.

- *Investments to reduce emissions.* As with prior cap-and-trade programs, a GHG cap-and-trade program provides companies with the flexibility to reduce their emissions or purchase allowances to cover their emissions. To determine the most profitable strategy, companies need to evaluate emission-reducing investments. In the case of SO_2 and other conventional pollutants, most options involve installing control equipment such as scrubbers to reduce SO_2 emissions from the stack gases. In contrast, GHG reduction strategies typically involve switching to less carbon-intensive fuels or increasing the overall energy efficiency of the operation.
- *Investments in new production capacity and retirement of existing capacity.* When emissions are subject to a cap-and-trade program, they become variable costs that will be reflected in firms' profits, and hence should be integrated into decision-making. In many cases, the affected decisions have time horizons of several decades. As a result, decisions made today must consider the strong possibility that plants or equipment built or acquired today may spend a large fraction of their potential lifetimes subject to emission caps that require the use of allowances. One technology may be the lowest cost alternative assuming no cap-and-trade program for CO_2 emissions, while another technology might have lower cost under a cap-and-trade program with high allowance prices. Similarly, the presence of the cap-and-trade program will affect the relative costs of keeping existing capacity in place versus replacing it with new capacity.
- *Investments in new products and processes.* As noted, putting a price on carbon will lead to opportunities to develop low-carbon alternatives and technologies. Indeed, the incentives for many of these technologies could come from other sources as well. Renewable electricity technologies in the United States and Europe are examples. In the United States, for example, additional wind and other renewable electricity technologies would be encouraged by federal tax credits and state-level renewable portfolio standards as well as by the price trajectory for carbon allowances, which would make fossil-fuel alternatives more expensive.

All of these decisions will be affected by major uncertainties, including uncertainties with regard to future climate change policy. The future is of course always uncertain, but companies making decisions over the next few years that involve substantial emissions of GHGs face additional uncertainty, because they do not know how stringent the caps will be (if they are imposed at all) or what specific features may be included that affect the relative costs of different options. Modeling suggests that uncertainties about allocations of allowances are likely to be very important. How will plants built in the near future be treated for purposes of allowance allocations? Will new plants receive at least some allowances automatically? Even if the precise design of the program were known, there would still be uncertainty about its effects over time on the price of allowances and other key inputs, e.g., the prices of fuels or purchased electricity.

Firms will need to consider using more sophisticated analyses that take into account uncertainties regarding future carbon controls. These analyses would begin with the structure outlined above, but also consider the fact that some of the uncertainties are likely to be resolved—or at least reduced in size—within a number of years. It is likely, for example, that if or when a federal GHG cap-and-trade program is put in place, many parameters that affect investment decisions would become more certain—the nature of the allocation, the likely allowance price trajectory, or possible effects on energy prices. This eventuality means that investment decisions should be evaluated within a structure that takes into account the value of waiting to make major decisions, a strategy that can lead to different sets of decisions than one that does not recognize these considerations.

C. Incorporation of Carbon Considerations Into Contractual and Other Business Arrangements

Investment decisions are not the only business decisions that might be affected by a GHG cap-and-trade program. The addition of carbon costs can alter contractual relationships and raise questions about how such additional costs should be incorporated into existing contracts. Most power purchase agreements in European electricity markets, for example, have clauses that anticipate the possibility of new taxes, but the carbon costs that arise from a cap-and-trade program are not always covered by such provisions. Thus, the issue of who bears any additional costs and who is entitled to any benefits is being determined based upon interpretations of contract terms that in many cases did not anticipate the development of the EU ETS. Other business decisions also can be affected by a GHG cap-and-trade program. Strategies for hedging against various price risks can be affected by the presence of a cap-and-trade program and, indeed, the implications can differ depending upon the nature of the program.

The ambiguity in European contracts regarding carbon costs provides a possible lesson for companies engaged in energy and other contracts in countries such as the United States that have not already developed a GHG cap and trade program. Anticipation of a cap-and-trade program in the United States provides an opportunity to provide clarity in these issues when the contracts are negotiated, even if there is substantial uncertainty whether, when, and how much such a program might be developed. Similarly, hedging strategies can be devised that take into account the likely future nature of any GHG cap-and-trade program.

VI. Concluding Remarks

The cap-and-trade approach has emerged as an important means of introducing cost-reducing flexibility into environmental control programs The last two decades have provided a great deal of experience with various forms of emissions trading. Indeed, emissions trading is now the dominant approach to addressing emissions of CO_2 and other GHGs in Europe, as well as in proposals in the United States and elsewhere.

Designers of GHG emissions trading programs can learn valuable lessons from prior programs relating to cost saving, environmental gains, and the design elements most likely to achieve these objectives. Emissions trading seems especially appropriate for dealing with GHGs because the gases mix uniformly and remain in the atmosphere for a long time, and thus there is much less concern—at least from an environmental effectiveness point of view—about where and generally when GHGs are emitted. The flexibility provided by a cap-and-trade program thus does not lead to major concerns that environmental objectives would be compromised through trades.

Despite this experience, designing an effective and efficient cap-and-trade program for GHGs is a complex undertaking. Numerous governments in Europe, the United States, and elsewhere are considering the nature of the choices that need to be made and wrestling with the policy choices they face. These policy choices include specific elements of cap-and-trade design, measures to address concerns about leakage and adverse effects on domestic industry competitiveness, and broader efforts to expand climate change.

A GHG cap-and-trade program will pose major challenges for many private firms. Even before a program is enacted, firms that are large users of energy, either directly or indirectly, would do well to consider how they would be affected and what changes in decisions would be warranted in light of the likelihood that a GHG cap-and-trade program will be put in place. These firms should determine what emissions trading means for them and what strategies they might pursue to respond to the new circumstances and take advantage of the flexibility trading offers. These strategies can include investments to lower carbon costs, changes in other investment decisions because of likely future carbon costs, as well as other decisions affected by these policies. Indeed, taking maximum advantage of the flexibility provided by a cap-and-trade program will enable firms to improve their profits relative to less flexible regulatory approaches and at the same time allow the trading programs to achieve their goals of meeting climate change objectives at a lower overall cost to society.