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DESIGNING A CAP-AND-TRADE PROGRAM FOR THE MIDWEST

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The Authors

INTRODUCTION

The Greenhouse Gas Accord announced by ten Midwestern governors in November 2007 involves nearly one fourth of U.S. greenhouse gas emissions in a regional agreement to improve energy security and design a greenhouse gas (GHG) reduction program. Among the strategies described in this accord is the use of a market-based, multi-sector cap-and-trade mechanism to reduce emissions. As the Midwest explores options for such a program, it will face a variety of design choices regarding program goals, costs, and equity. This paper is intended to guide many of these choices by describing some of the options available.

This paper begins with a general overview of the basic building blocks of cap and trade, followed by a discussion of the potential scope of coverage of a program, including what entities might be regulated and which emissions. The paper then focuses on how to set the initial emissions cap and the trajectory for emissions reductions under a potential program. An examination of the options for distributing allowances, or permits to emit, follows. The document then explores how a program might grant early reduction credits, offer project-based offset credits, and provide other potential cost-containment measures. The potential for linking with other similar programs is then briefly discussed.

Box 1 | PARTICIPANTS IN THE MIDWEST GREENHOUSE GAS ACCORD

- Illinois
- Iowa
- Kansas
- Manitoba
- Michigan
- Minnesota
- Wisconsin

Observers

- Indiana
- Ohio
- South Dakota

AN OVERVIEW OF CAP AND TRADE

In a cap-and-trade program, the government determines which facilities or emissions are covered by the program and sets an overall emissions target, or "cap," for covered entities. This cap is the sum of all allowed emissions from all included facilities. Once the cap has been set and covered entities specified, tradable emissions allowances (rights to emit) are distributed to the covered entities. Each allowance authorizes the release of a specified amount of greenhouse gas emissions, generally one metric ton of carbon dioxide equivalent (CO_2e). Because the total number of allowances is equal to the overall emissions cap (e.g., if a cap of one million tons of emissions is set, one million one-ton allowances will be issued), the environmental result is guaranteed. Covered entities must surrender allowances equivalent to the level of emissions for which they are responsible at the end of each of the program's compliance periods. Entities that have excess allowances may sell or "trade" allowances to entities whose emissions exceed their available allowances. Accurate emissions data and a robust emissions tracking system are both required prior to implementation to assure regulators that program goals will be met and companies that their reductions will be recognized. Allowance trading occurs because firms face different costs for reducing emissions. For some entities, implementing reductions at their own facilities may be relatively inexpensive. Those firms will then buy fewer allowances or sell surplus allowances to firms that face higher reduction costs. Since a ton of carbon dioxide (CO_2) emitted from one source has the same impact on the environment as a ton emitted from any other source, the location of a given emissions reduction does not matter. By giving firms a financial incentive to control emissions and the flexibility to determine how and when emissions will be reduced, the capped level of emissions is achieved in a manner that minimizes overall program costs.

Box 2 | FACTS ABOUT MIDWEST EMISSIONS

- **Eight of the ten states participating in or observing the Accord rank in the top 25 nationally for GHG emissions, with four states (Ohio, Indiana, Illinois, and Michigan) ranking in the top ten.**
- **The growth rate of total Midwest GHG emissions is slower than the national growth rate. However, some Midwest states that emit relatively few GHGs (e.g., Minnesota, Iowa, and Wisconsin) are experiencing emissions growth that outpaces the region and the nation, largely driven by population and economic growth.**
- **At over half a billion metric tons of CO_2e, the electric generation sector is the largest emitting sector in the Midwest and has the largest emissions growth rate.**
- **Nitrous oxide emissions constitute a greater share of emissions from the agriculture sector in the Midwest than methane. This is characteristic of the region's extensive crop cultivation.**

Sources: CAIT-US, http://cait.wri.org. Larsen, J.; T. Damassa, R. Levinson, "Charting the Midwest: An Inventory and Analysis of Greenhouse Gas Emissions in America's Heartland," World Resources Institute, October 2007.

In contemplating the design of a cap-and-trade program, it is helpful to consider the key design decisions listed below. This paper examines each of these design components in turn.

I. **Determining Scope and Point of Regulation.** Policymakers must initially determine the sectors, emissions sources (or entities), and greenhouse gases that will be covered by the program.

II. **Data Collection.** The success of a cap-and-trade program depends on the quality of the emissions data that underpins it. The trading system must go hand in hand with an emissions registry to which facilities covered by the program regularly submit emissions data.

III. **Setting the Initial Emissions Cap.** Once the scope is determined, an initial emissions cap will be needed. This "cap" represents the total amount of emissions that are permitted under the program during the first compliance period. This is usually accomplished with reference to actual emissions data attributable to the covered sources or entities during a baseline period.

IV. **Establishing the Reduction Schedule.** Once the starting cap is established, it will be necessary to set out the reduction trajectory or trajectories for the program. In general, the reduction pathway corresponds to a reduction in the total number of allowances issued in successive periods over the course of the program.

V. **Distributing Allowances.** For each year, the program authority issues allowances equal to the total number of tons permitted in that year's emissions cap. The program design will include a decision on how allowances will be distributed.

VI. **Early Reductions.** In some cap-and-trade programs, provisions are included to encourage and/or reward early reductions by covered entities before the start of the program.

VII. **Project-based Reductions (Offsets).** Another key decision in a greenhouse gas cap-and-trade program is whether and how to incorporate project-based reductions, or "offsets." Offsets are reductions obtained from outside the covered sectors or entities.

VIII. **Cost-containment.** In addition to the inherent incentive for low-cost reductions in a cap-and-trade program, as well as the additional flexibility afforded by an offsets component, program designers may wish to evaluate other potential cost-containment provisions.

IX. **Linking to Other Programs.** Lastly, in designing a cap-and-trade program, it may be considered important to bear in mind features that may be required if the program is to link with other existing and future trading systems.

The remainder of this paper approaches each design element in the order listed here.

I. DETERMINING SCOPE AND POINT OF REGULATION

The Midwestern Governors have called for a multi-sector cap-and-trade program. In carrying out this objective, the designers of the Midwest regional cap-and-trade program will need to carefully consider the appropriate scope of the multi-sector program. This section explores the topic of scope, beginning with a brief list of potential criteria for determining scope, followed by a review of the design options available to the region. Scope decisions include what greenhouse gases and what economic sectors will be covered by the program. Closely related to scope are decisions about the point of regulation within each sector, i.e., which sources or entities will have compliance obligations.

POTENTIAL DESIGN CRITERIA FOR DETERMINING SCOPE AND POINT OF REGULATION

In determining the appropriate scope for a cap-and-trade program to reduce emissions, it may be helpful to consider the potential criteria for making scope decisions. Several criteria may be relevant, including the desired breadth of coverage, environmental integrity, and administrative considerations. There are undoubtedly other considerations that could be brought to bear in this context, and a discussion on design criteria is probably a good place to start a deliberation on scope.

Broad Coverage Reduces Cost of Reductions. Given that the goal of a cap-and-trade program is to reduce greenhouse gas emissions, the breadth of program coverage is a potentially important criterion when considering alternative program designs. Previous regional programs have not covered every source of greenhouse gas emissions; for example, the Regional Greenhouse Gas Initiative (RGGI) in the Northeast covers 22 percent of GHG emissions in its states, while recent cap-and-trade proposals in Congress cover up to 86 percent of U.S. emissions.[1] There are thousands of sources of greenhouse gases across the economy and thus thousands of opportunities for emissions reductions, but these will differ in costs, suitability for measuring emissions, and potential levels of reductions. It may not make sense to cover some of these sources through cap and trade.

On the other hand, broader coverage is advantageous because it provides greater opportunities for "gains from trade," which is the basis of a cap-and-trade program's ability to lower the cost of compliance as compared to traditional command-and-control programs. The inclusion of a sector creates incentives for emissions reduction technologies and strategies that may have gone unrealized in the absence of a cap on that sector. Emissions sources in an included sector may present opportunities for lower-cost emissions reductions than would have otherwise been possible, reducing the overall cost of compliance for all of the sectors covered by the program. The number of covered entities is important to the function of the market created by a cap-and-trade program. Too many sources will increase administrative complexity, while too few may allow for some sources to exercise market power. In the latter case, a single source or group of sources holding a large percentage of total allowances may be able to affect the carbon price in order to improve their competitive standing.

The Program Must Ensure Environmental Integrity. The environmental integrity of a cap-and-trade program depends on its ability to ensure that emissions reductions are actually being made in accordance with established reduction goals and timetables. The ability to accurately measure greenhouse gas emissions and verify emissions reductions is central to the effective operation of a cap-and-trade system. A trading system relies on accurate knowledge of a source's emissions in order to ensure that the source holds allowances equal to emissions at the end of an established compliance period. Achievement of the program's environmental goals relies on the accuracy of these measurements. Some sources and sectors are better suited to accurate measurement than others. Emissions at power plant smokestacks can be easily measured with existing equipment and verified against fuel input and plant efficiency data. Agricultural operations, on the other hand, have many different emissions sources, as well as opportunities to store greenhouse gas emissions, commonly referred to as "sinks." Some of the sources and sinks are easy to measure and some are not. Many of the technologies and protocols to measure and reduce emissions may be either unavailable or prohibitively costly to implement across an entire sector.

Administration Must be Feasible. Another potentially important design criterion is the administrative complexity of different scope and point of regulation options. There are potential tradeoffs between increased coverage and the cost of program administration. As more types of sources and gases are added to the program, there may be additional administrative costs to accurately monitor those emissions and administer a program for those sources. For sectors with many distinct emitting entities, the cost of tracking their emissions and ensuring their compliance may be high. At some threshold the additional costs of tracking small amounts of emissions may outweigh the benefits of including small sources in a program.

The decision to include a specific emissions source may also depend on the prospects for low-cost emissions reductions from that source. While one attraction of a cap-and-trade system is the market's ability to create an incentive for innovation, some sources may not have existing or potential options for low-cost emissions reductions. Good substitutes for a carbon-intensive process or fuel may not be readily available.

DESIGN OPTIONS FOR SCOPE AND POINT OF REGULATION

Once the program designers have settled on which design criteria are important in making design decisions, it is helpful to identify the broad array of options available for scope and point of regulation. Once the options are identified, the design criteria can be applied to the options to aid in making program design decisions. Below are a number of options for consideration in the design of a multi-sector cap-and-trade program.

Determining Which Gases to Cover

Many gases contribute to climate change, and six have been covered in existing GHG programs: carbon dioxide, methane, nitrous oxide, perfluorocarbons, hydrofluorocarbons, and sulfur hexafluoride. These are sometimes known as the six Kyoto gases, due to their inclusion in the Kyoto Protocol. Other human-caused emissions affect climate change, including tropospheric ozone, carbon monoxide, and nitrogen oxides, among others. Some aerosols have a cooling effect, including sulfur dioxide and nitrogen oxides, while black carbon (soot) has recently been determined to have a warming effect.

The climate impact of greenhouse gases is measured on a scale of their global warming potential (GWP), which represents a combination of gases' warming ability and the duration of time that they remain in the atmosphere. GWP reflects the warming potency of a gas relative to the same amount of carbon dioxide, which is set at 1, and a gas's GWP will vary depending on the timescale used as a reference. For example, methane has a GWP of 25 over a 100-year time period, but 72 over a 20-year time period. In measuring greenhouse gas emissions, it is therefore important to consider both the quantity of a greenhouse gas and its GWP. In order to compare emissions in common units, greenhouse gas quantities are often described in terms of carbon dioxide equivalents (CO_2e), which convert the quantity of a gas into the equivalent amount of carbon dioxide, based on the gas's GWP.[2]

Table 1 | **Global Warming Potentials**

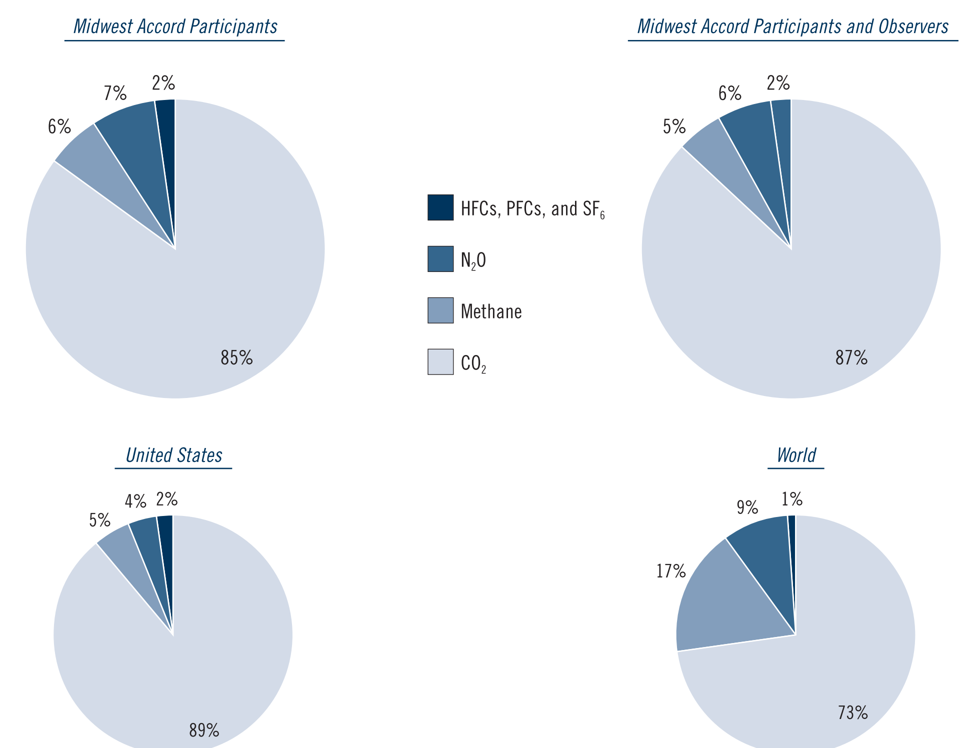
	LIFETIME (YEARS)	GLOBAL WARMING POTENTIAL (100 YEARS)
Methane (CH_4)	12	25
Nitrous Oxide (N_2O)	114	298
HFC-23	270	14,800
HFC-134a	14	1,430
Sulfur Hexafluoride (SF_6)	3,200	22,800

Notes: CO_2 Global Warming Potential = 1
GWP (100 years) refers to warming potency relative to the same amount of CO_2 over the same time period.
Source: 2007 IPCC Fourth Assessment Report (AR4) by Working Group 1, http://ipcc-wg1.ucar.edu/wg1/Report/AR4WG1_Print_Ch02.pdf

The decision to include various gases in a cap-and-trade program is related to the environmental benefit of including the gas as well as the administrative feasibility of covering the sources that emit the gas. As with the choice of sectors and sources, the choice of gases depends on the opportunities for emissions reductions and the cost of adequately monitoring emissions. The Regional Greenhouse Gas Initiative (RGGI), adopted by 10 northeastern and mid-Atlantic U.S. states, covers only carbon dioxide, as did the first phase of the European Union's Emissions Trading Scheme (EU ETS). This choice was made in part because it was possible to estimate these emissions based on existing fuel data and monitor emissions using continuous emissions monitors that in some cases were already required by law. The sectors that are most readily covered by a cap-and-trade system predominately emit CO_2. However, the EU ETS is expanding to include additional gases in later phases, all of the cap and trade bills introduced in Congress cover all six gases covered under the Kyoto Protocol, and almost 20 percent of U.S. GHG emissions are from non-CO_2 gases.

Including gases beyond CO_2 can substantially lower a program's abatement costs by providing additional opportunities for emissions reductions, particularly for gases with high GWPs. Preventing a ton of high-GWP emissions can have a benefit—in terms of avoided climate impact—many times the magnitude of an avoided ton of CO_2. The inclusion of other gases will also speed the development of reduction measures for non-CO_2 emissions by providing an incentive for these reductions. Some of the measurement and reduction strategies necessary for non-CO_2 gases have been developed under the Kyoto Protocol's Clean Development Mechanism.

Figure 1 | **GHG Emissions by Gas: States in Midwest Accord, U.S., and World (2003)**



Sources: WRI, CAIT and CAIT-US (2007). http://cait.wri.org. Environment Canada (2007).

Notes: Midwest Accord participants include Illinois, Iowa, Kansas, Michigan, Minnesota, and Wisconsin, as well as the province of Manitoba. Observers include Indiana, Ohio, and South Dakota. U.S. and Midwest data are for 2003. World data are for 2000—the latest year for which an international six-gas analysis is available. Data exclude emissions from international bunker fuels and land-use change and forestry.

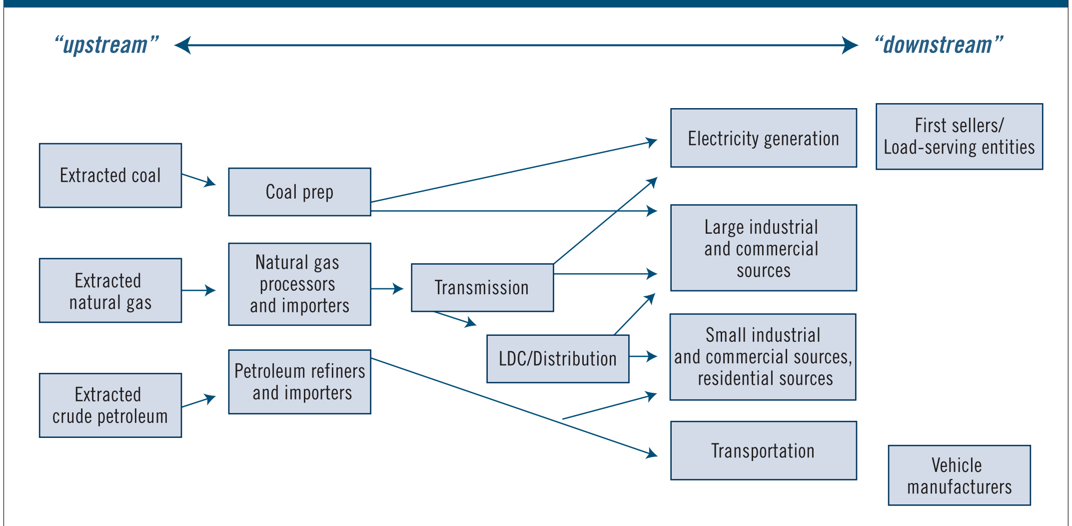
Determining Point of Regulation: Upstream vs. Downstream

The point of regulation defines which entities are responsible for compliance with the program, i.e. who must hold allowances at the conclusion of a compliance period. The point of regulation is defined according to an entity's position along the stream from the extraction of a fuel or creation of a chemical to the emission of a greenhouse gas. A downstream point of regulation covers entities as close to the point of greenhouse gas emissions as possible, such as a fossil fuel power plant or a manufacturing facility with process emissions. Upstream refers to points of regulation closer to the extraction of fossil fuels, such as the coal mine, refinery, or fuel distributor. It is possible to combine upstream and downstream coverage for different sources under a cap-and-trade program, as long as no ton of greenhouse gas is counted twice.

Downstream. In practice, most cap-and-trade programs have covered downstream entities, including the U.S. Acid Rain program, the European Union Emissions Trading Scheme (EU ETS), Southern California's Regional Clean Air Incentives Market (RECLAIM), and the northeast Regional Greenhouse Gas Initiative (RGGI), which will begin operation on January 1, 2009. Existing pollution control policies, state climate efforts, and the existing Federal voluntary reporting program provide facility-level emissions data that can inform program design. In general, a downstream program has the advantage of putting the compliance obligation on entities that have the ability to influence their emissions. For instance, manufacturers can improve process efficiency, change processes, or substitute material and fuel inputs. A downstream program directly rewards emissions reduction technologies such as carbon capture and sequestration. Under a downstream program additional sources can be added over time as emissions monitoring equipment and reduction technologies improve.

Upstream. Upstream coverage has previously been used in instances when substitutes are readily available, such as the Montreal Protocol to reduce ozone-depleting substances or U.S. gasoline lead regulations. An upstream approach generally requires inclusion of fewer individual entities for a given level of coverage. This approach assumes that the effect of allowance prices (i.e., an increase in the price of the product itself) will provide an incentive for emissions sources downstream to reduce emissions, or that suppliers will substitute low-carbon inputs. Under an upstream approach, fuel providers may not have compliance options beyond buying allowances or reducing output. For example, while fuel providers would have responsibility for holding allowances, they have limited ability to affect the carbon content of their fuels. In most cases, this price signal is passed to fuel consumers, who can respond by

Figure 2 | **Potential Points of Regulation: Upstream and Downstream**



increasing the efficiency of fuel use, switching to lower-carbon fuel sources, or capturing and storing emissions.

Upstream coverage may not apply at the point of extraction for all fuels. While it may be possible to put the point of regulation for coal on the mine mouth, oil and gas wells are too numerous and too small to require compliance by each individual source. A centralized "choke point" that is close to upstream but farther downstream than the point of extraction may be appropriate, such as the refinery. For some sectors with numerous small emissions sources, such an upstream approach may be the only effective option.

One complication to an upstream system is that it does not recognize greenhouse gas emissions that are captured at the point of emissions and sequestered. Thus a coal-fired power plant would not have an automatic incentive to invest in carbon capture and sequestration, because it would not realize any benefit to reducing its emissions. In other words, the required number of allowances is based on the carbon embodied in the coal used as a fuel, rather than the actual emissions of the facility. In order to provide the proper incentives to reduce emissions, an upstream system must include specific credit for carbon capture and storage. One such option would set aside allowances from the cap that could be used to reward entities that implement carbon capture.

Considerations for non-CO_2 gases. When it comes to choosing between upstream and downstream requirements, some non-CO_2 gases lend themselves to particular strategies. There is a growing consensus that hydrofluorocarbons and sulfur hexafluoride are better suited to upstream coverage. Both gases are emitted through numerous processes downstream and have upstream choke points that are amenable to regulation such as the producer or importer of the gas. Conversely, nitrous oxide (N_2O) emissions at chemical plants and perfluorocarbons emitted at aluminum plants are better covered downstream as the gases are generated in large volumes by processes at these sites.

Determining Which Sectors or Fuels to Cover

A cap-and-trade system is probably not appropriate for every sector of the economy, based on available emissions measurement and monitoring technologies, existing data, legal authority of states, and ease of enforcement. The following section provides a brief assessment of the suitability of various sectors for inclusion in a cap-and-trade program.

Natural gas. More than any other fossil fuel, natural gas is used by a wide variety of industries at widely varying scales. Natural gas is used in large quantities at power plants and as a feedstock for the chemical industry, and in very small quantities by individual residential and commercial customers. This diversity in the quantity of natural gas consumed and the scale of user presents a special set of considerations for the coverage of this fuel under a cap-and-trade system. In order to cover the natural gas used in residential and commercial appliances and equipment such as boilers, space and water heaters, and kitchen ranges, a number of options are available. One upstream option is to require the pipelines that carry natural gas to hold allowances for the carbon content of the fuel they sell, but this approach may face regulatory hurdles at the state and regional level. Another upstream option is to require natural gas processors to hold allowances for the carbon content of the fuel they sell. This does not provide complete coverage, as a significant percentage of gas is not processed, although some additional coverage can be obtained by including imported processed gas. Another option is a hybrid approach: covering the local distribution companies (LDCs) that sell gas to residential and commercial customers, while also including large consumers of natural gas at power plants and industrial facilities. The advantage of this option is that some state public utility commissions already require or encourage the LDCs to invest in efficiency programs and thus the LDCs already have in place a model for achieving emissions reductions. Requiring the decoupling of sales from profits for natural gas LDCs will further improve such a program by rewarding LDCs for efficiency improvements.

Another option is to cover large natural gas combustors only, and not include residential and commercial combustion in the cap and trade program but rather address that sector through more traditional standards and incentives. The rationale for this approach is that residential and commercial consumers are relatively unresponsive to natural gas price changes.

Transportation fuels. Transportation accounts for 25 percent of GHG emissions for the 7 governments participating in the Midwest Greenhouse Gas Accord.[3] With over 240 million passenger cars and trucks on the road,[4] a program covering individual mobile sources is not administratively feasible. Upstream coverage of oil would provide a comprehensive approach to addressing transportation emissions. Covering the emissions associated with passenger vehicle use would require including transportation fuels at the refinery gate, terminal racks, or another point upstream of combustion. The allowance price of carbon would be seen by consumers in the price of fuel, and refiners or distributors would be responsible for holding allowances equal to the carbon content of fuel sold. However, these covered entities would have few options for reducing the emissions associated with oil consumption. Moreover, consumers are relatively unresponsive to gasoline price changes, as seen in the very small changes in vehicle purchase and driving behavior over the last few years of high gasoline prices. Studies anticipate that reductions in the transportation sector will be more expensive than those in other sectors, and the inclusion of the transportation sector may only work to increase allowance prices and motivate further reductions in other sectors without achieving a large quantity of reductions in transportation.[5] Some states may have legal limitations on covering these emissions. Most states collect data at one or more of the points of regulation described above, but further analysis may be necessary for a Midwest system.

In order to include transportation under the cap and encourage vehicle manufacturers to build more efficient vehicles that use lower-carbon fuels, one option is to require vehicle manufacturers to hold allowances equal to the estimated emissions from the vehicles they sell. However, because manufacturers have no control over the use (especially the number of miles driven) and maintenance of the vehicles they sell, emissions estimates will be very uncertain and reliant on assumptions about consumer behavior. The uncertainties of actual emissions and reductions in this scenario would compromise efforts to include this option under a broader cap-and-trade program and without a price signal on fuels this option would not discourage increases in vehicle miles traveled. The numerous challenges in the transportation sector suggest that in addition to a possible cap-and-trade program covering transportation, other tools will be needed, such as a low-carbon fuel standard to reduce fuel carbon intensity, greenhouse gas performance standards for vehicles, and smart growth and public transportation initiatives.

Electricity. The electricity sector produces 32 percent of GHG emissions in the U.S. Midwest Accord states, almost entirely in the form of CO_2 emissions from fossil fuel combustion.[6] The electricity sector is highly regulated on a state-by-state basis and requires specific consideration under either an upstream or downstream program. Under a fully upstream system covering carbon content of fossil fuels, fuel providers would hold allowances associated with the eventual emissions at the point of combustion. In this case no entities in the electricity sector would have compliance responsibility, and a price signal would be passed from fuel providers to generators. Under a downstream system, there are two major options for coverage. A generator-based system would require power plants to hold emissions allowances, while a load-based system would require utilities—the electricity distributors—to hold allowances. A hybrid system could cover some fossil fuels upstream and others downstream.

Electric generators are very familiar with cap-and-trade compliance given their experience with the U.S. SO_2 program. A wide variety of both demand-side and supply-side reduction opportunities are available, including renewable electricity generation, biomass co-firing, and energy efficiency improvements such as compact fluorescent light bulbs. One challenge in the electricity sector is covering emissions associated with generation outside of states in the program. RGGI chose only to include generators within the covered states and convened a working group to address the possibility of increased electricity imports and associated emissions "leakage" outside the boundaries of the program. A load-based system could cover emissions associated with imports.

What Sources or Facilities Should be Covered in a Downstream Program?

In the design of a cap-and-trade program, a balance must be struck between covering as many emissions and emissions sources as possible and the administrative costs of monitoring, verifying, and tracking these emissions. Covering sources with very low total emissions could put an undue administrative burden on both the covered company and the government. However, it may be feasible to include sources with many small and similar emissions sources at a given facility, since a single company would be responsible for compliance. Inclusion of a source may be based on historical emissions or capacity to emit. Some energy generation facilities (for instance, diesel backup generation facilities at a hospital) may have the capacity to emit above a given threshold for a limited amount of time, but due to their purpose will never actually emit at those levels on the annual basis that is typically of interest for greenhouse gas emissions. Specific determinations may be required for these sources.

Process and combustion emissions. Most of the emissions associated with sources considered for inclusion in a cap-and-trade program are from the combustion of fuels, whether the entity combusting the fuel is covered in a downstream program or the carbon content of the fuel is covered in an upstream program. In addition to these combustion-based emissions, a program might also include process emissions that result from the creation of products. For some sources such as cement, process emissions are much greater than combustion emissions. Where administratively and technically feasible, coverage of process emissions can effectively increase the breadth of the program. Such emissions sources could include emissions associated with the production of cement or transportation fuels.

Embodied emissions for imported products. Just as GHG emissions associated with imported electricity can be covered under a cap and trade system, the emissions associated with imported products could also be covered. Including embodied emissions would help to address concerns about manufacturing moving outside the geographical boundaries of the program. Some sectors may be particularly sensitive to competitiveness concerns, and may manufacture products that can be easily imported from companies outside the cap-and-trade system. By applying a consistent carbon price signal to manufacturers inside and outside the system, covering embodied emissions can alleviate leakage while maintaining a competitive trade environment for manufacturers inside the system. However, the costs of accurately administering a system that must track or estimate emissions associated with a wide variety of products and their component parts from around the world would be significant and should be balanced against policy goals for leakage and competitiveness. One compromise might be to cover only a limited set of products that have significant competitiveness concerns.

Including lifecycle emissions associated with products requires a systematic examination of the greenhouse gas emissions associated with the creation of the materials in the product and the fuels used to power the manufacturing and transport of the product. Companies importing products would be responsible to hold allowances equal to these emissions. A separate monitoring and verification system for imported product lifecycle emissions would be necessary, and could be based on conservative default emissions values for various raw materials. Companies wishing to demonstrate lower than default emissions would have to certify the improvement through a third party verifier. Such a system would likely require a complex set of regulations and assessment processes and may raise a variety of legal issues.

II. DATA COLLECTION AND EMISSIONS REGISTRIES

Any program that regulates emissions of greenhouse gases depends on a mandatory registry that collects data from emitters and/or fuel suppliers. The U.S. Environmental Protection Agency (EPA) compiles a comprehensive national greenhouse gas inventory each year, which is critical for identifying aggregate and sectoral trends in national emissions, but does not attribute those emissions to individual parties.

Currently there is a patchwork of greenhouse gas data collection systems throughout the United States, rather than a single, comprehensive repository for emissions data. Existing data collection programs include:

- The Acid Rain Program, which requires that electric generating units regulated under the SO_2 cap-and-trade program also measure and report carbon dioxide (CO_2) emissions data to EPA;
- Mandatory reporting for large facilities in some states;[7] and
- Voluntary corporate-wide registries, including The Climate Registry, the California Climate Action Registry, and the U.S. Department of Energy's 1605(b) Voluntary Reporting Program.[8]

The majority of greenhouse gas emissions in the United States, such as emissions from industry, are not tracked at the direct emitter level.

The success of a cap-and-trade program depends on the quality of the emissions data that underpins it. The trading system must go hand in hand with a mandatory emissions reporting system to which affected facilities under the program regularly submit emissions data.[9] A cap-and-trade registry must also collect and track information on emissions allowances and offset projects.

Tracking emissions data is necessary to:

- Ensure compliance, such that each facility does not emit in excess of its allowances;
- Ensure that the emissions market functions effectively and efficiently by providing accurate and transparent data to market participants and the public;
- Allow regulators to distribute allowances properly; and
- Verify facilities' claims that they have achieved emissions reductions that may qualify for early action credit in the program.

Collecting data as early as possible is important. In order to allocate allowances and verify early action claims, regulators must rely on historical data collected prior to the beginning of the trading program or resort to estimating historical emissions based on incomplete proxy data. In the case of the Acid Rain Program, EPA began collecting emissions data two years before trading commenced and made allocation decisions based on data collected several years before trading began.[10]

A greenhouse gas cap-and-trade program would likewise benefit from collecting data from facilities before the start of the trading period. A trading program that begins in 2012, for example, could begin emissions reporting as early as 2009. Without high-quality historical data, allowances may be distributed incorrectly and claims of early action reductions may not be verifiable.[11]

The Midwest Accord commits states to participation in The Climate Registry, a joint initiative of over 40 U.S. states and tribes, as well as states and provinces in Canada and Mexico, to measure and collect GHG data using a common standard and a unified emissions reporting system. Participation in The Climate Registry will help ensure consistent emissions reporting throughout the region—an essential feature of a regional cap-and-trade program. Consistency in emissions measurement ensures that "a ton is a ton" throughout the region and that emissions allowances are a common currency throughout the program.

Box 3 | **MIDWEST GHG EMISSIONS INVENTORY**

This table compares emissions of all six Kyoto gases across the economies of the participants and observers in the Midwest Greenhouse Gas Accord. These data provide an indication of the importance of this region's role in emissions mitigation, and may serve as a guide in the determination of appropriate reduction targets.

Midwest GHG Emissions and Emissions Per Capita: 2003

CO_2, CH_4, N_2O, HFCS, PFCS, SF_6

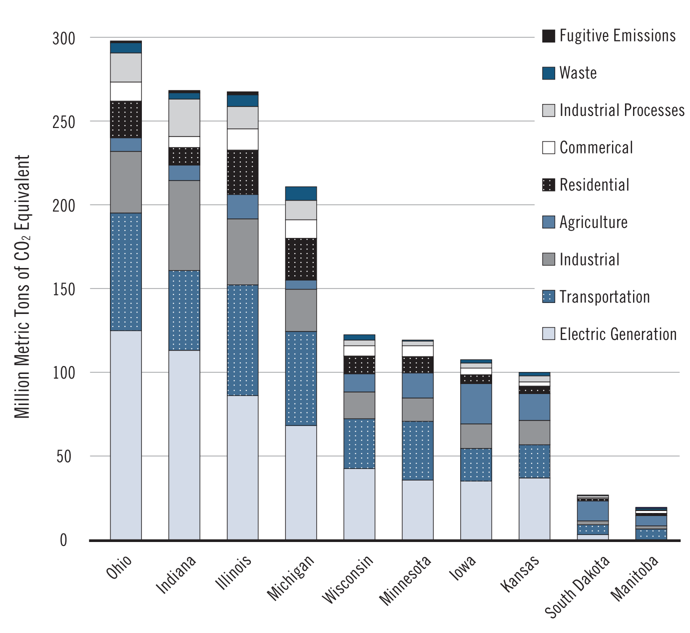
STATE	GHG EMISSIONS ($MTCO_2E$)	STATE RANK (2003)	% OF U.S. GHGS	GHG EMISSIONS PER CAPITA ($MTCO_2E$)	STATE RANK (2003)
Ohio	299	4	4.4	26	21
Indiana	269	6	4	44	7
Illinois	268	7	4	21	30
Michigan	212	9	3.1	21	32
Wisconsin	123	21	1.8	23	27
Minnesota	120	22	1.8	24	24
Iowa	108	23	1.6	37	11
Kansas	101	25	1.5	37	10
South Dakota	27	43	0.4	36	13
*Midwest U.S.**	*1,527*	*NA*	*22.7*	*27*	*NA*
U.S. Total	*6,737*	*NA*	*100*	*23*	*NA*
Manitoba	20	—	—	17	—

Sources: WRI, CAIT-US (2007); Environment Canada (2007)

Notes: *Midwest total does not include Manitoba. All data are for 2003. Totals exclude emissions from international bunker fuels and land-use change and forestry.

Because The Climate Registry is a voluntary GHG reporting program, states must also enact mandatory GHG reporting programs (which could use The Climate Registry) to ensure that all facilities that would be part of a cap-and-trade system report their emissions to state agencies. Some states in the Midwest are now moving toward developing mandatory reporting regulations for GHG emissions. In addition, several states in the Northeast and Western U.S. have or are currently enacting mandatory GHG reporting programs to support state policies. New Jersey and Maine have mandatory reporting programs in place, and California recently developed regulations for mandatory reporting to support its statewide GHG reduction law (AB 32). Other states in the Western Climate Initiative, such as New Mexico and Oregon, are developing similar rules. Additional states that participate in a regional cap-and-trade program will likewise have to enact mandatory reporting of all emissions sources that would be part of a cap-and-trade program to ensure that facilities in the program monitor and report their data.

Figure 3 | **Total GHG Emissions of Midwest States/Provinces by Economic Sector: 2003**



Sources: WRI, CAIT-US (2007); Environment Canada (2007)

III. SETTING THE EMISSIONS CAP

After the program scope and point of regulation has been determined, the initial emissions cap may be set, usually in reference to a baseline year or years. The initial emissions cap is the starting point for emissions under the program. The reduction schedule then specifies how the cap will increase in stringency over time through a decrease in the number of allowances in the program. This section discusses the options to consider and the issues that arise in establishing the initial cap and implementing a reduction schedule.

It bears noting that while the Midwestern states have agreed to a long-term emissions reduction target, this emissions reduction target may or may not directly correspond to the reductions sought through the cap-and-trade program. Because a cap-and-trade program will not be able to cover all emissions in the economy, it cannot be relied upon to fully achieve an economy-wide reduction goal. Indeed, achievement of a specific economy-wide target will likely require measures beyond the cap-and-trade program. Within the cap-and-trade program, the choice of a cap level depends on a number of factors, including breadth of coverage and projected impacts. Increased stringency of the cap will result in the need for fewer necessary reductions for sources outside the cap.

SETTING THE INITIAL EMISSIONS CAP

The initial emissions cap in a cap-and-trade program is generally established with reference to actual emissions from covered sources or entities in a baseline year or years. This has typically meant that actual emissions measurement, monitoring and reporting will precede establishment of the initial emissions cap and the start of a cap-and-trade program. Where actual emissions data are not available, mandatory emissions reporting from sources or entities to be covered will be warranted.

Setting the initial cap with reference to emissions in a baseline year or years helps to ensure that the cap is both realistically attainable in the short run and also stringent enough to motivate real greenhouse gas emissions reductions. Recent experience in the European Union suggests that a cap that is based on inaccurate emissions estimates can lead to an over-supply of allowances. Confidence in the emissions data can enable decision-makers to avoid this problem.

CONSIDERATIONS FOR A DECLINING CAP

The level of the cap will not be static if the program is to achieve ongoing reductions. In order to eventually achieve the long-term emissions reduction targets set out in the Midwestern Greenhouse Gas Accord[12] and to encourage further emissions reductions and low-carbon technology development and adoption, the cap must decline over time. Experience from prior cap-and-trade programs suggests that a gradual decline in the early years of a system allows covered entities lead time to invest in emissions reduction strategies. A continual and gradual decline will reduce allowance price volatility compared to large step changes in the cap level.

The emissions reduction timetable can have important consequences for program costs. A cap-and-trade program puts a price on GHG emissions by requiring emitters (or their upstream suppliers) to hold a sufficient number of allowances to cover their emissions. This price on GHGs in turn motivates each emitter to decide whether to continue its "business-as-usual" emissions or to reduce its emissions. The emitter's decision will take into account the financial impact of implementing reductions, buying needed allowances to cover residual emissions, and/or selling excess allowances.

These factors make GHG emissions allowances a commodity—the more stringent the reduction timetable, the more scarce the commodity becomes. Scarcity, by the laws of supply and demand, makes the commodity more expensive. As allowance prices rise, GHG emitters will be motivated to make larger investments in emissions reductions. These investments constitute the real resource cost of a cap-and-trade program. Policymakers thus will largely determine the cost of a cap-and-trade program when they specify the extent and timing of required emissions reductions.

While stringent emissions reduction targets will make GHG allowances more scarce and more expensive, it is important to bear in mind that these higher prices will also stimulate innovations in emissions reduction technologies. Induced technological change can be expected to make emissions reductions more cost-effective over time (i.e., to reduce the cost of preventing one ton of carbon dioxide emissions). As the cost of emissions controls falls (on a per-unit basis), the cost of achieving any particular target will also drop relative to what it otherwise would have been.

Another cost consideration is the link between the emissions reduction timetable and natural capital investment cycles. Many of the facilities, processes, and equipment that emit GHGs are capital assets with a natural lifecycle that extends over several years or decades. Examples include manufacturing facilities such as petroleum refineries and cement plants, and energy-consuming equipment in homes and commercial buildings. Reducing emissions in such situations can be appreciably more cost-effective if those reductions are synchronized with the natural life cycle of the equipment. For example, manufacturing plants are often shut down every few years for major maintenance and overhaul. Installation of emissions reduction technologies and processes can be substantially more cost-effective if done during such shut-downs rather than at other times. Structuring the emissions reduction timetable to allow some flexibility to firms to accommodate capital replacement cycles will thus likely reduce costs.

Conversely, there are many opportunities to reduce emissions almost immediately at little or no cost, especially in the energy efficiency arena. With relatively low initial costs, and often with energy cost savings during operation, such opportunities are sometimes referred to as "low-hanging fruit." Examples include energy-efficient lighting, office equipment, home appliances, and heating and cooling systems, along with improved building insulation and windows.

Another way to reduce the cost of a cap-and-trade program is to eliminate—to the degree possible—uncertainty about what will be required of GHG emitters over the long run. Uncertainty is costly because it clouds investment decisions and inherently increases the risks of choosing one option over another. Clarity about target levels over long periods of time reduces uncertainty and the sooner targets are announced, the cheaper they will be to attain. Such announcements "lubricate" carbon markets, stimulate innovation, and reduce regulatory risk in capital investment decisions.

IV. SETTING AN EMISSIONS REDUCTION SCHEDULE

Several questions must be answered to define a specific emissions reduction timetable.

What are the start and end dates for the emissions reduction pathway?

Considerations in selecting the first year in which emissions are capped include determining how quickly administrative structures can be put in place and the speed with which emissions data can be assembled to support allowance allocation.

The year in which emissions are first regulated does not have to be the same year that emissions are reduced relative to prior years. Though limited by a cap, emissions might be allowed to increase in the short run before being reduced. A desire to allow short-run increases in emissions (perhaps to avoid early retirement of capital equipment or to allow time for technology diffusion) is thus not a compelling reason to delay imposing a reduction timetable because increases can be addressed within the timetable.

When it comes to the long-term target date (i.e., the last year in which reductions are specified), the date must be far enough in the future to allow time for meaningful and sustained reductions in emissions. It should also create a long-run policy environment that provides the stability and certainty needed to encourage investment in low-carbon technologies. An emissions reduction timetable that extends over only a few years will be insufficient on both counts.

How will baseline issues be addressed?

Most emissions reduction timetables are defined in terms of a baseline year, with each reduction computed as a percentage of emissions in that year. Some Congressional proposals set 1990 as the baseline year, as does the Kyoto Protocol; others use 2005. To ensure comparability among policy proposals and the scientific, economic, and technology assessments being used by policy-makers, it is helpful to choose baselines consistent with other programs. If needed, adjustments can be made by reviewing historical emissions data and making the appropriate calculations.

In addition, setting reductions as a percent reduction from a baseline may leave residual uncertainty since there can be revisions to historical data after enactment of legislation. An alternative is to avoid the "percent of baseline" method and express emissions targets in absolute units, such as tons of CO_2. Both approaches—percent of baseline and tons of CO_2—have been used in legislation introduced in the current Congress.

Finally, if a policy choice is made to exclude some sectors and/or types of emissions sources from the cap-and-trade program, adjustments to the calculations may be needed. By way of example, if the state or regional emissions target (for all sectors) in a particular year is a ten percent reduction from some baseline year, but only two thirds of the total emissions are covered by the cap-and-trade program, then other policy requirements would be needed to ensure that the necessary reductions are made within the third of the economy outside the cap-and-trade program (or, cuts inside the program would need to be deeper), thereby assuring that the aggregate target is achieved.

What are the design choices when setting an emissions reduction timetable?

One way to think about reduction timetables is to consider allowable annual emissions. Emissions could be allowed to increase for some period of time before being reduced; alternatively, emissions could be stabilized at current levels before reductions begin. Finally, emissions cuts could begin immediately upon program launch. These three scenarios, which are only for purposes of illustration, demonstrate that it is not enough to specify the target emissions level in the final year

Table 2 | **Examples of Cap-and-Trade Program Coverage and Emissions Reduction Schedules**

EMISSIONS REDUCTION PROGRAM	GASES COVERED	SECTORS COVERED AND POINT OF REGULATION	NEAR-TERM TARGET	MID-TERM TARGET	LONG-TERM TARGET
RGGI	CO_2	Electricity sector	Stabilize emissions through 2014	10% below current level by 2019	
Lieberman-Warner bill proposed in U.S. Senate (S. 2191)	6 gases†	Economy-wide, "hybrid" – upstream for transport fuels & natural gas; downstream for large coal users; separate cap for HFC consumption	6% below 2005 level in 2012	20% below 2005 level in 2020	72% below 2005 level in 2050
European Union Emissions Trading Scheme	CO_2 (phase I, 2005-2007); 6 gases† (phase II and later)	Large point source combustion, refineries, and metal, mineral, pulp, glass, lime, cement and other industries	Determined at country level. Phase II: Approximately 7% below 2005 level in 2012	21% below 2005 level in 2020	

† 6 gases include carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride.

Sources: Regional Greenhouse Gas Initiative, http://www.rggi.org; World Resources Institute, http://pdf.wri.org/greenhouse-gas-emissions-under-lieberman-warner.pdf ; European Commission, http://europa.eu/rapid/pressReleasesAction.do?reference=IP/06/1650&format=HTML&aged=0&language=EN&guiLanguage=en, http://ec.europa.eu/environment/climat/climate_action.htm.

of the program. Because there are many pathways from today's emissions levels to those in a future target year, targets for intervening years are a necessary component of a comprehensive climate change policy.

V. DISTRIBUTING ALLOWANCES

In addition to deciding the scope of the cap-and-trade program, the initial cap, and the schedule of reductions, the designers of a cap-and-trade program must determine how emissions allowances will be distributed into the emissions marketplace. Allowance distribution is one of the most important issues in the design of a cap-and-trade program, because the program creates a potentially valuable new commodity. Decisions about the allocation of allowances represent a distributional equity issue and inevitably result in competing claims.

While discussions around distributing allowances are among the most contentious in the design of a cap-and-trade program, it is important to remember that a cap-and-trade program can achieve its primary environmental objective regardless of how allowances are distributed. Allowance distribution is largely a question of distributional equity or compensation, and while revenues can be used for complementary purposes, the primary environmental objective is achieved through the cap itself. Allowance value can reduce the price impacts of the program if the auction revenues or allowances are dedicated to energy efficiency, which reduces overall program costs. There are cases in which the benefit of free allowance distribution to emitters is not passed on to consumers; in such cases, additional consumer protection measures may be needed.

Allowance distribution presents both a challenge and an opportunity. No allocation formula will satisfy all interested stakeholders, yet allocation can be used to compensate affected firms and to ease the transition to a new program. Allowance value can also be used for low-income ratepayer assistance, technology research and development, adaptation measures, and many other public benefit purposes.

Key questions that must be answered include whether allowances should be given away for free (and if so, to whom), sold via an auction, or distributed using some combination of the two. If policymakers decide to allocate some allowances to emitters for free, it will be necessary to specify who will receive these allowances and on what basis (e.g., past or current emissions levels, some benchmark performance standard, output, or another basis). If the allowances are auctioned, decisions must be made regarding what type of auction and how the funds generated will be used. If a combined approach is selected—with some allowances given away and the rest auctioned—policymakers will have to determine how much of each and on what basis.

VI. DETERMINING WHETHER AND HOW TO CREDIT FOR EARLY REDUCTIONS

In the design of a cap-and-trade program, the Midwest will also confront the issue of whether and how to reward early actions to reduce emissions prior to the start of a mandatory program. The issue of credit for early action takes at least two forms; both are discussed below.

In existing cap-and-trade programs, early-reduction credit has been given to sources that will be covered under the cap for actions they take after the official announcement of the mandatory program but prior to the start of the program. Without credit for early action, those sources might choose to wait to make improvements at their plants or in their operations until after the program has started and those improvements will yield tangible credit under the program. Credit has been granted for those actions to remove this disincentive to improve the emissions profile of their operations while waiting for the program to begin.

Very often in the greenhouse gas cap-and-trade context, however, credit for early action is interpreted much more broadly. This is because, in the absence of mandatory climate policy, many emitters have taken it upon themselves to reduce emissions from their own activities voluntarily. Some have participated in government-led initiatives such as the EPA's Climate Leaders program; others have joined private programs such as the Chicago Climate Exchange. Those early actors are likely to seek credit for these voluntary early actions.

There are a number of design options available for crediting early action under either the more restrictive or more expansive approaches. The simplest way to reward early action is to distribute allowances through an auction. If emission allowances are sold through an auction, a company that reduces its emissions early will automatically be rewarded, because it will require fewer allowances once the program begins. If additional compensation is warranted, a share of the proceeds from revenues may also be distributed to early actors.

If free allocation of allowances is used, the most straightforward ways to reward early actors are to recognize these early reductions through baseline-setting, a set-aside of allowances, or the generation of additional "early action" credits.

Baseline-setting. In the case of free allocation of allowances based on a covered source's past emissions, early action can be recognized by choosing a baseline (or reference) year that is far enough in the past to precede any meaningful reductions that were undertaken prior to the onset of the cap-and-trade program.

Set-aside of allowances. Allocation methodologies can be explicitly designed to include compensation for early reductions. In this approach, some number of allowances is set aside from the total pool and distributed to entities based on demonstration of reductions made before commencement of the program.

Early action credits. Instead of reserving a fixed number of allowances within the cap, program designers could allow entities to earn additional credits for demonstrated early action projects. This approach is similar to the way that offsets are credited, and differs from the allowance set-aside in that it generates additional credits outside the cap. In this case, early reductions would be recognized and credited using the same rules that are applied to offset projects. In other words, early reductions could simply be recognized by allowing offsets from projects that were initiated prior to the commencement of the program, assuming the projects meet all applicable criteria.

The qualification criteria are clearly important for determining how allowances or credits might be awarded to early reduction projects. These projects will likely vary widely in their timing and degree of documentation. Program designers will have to decide over what period of time to recognize early reductions, based on the activities they hope to reward and the likelihood of reliable data. Another consideration is the degree of documentation required, and whether any project registered in an independent program (e.g., Climate Leaders or the Chicago Climate Exchange) should automatically qualify for credit, a decision that depends on program designers' level of comfort with the reporting rigor and stringency of each of these programs.

VII. PROJECT-BASED REDUCTIONS (OFFSETS)

Offsets can reduce program compliance costs by allowing cost-effective emission reductions made outside the cap to contribute to the overall target. Entities that are able to demonstrate such reductions earn offset credits, which can then be submitted in lieu of an allowance by entities covered by the cap. Use of these credits for compliance allows covered entities to release GHG emissions in excess of the number of allowances held; therefore, it is critical to ensure that these offsets represent true reductions elsewhere.

The first consideration is the definition of the overall goals and objectives of an offset program. Offsets might be designed to achieve a variety of goals, including:

- Reducing overall compliance costs by providing access to cost-effective emissions reduction opportunities from uncapped sources;
- Promoting investment and innovation in uncapped sectors of the economy;
- Allowing participation of sectors whose inclusion under the cap might be difficult for administrative reasons;
- Developing new investment opportunities that include actors otherwise unaffected by the program; and
- Promoting secondary social, environmental, and economic goals through the promotion of specific types of emission-reducing practices or technologies.

Goals for the inclusion of offsets will influence the design of the program. For example, some activities that generate cost-effective reductions (e.g., destruction of hydroflourocarbons, or HFCs) may contribute less to secondary environmental and economic goals. Emphasizing secondary objectives could be grounds for excluding certain types of projects, or for including others (e.g., forestry projects).

The second major consideration involves establishing the basic criteria governing what qualifies as an offset. At a minimum, policymakers should specify that offsets must represent emissions reductions that are:

- Real — actual emissions reductions and not artifacts of (incomplete) accounting;
- Additional — a response to the incentives provided by the offset program, not reductions that would have happened anyway under a "business as usual" scenario;
- Verifiable — resulting from projects or programs whose performance can be readily monitored and verified;
- Permanent — long-lasting, or backed by guarantees if they could be reversed, i.e., re-emitted to the atmosphere; and
- Enforceable – backed by contracts or legal instruments that define their creation, provide for transparency, and ensure exclusive ownership.

Detailed rules specifying how these basic criteria will be met can be left up to regulators. However, many of the details will depend on additional considerations that policymakers may wish to address.

Key questions and considerations will include:

- **Geographic scope.** From which non-capped sources will offsets be allowed? Designers of regional trading programs might choose to limit offsets to projects within their own boundaries, ensuring that secondary benefits accrue to the local region. Or, they may elect to accept projects from other areas of the country or the world, providing access to more cost-effective reduction opportunities. For example, the Regional Greenhouse Gas Initiative in the Northeast requires that offset projects occur within RGGI states or other states that have agreed to carry out certain obligations regarding oversight of offsets. If allowance prices exceed a pre-determined threshold, credits from mandatory programs outside the U.S. may be accepted as offsets.
- **Emissions scope.** Which greenhouse gases will be recognized as offsets? There are many low-cost reduction opportunities involving non-CO_2 gases.
- **Project types.** Based on program objectives and the administrative burden of processing a diverse variety of projects, there may be certain types of technologies or practices that the program should prioritize. There may also be sectors that should be excluded.
- **Limitations on use.** In principle, it is not necessary to limit the number of offsets that a capped entity is allowed to purchase and retire for compliance purposes, because reductions made anywhere are equivalent. In practice, limitations may be desired in order to spur greater reductions among capped sources,

or because of inherent uncertainties in how offset reductions are quantified.

- **Bottom-up or top-down accounting rules.** Ensuring that offsets are real, surplus, and permanent requires detailed rules for quantifying emissions reductions. These rules must be elaborated for each type of project or activity that qualifies for offset crediting. Rules can either be developed upfront by regulators (the top-down approach, used in RGGI), or proposed by individual offset providers as the program evolves (the bottom-up approach, used in the Kyoto Protocol's Clean Development Mechanism). The advantage of the latter approach is that it requires little upfront investment of time and resources by regulators, and allows maximal opportunities for offset providers (projects of any type can be proposed). The drawback is that it imposes high uncertainty and transaction costs on offset providers, at least in the early stages of the program. Under a top-down approach, regulators must devote significant time and resources upfront, and offsets may initially be allowed only for a few project types. The advantage of this approach is that it provides offset providers with certainty about the rules and can dramatically reduce transaction costs. A hybrid system is also possible. Rules may be elaborated upfront by regulators for important project types, allowing project developers to propose new rules for others.

Box 4 | MIDWESTERN EMISSIONS REDUCTION OPPORTUNITIES

A cap-and-trade program will provide an incentive for emission reductions both by companies directly covered by the program and by companies that can provide offset credits. Reduction opportunities will be found across the economy. The Midwestern states and provinces possess a wealth of reduction opportunities, and some of the following strategies may help the region achieve its target. Depending on the scope of the cap-and-trade program, these strategies may be possible as direct emission reductions or as offsets.

Wind power. **The Midwestern states have some of the greatest potential for wind development. Minnesota and Iowa are already among the top four states with the highest installed wind capacity, and numerous projects are currently under construction across the Midwest.† Wind power provides a zero carbon energy resource, as well as a source of income for landowners who can lease sites to wind developers.**

Carbon capture and sequestration. **The Midwest is home to a large coal resource as well as possible sites for the geologic sequestration of carbon dioxide.‡ Sequestration requires the capture of carbon dioxide from a power plant, which is then pumped into underground reservoirs where it will not contribute to atmospheric greenhouse gas levels. Power plant technologies such as integrated gasification combined cycle (IGCC) have the advantage of providing a concentrated CO_2 stream that is easier to capture, but CCS is applicable to conventional coal plants as well. A number of IGCC plants, geologic surveys, and sequestration trials are currently under development across the Midwest.**

Biomass co-firing. **Biomass resources such as wood, switch grass and other agricultural products may be burned in existing coal-fired power plants, replacing limited percentages of coal. Because these agricultural products sequester carbon as they grow, it is possible to have net zero carbon emissions from biomass replace some of the emissions associated with coal combustion. Lifecycle emissions associated with biomass growing practices must be taken into consideration.**

Agricultural and forestry emissions reductions. **Agricultural and forestry practices provide opportunities to sequester carbon dioxide biologically (in plants and soils), as well as to reduce emissions with technologies such as methane digesters for manure. Biological sequestration tends to be harder to measure than other reductions, and presents challenges on permanence and additionality, but is likely a significant source of reduction opportunities in the region. Some Midwest states have already created organizations to aggregate agricultural reductions for sale as offsets in emissions trading programs.‡‡**

Biofuels. **The Midwest has an enormous potential to produce biofuels from its fertile land. Biofuels can provide GHG emissions reductions that depend on the emissions caused per unit of energy (referred to as the fuels' life-cycle emissions, footprint, or profile), on the total amounts of fuels produced, and on the efficiency of vehicles in which the fuels are used. While corn-based ethanol provides some GHG reduction benefit, other feedstocks, conversion methods, and fuels have the potential to make a much greater contribution in the long term.**

† American Wind Energy Association 2007 Market Report. Available at http://www.awea.org/Market_Report_Jan08.pdf

‡ Midwest Geologic Sequestration Consortium. http://sequestration.org/

‡‡See the Illinois Conservation and Climate Initiative, http://www.illinoisclimate.org/

- **Project-specific assessments vs. performance standards.** Quantifying emissions reductions for offsets and determining whether they are "surplus" can be done through individual project assessments, or by using standardized benchmark criteria and performance standards. Project-specific assessments may be more rigorous, but can also be less transparent, more subjective, and ultimately less certain for offset providers. The CDM relies for the most part on project-specific assessments. Performance standards may leave more room for error, and may not be suitable for all project types, but they provide greater certainty for offset providers and lower transaction costs. In the United States, both the Regional Greenhouse Gas Initiative and Chicago Climate Exchange rely on standards-based rules.

- **Institutional roles and responsibilities.** An effective offset program must designate the entities responsible for validating project applications, verifying the performance of projects, certifying emissions reductions, and registering their associated offset credits. Many programs assign validation and verification responsibilities to accredited third parties (verifiers), although regulators can also perform these duties. Assigning responsibility to third parties can provide an independent check on program performance and reduce administrative costs.

- **Links to other programs.** Although considerations about whether and how to link to other emissions trading programs go beyond offsets, one option for quickly and easily expanding the scope of an offset program is to recognize offset credits from other established programs. Rather than develop separate rules and oversight for projects in other countries, for example, a Midwest program could simply recognize credits from Kyoto Protocol offset mechanisms (this could be done without committing the United States to full participation in the Kyoto system). A Midwest program could also recognize offset credits from other state or regional programs. The key issue for recognition would be deciding whether other program criteria and accounting rules are sufficiently compatible.

VIII. OTHER COST-CONTAINMENT MECHANISMS

Offsets are only one mechanism for reducing the cost of complying with a cap-and-trade program. In fact, cap-and-trade itself provides an incentive to seek the least-cost reductions available. However, regulated entities often seek assurance that compliance with an emissions reduction program will not exceed some level of costs. Unlike a carbon tax, which sets the price of a ton of carbon and lets the market determine the level of reduction, cap-and-trade sets the level of reduction and lets the market determine the price. For this reason, a policy cannot provide both environmental and price certainty; mechanisms that introduce price certainty into a cap-and-trade program do not ensure that the target reductions are achieved. Likewise, mechanisms that ensure the integrity of an emissions cap can serve to minimize the cost of reductions, but cannot ensure that prices will not exceed a given level.

MAINTAINING ENVIRONMENTAL CERTAINTY

The following mechanisms can be used to reduce compliance costs without allowing emissions to exceed the cap:

Banking. Banking permits entities with excess allowances in any compliance period to save (or "bank") those allowances for a future period. This allows the covered entities to anticipate changes in the cost of reductions over time and to save allowances obtained when prices are low to be used (or sold) at times when prices are higher.

Increased use of offsets. As discussed above, offsets can be an effective mechanism for containing costs, as long as the reductions are real and additional. However, there are a variety of reasons that policymakers may choose to limit offsets by project type, geographic scope, or quantity. If such limits are used, they may be tied to the price of allowances and relaxed if prices exceed a certain level. For example, RGGI not only expands the geographic scope of offsets allowed if prices reach a pre-defined threshold, but also increases the percentage of one's compliance obligation that may be met through offsets.

Borrowing. Borrowing can be considered the reverse of banking. Instead of saving allowances from today for the future, allowances from future periods are "borrowed" and used today. This can be done at either the firm or program level, and allows emissions in the current period to rise above the cap in exchange for lowering emissions below the cap in the future. In principle, borrowing should not jeopardize the environmental integrity of the program, since the total amount of reduction is not affected. However, there is a risk that future high prices will lead to additional borrowing from later periods, pushing meaningful reductions further and further into the future and limiting policymakers' ability to adjust the long-term cap downward if scientific findings warrant more aggressive action. In addition, there is a risk that borrowers facing economic hardship in the future will request and receive forgiveness of these "debts," allowing overall emissions to rise above the cap. Some of these concerns can be addressed by keeping the period over which borrowing can occur to only a few years. Likewise, the aggregate amount of reductions that can be shifted can be limited, in order to avoid indefinite borrowing. To avoid pressures for debt forgiveness, borrowing might be permitted at an overall program level—with allowances added to the near-term cap by a program administrator and deducted from a future period—rather than allowing individual firms to borrow against their own future allocations. Lastly, borrowing can be permitted with "interest," requiring a greater than one-to-one reduction of the future cap in exchange for tons borrowed in the present.

MAINTAINING PRICE CERTAINTY

The following mechanism provides price certainty, but at the expense of a hard cap on emissions.

Price cap. The term "price cap" describes a mechanism for keeping allowance prices at or below a pre-set level. In some variations, additional allowances are sold by the government at that price. Other approaches allow entities to pay a fee of the pre-set amount to the government in lieu of submitting an allowance. In either case, emissions beyond the overall cap are permitted. Price caps are similar to the price-triggered borrowing approach described above, but without the subsequent reduction in future emissions to preserve the aggregate amount of reductions. Price caps are sometimes referred to as a "safety valve," but the latter term is broader, and includes any mechanism that triggers a change in the program if compliance costs are higher than expected (such as the price-triggered increase in the allowable use of offsets under the RGGI program).

While the merits of price certainty versus environmental certainty are debated by economists, price caps introduce an additional wrinkle into cap-and-trade design, making it politically difficult to link one trading system with another. Linking trading systems, discussed in more detail in section VIII, involves accepting allowances from an outside trading program for compliance in one's own. If a program without a price cap accepts allowances from one with a price cap, it allows covered entities the option of paying a fee without a corresponding emissions reduction, an outcome unlikely to please policymakers who deliberately chose not to include this mechanism in their own system's design.

MAINTAINING A MINIMUM PRICE

While many covered entities argue for a maximum price on allowances, others advocate a floor level below which allowance prices may not drop. This is desirable for entities planning to invest in emissions reductions that can be sold to others for compliance, and seeking assurances that such sales will cover their costs. It is also appealing to those who fear that prices will be too low to provide incentives for new technologies. However, others argue against a floor price on the ground that consumers, who ultimately feel the effects of a price on GHG emissions, would benefit from low prices. The following mechanisms could be used to keep the price of allowances from falling excessively low.

Banking. Entities holding excess allowances in periods of low prices are able to bank these for sale in periods of higher prices, naturally maintaining an upward pull on the minimum price of allowances in the market. Because banking permits allowances to be saved in periods of low prices and used or sold in periods of high prices, it tempers price swings in either direction. Tightening the cap in future periods will also put upward pressure on prices.

Auction reserve price. The use of a reserve price for any auctioned allowances permits a program administrator to hold back any allowances for which bids are below a pre-set price. Any freely allocated allowances would not be directly affected, nor would the market price for traded allowances, meaning that allowance sellers may not receive all the price assurances they might like. However, such an approach effectively reduces the pool of allowances in the market if the reserve price is not met, which should increase the market price as well.

Price floor. An explicit price floor parallels the price cap (or ceiling) described above. If prices drop below a certain level, the program administrator could remove allowances from the system by buying them at that pre-set price. However, this raises concerns about the government being a buyer in a market that it administers. There is also a political challenge to implementing a policy of this type—policymakers are often hesitant to declare that, regardless of innovation and efficiencies, a program will cost no less than some amount of money.

IX. LINKING TO OTHER TRADING SYSTEMS

The nature of cap and trade is such that the broader the market, and the more diverse the emitters covered by the program, the more opportunities there are to find cost-effective reductions and minimize the cost of the program. In addition, a broader program helps ensure market liquidity, which also helps lower costs for participants. A consistent set of market rules covering emitters is also desirable because of administrative simplicity and because industries have concerns about competitors not subject to the same obligations. For these reasons, linking an emissions market to others (e.g., other states, regions, nations, or global markets) offers significant benefits.

However, linking to other markets also presents some concerns. Links can be two-way, in which programs mutually agree to accept allowances from each others' programs for compliance in their own; or one-way, in which any individual market may accept allowances from any other system without the reverse being true. Because linking effectively endorses other markets' allowances as being as good as one's own, it requires a great deal of trust in the design and administration of that other market, as well as harmonization of some technical details to making linking possible.

A variety of studies have looked at the design details relevant to linking emissions trading programs, including: program coverage (gases, sectors, and direct/indirect emissions), definition of trading units, absolute vs. relative targets, target stringency, allocation methodology, compliance periods, banking/borrowing, penalties or price caps, monitoring/reporting and verification, liability rules, registry requirements, and the crediting system for offsets.[13,14,15] Some have argued that relatively few design elements (such as specified trading restrictions or allowance price caps) actually preclude linkage,[16] while others note that the more individual programs diverge in their design, the more difficult linking is in the future.[17]

Despite the economic benefits, there are political considerations that may reduce the desire to link with other programs. Participants in one system benefit when they can buy cheaper reductions in a linked system, but such a purchase requires a flow of money from internal entities to external entities. Program designers may seek to limit the number of outside allowances (or offsets) accepted if they're concerned with keeping the economic and environmental co-benefits of reductions locally. (See the discussion of RGGI's use of limits on offsets from outside the U.S. in the offsets and cost-containment sections above.)

CONCLUSION

A cap-and-trade program offers policymakers a wide variety of mechanisms to achieve multiple program goals. Many of the decisions involved in the design of a cap-and-trade program speak to broader policy priorities regarding equity and economic development, as well as to the effectiveness of reducing greenhouse gas emissions. Careful design will allow policymakers to reduce greenhouse gas emissions, manage costs, address broader policy priorities, and enable links to other trading systems around the world.

NOTES

1. See Table 2 on emissions targets, page 14.
2. While different decisions on GWP could be made by the region, the standard GWP choice, adopted internationally by the United Nations as well as by current emissions trading programs in the US, is to use the 100-year time horizon to compare the global warming effect of gases. These are listed in Table 1.
3. WRI CAIT-US (2007). http://cait.wri.org. Environment Canada (2007). 2003 data. Includes the 6 U.S. states in Midwest accord and Manitoba.
4. U.S. Department of Transportation Bureau of Transportation Statistics National Transportation Statistics 2007. Available at http://www.bts.gov/publications/national_transportation_statistics/html/table_01_11.html.
5. Nordhaus, Robert R., Kyle W. Danish (2003). *Designing a Mandatory Greenhouse Gas Reduction Program for the U.S.*, Arlington, VA: Pew Center on Global Climate Change.
6. WRI CAIT-US (2007). http://cait.wri.org. Environment Canada (2007). 2003 data. Includes the 6 U.S. states in Midwest accord and Manitoba.
7. Reporting is required for large facilities in California, Connecticut, Maine, New Jersey, New Mexico, and Oregon.
8. These voluntary registries track and disclose emissions trends at the corporate level. Of these, only The Climate Registry requires that entities report data at the facility level.
9. For more information, please see Rich, D. (2008). *Designing a U.S. Greenhouse Gas Emissions Registry*. Washington, DC: World Resources Institute.
10. EPA made allocation decisions based on the heat input of electric generating units rather than historical emissions data. Heat input served as a reasonable proxy for emissions because all affected facilities were power plants. In the case of greenhouse gases, no such proxy data exists that would apply to all sectors, gases, and sources. Allocation decisions would be best informed by first collecting actual emissions data from facilities (though auctioning allowances rather than allocating them for free would be less dependent on such data).
11. Mandatory emissions reporting should precede implementation of a cap-and-trade program, but need not precede passage of legislation establishing such a program. Program designers may decide on an overall cap and general methods for distributing allowances before a registry is established.
12. Targets for GHG reductions and timeframes will be established consistent with states' individual targets, within eight months after the November 2007 signing of the Accord.
13. Bodansky, Daniel (2001). Linking U.S. and International Climate Change Strategies. White Paper. Prepared for the Pew Center on Global Climate Change.
14. Sterk, Wolfgang, Marcel Braun, Constanze Haug, Katarina Korytarova, Anja Scholten (2006). "Ready to Link Up? Implications of Design Differences for Linking Domestic Emissions Trading Schemes" Prepared as part of the Wuppertal Joint Emissions Trading as a Socio-Ecological Transformation (JET-SET) Project.
15. Schule, Ralf, Anger, Niels, Beuermann, Christiane, Braun, Marcel, Brouns, Bernd, Duckat, Renate, Onigkeit, Janina and Wolfgang Sterk (2005). "Linking Emissions Trading Schemes: Institutional, Economic and Environmental Effects of Policy Scenarios." Wuppertal Institute for Climate Environment and Energy. Working Paper CSP1.
16. Haites, Erik and Fiona Mullins (2001). "Linking Domestic and Industry Greenhouse Gas Emission Trading Systems." Prepared for Electric Power Research Institute, International Energy Agency and International Emissions Trading Association.
17. Bodansky (2001).

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