CURBING GREENHOUSE GAS EMISSIONS — TWO APPROACHES

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Policymakers evaluating strategies for reducing greenhouse gas emissions have two general approaches to consider. A **cap-and-trade** system curbs emissions by limiting the *quantity* of a pollutant (e.g., carbon dioxide) that can be emitted and then allocating a corresponding number of tradable emissions permits to sources covered by the program. A **carbon tax** curbs emissions by raising the *price* of fossil fuels based on their carbon content.

CAP-AND-TRADE

With this approach, a regulatory body (e.g., the federal government) sets a cap on emissions of a particular pollutant (e.g., gas X) from a designated group of polluters (e.g., power plants). The total emissions allowed under the cap are divided into individual permits (e.g., one ton of gas X) representing the right to emit that quantity of the pollutant. The permits are then allocated to the sources covered by the program. (There are a variety of allocation methods, including free distribution to the capped entities, an auction, or some combination of these.) At the end of the compliance period, each regulated source must report all emissions and surrender an equivalent number of permits.

Since the total number of permits is limited by the cap, they take on financial value and can be traded on the open market. Companies that are able to reduce their emissions at a low cost can sell their extra permits to companies for whom the cost of reducing emissions is high. Each company has the flexibility to choose how to meet its emissions target, but market incentives encourage companies to develop new technologies that lower the cost of reducing emissions.

Over time, the emissions cap may be lowered to achieve more aggressive pollution-reduction targets, requiring companies to adjust their strategies to comply with the new levels. Companies may also face competition for increasingly valuable emissions permits from environmental groups that purchase permits and retire them permanently from the system.[1]

Acid Rain Program

The most successful cap-and-trade system to date is the Acid Rain Program created under the 1990 Clean Air Act Amendments. The program set a permanent cap on the total amount of sulfur dioxide that could be emitted by power plants across the country. At full implementation in 2010, after increasingly stringent emissions limits have been imposed, the cap is expected to reduce annual SO_2 emissions to one-half of the amount of SO_2 emitted in 1980.

Regulated sources (power plants) are allocated allowances (permits) based on historic fuel consumption and emissions rates prior to the start of the program. At the end of each year, every source must have enough allowances to cover its emissions for that year. Sources that have unused allowances may trade or sell them, or bank them to use or sell in future years. Emissions trading gives each source the flexibility to design its own compliance strategy. Monitoring and stiff penalties promote compliance.

Design Considerations—Point of Regulation[2]

Designing an effective cap-and-trade program to reduce CO_2 emissions is far more complex than was creating a system to reduce emissions of SO_2. The Acid Rain Program covered large stationary sources of pollution—electric generators, the principle source of SO_2 emissions. Major sources of CO_2 emissions, on the other hand, include large stationary sources as well as other sectors such as transportation and energy use in commercial and residential buildings. Determining how to regulate emissions from all these sources is a key issue for policymakers.

Upstream cap-and-trade. An upstream program applies to *producers and importers* of fossil fuels, which would be required to have allowances equal to the potential CO_2 emissions of their products. Producers would pass along the cost of the allowances to fuel consumers. The higher prices would in turn encourage adoption of fuel- and energy-saving technologies and practices and promote the use of cleaner energy sources.

Downstream cap-and-trade. A downstream program applies to fuel *users*. It can apply economy-wide, to all CO_2 emissions sources, which would involve regulation of large stationary sources as well as vehicles, homes and other sectors—presenting huge administrative challenges. Or the program can apply only to large sources, such as power plants and large industrial facilities. Although much more manageable administratively, this would cover only about 50 percent of CO_2 emissions.

Hybrid upstream/downstream cap-and-trade. This approach includes regulation of both large emissions sources downstream and some upstream fuel suppliers, such as producers of fuels used for transportation purposes. Depending on the range of upstream fuel sources included, the program could cover up to 100 percent of CO_2 emissions. The design challenge is to ensure that each ton of emissions is counted only once in the system.

Sectoral hybrid program. This approach combines a downstream cap-and-trade system for large-source emitters (power plants, large industries) with upgraded efficiency standards for vehicles and for appliances used in homes and commercial buildings. It builds on existing efficiency standards programs and would achieve coverage of roughly 80 percent of energy-related CO_2 emissions without the problem of the potential double-counting of emissions. On the other hand, the higher efficiency standards would apply only to new products and vehicles and would therefore take time to penetrate the system.

Design considerations—Method of Allowance Distribution

Emissions allowances are extremely valuable assets—in the case of CO_2 allowances, worth tens, perhaps hundreds, of billions of dollars a year—and the way they are distributed has important implications for the equity of the program.

Free distribution. With this method, allowances are given free to the capped entities based on their historic emissions. This approach is meant to compensate regulated firms, in whole or in part, for the cost of the emissions reduction program. Research indicates, however, that most of the cost of meeting the emissions cap would be passed on to consumers in the form of higher prices, leaving the regulated entities with substantial profits.[3]

Auction. Alternatively, the government can sell the needed allowances to the regulated entities through an auction. This method would generate sizable revenues that could then be used to achieve other desired goals. Auction proceeds could be used to reduce existing taxes that dampen economic activity (e.g., payroll taxes, income taxes) or could be targeted to help lower-income households meet higher energy prices (e.g., by expanding the earned income tax credit). Funds could also be used to advance clean energy alternatives with investments in energy research and development, energy efficiency initiatives, and new technologies.

Hybrid. A mix of free distribution and allowance auctions can also be used. A portion of the allowances could be distributed free, for example, to entities and regions of the country that would be more adversely affected by the emissions cap. Over time, the free allocations could be phased out entirely.

CARBON TAX

As typically envisioned, a carbon tax would be imposed on fossil fuel suppliers at a rate that reflects the amount of carbon that will be emitted when the fuel is combusted. The tax would be included in the price of the coal, oil and natural gas supplied to wholesale users and ultimately passed on to consumers in the price of electricity, gasoline and other energy-intensive products. Coal, which generates the greatest amount of carbon per unit of energy (BTU), would be taxed at a higher rate per BTU than oil or natural gas.[4] By raising the price of carbon-based energy, the tax would create incentives to reduce energy use, stimulate demand for more energy-efficient products, and promote a shift to cleaner fuels and renewable energy.

A federal carbon tax would affect all sectors of the economy. Tax proponents suggest that it be levied at the wholesale stage as far "upstream" as practicable, namely at the point at which the fossil fuel passes from the producer (e.g., the coal mine, oil tanker, or natural gas wellhead) to the next entity in the supply chain. Electric power generators, for example, would pay the tax on the coal, oil, or natural gas they purchase and then pass the cost on to retail electric utilities "downstream," which in turn would pass it along in the rates they charge their customers.[5]

A carbon tax raises revenues directly. These can be used for a variety of purposes, such as those described above as possible uses for the proceeds from an auction of emissions permits.

The carbon tax can be set to reflect what economists call the social cost of carbon (SCC), "the present value of additional economic damages now and in the future caused by an additional ton of carbon emissions." Estimates of SCC vary widely, reflecting uncertainty about future climate change scenarios and disagreement as to how to value the impact of projected climate damages. In his most recent analysis, climate economist William Nordhaus estimates the SCC to be approximately $30/ton of carbon.[6]

A carbon tax of $30/ton would translate into a tax on gasoline of about 9 cents/gallon and a tax on coal-generated electricity of about 1 cent/kWh. It would raise about $50 billion/year, based on current levels of carbon emissions in the U.S. To stabilize CO_2 concentrations at 550 parts per million (widely considered to be a meaningful climatic goal), the carbon tax would have to ramp up steadily, rising to as much as $110/ton by 2025 and $330/ton by 2050.[7]

COMPARING THE TWO APPROACHES

A cap-and-trade system and a carbon tax are both market-based policy instruments that create incentives to reduce carbon emissions. A cap-and-trade system is a *quantity-based* instrument; it fixes the total quantity of emissions and allows the price of energy and energy-related products to fluctuate according to market forces. A carbon tax is a *price-based* instrument; it fixes the price of carbon-based energy and allows emissions levels to vary according to economic activity.

Emissions certainty

The strength of the **cap-and-trade** approach is that it sets firm limits on emissions. The cap is set at a level designed to achieve a desired environmental outcome (e.g., reduction of emissions to 80 percent of 1990 levels by 2050), and individual companies have the flexibility to choose how they will achieve their emissions targets.

A **carbon tax** does not ensure that any particular emissions target is met. It allows the quantity of emissions to fluctuate as the demand for energy rises or falls. Allowing emissions to vary from year to year gives firms the flexibility to abate less and pay more in taxes when abatement costs are unusually high (and vice-versa when abatement costs are low).[8] In order to achieve climatic goals, the tax rate can be adjusted over time to attain greater emissions reductions.

Price predictability

The advantage of a **carbon tax** is that it fixes the price of carbon emissions. It creates a permanent incentive to reduce emissions, thereby encouraging investment in alternative fuels and energy-efficient technologies that have high up-front costs.

Under a **cap-and-trade** system, the price of emissions permits may vary considerably from year to year. An especially cold winter, for example, or sudden growth in a particular industry could increase the demand for energy and cause a spike in the price of permits. This volatility in permit prices could weaken incentives to seek and invest in lower-carbon technologies.

Both major cap-and-trade programs in existence today—the Acid Rain Program and the European Union's Emissions Trading Scheme (ETS)—have experienced significant volatility in the price of emissions permits. In the case of the Acid Rain Program, the price of SO_2 permits has varied, on average, by more than 40 percent/year.[9] Under the ETS, far more permits were issued initially than were needed to cover actual emissions. When this was discovered, the permit price plummeted from 30 euros/ton of CO_2 to less than a euro/ton in February 2007.[10]

To address permit price volatility and soften the economic impact of emissions reductions, some cap-and-trade proposals include cost-control mechanisms and/or other features that introduce flexibility into the system.

> **Safety valve**. This feature would establish a ceiling on the price of emissions permits. If the permit price reached this trigger level, the government could sell as many additional permits at this price as capped entities wished to purchase. This would allow the level of emissions to exceed the cap. The cap would be met only if the permit price never rose above the safety valve price. The safety valve feature weakens the price signal needed to spur investment in expensive clean energy technologies.

Circuit breaker. This mechanism would freeze a gradually declining emissions cap if the permit price rose above a predetermined level. The intent is to prevent the price of carbon from reaching a level that would endanger the economy. Such a feature could create disincentives for companies to develop new efficiencies.

Banking. With banking, firms could save unused allowances for future years. This feature can offer incentives for early emissions reductions and flexibility with respect to the timing of investment.

Borrowing. This feature would provide relief if permit prices spiked unexpectedly. It would allow companies to borrow permits from future years and pay them back, with interest, when the short-term spike receded. Safeguards could include a mechanism to secure repayment and guard against defaults. The integrity of the cap would be preserved over the long term.

Offsets. These are carbon mitigation projects involving sources outside the sectors that are regulated by the cap-and-trade system. A capped entity could cover some of its emissions by purchasing credits created through an offset project, such as tree planting or capturing landfill gas (methane). Offsets typically offer a cheaper way for firms to meet their emissions targets than through direct emissions cuts. If not limited to a portion of capped entities' compliance obligations, offsets can delay investments in new clean-energy technologies. Care must also be taken to ensure that offset projects result in net benefits. They must be real, additional (not simply an action that would have taken place anyway), verifiable (by an independent third party), permanent, and enforceable.

Environmental effectiveness

The impact of a **cap-and-trade** system depends on a variety of factors. (1) How stringent is the emissions target? Will it put the country on a path that will reverse the growth of its emissions? (2) How will baseline emissions be measured and a corresponding and appropriate number of emissions permits be determined and distributed? (3) Will the cap be applied economy-wide or to only certain sectors? (4) What types of cost control measures, if any, are included? Are they set high enough to spur investment in clean energy technologies? (5) Will any revenues be generated and directed to development and adoption of energy-saving technologies?

The impact of a **carbon tax** depends in large part on whether the tax rate is set high enough to create real market incentives to develop and adopt climate-friendly technologies. Although a carbon tax does not establish a firm limit on emissions, it applies economy-wide and provides a continual incentive for companies to make carbon-saving investments. The tax rate also can be increased over time to provide stronger incentives to reduce emissions.

Equity

The method by which emissions permits are allocated will have a major impact on the equity of a **cap-and-trade** system. Free distribution could lead to significant overcompensation of the firms receiving the permits; research indicates that only a modest portion of the allowance value—less than 15 percent—is needed to offset the costs of the cap. The remainder would be passed along in increased prices to consumers "downstream." These price increases would disproportionately affect lower-income households, both because they tend to spend a larger fraction of their income than do higher-income households and because energy products make up a bigger share of their spending.[11] Auctioning emissions permits, on the other hand, would generate revenues that could be earmarked to offset the regressivity of the price increases caused by the cap.

A **carbon tax** directly raises substantial revenues. These could be used to fund "progressive" tax-shifting policies that would reduce the burden of higher energy costs on lower-income groups. A lump sum rebate to all households, for example, could easily offset the burden that increased prices would impose on those at the lower end of the income scale.[12] An expanded earned income tax credit could target assistance more narrowly. Revenues could also be used to fund energy-efficiency programs in low-income communities.

Simplicity and transparency

A **cap-and-trade** system requires new institutions—a system to allocate emissions permits, markets where firms can buy and sell those permits, brokers, and a means of monitoring emissions and trades—all of which entail significant transactional costs. Within that framework, the method chosen for allocating emissions permits is a major factor in the ultimate fairness and efficiency of the cap-and-trade market. Auctioning the permits rather than distributing them for free can help promote simplicity and transparency for the system.[13]

A **carbon tax** can be levied and collected through existing institutions that have experience in enforcing compliance. It is simpler and less expensive to administer and enforce than is a cap-and-trade system. Its underlying premise—that the price of energy and energy-intensive products should include the environmental costs associated with their production—is transparent and readily understood.

LOOKING AHEAD

Although economists generally favor a carbon tax, most business interests and environmentalists are backing a cap-and-trade approach. In January 2007, a group of major U.S. businesses and leading environmental organizations joined together to call on the federal government to enact strong legislation requiring significant reductions in emissions. This U.S. Climate Action Partnership (USCAP) endorsed a blueprint for a mandatory, economy-wide, market-driven approach, with a cap-and-trade program as its cornerstone.[14]

The majority of climate change proposals currently under consideration in Congress would establish cap-and-trade programs to reduce emissions. They vary in terms of scope of coverage (e.g., economy-wide, electricity sector), stringency of the cap, permit allocation provisions, treatment of offsets and cost controls, funds for new technologies and efficiency programs, and many other details. Two carbon tax proposals have also been introduced.

Cap-and-trade initiatives are already underway at the regional level. Two groups of states are in the process of developing emissions trading systems—the Regional Greenhouse Gas Initiative (RGGI), formed by ten Northeast and Mid-Atlantic states, and the Western Regional Climate Action Initiative of six Western states, joined by British Columbia and Manitoba.[15]

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1 The Clean Air Conservancy (http://www.cleanairconservancy.org/) retires emissions permits permanently from the system by purchasing permits and by encouraging companies to donate pollution rights to CAC (rather than sell them to other firms). The CAC Trust currently holds permits for over 7 billion pounds of sulfur dioxide, nitrous oxide, and carbon dioxide.

2 Although a cap-and-trade program can be designed to cover all greenhouse gases, this paper discusses the concept in the context of limiting emissions of carbon dioxide (CO_2).

3 Congressional Budget Office, *Trade-Offs in Allocating Allowances for CO_2 Emissions* (April 25, 2007), p. 5. Available at: http://www.cbo.gov/ftpdocs/80xx/doc8027/04-25-Cap_Trade.pdf.)

Contrary to what one might expect, free distribution of permits does not prevent consumer prices from rising as a result of the cap. Firms that receive the free permits have the option of forgoing production and selling the permits to other producers. If instead they use the allowances to cover the carbon emissions of their product, they will give up the income they could have earned by selling the allowances. They will pass this "opportunity cost" on to their customers just as they would actual expenses. Thus, free distribution could yield windfall profits for firms' owners and shareholders.

4 Coal contains .03 tons of carbon per million BTU of energy. Oil contains .024 tons and natural gas .016 tons of carbon/million BTU of energy. (BTU—British Thermal Unit—is a basic measure of the heat, or energy, value of fuels.)

5 Details about how a federal carbon tax might be implemented come from the Carbon Tax Center (http://www.carbontax.org/tech/implementing-carbon-taxes/).

6 William D. Nordhaus, *The Challenge of Global Warming: Economic Models and Environmental Policy* (Yale University, New Haven, CT, 2007), pp 19-24. Available at: http://nordhaus.econ.yale.edu/dice_mss_072407_all.pdf.

7 Richard G. Newell and Daniel Hall, *U.S. Climate Mitigation in the Context of Global Stabilization* (Resources for the Future, May 2007), p 2. Available at: http://www.weathervane.rff.org/Backgrounders/RFF-BCK-USMitigationGlobalStabilization.pdf

NOTE: In discussions of the social cost of carbon and suggested carbon tax rates, it is important to distinguish between estimates quoted in terms of tons of carbon and those expressed in terms of tons of CO_2. There are roughly 27 tons of carbon in 100 tons of CO_2. Put another way, the weight of CO_2 is 3.67 times the weight of carbon.

To convert a tax on carbon into a tax on CO_2, multiply the $/ton carbon by .273. Thus, a $30/ton tax on carbon is equal to about an $8/ton tax on CO_2. Conversely, to convert a tax on CO_2 into a carbon tax, multiply the $/ton CO_2 by 3.67. Thus a $10/ton tax on CO_2 is equal to about a $37/ton tax on carbon.

For consistency, this paper discusses tax rates in terms of price/ton of carbon throughout. Newell and Hall discuss prices/ton of CO_2.

8 Ian W.H. Parry and William A. Pizer, *Emissions Trading versus CO_2 Taxes* (Resources for the Future, May 2007), p. 2. Available at: http://www.weathervane.rff.org/Backgrounders/RFF-BCK-TradingvsTaxes.pdf. In the authors' view, "imposing strict limits makes economic sense only if (1) we are rapidly approaching a threshold in atmospheric greenhouse gas concentrations beyond which there is a risk of dangerous climate change; and (2) those strict limits are globally enforced."

9 Robert J. Shapiro, *Addressing the Risks of Climate Change: The Environmental Effectiveness and Economic Efficiency of Emissions Caps and Tradable Permit, Compared to Carbon Taxes* (The American Consumer Institute, February 2007), p 5. Available at: http://www.theamericanconsumer.org/Shapiro.pdf. Shapiro notes that price volatility has increased in the last three years as permit prices have risen by an average of more than 80 percent/year, despite a safety-valve provision allowing the EPA to auction additional permits.

10 Ronald Bailey, *Carbon Taxes Versus Carbon Markets: What's the Best Way to Limit Emissions?* (The American, May 18, 2007). Available at: http://www.american.com/archive/2007/may-0507/tax-or-trade/

11 Congressional Budget Office, *Trade-Offs in Allocating Allowances*, pp. 3-5.

12 The example of the impact of a lump-sum rebate on household income is taken from a set of scenarios developed to analyze the distributional effects of different uses of revenues from a cap-and-trade program. CBO, *Trade-Offs in Allocating Allowances*, p. 6.

13 Dallas Burtraw, *Climate Change: Lessons Learned from Existing Cap and Trade Programs*, (written testimony for the U.S. House of Representatives, March 29, 2007). Available at: http://www.rff.org/rff/News/Releases/2007Releases/BurtrawKoppTestimony3-29-07.cfm. Burtraw notes that "the best market design is simple and transparent. This is the best guarantee that a cap-and-trade market is fair and efficient. If, as they say, the devil is in the details, then the more details there are, the more places there are for the devil to hide. In many cases, details that seem compelling to appease one group or to fix one problem only beget other problems, opening the door for unintended consequences."

14 United States Climate Action Partnership, *A Call for Action: Consensus Principles and Recommendations* (January 2007). http://www.us-cap.org/

15 For further information, see the following: Regional Greenhouse Gas Initiative, *Goals and Guiding Principles*, (http://www.rggi.org/goals.htm); Pew Center on Global Climate Change, *What's Being Done: Regional Initiatives*, (http://www.pewclimate.org/what_s_being_done/in_the_states/regional_initiatives.cfm).