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ASSESSING THE OPTIONS FOR DESIGNING A MANDATORY U.S. GREENHOUSE GAS REDUCTION PROGRAM

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Abstract: With the United States accounting for over one-fifth of global emissions of greenhouse gases, the U.S. government is facing pressures—from both domestic and international sources—to establish a comprehensive mandatory reduction program to address the risk of global climate change. If Congress decides to move forward with such a program, it could be creating an environmental regulatory regime of unprecedented scope and impact. Many policymakers are considering innovative market-based approaches to regulation, including a multibillion dollar economy-wide "cap-and-trade" program. The authors evaluate four models for a domestic program against a set of several criteria, including environmental effectiveness, cost, administrative feasibility, distributional equity, and political acceptability.

Introduction

Until now, U.S. climate change policy at the federal level has consisted of voluntary greenhouse gas (GHG) mitigation programs, research and development, and a subset of energy policies that focus on energy efficiency and renewable energy. However, the U.S. government is facing pressures—from both domestic and international sources—to establish a federal mandatory reduction program to address the risk of global climate change. If Congress decides to move forward with such a program, it could be creating an environmental regulatory regime of

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unprecedented scope and impact. Sources of greenhouse gases range from electric power plants to every car on the road. In addition, many policymakers are considering innovative market-based approaches to regulation, including a multi-billion dollar economy-wide cap-and-trade program.

This Article identifies issues that must be addressed in the design of a mandatory domestic GHG reduction program. The Article then evaluates a number of proposals, including (1) comprehensive cap-and-trade programs; (2) a GHG tax; and (3) a "sectoral hybrid" program that combines elements of a cap-and-trade program with product efficiency standards for automobiles and consumer products.

While there is a substantial body of opinion, particularly among economists, that an economy-wide cap-and-trade or GHG tax program may be optimal from a cost-effectiveness point of view, it is possible that a GHG regulatory program will be developed from discrete familiar elements, such as existing Corporate Average Fuel Economy (CAFE) and appliance efficiency standards, plus large stationary source controls modeled on the acid-rain control program. Rather than creating a whole new system, Congress may choose the latter approach because of both familiarity and political sensitivity regarding program designs that result in overt increases in prices for gasoline and home heating fuels. We review the implications of these two fundamentally different approaches.

While this Article focuses on options for federal regulatory policies, it is important to note that a domestic climate change program could enhance its regulatory policies with a range of non-regulatory measures, such as funding for research and development into new technologies, financial and other incentives, public education, and changes in infrastructure and land-use policies. In addition, state and local governments may supplement a federal regulatory program with their own policy initiatives.[1]

I. U.S. Greenhouse Gas Emissions Profile

Domestic climate change policy will likely focus on reductions or sequestration of emissions of six GHGs: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and what have been called the "syn-

[1] For more information on current state and local climate change policy initiatives, see the Pew Center on Global Climate Change's State and Local Net Greenhouse Gas Emissions Reduction Programs database, *at* http://www.pewclimate.org/states.cfm (last visited Jan. 14, 2005).

thetic gases," hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6).[2]

Because GHGs have long lifetimes in the atmosphere, it matters little where or exactly when GHG emission reductions are made.[3] For example, one ton emitted in the United States has the same impact as one ton emitted in Malaysia, and reducing one ton of GHG emissions now, rather than five years from now, will make little difference in atmospheric GHG concentrations in 2050.[4] This means that an effective regulatory program can allow flexibility as to where emission reductions occur and substantial but not unlimited flexibility as to when they occur.

Different GHGs vary as to their residence lives in the atmosphere and their heat-trapping, or "radiative forcing," effects.[5] Some GHGs have very long atmospheric lifetimes.[6] The Kyoto Protocol adopts a weighting formula called "Global Warming Potential" (GWP), which measures the impact of one ton of any GHG with reference to one ton of CO_2.[7] With such an agreed-upon "exchange rate," policymakers can develop a unitary program objective in terms of "CO_2-equivalent" units, which allows regulated firms to pick whatever mix of reductions of different GHGs they believe is most cost-effective.[8]

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[2] *See* U.S. EPA, Inventory of Greenhouse Gas Emissions and Sinks: 1990–2001, at ES-1 to ES-2 (2003), *available at* http://yosemite.epa.gov/oar/globalwarming.nsf/UniqueKeyLookup/LHOD5MJQ6G/$File/2003-final-inventory.pdf. HFCs and PFCs are industrial products that are substitutes for ozone-depleting substances. *Id.* Ozone-depleting substances themselves are GHGs, but the United States and other countries are phasing out these substances pursuant to an international treaty, the Montreal Protocol on Substances that Deplete the Ozone Layer, Sept. 16, 1987, 26 I.L.M. 1541 (entered into force Jan. 1, 1989). Certain other gases—carbon monoxide (CO), nitrogen oxides (NO_x), and non-methane volatile organic compounds (NMVOCs)—are not GHGs but have an indirect effect on climate change by influencing the creation and destruction of tropospheric and stratospheric ozone. *See* U.S. EPA, *supra*, at ES-2. These gases are "criteria pollutants" under the Clean Air Act (CAA) and therefore are subject to established regulatory regimes. 42 U.S.C. § 7412 (2000). Emissions of another criteria pollutant, sulfur dioxide (SO_2), also indirectly affect climate change by altering the absorptive characteristics of the atmosphere. *See* U.S. EPA, *supra*, at ES-2.

[3] *See* U.S. EPA, *supra* note 2, at 1-8.

[4] *See id.*

[5] *See* Intergovernmental Panel on Climate Change, Climate Change 2001: The Scientific Basis 356 (J.T. Houghton et al. eds., 2001) [hereinafter IPCC].

[6] For example, a ton of PFCs can persist in the atmosphere for 10,000 to 50,000 years. *See id.* at 47.

[7] Pew Ctr. on Global Climate Change, GWP and Carbon Dioxide Equivalents (CO_2E) [hereinafter Pew Ctr. on Global Climate Change], *at* http://www.pewclimate.org/global-warming-basics/facts_and_figures/gwp.cfm (last visited Jan. 14, 2005).

[8] *See* IPCC, *supra* note 5, at 385–86.

A. *Carbon Dioxide*

Carbon dioxide emissions, resulting almost entirely from combustion of fossil fuels, dominate GHG emissions in the United States and are likely to be among the principal initial targets of any domestic GHG regulatory program. In 2001, energy-related CO_2 emissions accounted for approximately eighty-one percent of U.S. GWP-weighted emissions.[9]

Within the energy sector, the principal means of abating CO_2 emissions are switching from energy sources with high carbon content to those with low or zero carbon content, such as renewables; improving the efficiency of energy conversion or use; reducing energy use; and developing carbon capture and sequestration technologies.[10]

Annual U.S. CO_2 emissions also are affected by land use, land-use change, and forestry (LULUCF) activities.[11] Plants and certain other biotic matter remove CO_2 from the atmosphere and store or "sequester" it as carbon, at least temporarily, through the process of photosynthesis.[12] Hence, forests and agricultural lands are "reservoirs" of carbon and a range of activities can enhance their sequestration potential.[13] Conversely, certain land use changes, such as deforestation, can oxidize the carbon stored in biotic matter, thereby leading to CO_2 emissions.[14]

B. *Other GHGs*

Methane is the second-largest contributor to U.S. GHG emissions, constituting 8.7% of total U.S. GWP-weighted emissions in 2001.[15] Methane is emitted from landfills; natural gas and petroleum production, transportation, and processing; agricultural activities; coal mining; stationary and mobile combustion; wastewater treatment; and certain industrial processes.[16]

Nitrous oxide is a GHG with heat-trapping potential that exceeds that of CO_2 by an order of magnitude.[17] Emissions of nitrous oxide made up 6.1% of U.S. GWP-weighted emissions in 2001.[18] The pri-

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[9] *See* U.S. EPA, *supra* note 2, at 2-1.
[10] *See id.* at ES-10 to ES-17.
[11] *Id.* at ES-17.
[12] *Id.*
[13] *Id.*
[14] *See id.*
[15] *See* U.S. EPA, *supra* note 2, at ES-3 tbl.ES-1, ES-18 fig.ES-14.
[16] *Id.* at ES-18 to ES-20.
[17] *Id.* at ES-20.
[18] *Id.* at ES-3 tbl.ES-1.

mary human activities resulting in emissions of nitrous oxide are agricultural soil management, fuel combustion in motor vehicles, and production processes for adipic and nitric acid.[19]

Emissions of HFCs and PFCs are primarily associated with their use as substitutes for ozone depleting substances banned under the Montreal Protocol treaty.[20] Emissions of HFCs, PFCs, and SF_6 also result from certain other industrial processes, including production of primary aluminum, certain steps in the manufacture of products in the semiconductor industry, and activities related to the operation of electrical transmission and distribution equipment.[21] These gases have very powerful heat-trapping effects.[22] They constituted 1.6% of U.S. GWP-weighted emissions in 2001.[23]

C. *U.S. GHG Emission Trends*

Eventual stabilization of atmospheric concentrations of GHGs will require very large reductions in GHG emissions worldwide. Notwithstanding a slight decline in 2001,[24] U.S. emissions are projected to increase. As discussed above, U.S. emissions were 11.9% higher in 2001 than they were in 1990.[25] Between 1990 and 2000, the GHG "intensity" of the U.S. economy—the ratio of total GHG emissions to economic output—declined by 17.5%.[26] In a report submitted to the United Nations in 2002, the U.S. government projected that by 2020, U.S. GHG emissions will rise 42.7% from year-2000 levels.[27]

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[19] *Id.* at ES-20 to ES-22.

[20] *Id.* at ES-22; *see* Montreal Protocol on Substances that Deplete the Ozone Layer, *supra* note 2.

[21] U.S. EPA, *supra* note 2, at ES-22.

[22] *See id.*

[23] *See id.* at ES-3 tbl.ES-1.

[24] *See* Energy Info. Admin., U.S. Dep't of Energy, Emissions of Greenhouse Gases in the United States 2001, at ix (2002), *available at* http://www.eia.doe.gov/oiaf/1605/gg02rpt/pdf/057301.pdf. According to the U.S. Energy Information Administration (EIA), U.S. GHG emissions declined 1.2% in 2001. *Id.* The EIA attributed this decrease to reduced economic growth, warmer winter weather, and reduced electricity demand. *Id.*

[25] *Id.*

[26] *Id.* at 4.

[27] *See* U.S. Dep't of State, U.S. Climate Action Report 2002, at 73 (2002), *available at* http://yosemite.epa.gov/oar/globalwarming.nsf/UniqueKeyLookup/SHSU5BWHU6/$File/uscar.pdf. This projection did not take into account the effects of the Bush Administration's climate policy announced on February 14, 2002. *Id.* at 78–79.

II. Domestic Climate Policy Framework

The existing federal framework for addressing climate change in the United States is a combination of voluntary programs, tax incentives, energy efficiency standards, and research and development. These programs, and certain Clean Air Act provisions, are described below.

A. *Voluntary Programs*

Since 1993, the federal government has established a number of voluntary GHG emission reduction programs to encourage businesses to undertake GHG mitigation actions. This approach began with the Clinton Administration's "Climate Change Action Plan" (CCAP).[28] The Bush Administration has adopted a similar voluntary strategy.[29] A key supporting element of both the Clinton and Bush Administrations' voluntary programs is the Department of Energy's (DOE) voluntary GHG reporting program under § 1605(b) of the Energy Policy Act of 1992.[30] The § 1605(b) program authorizes DOE to develop a system to document voluntary GHG mitigation actions reported by firms and others participating in various voluntary programs.[31] Elec-

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[28] *See* William J. Clinton & Albert Gore, Jr., The Climate Change Action Plan 1–4 (1993). The Climate Change Action Plan (CCAP) included the "Green Lights" program, encouraging business to upgrade lighting; the "Natural Gas Star" program, encouraging voluntary methane reductions by natural gas producers and distributors; the "Coalbed Methane Outreach Program," encouraging coal mining firms to capture and use methane that otherwise would be vented to the atmosphere; and two programs under which businesses committed to take actions to mitigate their GHG emissions and to report those actions in a transparent format. *Id.* at 12, 17, 22, 23, 24. One program, "Climate Wise," established such agreements with individual businesses, nonprofit groups, and state and local governments. *Id.* at 17. A second program, "Climate Challenge," established agreements with electric utilities. *Id.* at 22.

[29] *See* George W. Bush, Global Climate Change Policy Book (2002). The Bush Administration climate policy has included: the National Climate Change Research Initiative; the National Climate Change Technology Initiative, which focuses on geological sequestration; the FutureGen Initiative, which aims to develop "zero-emissions" coal-fired power plants; the FreedomCAR Initiative, which aims to develop and deploy hydrogen fuel-cell vehicles; the Hydrogen Fuel Initiative, which aims to develop viable fuel cells and hydrogen infrastructure; and the Climate VISION Program, which aims to establish voluntary emission reduction agreements with key sectors of the economy. *See id.*; George W. Bush, Climate Change Fact Sheet, *at* http://www.whitehouse.gov/news/releases/2003/09/20030930-4.html (last visited Jan. 14, 2005).

[30] *See* Energy Policy Act of 1992, Pub. L. No. 102-486, § 1605(b), 106 Stat. 2776 (codified at 42 U.S.C. § 13,385 (1994)). Rules for the § 1605(b) program are set forth at 59 Fed. Reg. 52,769 (Oct. 19, 1994).

[31] *See* Energy Policy Act of 1992 § 1605(b).

tric utilities, in particular, have reported numerous projects under the § 1605(b) program.[32]

While the various voluntary programs have led to a significant number of emission reduction projects, overall emission levels have continued to increase.[33] Several factors have contributed to the limited effectiveness of voluntary programs.[34] First, while some participants in these programs have committed to taking particular mitigation actions, they have not in many cases committed to limiting their company-wide emissions below a particular baseline; for many, total system emissions increased substantially in response to increased market demand for products and services.[35] Second, some participants committed to actions that they might have implemented anyway for business reasons.[36] In particular, commentators have asserted that the § 1605(b) program lacks rigorous reporting standards and verification requirements, and concerns have been raised that some reductions reported under the program have been double-counted.[37] The Bush Administration has pledged to address these shortcomings in a planned upgrade to the program to be completed by the end of 2004.[38] However, any voluntary program remains subject to a fundamental limitation—it only addresses the emissions of those firms that volunteer to participate.[39]

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[32] *See* Energy Info. Admin., Reporting Entities, Data Year 2002, *at* http://www.eia.doe.gov/oiaf/1605/TableB1_2002.html (last visited Jan. 14, 2005).

[33] *See* Natural Res. Def. Council, Reported "Reductions," Rising Emissions, at iii (2001) [hereinafter NRDC], *available at* http://www.nrdc.org/globalwarming/reductions/reductions.pdf.

[34] For a critical review of the rigor and effectiveness of voluntary programs established under the CCAP, see *id.*; *see also* U.S. Gen. Accounting Office, Global Warming: Information on the Results of Four of EPA's Voluntary Climate Change Programs (1997), *available at* http://www.gao.gov/archive/1997/rc97163.pdf.

[35] *See* David Gardiner & Lisa Jacobson, *Will Voluntary Programs be Sufficient to Reduce U.S. Greenhouse Gas Emissions?*, 44 Env't 24, 27 (2002).

[36] *See* NRDC, *supra* note 33, at 9.

[37] *See* Pew Ctr. on Global Climate Change, Greenhouse Gas Reporting and Disclosure: Key Elements of a Prospective U.S. Program 3 (2002), *available at* http://www.pewclimate.org/docUploads/policy_inbrief_ghg.pdf.

[38] At the end of 2003, the Department of Energy published proposed revisions to the § 1605(b) general guidelines. *See* 68 Fed. Reg. 68,204 (proposed Dec. 5, 2003) (to be codified at 10 C.F.R. pt. 300). For more information on the Administration's efforts to enhance the § 1605(b) requirements, see Office of Policy and Int'l Affairs, U.S. Dep't of Energy, Enhancing DOE's Registry of Greenhouse Gas Emissions and Emission Reductions, *at* http://www.pi.energy.gov/enhancingGHGregistry/index.html (last visited Jan. 14, 2005). To this end, the Administration is holding a series of workshops. *See id.*

[39] *See* NRDC, *supra* note 33; *see also* Thomas P. Lyon, Res. for the Future, Voluntary Versus Mandatory Approaches to Climate Change Mitigation (2003), *available at* http://www.rff.org/Documents/RFF-IB-03-01.pdf; Gardiner & Jacobson, *supra* note 35

For these reasons, current U.S. voluntary programs—while helpful in building awareness, encouraging experimentation, and achieving some company-level emission reductions—are not expected to reduce or even stabilize U.S. GHG emissions in the next decade relative to current levels.[40]

In addition to the voluntary GHG programs described above, the U.S. government has established a number of non-regulatory programs aimed at increasing energy efficiency.[41] Because energy-related GHG emissions make up over eighty percent of total U.S. emissions, these programs contribute to reducing GHG emissions.[42] However, like the voluntary GHG reduction programs, they do not impose actual limits on emissions and are incapable of achieving substantial emission reductions with a high degree of certainty.[43]

Finally, federal tax law provides a range of tax credits and other incentives to encourage use of renewable energy and fuel-efficient vehicles.[44] These include: a deduction for a portion of the purchase cost of a "clean-fuel" vehicle, defined to include hybrids;[45] a credit for the purchase of an electric vehicle;[46] an investment credit for solar or geothermal energy equipment[47] and favorable depreciation rates for such equipment;[48] and a credit for production of electricity from wind, cer-

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(concluding that voluntary programs are inadequate to significantly reduce short- or long-term emissions).

[40] *See* Gardiner & Jacobson, *supra* note 35, at 31–32.

[41] Two voluntary energy efficiency programs, "Industries of the Future" and "National Industrial Competitiveness through Energy, Environment, and Economics" (NICE), established public-private partnerships to encourage businesses and state governments to adopt the best practices and technologies. *See* U.S. Dep't of Energy, Indus. of the Future, *at* http://www.eere.energy.gov/industry/program_areas/industries.html (last updated Dec. 29, 2004). Another initiative, the "Energy Star" program, steers consumers to energy efficient products by awarding a government "Energy Star" label to such products. *See generally* U.S. EPA, Energy Star—The Power to Protect the Environment Through Energy Efficiency (2003), http://www.energystar.gov/ia/partners/downloads/energy_star_report_aug_2003.pdf (last visited Jan. 14, 2005). To earn an "Energy Star" label, a product typically must be in the upper quartile of its product class when it comes to energy efficiency. *See id.* For descriptions of other federal energy efficiency programs, see U.S. Dep't of Energy, Power Topics, *at* http://www.eere.energy.gov/EE/power.html (last updated Jan. 11, 2005).

[42] *See* U.S. EPA, *supra* note 2, at 2-1.

[43] *See id.*

[44] *See, e.g.*, 26 U.S.C. §§ 30, 45, 48, 168 (2000).

[45] *Id.* § 179A.

[46] *Id.* § 30.

[47] *Id.* § 48.

[48] *Id.* § 168.

tain types of biomass, or poultry waste.[49] Congress is considering a number of additional tax incentives and modifications to existing tax programs in the context of proposed federal energy legislation.[50]

B. *Product Efficiency Standards*

1. Corporate Average Fuel Economy

Existing federal law includes two major mandatory energy efficiency programs: one for automobiles,[51] and the other for consumer products other than automobiles.[52] Both were established in 1975 under the Energy Policy and Conservation Act (EPCA).[53] The program for motor vehicles—known as Corporate Average Fuel Economy or "CAFE"—requires each automobile manufacturer or importer to meet average fuel economy standards for the fleet of new vehicles it manufactures or imports in each model year.[54] These standards are expressed in miles per gallon (mpg).[55] Separate standards are set for passenger automobiles and "light-duty trucks"—including sport utility vehicles (SUVs) and minivans—currently at 27.5 mpg and 20.7 mpg respectively.[56]

The statute applies only to new vehicles and does not regulate in-use consumption of fuel.[57] More stringent standards improve on-the-road fuel economy only to the extent that new vehicles replace less efficient existing vehicles.[58] In addition, for new vehicles, if vehicle

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[49] *Id.* §§ 45, 48, 168, 179A.

[50] *See* Energy Info. Admin., U.S. Dep't of Energy, Analysis of Selected Provisions of Proposed Energy Legislation: 2003 (2003), *available at* http://www.eia.doe.gov/oiaf/servicerpt/eleg/pdf/sroiaf(2003)04.pdf.

[51] 49 U.S.C. §§ 32,900–32,901 (2000).

[52] 42 U.S.C. §§ 6291–6309 (2000).

[53] Energy Policy and Conservation Act of 1975, Pub. L. No. 94-163, 89 Stat. 871 (1975) (automobile fuel economy standards are codified as amended at 49 U.S.C. §§ 32,901–32,919).

[54] 43 U.S.C. § 32,902 (2000).

[55] *Id.*

[56] *Id.* § 32,902(a), (b); 67 Fed. Reg. 16,052 (Apr. 4, 2002) (to be codified at 67 C.F.R. pt. 533). Another federal law influencing automobile fuel economy is the "gas guzzler" tax. *See* Internal Revenue Code, 26 U.S.C. § 4064 (2000). Under this law, cars achieving less than 22.5 mpg are subject to a sliding scale of tax charges, ranging from $1000 to $7700. *Id.* Light-duty trucks are exempt. *Id.*

[57] 26 U.S.C. § 32,901(a)(4).

[58] *Id.* § 4064(b)(1)(B). However, the current program does not provide consumers with incentives to purchase new, fuel-efficient vehicles even if they are available and in fact may retard turnover to the extent it drives up the cost of new vehicles. *See id.*

miles traveled (VMT) increase faster than average fuel economy, overall fuel use will go up notwithstanding the CAFE requirements.[59]

The statute contains a number of idiosyncratic features that increase its complexity, while decreasing its effectiveness.[60] Trucks and SUVs are subject to far less stringent standards than cars.[61] Compliance with the standard is determined separately for vehicles manufactured in the United States, Canada, or Mexico, and those vehicles manufactured elsewhere but used in the United States.[62] Special credit is given to electric vehicles and to alternative fuel-capable vehicles.[63]

While the CAFE program made a significant contribution to moderating U.S. fuel use in the first years after its enactment, its impact has declined over time for a number of reasons.[64] First, the standards were frozen for many years. Therefore, the standards have not taken into account the increasing proportions of truck, SUV, and minivan sales. Starting in 2001, such "light-duty trucks" made up over fifty percent of vehicles sold.[65] Congress's decision to freeze the standards throughout most of the 1990s, combined with the change in product mix, has had the effect of decreasing the ability of the program to moderate fuel use.[66] Second, real gasoline prices have declined, encouraging more driving and dampening incentives for drivers to demand more efficient vehicles. Accordingly, even though fuel economy for cars has improved since the enactment of CAFE, overall fuel use—and, therefore, GHG emissions—has risen steadily.[67]

Of course, policymakers did not design CAFE as a domestic GHG regulatory program, and to function as one it would need not only to have the features noted above corrected—removing the freeze on

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59 *See* Transp. Research Bd., Nat'l Research Council, Effectiveness and Impact of Corporate Average Fuel Economy (CAFE) Standards 83–85 (Duncan Brown ed., 2002).

60 *See* 43 U.S.C. § 32,902.

61 *Compare* 49 U.S.C. § 32,902(a), *with* § 32,902(b).

62 *See* Transp. Research Bd., *supra* note 59, at 15.

63 49 U.S.C. § 32,905.

64 *See* Transp. Research Bd., *supra* note 59, at 14, 15–16.

65 *See* Michelle Maynard, *Bracing for Soft Sales, Carmakers Seek Out Higher Ground,* N.Y. Times, Jan. 11, 2002, at F1. Congress lifted its freeze on CAFE standards in 2001. *See* The Department of Transportation and Related Agencies Act of 2001 for FY 2002, Pub. L. No. 107-87, 115 Stat. 833 (2001). The Bush Administration, through the National Highway Traffic Safety Administration, has proposed increasing the CAFE standard for light trucks from its current level of 20.7 mpg to 21.0 mpg for model year 2005, 21.6 mpg for model year 2006, and 22.2 mpg for model year 2007. *See* Light Truck Average Fuel Economy Standards Model Years 2005–07, 67 Fed. Reg. 77,015 (proposed Dec. 16, 2002).

66 *See* Transp. Research Bd., *supra* note 59, at 15.

67 *See* Transp. Research Bd., *supra* note 59, at 19–20 fig.2-9.

more stringent standards and modifying the electric vehicle and alternative fuel credits[68]—but also the mpg standard would have to be translated into terms of pounds of CO_2 per mile to take into account the carbon content of fuel.[69] Additionally, as discussed below, a number of other changes would be needed to integrate such a program into a domestic cap-and-trade program for GHGs.

2. Appliance Standards

EPCA also established an energy efficiency program for consumer products other than autos—usually referred to as the "appliance efficiency program."[70] It includes mandatory energy labeling and energy efficiency standards for a wide range of consumer products, including air conditioners, washers, dryers, kitchen ranges, and furnaces.[71] Standards also cover some equipment used in industrial applications, such as most industrial motors.[72] According to DOE, the standards program has resulted in a greater than one quad reduction of energy use annually, equivalent to roughly one percent of energy use or about seventy-five million tons of CO_2.[73] It aims at requiring for each type of consumer product the maximum energy efficiency that is technologically feasible and economically justified; but its complex regulatory framework makes prompt action to promulgate stringent new standards quite difficult.[74]

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[68] The electric vehicle credit does not take into account GHG emissions associated with electric generation. 26 U.S.C. § 32,903 (2000). The alternative fuel credit is available for vehicles that are capable of using alternative fuels, whether or not these fuels are actually used. *Id.* § 32,905(b).

[69] *See* PEW CTR. ON GLOBAL CLIMATE CHANGE, *supra* note 7.

[70] *See* Energy Policy and Conservation Act of 1975, *supra* note 53 (appliance efficiency standards are codified at 42 U.S.C. §§ 6291–6309 (2000)).

[71] 42 U.S.C. § 6292.

[72] *Id.* For more information on existing energy efficiency standards for commercial and industrial equipment, see U.S. Dep't of Energy, Building Technologies Program: Appliances & Commercial Equipment Standards, *at* http://www.eren.doe.gov/buildings/appliance_standards/ (last updated Jan. 5, 2005).

[73] TORU KUBO ET AL., AM. COUNCIL FOR AN ENERGY-EFFICIENT ECON., OPPORTUNITIES FOR NEW APPLIANCE AND EQUIPMENT EFFICIENCY STANDARDS 5, 6 (2001), *available at* http://www.aceee.org/energy/A016full.pdf; Telephone Interview with Michael McCabe, Acting Program Manager, Office of Building Technologies, Office of Energy Efficiency and Renewable Technology, U.S. Department of Energy (Apr. 4, 2003).

[74] In the case of electric appliances, CO_2 emissions are from the electric generator rather than from the appliance, as in the case of gas appliances. *See* KUBO ET AL., *supra* note 73, at 8. As with CAFE, the efficiency standards are expressed in terms of energy use, not GHG emissions. *See id.* Also, efficiency standards on appliances are currently not comparable across energy types. *See id.* at 5–6. Thus for example, a highly efficient electric wa-

While the standards program in its present form could be used for GHG regulatory purposes, it would be better adapted to that purpose if the standards were expressed in the form of direct or indirect GHG emissions per unit of output, and if a trading feature could link it to GHG regulation in other sectors.[75]

C. *Clean Air Act*

Aside from a requirement that electricity generators, who account for about one-third of U.S. GHG emissions, monitor and report their CO_2 emissions, the Clean Air Act (CAA)[76] does not directly address control of GHG emissions, much less explicitly authorize GHG regulation. The question of whether EPA has *implied* authority under the CAA to regulate GHGs—by virtue of its CAA authority to regulate "air pollutants"—is the subject of vigorous debate.[77]

This debate is beyond the scope of this Article, which contemplates action by Congress to establish a GHG regulatory program by statute, rather than action by EPA using its existing CAA authorities. Nevertheless, it is worth observing that the acid rain provisions of the CAA present a useful model for a cap-and-trade program applicable to CO_2 emissions from electricity generators—which is one of the models for GHG regulation considered below.[78] The acid rain program imposes a national limit on SO_2 emissions from electricity generators—currently set at 8.9 million tons per year—allocates allow-

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ter heater produces much more CO_2 emissions than a gas water heater of fairly low efficiency because the efficiency of fuel to electric conversion is so low. *See id.* For the appliance standard program to work in the GHG context, the standards should reflect revised direct and indirect CO_2 emissions. *See generally* Kubo et al., *supra* note 73, at 7–15.

[75] *See* Cong. Budget Office, Who Gains and Who Pays Under Carbon-Allowance Trading? The Distributional Effects of Alternative Policy Designs 4–5 (2000).

[76] *See* Clean Air Act, 42 U.S.C. §§ 7401–7671q (2000).

[77] In response to a petition for rulemaking, EPA published a decision stating it lacks authority under the Clean Air Act to regulate GHGs to address climate change. *See* Control of Emissions from New Highway Vehicles and Engines: Notice of Denial, 68 Fed. Reg. 52,922 (Sept. 8, 2003). A number of state attorneys general and environmental groups have filed a petition for review of this Notice of Denial in the Court of Appeals for the District of Columbia Circuit. *See* Petitioners' Brief, Massachusetts v. U.S. EPA, No. 03-1361 (D.C. Cir. 2005 filed Oct. 23, 2003). The Petitioners filed their opening brief in the case on June 22, 2004. *See id.*

[78] The acid rain program is set forth in Title IV of the CAA and related regulations. *See* 42 U.S.C. §§ 7651–7651(o). For an examination of the acid rain program, other trading programs, and the lessons those programs may hold for GHG emissions trading, see A. Denny Ellerman et al., Pew Ctr. for Global Climate Change, Emissions Trading in the U.S.: Experience, Lessons, and Considerations for Greenhouse Gases (May 2003), *available at* http://www.pewclimate.org/docUploads/emissions_trading.pdf.

ances to existing sources to emit specified quantities of SO_2, and allows sources to trade and bank allowances, so that they can pursue least-cost compliance strategies.[79]

D. *Options for a Domestic Program to Secure Greenhouse Gas Reductions*

While voluntary programs, the CAFE program, tax incentives, and product efficiency standards have contributed to reductions in GHGs that would not otherwise have occurred, they neither individually nor collectively are likely to achieve significant economy-wide reductions in GHG emissions from current levels.[80] Substantial attention has been given to formulating and evaluating a range of alternative mechanisms for controlling U.S. GHG emissions.[81] For example, several bills have been introduced that would establish a CO_2 cap-and-trade program for electric utilities, modeled on the SO_2 program under Title IV of the CAA.[82] In January 2003, Senators John McCain (R-AZ) and Joseph Lieberman (D-CT) introduced legislation that would establish an economy-wide GHG cap-and-trade program.[83] In March 2004, a companion version of the McCain-Lieberman bill was introduced in the House.[84]

The principal options for a mandatory GHG reduction program, and the ones evaluated below, are:

Cap-and-Trade: A comprehensive cap-and-trade program, similar in many respects to the acid rain program, that allocates or auctions a fixed number of tradable allowances to emitters and requires them to surrender allowances equal to their emissions in a particular compli-

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[79] *See* Clean Air Act, 42 U.S.C. §§ 7651–7651(o).

[80] *See* Douglas W. Smith et al., Pew Ctr. for Global Climate Change, Designing a Climate-Friendly Energy Policy: Options for the Near-Term, at v (2002) (suggesting that even implementation of a "climate-friendly energy polic[y]" would not be adequate to reduce U.S. GHG emission levels to year-1990 levels), *available at* http://www.pewclimate.org/docUploads/energy.policy.pdf.

[81] *See generally* The H. John Heinz III Ctr. for Science, Econ. & the Env't, Designs for Domestic Carbon Emissions Trading (1998) [hereinafter Heinz Ctr.], *available at* http://www.heinzctr.org/NEW_WEB/PDF/gc_emissions_trading.pdf.

[82] These bills are: the Clean Smokestacks Act of 2003, H.R. 2042, 108th Cong. (2003); the Clean Air Planning Act of 2003, S. 843, 108th Cong. (2003); and the Clean Power Act of 2003, S. 366, 108th Cong. (2003).

[83] *See* Climate Stewardship Act of 2003, S. 139, 108th Cong. (2003) (commonly known as the McCain-Lieberman bill). In October 2003, the McCain-Lieberman bill was defeated 43–55 in the U.S. Senate. Senators McCain and Lieberman have pledged to reintroduce the bill. *See id.*, 149 Cong. Rec. S.13,572 (daily ed. Oct. 30, 2003).

[84] *See* Climate Stewardship Act of 2004, H.R. 4067, 108th Cong. (2004).

ance period—known as "downstream" cap-and-trade.[85] A variant of this program requires firms to surrender allowances equal to the carbon content of the fuel and the GHG content of certain other products they sell each year—known as "upstream" cap-and-trade.[86]

GHG tax: A tax either on GHG emissions or on the carbon content of fuel and the GHG content of certain other products.[87]

Sectoral Hybrid: A program that combines a large-source cap-and-trade program with product efficiency standards, that is, standards for consumer products and equipment that prescribe emissions per unit of output—pounds of CO_2 per mile, for example—or energy efficiency levels.[88]

This Article also discusses in general terms additional options such as stationary source emission standards, stand-alone product efficiency standards, and a stand-alone large-source cap-and-trade program.

III. Design Criteria for a Domestic GHG Regulatory Program

Evaluating different GHG regulatory program options involves a number of considerations. The first design decision is establishing the program's emissions reduction objective. Once an emissions reduction objective is set, policymakers have to design a regulatory program to meet it. Key design criteria include environmental effectiveness, cost, administrative feasibility, distributional equity, and political acceptability. The sections that follow elaborate on each of these criteria.

The emissions reduction target for a domestic program establishes the level and timing of reductions at the national level. The target can be set for purposes of compliance with an international obligation or could be established as a matter of domestic policy, independent of any international obligations. Moreover, it could take the form of a cap on domestic GHG emissions or a limit on GHG emissions per unit of output, also referred to as an "emissions intensity" target. It could establish a GHG reduction target for an initial compliance period, or it could establish a long-term emissions reduction path, phasing in progressively

[85] *See* Cong. Budget Office, An Evaluation of Cap-and-Trade Programs for Reducing U.S. Carbon Emissions (2001).

[86] *See id.*

[87] *See* Robert N. Stavins, *Policy Instruments for Climate Change: How Can National Governments Address a Global Problem?*, 1997 U. Chi. Legal F. 293, 303.

[88] *See* Tim Hargrave, Ctr. for Clean Air Policy, An Upstream/Downstream Hybrid Approach to Greenhouse Gas Emissions Trading (2000), *available at* http://www.ccap.org/pdf/Hybrid1.PDF.

more stringent targets over an extended period of time. This Article does not address the issues of whether or how to set a target, or what target to set. Instead, it evaluates different designs for a program that will meet whatever target is decided upon.[89]

The criteria for evaluating design options are described below.

A. *Environmental Effectiveness: How Effective Is the Program in Meeting Its Emissions Reduction Target?*

A regulatory program's effectiveness in meeting its target is a function of a number of factors, including its coverage of sources throughout the economy, its certainty in meeting a particular emissions target, and its provisions for enforcement.

1. Coverage: Are All Sources and Gases Covered?

A program's coverage refers to the extent to which it directly or indirectly regulates sources of GHG emissions throughout the U.S. economy and applies to the full range of GHGs. Broad coverage is preferable from an environmental perspective, but may have to be balanced by considerations of administrative cost. Compared to a program with full coverage, a program with only partial coverage either will reduce emissions less, or will attain the same emission reductions at much higher cost because it excludes opportunities for inexpensive reductions in uncovered sectors or gases. Programs with only partial coverage also risk "leakage."[90] Leakage occurs when a regulatory program encourages shifting of emission-generating activities from regulated to non-regulated firms.[91]

2. Environmental Certainty: Will the Program Ensure That the Emissions Reduction Target Will Be Met?

Some program designs provide greater certainty that total emissions from regulated firms will not exceed a particular level. For example, a "quantity-based" approach, such as a conventional cap-and-

[89] For a review of the debate between proponents of aggressive near-term emission reduction policies and proponents of "back-loading" deeper emission reductions to future years, see MICHAEL TOMAN, RES. FOR THE FUTURE, MOVING AHEAD WITH CLIMATE POLICY 4 (2000), *available at* http://www.rff.org/Documents/RFF-CCIB-26.pdf. The question of how to design a regulatory program to implement a carbon-intensity target is not addressed in this Article.

[90] CONG. BUDGET OFFICE, *supra* note 85, at 6.

[91] *See id.*

trade program, enforces an overall limit on emissions from the covered firms.[92] By contrast, "price-based" approaches, such as emission taxes or trading programs with a safety valve, do not place a precise limit on total emissions, but instead impose a particular price or price limits per ton of emissions.[93] While establishing an emissions charge or tax has the effect of reducing emissions, the approach does not ensure that emissions will be reduced to a precise level.[94] In addition, as explained below, a standards approach that limits emissions per unit of output, as opposed to tons per year—often referred to as a "carbon intensity" approach—will not achieve a particular emissions reduction target with certainty.[95] However, because it is cumulative rather than annual emissions that are important, taxes or standards should be able to provide almost equivalent environmental certainty if there is political will to adjust them over time.

3. Enforcement: Is the Program Enforceable?

Any regulatory program's overall success in reducing emissions also is a function of its enforcement mechanisms. Enforcement is, in turn, a function of clear rules, precise and effective measurement of emissions, pursuit of violators, and having non-compliance penalties high enough to exceed any benefits associated with non-compliance.[96]

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[92] As discussed in Part IV.A of this Article, a cap-and-trade program could require firms to surrender allowances for their CO_2 emissions (downstream) or it could require firms to surrender allowances for the CO_2 emissions imputable to the fuel they sell or produce (upstream). To simplify matters, this section of the Article refers to programs that limit "emissions." However, all the observations here apply with equal force to programs that limit the carbon content of fuels.

[93] *See* Henry D. Jacoby & A. Denny Ellerman, MIT Joint Program on the Science and Policy of Global Climate Change, The Safety Valve and Climate Policy 2 (revised ed. July 2002), *available at* http://web.mit.edu/globalchange/www/MITJPSPGC_Rpt83.pdf. For a discussion on the pros and cons of the safety valve approach, see Part IV.A.4.

[94] *See id.* at 5.

[95] *See* Ctr. for Clean Air Policy, US Carbon Emissions Trading: Description of an Upstream Approach 10 (1998), *available at* http://www.ccap.org/pdf/upstpub.pdf.

[96] For a review of compliance enforcement mechanisms, including non-sanctioning mechanisms, see Eric Dannenmaier & Isaac Cohen, Pew Ctr. on Global Climate Change, Promoting Meaningful Compliance with Climate Change Commitments (2000).

B. *Cost-Effectiveness: Will the Program Design Allow Cost-Effective Compliance?*

A key consideration in evaluating a GHG regulatory program is whether it permits compliance with the program's target at the least cost to the U.S. economy—what is referred to as "cost-effective" compliance. The first cost-related issue is the direct cost of complying with the program. A program designed to meet a particular target minimizes compliance costs to the extent that it maximizes flexibility to adopt a least-cost compliance strategy—that is, flexibility as to what, where, and when emission reductions are attained. In addition, some program designs can cap compliance costs, but do so at the risk of missing the program's target. Another key cost-related consideration is administrative cost. Finally, some program designs raise revenue, which, as explained below, could be used to offset part of the overall cost of the program by reducing "distortionary" taxes on capital and labor.

1. Flexibility: Will the Program Provide Flexibility as to How, Where, and When Emission Reductions Are Attained?

A cost-effective program will provide wide flexibility to regulated firms in determining how to reduce emissions to meet the program target ("what" flexibility), where to reduce them ("where" flexibility), and within limits, when to reduce them ("when" flexibility).[97] "What" flexibility implies that a firm can comply by implementing any of the full range of GHG mitigation measures, including increasing energy efficiency; switching fuels; reducing consumption; adopting LULUCF measures, including agriculture; or taking other action to reduce or sequester GHGs. Second, it implies that firms can comply through reductions in any of the major GHGs. Third, it implies that firms that can achieve low-cost reductions will undertake a greater proportion of emission reductions than firms that achieve reductions at higher costs. Many different kinds of firms and activities generate emissions of different GHGs; their costs of reducing those emissions and the means of reduction available to them vary widely. A program with maximum "what" flexibility has the effect of equating marginal costs of mitigation across all firms subject to the program, thereby generating the lowest-cost distribution of abatement activities throughout the economy.[98]

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[97] *See* Toman, *supra* note 89, at 4.

[98] *See* Richard B. Stewart & Philippe Sands, *The Legal and Institutional Framework for a Plurilateral Greenhouse Gas Emissions Trading System*, *in* United Nations Conference on Trade and Development, Greenhouse Gas Market Perspectives: Trade and Invest-

The other critical benefit of building "what" flexibility into the U.S. climate policy architecture from the beginning is that it spurs technological innovation. Achieving the long-term aim of stabilizing atmospheric concentrations will not be possible without the development and widespread deployment of a range of next-generation approaches to climate protection, including new clean energy technologies. Policy approaches that prescribe the use of particular technologies, such as design standards, provide little incentive for developing such next-generation approaches. By contrast, approaches that specify environmental outcomes or place a price on environmental damage without prescribing the means of compliance can stimulate the kind of innovation that ultimately will be needed to achieve deeper emission reductions over time.

"Where" flexibility implies that the program will recognize reductions achieved throughout the world. A domestic GHG program that is integrated with the emerging international market in GHG emission reductions almost certainly will have lower compliance costs than a program that credits only reductions made within the United States.[99] Studies have suggested that opening up a U.S. climate program to trading even with just the industrialized countries that are subject to Kyoto Protocol emission limits could reduce a U.S. program's marginal abatement cost by anywhere between thirteen percent and sixty-eight percent.[100] Gains from trade would be far greater if the U.S. program credited reductions achieved in developing countries, where low-cost abatement options are in abundant supply.[101] For these reasons, the ultimate cost of a U.S. climate change program will depend in great measure on the extent to which it provides for international emissions trading.

"When" flexibility provides the regulated firm with choices as to the timing of emission reductions. Even before the regulatory pro-

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MENT IMPLICATIONS OF THE CLIMATE CHANGE REGIME 5–6 (2001), *available at* http://www.unctad.org/en/docs/poditctedm9.en.pdf.

[99] *See* RICHARD ROSENZWEIG ET AL., PEW CTR. ON GLOBAL CLIMATE CHANGE, THE EMERGING INTERNATIONAL GREENHOUSE GAS MARKET 12 (2002), *available at* http://www.pewclimate.org/docUploads/trading.pdf.

[100] *See* Jae Edmonds et al., *International Emissions Trading, in* CLIMATE CHANGE: SCIENCE, STRATEGIES, AND SOLUTIONS 245, 257 tbl.6 (Eileen Claussen ed., 2001). Edmonds and his colleagues compare the results of five different studies that modeled the marginal abatement costs associated with a program aimed at reducing industrial country GHG emissions 5.2% from 1990 levels in 2010. *See id.*

[101] *See id.* at 254. Indeed, a U.S. program that credits reductions achieved in countries not subject to emission limits will have lower costs even if the cost of reductions in those countries is the same as in the United States.

gram becomes binding, policymakers can establish a "credit for early action" policy to assure firms that any pre-program efforts to reduce emissions will be recognized. Such early reduction efforts would have the same environmental value as reductions made after the regulatory program has commenced.[102] Policymakers also can set an ultimate compliance deadline for the regulatory program that gives firms sufficient lead time to develop cost-effective control strategies and that allows a market for emission reductions to evolve. Further, in establishing a program's emissions target, consideration can be given to determining compliance on the basis of a multi-year emissions average, rather than the level of emissions in a single year. A multi-year approach gives firms the flexibility to manage their emissions over time and avoids penalizing them for emission changes caused by difficult-to-control fluctuations in business cycles and weather.

Other "when" flexibility measures include "banking" and "borrowing."[103] Programs can be designed so that firms that over-comply can "bank" emission credits and use them in a subsequent compliance period or sell them at a later date when prices in the trading market might be higher. A "borrowing" provision would allow a firm to comply with its obligations in one compliance period in part by committing to even deeper-than-required reductions in the subsequent compliance period. With a limited borrowing provision, a regulatory program could obtain a greater overall level of emission reductions from those firms that could benefit from additional time to modify their operations or invest in new technologies. A multi-year compliance period approach would offer similar temporal flexibility as a borrowing provision. A firm's ability to borrow has to be limited, however, lest it become a means of simply avoiding reductions.

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[102] *But see* Robert R. Nordhaus & Stephen C. Fotis, Pew Ctr. on Global Climate Change, Analysis of Early Action Crediting Proposals 28–29 (1998) (discussing the policy challenge of developing a "baseline" for the purpose of distinguishing reductions that would have occurred even in the absence of the program—known as "anyway" tons—from those that occurred as a result of the program—known as "additional" tons), *available at* http://www.pewclimate.org/docUploads/pol_early.pdf.

[103] *See* Ellerman et al., *supra* note 78, at 5–6.

2. Cost Predictability: Are Costs of Compliance Reasonably Predictable?

A regulatory program also can be designed so that total compliance costs are capped.[104] As discussed above, "price-based" approaches, such as emission taxes, do not provide assurances that a particular level of emission reductions will be achieved. On the other hand, such programs do provide assurances that the costs of compliance will not rise above a particular per-ton level. This kind of certainty about costs generally is not possible with a quantity-based program, such as a traditional cap-and-trade program, where it is implied that the quantitative limit on emissions will be enforced regardless of compliance costs. To address the risk of spiraling compliance costs associated with a cap-and-trade program, some have proposed a "safety valve" mechanism, in which additional allowances would be made available at a pre-set price representing the maximum acceptable cost.[105]

3. Raising Revenue: Will the Program Raise Revenues That Can Be Used to Offset a Portion of Its Costs?

Some program designs that raise revenue, such as GHG taxes or allowance auctions, offer an opportunity to offset economic costs of the program borne by particular sectors through financial assistance programs or reduce the overall cost of the program through a reduction in federal taxes.[106] Economic analysis indicates that programs that recycle the revenue to reduce distortionary taxes on capital, labor, or income have significant potential to reduce overall costs of a GHG regulatory program to the economy.[107] However, it may prove politically difficult to implement tax cuts that increase economic efficiency. The revenues raised could just as easily be spent on activities that reduce or have no impact on economic efficiency as on activities that improve it.

4. Long-Term Incentives: Will the Program Induce Key Sectors to Begin Investing in Low-Emission Technologies and Practices?

Most climate change analysts agree that moderating the increase in atmospheric concentrations of GHGs ultimately will require a sub-

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[104] *See* William Pizer, Res. for the Future, Choosing Price or Quantity Controls for Greenhouse Gases 2 (1999), *available at* http://www.rff.org/Documents/RFF-CCIB-17.pdf.

[105] *See* Jacoby & Ellerman, *supra* note 93, at 4.

[106] *See* Stavins, *supra* note 87, at 301–07.

[107] *See id.* at 305.

stantial transformation in the way that industrialized countries like the United States produce and use energy.[108] Near-term policy choices will have a major impact on the cost of such a long-term effort. The reason is that energy-producing and energy-using technologies involve long-term capital investments that are not readily converted to other uses. Therefore, a domestic program needs to send a credible long-term signal to key sectors of the economy that encourages a shift toward lower-carbon technologies and lower-emitting practices. A domestic program that leaves certain sectors uncovered could result in those sectors "locking in" higher-emitting technologies and practices, potentially increasing the cost of achieving more substantial economy-wide GHG reductions in the future.[109]

C. *Administrative Feasibility: Can the Program Be Administered and Does It Minimize Administrative and Transaction Costs?*

A key consideration in designing any regulatory program is whether it is feasible to administer. A program that is infeasible to administer will be both environmentally ineffective and economically inefficient. One key feasibility consideration is minimizing administrative costs—including the costs of designing the program and the costs of implementing it, both for the regulated firm, which must bear reporting or other costs, and for the regulator. Administrative costs are a function of the number of regulated firms, the availability of needed data about those firms, and the complexity of the regulatory program.[110] In addition, program designs that build upon existing and familiar programs will impose smaller implementation costs and less difficulty for the regulator and the firms to be regulated than programs that represent a new departure. Finally, in designing market-based regulatory programs, careful attention needs to be given to avoiding unnecessary program complexities and uncertainties that run up participants' transaction costs.[111]

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[108] *See, e.g*, BATTELLE GLOBAL ENERGY TECH. STRATEGY PROGRAM, GLOBAL ENERGY TECHNOLOGY STRATEGY: ADDRESSING CLIMATE CHANGE (2000), *available at* http://www.pnl.gov/gtsp/docs/infind/cover.pdf.

[109] *See* ROBERT J. LEMPERT ET AL., PEW CTR. ON GLOBAL CLIMATE CHANGE, CAPITAL CYCLES AND THE TIMING OF CLIMATE CHANGE POLICY 42 (2002) (discussing the importance of capital investment cycles in determining the timing and stringency of climate change policies), *available at* http://www.pewclimate.org/docUploads/capital_cycles.pdf.

[110] *See* CTR. FOR CLEAN AIR POLICY, *supra* note 95, at 2.

[111] Programs that involve substantial redistribution of income or wealth—for example, auction or tax type programs—can trigger substantial lobbying and litigation expenditures. *See* Stavins, *supra* note 87, at 295–96.

Another particularly important administrative criterion for a climate change policy is adaptability, given the necessary duration of any effort to stabilize concentrations of GHGs in the atmosphere. A U.S. climate change policy framework needs to be able to evolve over time to accommodate adjustments in the emission reduction commitments as new information becomes available and as the U.S. economy changes. In addition, because stabilization of GHG concentrations ultimately will require global efforts, the policy framework will have to be flexible enough to provide for coordination with other countries.

D. *Distributional Equity: Is the Burden of Compliance with the Program Fairly Apportioned?*

Another consideration in designing a regulatory program is how its costs are distributed across society.[112] Even the most cost-effective program design may be unacceptable if its costs are distributed in such a way that is perceived to be unfair.

All other things being equal, a regulatory program that aims to reduce GHG emissions will tend to impose its largest costs on firms and households that produce fossil fuels or are heavily dependent on them.[113] A GHG regulatory program also will tend to be relatively more costly for low-income individuals because they spend a greater proportion of their total income on energy.[114]

Some regulatory programs provide opportunities for modifying these distributional impacts. For example, in an emissions trading program, the government could allocate allowances on a cost-free basis to firms that would bear the brunt of regulatory compliance costs. Alternatively, the government could auction allowances and use the revenue to compensate those particularly burdened by the regulatory program through targeted tax breaks or lump-sum payments. Emission tax programs hold similar revenue recycling potential.

E. *Political Acceptability: Are There Elements of Program Design that Affect Its Political Acceptability?*

Program designs that promise relatively greater environmental effectiveness, lower costs, and a more equitable distribution of regulatory burdens will be more likely to obtain political support than other

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[112] *See* Cong. Budget Office, *supra* note 75, at 9–11.
[113] *See id.* at 19.
[114] *See id.* at 20.

designs. However, the U.S. experience with environmental and energy policy suggests that other factors also affect a program's political acceptability. Indeed, considerations of political acceptability may lead policymakers away from what could otherwise be an optimal program design with respect to environmental effectiveness, cost, and equity.[115]

For example, twenty-five years of environmental and energy policy experience suggests that it is difficult to gain public support for a program that relies principally on direct increases in the price of energy—either through taxes or regulatory measures—even where such a program arguably is more cost-effective or will result in a more equitable distribution of regulatory burdens than other approaches.[116] Even in times of most compelling national circumstances, such as the 1973 Arab oil embargo, Congress was unwilling to use energy price increases to rein in consumer demand.[117] On the other hand, program designs involving emissions trading or emission charges offer the opportunity to develop what may be a politically attractive policy package—using the revenue raised from regulation of GHG emissions as a basis for reducing taxes on income.[118]

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[115] *See* Nathaniel O. Keohane et al., *The Choice of Regulatory Instruments in Environmental Policy*, 22 Harv. Envtl. L. Rev. 313, 320–21 (1998).

[116] The initial U.S. reaction to the Arab oil embargo of 1973–74 was to impose price controls on petroleum rather than to allow prices to rise to world market levels. *See generally* J. Yost Conner, Jr., Note, *Revisiting CAFE: Market Incentives to Greater Automobile Efficiency*, 16 Va. Envtl. L.J. 429 (1997) (discussing the Arab oil embargo and EPCA). The Ford Administration in 1975 submitted legislative proposals to reduce vulnerability to OPEC action through a mix of pricing policies (decontrol of oil and natural gas prices), encouragement of U.S. fossil-fuel production, establishment of a strategic petroleum reserve (SPR) and energy labeling of, but not standards for, efficiency of consumer products. *See generally* Julia Richardson & Robert Nordhaus, *The National Energy Act of 1978*, 10 Nat. Resources & Env't 62 (Summer 1995). The Congress responded by enacting the Energy Policy and Conservation Act, which mandated efficiency standards for automobiles and appliances and established the SPR, but which maintained price controls on oil and natural gas. *See id.* In the late 1970s, the Carter Administration was faced with severe interstate natural gas shortages and continuing vulnerability of the U.S. to oil supply interruptions. *See id.* The Administration proposed to increase gasoline taxes, impose new taxes on crude oil, natural gas, and petroleum products, strengthen energy efficiency standards, and ultimately to remove price controls on new natural gas. *See id.* Congress balked at the energy taxes, but enacted most of the Carter regulatory programs. *See id.* Clinton's BTU tax of 1993 suffered a fate similar to the Carter tax proposals—it died.

[117] *See* Conner, *supra* note 116, at 431.

[118] *See* Anne E. Smith & Martin T. Ross, Ctr. for Clean Air Policy, Allowance Allocation: Who Wins and Loses Under a Carbon Dioxide Control Program? 10 (2002), *available at* http://www.ccap.org/pdf/ccap_cra_report.pdf.

IV. Evaluating Different Approaches to Regulating Domestic GHG Emissions

Using the criteria developed above, we evaluate three principal approaches to regulating domestic GHG emissions: (1) an emissions trading—or cap-and-trade—program; (2) a GHG tax program; or (3) a sectoral hybrid program combining a large-source cap-and-trade program with product efficiency standards. Each approach presents its own design choices, For example, a cap-and-trade program could be upstream or downstream.

A. *Emission Trading (Cap-and-Trade) Programs*

1. Overview of Emission Trading Programs

A conventional cap-and-trade program establishes an economy-wide or sectoral "cap" on emissions in terms of tons per year or other compliance period, and allocates or auctions tradable allowances, such as the right to emit one ton of GHGs, to GHG emission sources or to fuel suppliers.[119] The total number of allowances is equal to the cap. A downstream cap-and-trade program applies to sources of GHG emissions and requires them to surrender allowances equal to their emissions.[120] An upstream program applies to fuel suppliers and requires them to surrender allowances equivalent to the carbon content of fossil fuels they supply.[121] Cap-and-trade programs are best suited to regulation of emission sources that can be readily measured and monitored. In the GHG context, such sources include almost all sources of CO_2 emissions from fossil-fuel combustion as well as many sources of other GHG emissions.[122] Other types of sources can be regulated on an "opt in" or project basis, or through supplemental regulation.[123] The trading feature of a cap-and-trade program authorizes regulated firms—and anyone else—to buy, sell, or hold allowances.

In a well-functioning emissions trading market, allowances will end up distributed among firms that need them in a way that minimizes the cost of reducing emissions. For example, in a conventional downstream cap-and-trade program, firms subject to the program buy

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[119] *See* Cong. Budget Office, *supra* note 85, at viii.

[120] *See id.* at 5–6.

[121] *See id.*

[122] *See generally* Ctr. for Clean Air Policy, *supra* note 95, at 1–3.

[123] *See* Box 1, *supra* Part IV.A.

allowances if their costs of reducing emissions—referred to as their costs of "abatement"—exceed the allowance price.[124] Firms sell allowances if their abatement costs are lower than the allowance price.[125] Trades continue in this way until firms are indifferent between buying and selling allowances—or, in other words, between abating one more ton of CO_2 or emitting an additional ton.[126] At this point, the program has equalized marginal abatement costs across the economy, and, in theory, the final distribution of allowances and abatement throughout the economy reflects the least-cost outcome.[127]

A GHG emissions trading program could incorporate all forms of "what," "where," and "when" flexibility, discussed above. Each firm affected by a GHG emissions trading program could reduce its need for allowances or exposure to higher energy costs by adopting its lowest-cost means of abatement. Firms also would have an incentive to develop new technologies or practices to reduce emissions or increase their energy efficiency. A U.S. domestic cap-and-trade program also could be integrated with emerging cap-and-trade programs in other countries and, if the parties so provided, with an international regime such as the Kyoto Protocol.[128]

A cap-and-trade program can be extended beyond energy-related sources of CO_2 emissions by directly regulating: (1) sources of non-CO_2 GHGs and/or (2) LULUCF activities that emit or remove CO_2. Some GHG sources and sinks, however, may not be amenable to regulation through such an approach because their emissions may be too difficult to measure for purposes of setting a cap and allocating allowances, or to monitor for purposes of enforcement.

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[124] *See* Stavins, *supra* note 87, at 305.

[125] *See id.*

[126] *See id.*

[127] *See id.*

[128] Crediting Kyoto instruments—specifically, Assigned Amount Units, Emission Reduction Units, Certified Emission Reductions, and Removal Units—in a U.S. domestic program appears feasible. In addition, the Protocol does not appear to prohibit countries from hosting emission reduction projects outside the Kyoto regime. Accordingly, a U.S. program could have its own project-based crediting mechanism for international projects. However, there does not appear to be any way that U.S. firms could sell U.S. emission reduction credits or allowances to Kyoto party countries for use in the Kyoto regime unless the United States becomes a party to the Protocol. *See* Kyoto Protocol to the United Nations Framework Convention on Climate Change, Dec. 10, 1997, 37 I.L.M. 22; *see also* Daniel Bodansky, Pew Ctr. on Global Climate Change, Linking U.S. and International Climate Change Strategies (2002) (discussing U.S. ratification of Kyoto Protocol), *available at* http://www.pewclimate.org/docUploads/us_international_strategies.pdf.

In some cases, these sources and sinks could be incorporated into the cap-and-trade program on a project-by-project basis, known as "project-based crediting." Under project-based crediting, a firm could earn emission credits by undertaking a climate change mitigation project at a source or sink not otherwise subject to the cap-and-trade program. To earn credits, a project would have to meet certain criteria. For example, the firm would have to provide for adequate measurement and monitoring and demonstrate that the project achieves reductions or removals beyond a baseline or "business-as-usual" scenario. The firm also would have to establish that the project would not simply shift emitting activities from the project site to another, unregulated site, an effect commonly referred to as "leakage." Credits earned for projects could be fully fungible with allowances in the emissions trading market. An example of this kind of project-based crediting mechanism is the Kyoto Protocol's "Clean Development Mechanism."[129] From a cost-effectiveness standpoint, project-based crediting is inferior to a cap-and-trade approach because it entails higher transaction costs. Project-based crediting, however, may be the only way to incorporate certain difficult-to-measure sources into a market-based program.

In addition to these forms of "what" and "where" flexibility, a GHG emissions trading program could provide for "when" flexibility by allowing for banking and borrowing. Firms required to surrender allowances to cover their emissions or the carbon content of fuel supplied could be authorized to bank surplus allowances for use in a later compliance period. Some form of limited borrowing, using future allowances to cover current emissions, also could be considered. Borrowers could be required to repay with "interest," i.e., additional allowances.

Box 1: Multi-Gas Approaches to GHG Regulation

While most proposals for domestic GHG regulatory programs have focused on addressing CO_2 emissions from the energy sector, research suggests that a multi-gas approach could achieve comparable results at substantially lower cost.[130] Designing a multi-gas program involves consideration of two factors: (1) determining the relative

[129] *See* Nordhaus & Fotis, *supra* note 102, at 7–8.

[130] For a more extensive discussion of issues and options involved in multi-gas approaches to climate change policy, see John M. Reilly et al., Pew Ctr. on Global Climate Change, Multi-Gas Contributors to Global Climate Change (2003), *available at* http://www.pewclimate.org/docUploads/Multi-Gas.pdf.

value of reductions of different kinds of gases, and (2) measurement and monitoring of reductions.[131]

A multi-gas regulatory program requires a formula that will allow policymakers to accurately weigh the value of, for example, reducing a ton of CH_4 relative to reducing a ton of CO_2. The Global Warming Potential formula is the "exchange rate" approach most widely used at this time, but has been criticized for not being the right measure for determining the optimal trade-offs among gases.[132]

Another issue for policymakers is the extent to which emissions from different sources of non-CO_2 GHGs can be accurately measured and monitored. Ease of measurement and monitoring dictates whether sources could be regulated through a cap-and-trade program or whether some other policy approach is necessary.

Sources of the synthetic gases—HFCs, PFCs, and SF_6—are good candidates for inclusion in a cap-and-trade program.[133] The gases are produced by a relatively small number of large firms, and because the gases themselves are sold rather than emitted as by-products, these firms already have incentives to monitor them.[134] Unlike the industrial gases, industrial emissions of nitrous oxide are a by-product, and therefore, not currently measured by most firms. However, because the sources are large and concentrated, firms likely could develop

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[131] The European Commission has determined that the complexities of including sources of non-CO_2 GHGs into a cap-and-trade program are significant enough that it has decided not to include such sources in at least the first phase (2005–2007) of the European Union cap-and-trade program. *See* Council Directive 2003/87/EC, 2003 O.J. (L 275) 32 [hereinafter Council Directive] (establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC), *available at* http://europa.eu.int/eur-lex/pri/en/oj/dat/2003/l_275/l_27520031025en00320046.pdf (Oct. 25, 2003). On the other hand, the U.K. is including all six major GHGs in its trading program. *See* REILLY ET AL., *supra* note 130, at 21–22.

[132] The GWP formula has come under significant criticism from a number of quarters for not accurately representing the full relative benefits of reductions in the different GHGs. *See* REILLY ET AL., *supra* note 130, at 57 (citing several studies). These studies assert that the GWP formula is flawed because it compares the different gases solely on the extent of their radiative forcing—the strength of their effects on the climate system—and their residence life in the atmosphere up to 100 years. *See id.* Such an approach omits important information. For example, it does not take into account climate effects resulting from the interaction of GHGs, nor does it account for their non-climate environmental effects. *See id.* Some studies also cite problems with the GWP formula's approach to time. *Id.* On the one hand, the formula equates effects taking place in 20 years with effects taking place in 100 years. On the other hand, effects taking place after 100 years are omitted altogether. Research to address these issues continues.

[133] *See id.* at 1.

[134] *See id.* at 25.

adequate measurement and monitoring capabilities in order to be included in a cap-and-trade program.[135] For example, in the 1990s, DuPont implemented voluntary controls on its nitrous oxide emissions and developed measuring and monitoring systems to calculate the results; it achieved a nearly fifty percent reduction in its GHG emissions.[136]

While not as amenable to regulation through a cap-and-trade program, a domestic program could address certain sources of methane through a project-based crediting mechanism. For example, firms could earn credit for achieving reductions in methane from coal mines and large landfills through the installation of devices that collect and sell the gas for energy purposes.[137]

Other cases are more difficult, such as agricultural sources of methane and nitrous oxide. These sources are highly diffuse and, for now, it is difficult to measure and monitor the effects of any mitigation activities.[138] Policymakers likely will have to rely on regulatory standards, incentives, or the publication of "best practices" to address these sources.

Box 2: Integrating Land Use, Land-Use Change, and Forestry (LULUCF) Activities into a Domestic GHG Regulatory Program

LULUCF activities offer a range of highly cost-effective climate change mitigation opportunities.[139] For example, applying "best management practices" and new technologies to U.S. croplands potentially could sequester 60 to 200 million metric tons of carbon per year.[140] Slowing deforestation of forests—particularly tropical forests—could address a source of twenty to twenty-five percent of annual

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[135] *See id.* at 34.

[136] For more information on DuPont's climate change program, see DuPont, Position Statements: Global Climate Change, *at* http://www.dupont.com/corp/news/position/global_climate.html (last updated Dec. 12, 2002).

[137] An Environmental Law Institute study suggests that it would be feasible to include large landfills and coal mines in a cap-and-trade program. *See* Envtl. Law Inst., Implementing an Emissions Cap and Allowance Trading System for Greenhouse Gases: Lessons Learned from the Acid Rain Program 16–19 (1997).

[138] *See id.* at 20, 23.

[139] *See* Intergovernmental Panel on Climate Change, Land Use, Land-Use Change, and Forestry § 2.2.1, at 61 (Robert T. Watson et al. eds., 2000) [hereinafter IPCC].

[140] *See* Pew Ctr. on Global Climate Change, Agriculture's Role in Addressing Climate Change 2, *available at* http://www.pewclimate.org/docuploads/policy_inbrief_ag.pdf.

global CO_2 emissions.[141] To be sure, the capacity of forests to absorb CO_2 emissions is not infinite, and any forest eventually will start to release sequestered carbon emissions back to the atmosphere. However, in the near-term, LULUCF activities have the potential to achieve substantial mitigation benefits at relatively low cost, allowing time for the development and deployment of the next-generation clean energy technologies that will be needed to achieve deeper cuts in emissions. LULUCF activities also can offer many side-benefits, including biodiversity protection, improvement of agricultural productivity, and economic development for rural communities.

Including any but the very largest domestic landowners in a cap-and-trade program does not appear to be feasible currently; land ownership is too diffuse, measuring emission impacts of LULUCF activities is too resource-intensive, and the relation between practices and emissions varies widely depending on a multiplicity of local conditions.[142] However, it would be feasible to credit a variety of discrete domestic and international LULUCF activities through a project-based crediting mechanism.[143]

Accommodating LULUCF activities in a project-based mechanism will require attention to definitions and rules. As with other types of climate change mitigation projects, LULUCF projects should meet criteria for baselines, measurement and monitoring, and leakage. At this point in time, some types of LULUCF projects present relatively greater measurement challenges than projects in the energy sector.[144] LULUCF project criteria also will have to address the risk of reversibility or "non-permanence."[145] Unlike energy projects, the carbon benefits of some types of LULUCF projects can be reversed if there is a later natural or human disturbance to the site, such as a forest fire.[146] Policymakers will have to develop an approach that adequately accounts for the reversibility risk of LULUCF projects. In developing a policy approach, policymakers can draw important lessons from the forestry industry, which has developed over time a range of

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[141] *See* IPCC, *supra* note 139, § 3.5.

[142] *See* Bernhard Schlamadinger & Gregg Marland, Pew Ctr. on Global Climate Change, Land Use & Global Climate Change 31 (2000), *available at* http://www.pewclimate.org/docUploads/land_use.pdf.

[143] *See id.* at 39 (discussing projects under the Kyoto Protocol).

[144] *See id.* at 42.

[145] *See id.* at 49.

[146] *See id.* at 31–35 (discussing the issue of permanence).

sophisticated practices and insurance instruments to protect its investments in forestry assets.[147] A number of approaches have been proposed to address the reversibility issue, including making project proponents fully liable for later carbon losses; encouraging project proponents to obtain insurance; encouraging project proponents to rely on a pool of forestry projects; discounting of LULUCF credits; and making LULUCF credits time-limited.[148]

Certain types of LULUCF activities appear particularly promising, including cropland and grazing land management; returning cropland to grassland or forest cover; conservation of threatened international forests; dedication of existing private domestic forestland to permanent forest status; and reforesting or replanting with native species lands that were historically forested but have not been in forest for a decade or more.[149]

2. Designing an Emissions Trading Program

Creating a GHG emissions trading program involves three fundamental design decisions that build upon this basic model.[150] Policymakers need to determine which firms will be required to hold allowances for compliance, how allowances initially will be allocated, and whether the program will enforce a strict quantitative emissions target or adopt a price-based "safety valve" approach—an approach that provides that permits will not exceed a specified cost threshold. Each design decision has various implications for the trading program's effectiveness, cost, administrative feasibility, distributional consequences, and political acceptability.[151]

3. Who Is the Regulated Firm?

A key step in designing a GHG emissions trading program is determining who are to be the regulated firms—that is, the firms that will be required to hold allowances for compliance purposes.[152] As noted

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[147] *See* George H. Weyerhauser, Jr., & Robert S. Prolman, *Climate Change: A Common Sense View from the Forest*, *in* U.S. POLICY ON CLIMATE CHANGE: WHAT NEXT? (John A. Riggs ed., 2002), *available at* http://www.aspeninstitute.org/aspeninstitute/files/Img/pdf/WeyerhaeuserEEEClimate.pdf.

[148] *See generally* SCHLAMADINGER & MARLAND, *supra* note 142.

[149] *See generally* PEW CTR. ON GLOBAL CLIMATE CHANGE, *supra* note 140.

[150] *See* CONG. BUDGET OFFICE, *supra* note 85, at viii.

[151] *See id.* at 4.

[152] *See id.* at viii.

above, there are two basic options: a downstream approach and an upstream approach.[153] A downstream program would require firms to hold allowances to cover their GHG emissions.[154] An upstream approach, by contrast, would limit emissions by requiring fuel suppliers to hold allowances for the carbon content of fuel they sell to downstream emitters.[155] A limit on the carbon content of fuel equates to a limit on CO_2 emissions because, with a few minor exceptions, all of the carbon in fuel sold downstream is fully combusted as CO_2.[156] Programs that combine downstream and upstream approaches also are possible.

a. *Downstream Cap-and-Trade*

A downstream program has the political and administrative advantages of familiarity. The CAA acid rain provisions for electricity generators is widely regarded as a success and could be relatively easily adapted for GHG trading for those firms. A number of extant proposals for a domestic GHG regulatory program have focused on the establishment of a CO_2 cap-and-trade program covering the electricity-generating sector.[157] In addition, the European Council has ap-

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[153] *See id.*

[154] *See id.*

[155] *See id.*

[156] An upstream program would have to be designed in such a way as to exempt the few non-fuel uses of fossil fuels. These include asphalt, lubricating oil, and waxes. CTR. FOR CLEAN AIR POLICY, *supra* note 95, at 9.

[157] These proposals include four bills introduced in the 108th Congress as well as the McCain-Lieberman bill. *See* Clean Smokestack Act of 2003, H.R. 2042, 108th Cong. (2003); Clean Air Planning Act of 2003, S. 843, 108th Cong. (2003); Clean Power Act of 2003, S. 366, 108th Cong. (2003); Climate Stewardship Act of 2003, S. 139, 108th Cong. (2003). In addition, the state of New Hampshire has passed legislation establishing a "multi-emissions" program with CO_2 trading for electric power generators in the state. *See* N.H. REV. STAT. ANN. § 125-O (2002) (effective July 1, 2002). The Commonwealth of Massachusetts has promulgated regulations establishing a similar program. *See* Emissions Standards for Power Plants, MASS. REGS. CODE tit. 310, § 7.29 (2001). Under the "Regional Greenhouse Gas Initiative," governors of eight states in the Northeast have committed to the establishment of a cap-and-trade program for CO_2 emissions by power plants. Their goal is to establish such a program by April 2005. *See* Reg'l Greenhouse Gas Initiative, About RGGI, *at* http://rggi.org/about.htm (last visited Nov. 14, 2004). A paper by the Progressive Policy Institute outlines a proposal for a downstream cap-and-trade program, including not only electric power generators but also other large industrial sources. *See* DEBRA KNOPMAN & JONATHAN NAIMON, PROGRESSIVE POLICY INST., HOW A DOMESTIC GREENHOUSE GAS EMISSIONS TRADING MARKET COULD WORK IN PRACTICE (2000), *available at* http://www.ppionline.org/documents/greenhouse_gas.pdf; JON A. NAIMON & DEBRA S. KNOPMAN, PROGRESSIVE POLICY INST., REFRAMING THE CLIMATE CHANGE DEBATE (1999), *available at* http://www.ppionline.org/ndol/print.cfm?contentid=1348. In a study for the World Wildlife Fund, the Tellus Institute analyzed and recommended a downstream cap-and-trade program for the electricity-generating sector with a range of standards and in-

proved the establishment of a downstream cap-and-trade program for the member countries of the European Union.[158]

However, a pure downstream approach to regulating U.S. GHGs has a fundamental drawback: it could not feasibly be applied on an economy-wide basis. Sources of CO_2, the primary GHG, number in the hundreds of millions. The sources include not only large facilities, such as those in the electricity generating sector, but also households and vehicles. The administrative costs of allowance allocation, monitoring, and enforcement for so many sources, especially the small ones, would likely be prohibitive.

Realistically, a downstream trading program could encompass only a subset of emission sources, such as electricity generators and other large stationary sources. While such a large-source downstream program would not be hindered by the administrative impediments associated with an economy-wide downstream program, it could reach, at most, less than half of the nation's CO_2 emissions, primarily because it would not reach emissions from the transportation and building sectors.[159] In terms of dollars per ton, a limited downstream program would likely be more costly than a more comprehensive emissions trading program that met the same reduction target. The full burden of achieving the emissions objective would fall on electricity generators and large industrial sources. Low-cost abatement op-

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centive programs. Alison Bailie et al., Tellus Inst. and Stockholm Env't Inst.—Boston Ctr., The American Way to the Kyoto Protocol: An Economic Analysis to Reduce Carbon Pollution 12 (2001), *available at* http://www.tellus.org/energy/publications/E01-073-3.pdf. Finally, three different coalitions of electric power generators have proposed various versions of a multi-emissions program with CO_2 trading for generators. *See Competing Utility Emissions Plans May Create Congressional Hurdle*, Inside EPA, Aug. 17, 2001 (describing proposals of the coalition "Clean Power Group"—consisting of NiSource, Enron, Calpine, El Paso, and Trigen—and the coalition "Clean Energy Group"—consisting of Conectiv, Consolidated Edison, Northeast Utilities, PG&E National Energy Group, and Sempra Energy); *New Utility Proposal Advocates Voluntary Carbon Cuts*, Inside EPA, Sept. 7, 2001 (describing proposal of the coalition "Energy for a Clean Air Future," which consists of PPL, Reliant, TECO Energy, Transalta, and Wisconsin Energy).

[158] *See* Council Directive, *supra* note 131, at 34.

[159] *See* Ctr. for Clean Air Policy, U.S. Carbon Emissions Trading: Some Options that Include Downstream Sources 2–3 (1998) [hereinafter CCAP, Options], *available at* http://www.ccap.org/pdf/wwwdown.pdf. The Center for Clean Air Policy also has examined options for extending the coverage of a downstream trading program to at least some portion of transportation sector emissions by requiring automakers to surrender allowances for emissions imputed to new vehicles they sell or for all vehicles on the road. *See id.* at 30–37; *see also* Steve Winkelman et al., Ctr. for Clean Air Policy, Transportation and Domestic Greenhouse Gas Emissions Trading 12–13 (2000), *available at* http://www.ccap.org/pdf/TGHG.pdf.

portunities in other sectors could be lost.[160] In addition, a limited downstream program could lead to leakage—that is, firms would have incentives to shift production from regulated to exempt facilities.[161] For example, if the program applied only to industrial sources above a certain size, output—and therefore emissions—might shift to sources below the size cutoff. Finally, opting for a large-source downstream cap-and-trade program instead of a program with economy-wide coverage would raise the long-term cost of achieving more substantial emission reductions because the sectors left unregulated would lack incentives to begin investing in low-carbon technologies, and instead might lock in higher-emitting technologies and practices.

A downstream cap-and-trade program that focused on electricity generators and large industrial sources still could be designed to achieve substantial emission reductions. The electricity-generating sector accounts for approximately forty percent of the U.S. CO_2 emissions and ten percent of world emissions.[162] The choice to start with a limited downstream program would not necessarily preclude moving to a more comprehensive upstream program later. The second stage of the program could be an upstream program for other sectors of the economy. In the alternative, policymakers could shift the point of regulation from electricity generators to upstream fuel suppliers, in which case, the former could sell any of their banked allowances to the latter. However, such a transition may be difficult because program participants may develop vested interests in the persistence of the program in a particular form.

b. *Upstream Cap-and-Trade*

While a realistic downstream emissions trading program could reach at most about fifty percent of U.S. emissions, it would be feasible to address virtually all sources of U.S. CO_2 emissions through an upstream emissions trading program.[163] The Center for Clean Air Pol-

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[160] Some abatement opportunities in uncapped sectors could be made available through project-based crediting, but, as discussed above, project-based crediting entails higher transaction costs than a cap-and-trade approach. *See* ENVTL. LAW INST., *supra* note 137, at 12–13.

[161] *See* CONG. BUDGET OFFICE, *supra* note 85, at 6; CCAP, OPTIONS, *supra* note 159, at 14.

[162] *See id.* at 7 tbl.1.

[163] *See* CTR. FOR CLEAN AIR POLICY, *supra* note 95, at 5. Policymakers also might be able to address some portion of emissions of the industrial GHGs through upstream controls on firms that manufacture the gases or on firms that use the gases in products. This Article generally will discuss the upstream approach in the context of CO_2 regulation.

icy has found that an upstream program involving fewer than 2000 regulated facilities—approximately the same number of regulated facilities that are subject to the CAA acid rain program—could reach virtually all of the CO_2 emissions in the U.S. economy.[164] These 2000 facilities would include a combination of petroleum refineries, oil importers, natural gas pipelines, natural gas processing plants, coal preparation plants, and certain coal mines where the production bypasses preparation plants. Fuel data is generally available for these firms, thereby easing the reporting burden on the firms and the monitoring and enforcement burden on the government.[165] Like a downstream system, an upstream emissions trading program would give downstream energy users the incentives and the flexibility to implement the most cost-effective means of reducing their emissions.[166]

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[164] *Id.* at 6–7. Climate Policy Center (formerly known as Americans for Equitable Solutions), with support from Resources for the Future, has proposed an upstream cap-and-trade program, called the "Sky Trust." *See* CLIMATE POLICY CTR., THE SKY TRUST PROPOSAL TO REDUCE U.S. CARBON EMISSIONS (2000), *available at* http://www.cpc-inc.org/library/files/10_skytrustno.pdf; Richard D. Morgenstern, *Reducing Carbon Emissions and Limiting Costs, in* U.S. POLICY ON CLIMATE CHANGE, *supra* note 147, at 166. In its evaluation of four options for a U.S. GHG cap-and-trade program, the Congressional Budget Office found that, of the four models it reviewed, the Sky Trust model had the highest overall score under the study's criteria of: (1) ease of implementation; (2) carbon target certainty; (3) incremental cost certainty; (4) cost-effectiveness; and (5) equitable cost distribution. *See* CONG. BUDGET OFFICE, *supra* note 85, at 18 tbl.2. The proposal also has received favorable notices in *The Economist* and *The New Republic. See A Novel Approach to Tackling Climate Change Could Satisfy Economists and Environmentalists Alike,* ECONOMIST, Feb. 14, 2002, at 49; Gregg Easterbrook, *Climate Change—How W. Can Save Himself on Global Warming,* NEW REPUBLIC, July 23, 2001, at 22.

[165] Under the S. 366 scheme, the government would allocate allowances annually to achieve six policy aims: (1) relief for electricity consumers; (2) transition assistance for dislocated workers and communities negatively impacted by the legislation; (3) encouragement of renewable power, energy efficiency, and cleaner energy sources; (5) transition assistance for electricity generating facilities; and (6) encouragement of biological and geological carbon sequestration projects.

[166] At least two further design questions arise with an upstream program: (1) How can the program reward facilities that "capture" CO_2 emissions at the stack? and (2) Would an upstream program concentrate power over the allowance market in the hands of a few large firms? With regard to carbon capture, the question arises because an upstream program would regulate carbon at the fuel level rather than at the emissions level. For this reason, sources would not have an incentive to implement carbon capture because it would not lower the price they pay for fossil fuels. However, it would be possible to design an upstream cap-and-trade program such that downstream firms could earn project-based emission credits for carbon capture activities and sell those credits to upstream firms. This would introduce carbon capture activities into the program in much the same way that land-use activities might be introduced into either an upstream or downstream program. With regard to the market power issue, the question arises because the petroleum industry currently is dominated by a small number of very large firms. The concern is that, under an upstream program, one or more of these firms would receive the bulk of the allowances

However, the incentive would take a different form. Instead of facing limits on their emissions, downstream sources would face limits on the physical availability of carbon-based fuels, which, in turn, would be reflected in fuel price increases. Theoretically, downstream firms and consumers should respond to this price signal in the same way as they would to a requirement to hold allowances directly—that is, under an upstream emissions trading program, the cap on fuel carbon would induce downstream sources to adopt the least-cost mix of emission reduction measures. Whether in practice the impacts on fuel use, technical innovation, and efficiency will be the same is not possible to predict. However, because an upstream emissions trading program feasibly, though indirectly, would reach all sources of CO_2 emissions, such a program arguably could achieve any given emissions reduction objective at less cost than a large-source downstream program.

Some commentators argue that an optimal domestic program would combine an upstream cap-and-trade program with enhanced product standards.[167] Their rationale is that, from a societal view, consumers often do not respond efficiently to changes in the price of energy.[168] For example, studies suggest that drivers do not take into account fuel costs savings over the entire useful life of a vehicle in deciding what level of fuel economy they want from a new vehicle.[169]

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and thereby have the power to control prices by witholding its allowances from the market. Such an outcome is highly unlikely for at least three reasons. First, the shape of the market is determined not by the firms regulated under the policy, but by the allocation of allowances. As discussed below, if policymakers opted for an upstream cap-and-trade program and decided to distribute allowances with the aim of minimizing the impacts of the program, they likely would distribute most if not all of the allowances to *downstream* energy users, who would be paying higher fuel prices as a result of the upstream cap. Alternatively, if policymakers opted to auction the allowances, petroleum industry titans would not have any particular advantage over any other bidder, for example, firms from other industries and investment banks. Second, even if allowances were distributed solely to the regulated upstream firms, it is unlikely that one or more of the major oil firms would receive enough allowances to exercise market power. The use of petroleum products accounts for less than half of the total emissions associated with the combustion of fossil fuels. Therefore, under such an allocation scenario, even the dominant petroleum firms would receive a relatively small share of the total allowances. Finally, policymakers could mitigate any potential for market power by providing for international emission trading, credits for reductions in non-CO_2 gases, and credit for reductions from unregulated sources. These "what" flexibility measures would expand the market and thereby diminish the ability of any individual firm or firms to exercise market power.

[167] *See* Ctr. for Clean Air Policy, *supra* note 95, at 28.

[168] *See* Kubo et al., *supra* note 73, at 78.

[169] *See* Cong. Budget Office, Reducing Gasoline Consumption: Three Policy Options 16 box 2 (2002), *available at* http://www.cbo.gov/ftpdocs/39xx/doc3991/11-21-GasolineStudy.pdf; David L. Greene & Andreas Schafer, Pew Ctr. on Global

This potential failure of some end-users to respond efficiently to a price signal does not affect the environmental effectiveness of an upstream cap-and-trade program because such a program imposes an absolute cap on the carbon content of fuel used in the economy. On the other hand, if consumers do not respond efficiently to the price signal, a disproportionate share of the burden of meeting an emissions cap could fall onto firms in the electricity-generation and industrial sectors, potentially diminishing the overall cost-effectiveness of the program.

These commentators argue that supplementing the upstream program with efficiency standards—such as modified CAFE requirements—could address these market failures by forcing more energy-efficient products into the marketplace.[170] For example, the program originally proposed by Senators McCain and Lieberman in January 2003 would have established an upstream cap on transportation sector emissions, but also would have incorporated incentives for automakers to sell more fuel-efficient cars.[171] The latter element was removed from the version of the McCain-Lieberman bill that was voted on in the Senate in October 2003.

Of course, any economy-wide upstream approach implies that households will see price increases in gasoline and home heating fuels. Policymakers concerned about shielding households from such price increases might prefer alternatives to an economy-wide approach, such as a downstream cap-and-trade program, which would shield consumers from fuel price but not electricity price increases or a program that combines a downstream program with product efficiency standards. In assessing these alternatives, however, it is important to keep in mind that program designs that shield households from overt price increases

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CLIMATE CHANGE, REDUCING GREENHOUSE GAS EMISSIONS FROM U.S. TRANSPORTATION 22–23 (2003); TRANSP. RESEARCH BD., *supra* note 59, at 64–65.

[170] *See infra* Part IV.C.

[171] *See* Climate Stewardship Act of 2003, S. 139, 108th Cong. (2002). The program originally proposed by Senators McCain and Lieberman would have capped the carbon content in fuels used for transportation purposes and would have allocated a portion of the allowances to petroleum importers and refiners. At the same time, the program would have encouraged the production and sale of more fuel-efficient cars by providing that an automaker that over-complied with the CAFE standards by 20% or more could convert its excess CAFE credits into "registered GHG credits." The automaker then would have been able to sell these credits into the cap-and-trade program. Acknowledging that an improvement in fuel economy also would free up allowances for use by regulated petroleum importers and refiners, the McCain-Lieberman program would have provided that anytime an automaker was awarded GHG credits, the government would have to remove a corresponding amount of allowances from the allotment to the transportation sector. This approach avoids a "double-counting" outcome.

for gasoline and home heating fuels do not necessarily shield them from higher costs. Alternative programs would put greater pressure on other sectors to achieve the emissions target; their compliance costs would come back to households in the form of higher prices for electricity and other goods and services. Indeed, because alternative designs are less efficient, the overall costs faced by households likely would be higher under such designs. Additionally, any program design that fails to provide a key sector with incentives to start shifting to lower-emitting practices and products increases the costs of achieving deeper emission reductions in the future. Finally, it should be noted that the impact of an upstream program on fuel prices can be controlled, either by starting with a moderate emissions cap or, as discussed in Part IV.A.4 below, by incorporating a safety valve approach.

c. *Upstream/Downstream*

Another approach is an upstream/downstream program that would use the familiar design of the Clean Air Act acid rain program for electricity generators, but would cover other sectors, such as the transportation sector, with an upstream program. The program proposed by Senators McCain and Lieberman reflects such an upstream/downstream design.[172] An upstream/downstream program would require upstream suppliers of fuel, such as refiners, gas pipelines, and processors, to hold allowances sufficient to cover the carbon content of fuel they deliver, subject to an exemption for deliveries to firms, such as electricity generators, that are subject to downstream regulation. These downstream firms, in turn, would be required to hold allowances for their emissions.

An upstream/downstream cap-and-trade that subjected electricity generators to downstream regulation and made all transactions for other uses subject to upstream regulation would end up with a somewhat greater number of regulated firms and would require a significantly more complex administrative system.[173] For example, because electricity generators' fossil fuel usage would be subject to a

[172] Though it reflects an upstream-downstream design, the McCain-Lieberman bill would omit any controls on natural gas or oil used for non-transportation purposes. The Progressive Policy Institute has proposed an upstream-downstream program. *See* Jan Mazurek, Progressive Policy Inst., Cap Carbon Dioxide Now (2002), *available at* http://www.ppionline.org/documents/co2_0602.pdf. The Center for Clean Air Policy also has outlined an upstream-downstream program option. *See* Hargrave, *supra* note 88.

[173] The program described by the Center for Clean Air Policy for purposes of its analysis would encompass 8400 facilities. Hargrave, *supra* note 88, at 18.

downstream allowance requirement, refiners' sales of fuel oil to those generators would be exempt from the upstream allowance requirement. This arrangement would make fuel destined for electricity generators less expensive than fuel destined for non-generators, such as truckers and building owners, thus creating an incentive for generators to buy fuel and resell it to others. Regulatory controls would be needed to prevent such behavior.

d. *Sectoral Hybrids*

A fourth approach would combine a cap-and-trade program covering large sources with efficiency standards for smaller sources in the transportation sector and the residential and commercial buildings sector. This hybrid approach is discussed in Part IV.C.

4. How Should Allowances Be Allocated?

Once a cap is set for the cap-and-trade program and it is determined what firms will be regulated, then a number of allowances equal to the cap must be distributed for use within the economy. The process for this distribution—the allowance allocation methodology—is likely to be the most difficult and potentially contentious issue in designing a cap-and-trade program.

There are two fundamental choices for allowance allocations: (1) distribution of allowances at no cost to firms affected by the regulatory program, or (2) an auction under which the government sells allowances to the highest bidder, and uses the proceeds to compensate affected firms, workers, or communities, to reduce taxes, or some combination of the above. If free distribution is chosen, then policymakers will have to decide how to allocate allowances to firms or individuals. Several allocation methods have been suggested, based on experience with existing electric generator cap-and-trade programs. These include "grandfathering," where allowances are allocated based on emissions prior to the start-up of the regulatory program, and a "generation performance standard," which allocates allowances based on post-start-up electric output, measured either as of a certain date or on the basis of a periodic updating.[174] If an auction is chosen, poli-

[174] *Id.* at 12. A number of recent economic studies have been critical of the Generation Performance Standard (GPS) approach, asserting that it has the potential to degrade the underlying cost-effectiveness of a cap-and-trade program. *See, e.g.*, DALLAS BURTRAW ET AL., RES. FOR THE FUTURE, THE EFFECT OF ALLOWANCE ALLOCATION ON THE COST OF CARBON EMISSION TRADING (2001) [hereinafter BURTRAW ET AL., ALLOWANCE ALLOCATION], *avail-*

cymakers will have to decide on the disposition of the revenues from the auction (revenue recycling). Recycling alternatives include direct compensation to affected firms, workers, communities, or consumers, and reductions in taxes on labor and capital.

The choice between auction and free distribution, and the subsidiary choices respecting allocation method and revenue recycling, have important implications both for the one who bears the cost of the program and the program's overall cost. These choices and their implications are explored below.

a. *Free Distribution*

Under conventional "command-and-control" environmental regulation, the regulated firm bears the direct costs of limiting emissions to an allowable level, but is not required to purchase its entitlement to allowable emissions.[175] Free distribution of allowances reaches a comparable result under market-based regulation by providing an initial

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able at http://www.rff.org/Documents/RFF-DP-01-30.pdf; DALLAS BURTRAW ET AL., RES. FOR THE FUTURE, THE EFFECT ON ASSET VALUES OF THE ALLOCATION OF CARBON DIOXIDE EMISSION ALLOWANCES (2002) [hereinafter BURTRAW ET AL, ASSET VALUES], *available at* http://www.rff.org/Documents/RFF-DP-02-15.pdf; CAROLYN FISCHER, RES. FOR THE FUTURE, REBATING ENVIRONMENTAL POLICY REVENUES: OUTPUT-BASED ALLOCATIONS AND TRADABLE PERFORMANCE STANDARDS (2001), *available at* http://www.rff.org/Documents/RFF-DP-01-22.pdf; DAVID HARRISON, JR. & DANIEL B. RADOV, NAT'L ECON. RESEARCH ASSOCS., EVALUATION OF ALTERNATIVE INITIAL ALLOCATION MECHANISMS IN A EUROPEAN UNION GREENHOUSE GAS EMISSIONS ALLOWANCE TRADING SCHEME (2002) (prepared for DG Environment, European Commission), *available at* http://www.nera.com/image/5240_es.pdf; LEE LANE, CLIMATE POLICY CTR., ALLOCATION OF ALLOWANCES AND CONSUMER IMPACT (2001), *available at* http://www.cpc-inc.org/library/files/13_lanemay01.pdf. As between the two methods of free distribution, which appear to be applicable only if allowances were distributed to utilities in any event, the papers rate the grandfathering method higher than the GPS method. *See, e.g.*, BURTRAW ET AL., ASSET VALUES, *supra*, at 18. The GPS approach, they assert, degrades the cost-effectiveness of a cap-and-trade program because it encourages relatively greater output from low-emitting generation—since utilities earn allowances on the basis of their generation—and relatively less conservation—since greater output means relatively lower electricity prices. *See, e.g.*, BURTRAW ET AL., ALLOWANCE ALLOCATION, *supra*, at 22. By contrast, the grandfathering approach does not distort the incentives created by the emissions cap. *See* BURTRAW ET AL., ASSET VALUES, *supra*, at 10. Burtraw et al. further assert that utilities themselves should prefer alternatives to a GPS approach, because the lower electricity prices resulting under the GPS approach erode the value of utility assets. *See id.* Indeed, Burtraw et al. conclude that utilities may be better off paying for allowances than receiving them for free on a GPS basis. *See id.* What explains this seeming paradox? Electricity prices are higher under an auction than under a GPS approach, resulting in greater revenues for utilities. Therefore, so long as utilities can pass along most of the costs of allowance purchases to their customers, the relative benefits of higher revenues under the auction will exceed the greater costs.

[175] *See* Stavins, *supra* note 87, at 300.

free allocation of allowances to firms affected by the program. This approach was used in the CAA acid rain program.[176]

A number of recent studies argue for a departure from the acid rain model in the context of a GHG cap-and-trade program, for several reasons.[177] First, the studies indicate that the allowances created by a U.S. GHG trading program could have substantially greater value than acid rain allowances under the CAA.[178] Second, these studies—if correct—indicate that free distribution of 100% of allowances to regulated firms would overcompensate them for their lost profits, because these firms can pass through to customers much of their costs of compliance. One study found that for a stand-alone electric generator cap-and-trade program, free distribution of all allowances to the electricity generators would increase the sector's net worth by fifty percent,[179] implying—if the analysis is correct—that power producers in the aggregate would be better off with mandatory GHG regulation modeled on the acid rain program than they would be with no GHG regulation at all. Of course, the impacts on allowance recipients would depend on the method of free distribution and would vary on a

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[176] *See* Clean Air Act, 42 U.S.C. § 7651(e) (2000).

[177] *See, e.g.*, Burtraw et al., Allowance Allocation, *supra* note 174; Burtraw et al., Asset Values, *supra* note 174; Lawrence H. Goulder, Res. for the Future, Confronting the Adverse Industry Impacts of CO_2 Abatement Policies: What Does it Cost? (2000) [hereinafter Goulder, Abatement Policies], *available at* http://www.rff.org/Documents/RFF-CCIB-23.pdf; Lawrence H. Goulder, Res. for the Future, Mitigating the Adverse Impacts of CO_2 Abatement Policies on Energy-Intensive Industries (2001) [hereinafter Goulder, Adverse Impacts] (on file with authors); Harrison & Radov, *supra* note 174; Lane, *supra* note 174; Smith & Ross, *supra* note 118.

[178] *See, e.g.*, Smith & Ross, *supra* note 118, at 21. For example, the Smith & Ross study calculates that a U.S. program that aimed to achieve reductions on par with the U.S. target under the Kyoto Protocol would create U.S. allowances with a total present value of $1.8 trillion, which is roughly equivalent to three percent of the entire capital base of the United States. *See id.* The U.S. Energy Information Administration has determined that full compliance with the Kyoto Protocol—if it were to be achieved through economy-wide trading aimed at achieving a more than a 30% reduction in emissions from BAU levels—would create allowances with a total annual value of approximately $450 billion in 2010 (in 1997 dollars). *See* Energy Info. Admin., U.S. Dep't of Energy, Impacts of the Kyoto Protocol on U.S. Energy Markets and Economic Activity, at xxi (1998). Even a more moderate program could create a high-value asset. Economists from Resources for the Future assert that a program that aimed to achieve reductions from the electricity sector of only six percent from business-as-usual levels in 2012—or a reduction in 35 million metric tons from BAU levels—would establish a pool of allowances worth $14.8 to $23.6 billion per year. *See* Burtraw et al., Allowance Allocation, *supra* note 174, at 6. By contrast, the acid rain program creates allowances worth a total of $2.7 billion in 2010. *See id.* at 6. These studies are cited to show a range of the estimates of the costs of a comprehensive U.S. program. They do not reflect the judgment of the authors as to likely costs.

[179] *See* Smith & Ross, *supra* note 118, at 5.

firm-by-firm basis. That is, utilities heavily reliant on coal would fare worse than utilities with natural gas, nuclear, or renewable power plants.[180] In addition, overcompensation might not be an issue for utilities subject to cost-of-service regulation if, for purposes of setting customers' rates, regulators required that utilities value the allowances at their cost—zero—rather than at their market value.[181]

In any event, distribution of all of the allowances to firms subject to the cap would do nothing to alleviate the financial losses borne by firms and consumers *not* subject to the cap. For example, absent some compensation mechanism under any GHG cap-and-trade program, both coal producers and owners of coal-fired power plants would suffer a substantial proportion of the financial losses resulting from the emissions cap. Yet, under a downstream program where allowances were allocated only to electricity generators subject to the cap, coal producers would receive no relief, even though, according to one study, their projected equity losses could be more than sixty percent.[182] Nor would this approach to allowance allocation provide any relief to coal miners who might face significant losses in income. Similarly, under an upstream trading program, distribution of allowances to fuel transporters and processors subject to the cap would do nothing to address the financial losses of the electricity generators downstream from the point of regulation, which would be paying more for coal and natural gas. Moreover, neither approach would address the impacts on other firms and on households, both of which would face significantly higher energy prices as a result of either an upstream or downstream trading program,[183] or the likely reduction in federal tax

[180] *See* Burtraw et al., Asset Values, *supra* note 174; Goulder, Adverse Impacts, *supra* note 177, at 17–18 (finding that, in a scenario in which all allowances are distributed gratis to fuel producers, coal industry profits will rise by 155% in 2002 and by 218% in 2025—coal industry equity values increase by a factor of seven over the same time period).

[181] *See* Burtraw et al., Allowance Allocation, *supra* note 174, at 7. Under cost-of-service regulation, a utility's rates are set administratively based on the costs incurred in providing electricity service. *Id.* In the acid rain program, most regulators have treated grandfathered allowances as zero-cost assets, because they were distributed to utilities for free. *See id.* Accordingly, utility regulators generally have not taken into account the opportunity costs of surrendering an acid rain allowance instead of selling it in the market. *See id.* at 6. As a result, most utilities have not been allowed to pass on these opportunity costs to their ratepayers in the form of higher electricity prices. *See id.* at 20.

[182] *See* Smith & Ross, *supra* note 118, at 25.

[183] *See id.* at 4–5 (demonstrating that coal miners and coal mining communities could be particularly hard hit by a GHG regulation program); Jim Barrett, Pew Ctr. on Global Climate Change, Worker Transition & Global Climate Change (2001), *available at* http://www.pewclimate.org/docUploads/worker_transition.pdf; Judith M. Greenwald et

revenues because of reduced levels of economic activity attributable to the program.[184]

For these reasons, these recent economic studies urge policymakers to de-link the allocation of allowances from the incidence of regulation, and to link it instead to economic losses attributable to the regulatory program. In this regard, an important finding of the allowance allocation studies is that the government might need to distribute only a relatively small percentage—six to thirteen percent—of the total allowances to energy sector firms to eliminate their equity losses from an efficient upstream cap-and-trade program.[185] If correct, this means the government could distribute the value of the balance of the allowances to achieve other ends—for example, to assist burdened firms outside the energy sector, to help consumers, to aid particularly hard-hit workers or their communities, or to prevent a decline in government revenues.[186] It should be noted, however, that these conclusions are critically dependent on the details of the regulatory program and on modeling techniques. As discussed below, if the regulatory program were less efficient than an upstream cap-and-trade program, or if the period for allocation of allowances to compensate affected energy firms were limited to ten years for example, then the percentage of allowance value allocated to the firms would have to be higher and the percentage available for other uses would be, at least initially, much smaller.

These studies also add an important perspective on the long-standing debate on whether, in a free distribution regime, allowances should be allocated on a grandfathering or generation performance standard basis. If a policy objective of allowance allocation is to compensate firms affected by the cap-and-trade program for their lost

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al., Pew Ctr. on Global Climate Change, Community Adjustment to Climate Change Policy (2001), *available at* http://www.pewclimate.org/docUploads/community_adjust.pdf.

[184] *See* Smith & Ross, *supra* note 118, at 21. A critical finding of the Smith & Ross study was that the GHG program it modeled would reduce U.S. tax revenues by $50 billion in 2010. This would correspond to 56% of the total value of the allowances created under the program. *See id.*

[185] Goulder, Adverse Impacts, *supra* note 177; Smith & Ross, *supra* note 118.

[186] *See, e.g.*, Clean Power Act of 2003, S. 366, 108th Cong. § 707 (2003). S. 366 would establish a utility cap-and-trade program covering emissions of CO_2, NO_x, and SO_2. *See id.* Under the S. 366 scheme, the government would allocate allowances annually to six categories: (1) electricity consumers; (2) transition assistance; (3) renewable electricity generating units, efficiency projects, and cleaner energy sources; (4) electricity generating facilities; (5) encourage biological carbon sequestration; and (6) encourage geological carbon sequestration. For a number of the categories, allowances would go to a trustee, who then would be responsible for selling the allowances and redistributing the revenues according to various formulae. *See id.*

profits, allowances should be distributed to firms on the basis of their projected financial losses from the emissions cap, not past emissions or current output. This is because a firm's economic losses are not necessarily related to its output or emissions. Determining the amount of such losses on a firm-by-firm basis could be complex, but it could be done administratively in the same way "stranded investment" is determined in electric restructuring proceedings.[187]

b. *Allowance Auction and Revenue Recycling*

A number of economists and policy analysts advocate for the governmental distribution of allowances through an auction or, alternatively, through a fiduciary.[188] They cite two advantages of this approach.[189] First, it could potentially provide a less cumbersome mechanism for distributing the value of the allowances to groups suffering financial losses from a GHG emissions cap. Instead of giving consumers and others allowances to sell, the government itself could sell the allowances and recycle the revenue to the economically vulnerable groups through lump-sum payments or aid programs; the government also could retain some of the revenues to prevent erosion of the federal tax base.

Recycled revenues could further be used to reduce distortionary taxes that produce a net drag on the economy. Economists argue that existing wage-related taxes create a disincentive to work, and that existing taxes on interest, dividends, capital gains, and corporate income discourage productive investments. According to this argument, using the proceeds of an allowance auction to reduce taxes on income or investment, rather than as a means of direct compensation,

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[187] *See* 75 F.E.R.C. ¶ 61,080 (Apr. 24, 1996) (commonly known as Order 888).

[188] For studies proposing an auction approach, see, for example, BURTRAW ET AL., ALLOWANCE ALLOCATION, *supra* note 174; CONG. BUDGET OFFICE, *supra* note 85; PETER CRAMTON & SUZI KERR, RES. FOR THE FUTURE, TRADABLE CARBON PERMIT AUCTIONS: HOW AND WHY TO AUCTION NOT GRANDFATHER 3–17 (1998); GOULDER, ADVERSE IMPACTS, *supra* note 177; SMITH & ROSS, *supra* note 118. Both the Jeffords bill and the McCain-Lieberman bill would distribute allowances to a designated fiduciary and direct the fiduciary to use the proceeds from allowance sales to achieve certain purposes. *See* S. 366 § 707 (establishing a trustee); S. 139(C) (establishing the "Climate Change Credit Corporation").

[189] *See, e.g.*, ANNE E. SMITH ET AL., CHARLES RIVER ASSOCS., IMPLICATIONS OF TRADING IMPLEMENTATION DESIGN FOR EQUITY-EFFICIENT TRADE-OFFS IN CARBON PERMIT ALLOCATIONS (2002).

would result in overall economic gains that could significantly reduce the cost of GHG regulation to society as a whole.[190]

A number of recent studies, including a study conducted by Charles River Associates (CRA), described below in Box 3, look at the efficiency implications of different design options for a cap-and-trade program.[191] While the quantitative results of these studies are very much dependant on modeling assumptions, they are useful in illustrating the interactions of the design elements of a cap-and-trade program.[192] First, compensatory allowance allocations to energy sector firms, if they are made on a permanent basis, appear to require only a small percentage of allowances or allowance revenues.[193] However, if these allocations are made over a relatively short transition period—ten years, for example—then the percentage allocated to these firms will have to be much larger in the early years of the program. Second, if the program is designed to be revenue-neutral to the federal government and policymakers assume no offsetting fiscal benefits from the program, then a large proportion of auction revenues—in the CRA analysis of an upstream cap-and-trade program, about fifty percent—would be retained by the government.[194] Third, in the CRA analysis of an upstream cap-and-trade program, once prior claims are satisfied, the allowance proceeds that remain are sufficient to reduce the social cost of the trading program by thirty-five percent, if the proceeds are dedicated to reducing marginal tax rates.[195] Fourth, if policymakers settle on a program that is less cost-effective than an up-

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[190] Economists are careful to note that such efficiency improvements would result only from reductions in marginal taxes. Increases in standard deductions or other per-person or per-household rebates, on the other hand, do not produce such economic gains. *See* Smith & Ross, *supra* note 118, at 14. Such approaches just redistribute the costs of the GHG regulatory program. *See id.* At one time it was believed that recycling revenues from an allowance auction to reduce distortionary taxes would not merely offset some of the costs of a GHG emissions cap, but would also generate a net gain in GDP. This implied that a GHG cap-and-trade program could provide a "double dividend" of environmental benefits *and* economic development. More recent research suggests that this result is highly unlikely because the interaction of the emissions cap and existing distortionary taxes (the "tax interaction effect") makes GHG regulation more costly than was previously believed. *See* I. Parry et al., *When Can Carbon Abatement Policies Increase Welfare? The Fundamental Role of Distorted Factor Markets*, 37 J. Envtl. Econ. & Mgmt. 52, 74 (1999) (finding that the cost to the U.S. economy of a 15% reduction in CO_2 emissions is 2.6 times greater when the tax interaction effect is taken into account).

[191] *See, e.g.*, Smith et al., *supra* note 189.

[192] *See, e.g.*, *id.*

[193] *See, e.g.*, *id.*

[194] *See id.*

[195] *See id.*

stream cap-and-trade program, then the costs imposed by the regulatory program will increase while the total allowance proceeds available to the government to address those costs will decrease.

For all of these reasons, choices respecting allowance allocation have important implications, both for cost-effectiveness and distributional equity. They also raise political feasibility issues. For example, the practice of requiring regulated firms to purchase allowances through a government auction could be characterized by its opponents as a new tax. In addition, obtaining the efficiency benefits of revenue recycling implies taking on not only development of a GHG regulatory program but also tax reform.

Box 3: Modeling Design Alternatives for Allowance Allocation: Results of One Study

The CRA study illustrates the potential impacts of design alternatives for distributing the allowances under a cap-and-trade program.[196] The study models an upstream cap-and-trade program that would reduce U.S. GHG emissions to year-2000 levels in 2010.[197] The model was run without a number of the flexibility measures described above—such as international GHG trading, domestic sequestration, and reductions in non-CO_2 gases—and did not take into account any benefits of avoided climate change damage that may result from the program.[198] This scenario shows a long-run reduction in welfare of about 0.4%.[199] Assuming allowance allocations were permanent, only about six percent of allowances would have to be allocated to firms in the energy sector to compensate firms for equity losses resulting from the upstream cap-and-trade program.[200] However, about fifty percent of auction revenues would need to be retained by the federal gov-

[196] SMITH ET AL., *supra* note 189.

[197] See *id.* at 12.

[198] *See id.*

[199] *Id.* at 21 fig.4.

[200] *Id.* at 14. The CRA study defines the energy sectors as including those firms engaged in coal mining, crude oil extraction, natural gas production and extraction, petroleum refining, and electricity generation. *Id.* at 10 tbl.1. The percentage of allowance proceeds needed to preserve existing assets is highly dependent on a number of assumptions. For example, in a 2002 study done for the Center for Clean Air Policy, Charles River Associates used a different modeling design and arrived at percentages ranging from 9% to 21%. *See* SMITH & ROSS, *supra* note 118, at 25. In both that study and the 2002 study discussed in Box 3, the results varied depending on a number of factors, including the assumed scope of trading in the U.S. domestic program and the availability of international emissions trading. *See* SMITH & ROSS, *supra* note 118, at 25.

ernment to offset revenue losses attributable to the decrease in GDP resulting from the program, assuming that the program is to be revenue-neutral vis-a-vis the federal government, and that there are no offsetting fiscal benefits from mitigating climate change.[201] If the balance of the revenues—about 40%—were used to reduce marginal personal income tax rates, the efficiency gains from this tax reduction would reduce the overall cost of the program by about 35%, so that the long-term welfare loss would be about 0.25%.[202]

In contrast to an upstream cap-and-trade program, a downstream cap-and-trade program combined with an increase in CAFE standards to 35.0 mpg would reduce welfare by about 0.8% in the long run, even with the benefit of income tax reductions.[203] It would also entail a larger share of allowances for the federal government if the program is to be revenue-neutral for the federal government. At the same time, because fewer sources would be subject to a cap-and-trade program, the pool of allowance proceeds from which to achieve such compensation would be smaller.[204]

5. Emissions Certainty Versus Cost Certainty

The third critical design issue in designing an emissions trading program is determining what balance to strike between certainty about achieving a particular level of emission reductions and certainty about costs of compliance.

Policymakers can limit the costs of complying with an emissions trading program through a safety valve feature, which would authorize the government to sell additional allowances at a predetermined price.[205] With a safety valve mechanism in place, the market price of allowances—and therefore the marginal cost of abatement—will rise no higher than the safety valve price.[206] The effect is to cap compliance costs.[207]

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[201] SMITH ET AL., *supra* note 189, at 16.

[202] *Id.* at 20.

[203] *Id.* at 20–23.

[204] Note that this scenario does not include the trading features discussed below in connection with a sectoral hybrid program.

[205] *See* JACOBY & ELLERMAN, *supra* note 93.

[206] *See id.*

[207] *See id.* at 4. During discussions in 1999 regarding proposed "credit for early action" legislation, staff at the Resources for the Future suggested the use of a safety valve approach. *See* Raymond Kopp et al., *A Proposal for Credible Early Action in U.S. Climate Policy*,

Establishing a safety valve, however, implies that emissions are *not* capped. If compliance costs turn out to be higher than expected, firms can purchase more allowances and total emissions can rise above the cap. This is not to say that emissions would be entirely unlimited—firms would have to pay the safety valve price to increase their emissions—but the safety valve option would mean that there was not a precise and absolute cap. Thus, the safety valve option presents policymakers with a potential trade-off between emissions certainty and compliance cost certainty.

How important is certainty about meeting a particular emissions cap? The atmosphere is not particularly sensitive to small differences in emission levels. Scientists have not identified a particular threshold level over which the potential for damage is great. For these reasons, policymakers might not attach significant value to assurances that the United States will meet a particular, near-term emissions target with precision.

By contrast, assurances that the compliance costs will not rise above a particular per-ton level could be central to building political support for moving forward on climate change. There are significant differences in opinion on how much it will cost to reduce GHG emissions in the United States because the cost would be largely a function of future levels of economic activity, which are difficult to forecast.[208] Yet, establishing a cap-and-trade program without a safety valve mechanism means that the cap will have to be met, regardless of cost. A safety valve mechanism can help remove cost uncertainties as a barrier to action.[209]

WEATHERVANE (Feb. 1999), *at* http://www.weathervane.rff.org/features/feature060.html (last visited Jan. 14, 2005).

[208] *See* JACOBY & ELLERMAN, *supra* note 93, at 6–7.

[209] A number of the extant proposals for domestic and international cap-and-trade programs include a safety valve provision or similar mechanism. *See, e.g.*, JOSEPH E. ALDY ET AL., CLIMATE CHANGE: AN AGENDA FOR GLOBAL COLLECTIVE ACTION 27 (2001), *available at* http://www.pewclimate.org/docUploads/stiglitz.pdf; CLIMATE POLICY CTR., *supra* note 164; WARWICK J. MCKIBBIN & PETER J. WILCOXEN, THE BROOKINGS INST., THE NEXT STEP FOR CLIMATE CHANGE POLICY (2000), *available at* http://www.brookings.org/views/papers/mckibbin/20000201.htm; DAVID G. VICTOR, THE COLLAPSE OF THE KYOTO PROTOCOL AND THE STRUGGLE TO SLOW GLOBAL WARMING (2001); *Competing Utility Emissions Plans May Create Congressional Hurdle*, *supra* note 157 (describing proposal of the "Clean Power Group," which includes a "circuit-breaker" provision that works like a safety valve). In addition, the Bush Administration's proposed "Clear Skies Act" legislation—which would set controls on nitrogen oxides, sulfur dioxide, and mercury—incorporates a safety valve. *See* S. 2815, 107th Cong. § 403 (2002).

Some commentators argue that a safety valve mechanism inevitably would be an "easy out," diminishing incentives for firms to innovate or to build a bank of early reductions, both of which are key factors in driving down the long-term costs of reducing emissions.[210] However, other commentators have argued that a safety valve option could make risk-averse households and firms willing to accept a more aggressive emissions cap—and therefore higher emissions price—than otherwise would be the case, because they would have assurances that their costs would not exceed the safety valve level.[211]

Ultimately, the decision whether to adopt a safety valve approach could depend on the timing and stringency of the regulatory program. Because the United States has elected not to become a party to the Kyoto Protocol, at least for now, U.S. policymakers have flexibility in setting the emissions target and compliance timetable for a domestic climate program.[212] They might opt for a gradual approach, that is, an approach that aims to make a start in reducing U.S. emissions while keeping compliance costs low. If policymakers design such a moderate, and therefore relatively lower-cost program, they might reasonably conclude that a safety valve provision is unnecessary and opt instead for certainty in meeting the target. Alternatively, they could incorporate a safety valve in the program's early stages and raise the safety valve price over time.[213]

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[210] Environmental Defense, an environmental advocacy organization that has been a pioneer in designing and promoting market-based approaches to environmental protection, has made these arguments. *See, e.g.*, ENVTL. DEF., FROM OBSTACLE TO OPPORTUNITY: HOW ACID RAIN EMISSIONS TRADING IS DELIVERING CLEANER AIR 36–37 (2000) *available at* http://www.environmentaldefense.org/documents/645_SO2.pdf.

[211] *See* ALDY ET AL., *supra* note 209.

[212] *See* Kopp et al., *supra* note 207.

[213] *See* PIZER, *supra* note 104; *see also* William Pizer, *Combining Price and Quantity Controls to Mitigate Global Climate Change*, 85 J. PUB. ECON. 409, 431 (2002). In a set of studies, economist Martin Weitzman was the first to find that where costs of compliance are uncertain, "quantity controls," such as cap-and-trade programs, and "price controls," such as emission taxes, result in different levels of efficiency. *See* Martin Weitzman, *Prices v. Quantities*, 41 REV. ECON. STUD. 477, 485–87 (1974). Weitzman determined that, where costs are uncertain and the marginal benefits of regulation—i.e., the environmental damage avoided—are relatively flat, fixing the price first results in a level of costs that approximates what the optimal price will turn out to be once costs are known. *See id.* By contrast, if the marginal benefits of regulation rise steeply—this would occur in situations in which environmental damage is catastrophic after a certain level of emissions—fixing the quantity first results in a level of control likely to be in the range of what would be optimal once costs are known. *See id.* One way to look at an emissions trading program with a safety valve mechanism is as a hybrid approach, combining elements of a cap-and-trade program and an emissions tax. *See id.* Pizer has modeled application of such a hybrid approach to cli-

6. Evaluation of Cap-and-Trade Programs

Environmental Effectiveness: A cap-and-trade program, if comprehensive in coverage and properly administered, can be highly effective in meeting its target. A comprehensive upstream cap-and-trade program would be environmentally effective as to CO_2, but may not be feasible for other gases or sinks. A large-source downstream program could be equally effective with respect to the sectors it covered, but would have to be supported by other measures to provide full coverage. An all-sector downstream program is likely to be ineffective because it could be administered and enforced only with great difficulty.

Cost-Effectiveness: Cap-and-trade programs, if they include flexibility measures, can attain emission reductions at low cost. Allowance allocation policies could increase or decrease the costs imposed by the program.

Administrative Feasibility: An upstream cap-and-trade program appears to be fully administrable for CO_2 and for certain other GHGs. An all-sector downstream cap-and-trade does not appear to be feasible because of the number of regulated firms involved. A hybrid program that combines a downstream cap-and-trade for large sources with an upstream program applicable to suppliers of fuel for smaller sources appears to be feasible, though somewhat more complex than a full upstream program.

Distributional Equity: The distributional consequences of a cap-and-trade program depend critically on how allowances are allocated, or—if they are auctioned—how the auction proceeds are distributed.

Political Acceptability: Because any all-sector cap-and-trade program, whether upstream or downstream, will drive up consumer costs for gasoline, natural gas, and home heating oil, it is likely to be politically difficult. An all-source downstream cap-and-trade, because it implies regulating millions of sources, is likely to be even more difficult. A downstream cap-and-trade program limited to electricity generators and other large stationary sources could be more acceptable politically, but to be effective it would have to be coupled with a regulatory program to cover other sectors.

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mate policy and found substantial gains over a pure quantitative—i.e., cap-and-trade—approach. *See id.*

B. *GHG Tax*

1. Overview of GHG Tax Approach

Another market-based approach to reducing GHG emissions is a GHG tax program. Under such a program, policymakers would impose a per-ton fee on CO_2 emissions or on the carbon content of fuel. Other GHG emissions, to the extent measurable, would also be taxed. In addition, the program could be designed so that firms earn a tax credit for CO_2 emissions reduced through land-based sequestration projects, carbon capture projects, or for project-based reductions in GHGs that are not subject to tax. Firms subject to the tax would have an incentive to reduce their emissions—thereby avoiding the tax—until the cost of achieving reductions exceeded the cost of paying the tax. Accordingly, as with an emissions trading program that incorporates a safety valve, a tax program would provide near-term cost certainty but not absolute near-term emissions certainty.

A tax program would offer practically all of the flexibility, and therefore cost-effectiveness, of an emissions trading program. Firms would have the incentive and the opportunity to adopt the lowest-cost means of reducing their energy-related emissions; the "payment" for additional reductions would take the form of tax savings. Just as firms subject to an emissions trading program could bank excess allowances, firms participating in an emissions tax program could literally bank their tax savings from reducing their emissions. Tax credits also could be made available for emission reductions achieved through projects financed in other countries or for valid emission allowances acquired from other countries' regulatory programs.[214]

Designing a domestic GHG tax program would raise some of the same fundamental issues that arise in designing an emissions trading program. For example, it would be necessary to determine whether

[214] A carbon tax program might have difficulty in accommodating those firms that otherwise would be able to sell their surplus U.S. allowances into an international emissions trading market. *See* Robert W. Hahn & Robert N. Stavins, Res. for the Future, What Has Kyoto Wrought? The Real Architecture of International Tradable Permit Markets (1999), *available at* http://www.rff.org/Documents/RFF-DP-99-30.pdf. However, this may be an immaterial concern since, as discussed above, under the Marrakech Accords that implement the Kyoto Protocol, there appears to be little possibility that U.S. reductions can be credited against other countries' emission reduction obligations under the Protocol, though nothing in the Marrakech Accords precludes the United States from establishing a GHG program that credits Kyoto units. *See supra* text accompanying note 128.

the program should tax upstream firms, downstream firms, or some combination of the two. The analysis is largely the same as that for an emissions trading program. A downstream tax would take the form of a tax on CO_2 and certain other GHG emissions. Because enforcing the tax would require tracking the emissions of each firm subject to the tax, a downstream emissions tax, like a downstream emissions trading program, could not feasibly reach all of the hundreds of millions of sources of CO_2 emissions in the economy. An upstream tax program would take the form of a tax on the carbon content of fuels sold into the energy system. Like an upstream emissions trading program, an upstream GHG tax could be applied to a few thousand firms that produce, refine, and market fuels. The tax on these firms would lead to higher prices for carbon-intensive fuel and higher prices for energy. The program thus could effectively regulate the entire energy system, providing downstream firms with incentives to switch fuels, increase energy efficiency, and reduce energy use.

A tax program would raise revenue in much the same way as would an emissions trading program with an allowance auction. Accordingly, a tax program would offer an opportunity to reduce distortionary taxes on labor or capital. In addition, revenues from the tax could be used for any of the purposes described above with regard to revenues from an allowance auction, such as assisting vulnerable workers and communities.

In addition, it is possible to design a tax program to mimic the effect of free distribution of allowances under an emissions trading program. How would this work? The tax program could offer an exemption from the tax up to a certain fixed amount of tons of carbon supplied (upstream) or emitted (downstream).[215] As with free allocation of allowances, a tax program could base the size of the exemption on particular characteristics of the firms, such as output in a base year. The tax program still could achieve its environmental objective so long as firms remain subject to the tax at the margin, that is, for the last tons supplied (upstream) or emitted (downstream). However, as with free allocation of allowances in an emissions trading program, a modified tax would reduce the burden of the program on those firms directly subject to the tax, but would not assist firms and consumers suffering indirect costs from the tax program. They would not

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[215] *See* Goulder, Abatement Policies, *supra* note 177, at 3–4. For a tax exemption to be fully equivalent to free distribution, the exemption would have to be converted to some form of tradable tax credit.

pay the tax and therefore would not benefit from the partial exemption, yet they still would bear financial losses as a result of the program. Of course, opting for this kind of modified GHG tax would reduce the total revenues brought in by the tax program and therefore reduce the ability to achieve other objectives with those revenues.

Finally, the major problem with a GHG tax is that it is a tax. As noted above, U.S. experience since 1973 indicates that taxes as an instrument of energy or environmental policy, no matter how pressing the need, have not been accepted by Congress or the public.[216] Thus, a workable GHG tax system could be devised, but its adoption would appear to contradict conventional political wisdom. On the other hand, a GHG tax system could be politically palatable if it were an integral part of a comprehensive reform of the tax code, in which the GHG tax replaced or reduced other, even less popular taxes.

2. Evaluation of GHG Tax Approach

Environmental Effectiveness: A GHG tax program (upstream) could be highly effective in reducing U.S. GHG emissions because of its economy-wide coverage of CO_2 emissions. However, if certainty in meeting a particular short-term emissions target were a priority, a tax program would be less preferable than an upstream cap-and-trade program. As with a trading program, sources and sinks not amenable to direct taxation would have to be addressed through a tax credit mechanism or through standards.

Cost-Effectiveness: A GHG tax program would offer all sources incentives and opportunities to adopt their least-cost mitigation options. As a price-based program, a tax program would offer certainty as to compliance costs. As with allowance allocation, different use of the tax revenues could decrease or increase the total cost imposed by the program.

Administrative Feasibility: An upstream GHG tax program would not present significant administrative complexities. An economy-wide downstream GHG tax program, on the other hand, would be administratively infeasible.

Distributional Equity: The distributional consequences of a GHG tax depend critically on how tax revenues are used.

Political Acceptability: Experience suggests that Americans are reflexively opposed both to tax programs and to gasoline price increases. The GHG tax combines the two.[217] A GHG tax approach

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[216] *See supra* Part III.
[217] *Id.*

might have some appeal if introduced as part of a tax reform package that included cuts in income or payroll taxes.

C. *Sectoral Hybrid Program*

1. Introduction

The final of the three major design options for a U.S. climate change program analyzed in this paper is a sectoral hybrid program. A sectoral hybrid program could combine a downstream cap-and-trade program for large sources in the electricity and industrial sectors with enhanced product efficiency standards to cover small GHG sources—mainly consumer products and equipment—in the transportation, residential, and building sectors.[218] This hybrid approach has the potential of avoiding some of the political challenges associated with a full upstream cap-and-trade program or GHG tax.

A sectoral hybrid program would provide a mechanism to reach transportation and household emissions that policymakers may be unwilling or unable to regulate directly—as through a downstream cap-and-trade program, or through regulation of fuels—as through an upstream cap-and-trade program. The standards component of the program would regulate the performance characteristics of newly-manufactured products used in the transportation sector and in the residential and commercial buildings sector. For example, while it would not be administratively feasible to directly regulate every household on the basis of its furnace use or every motorist on the basis of emissions resulting from use of his or her motor vehicle, it would be feasible to implement standards that force more energy-efficient furnaces and more fuel-efficient cars into the marketplace.

One advantage of using product efficiency standards to complement a cap-and-trade program is that policymakers could build upon the energy efficiency standards already in effect under U.S. law. Some of the flexibility benefits of a cap-and-trade program can be attained by establishing "tradable" standards, thus providing a degree of exchange between sectors subject to a cap-and-trade program and sectors subject to standards. While a sectoral hybrid program could be attractive to policymakers because it starts with familiar elements, it

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[218] The Center for Clean Air Policy and the Heinz Center have explored domestic policy designs that would combine a cap-and-trade program with standards for downstream firms. *See* CCAP, OPTIONS, *supra* note 159, at 8–12; HEINZ CTR., *supra* note 81, at 56–67 (describing "Option III" and "Option IV").

would require addressing or accepting a number of problematic aspects of a product efficiency standards program. A sectoral hybrid still would leave noticeable gaps in emissions coverage, unless current efficiency standards were significantly expanded. In addition, transforming conventional standards into tradable standards and coordinating the standards program with the cap-and-trade program would pose considerable administrative challenges. And even if these obstacles could be overcome, a standards program remains inherently less cost-effective than a full upstream cap-and-trade program because standards do not provide any incentives to reduce use, nor do they dictate the rate at which end-users replace their old products for more efficient, new ones.

Box 4: Example of a Sectoral Hybrid Program

PHASE I

Tradable Standards:

Autos: All automobiles using gasoline or diesel fuel would be subject to a tightened CAFE standard that would be translated into a "mpg-equivalent standard" for CO_2 emission trading purposes. Manufacturers could trade between product lines, with each other, and with firms subject to cap-and-trade programs. Non-automobile engines using gasoline or diesel would be subject to comparable standards.

Appliances: Appliance standards for gas and oil-fired equipment could be strengthened and converted to CO_2 emission standards, and expanded to cover all natural gas and oil-fired equipment used in residential or commercial applications that consume any significant amount of energy. As with autos, manufacturers could trade among covered product lines, among manufacturers, and with firms subject to cap-and-trade. Efficiency standards for electric appliances would be retained to prevent electric appliances from gaining a competitive advantage over gas appliances subject to standards.

Downstream Cap-and-Trade: Electricity generators and other large stationary sources would be subject to a downstream cap-and-trade program modeled on the CAA acid rain program. Flexibility measures would be included. Sources and sinks of GHGs not covered by the cap-and-trade program or standards would be addressed through project-based credit trading. Policymakers could consider establishing a safety valve.

Allowance Allocation: A percentage of allowances would be distributed free to electricity generators, coal producers, and certain industrial energy users for a limited period. The balance would be auctioned.

Revenue Recycling: Auction revenues would be used to reduce taxes and for lump-sum payments to individuals and/or communities.

POTENTIAL PHASE II

Upstream Cap-and-Trade: Refiners, gas pipelines, coal processors, fossil-fuel importers, and certain other firms would be required to surrender allowances to cover the carbon content of fossil fuels sold or used by those firms. Full flexibility would be permitted, including trading with the sectors outside the upstream cap-and-trade program. However, the following sales and uses would be exempt from the upstream allowance requirement, because they would be controlled directly or indirectly by the downstream cap-and-trade or the product efficiency standards program:

1. Gasoline or diesel fuel sold or used in automobiles or engines.
2. Natural gas, natural gas liquids, or fuel oil sold for use in a residential or commercial building.
3. Any fuel used in an electric generation unit or other large stationary source covered by the downstream program.

Sources and sinks of GHGs not covered by the cap-and-trade program would be addressed through project-based crediting.

2. Designing the Standards Component of a Sectoral Hybrid Program

Designing the product efficiency standards component of a sectoral hybrid would involve a number of steps. First, it would be necessary to adapt existing standards to the new purpose of regulating GHG emissions. Second, policymakers may decide that it is necessary to develop new standards for products and processes not now covered by standards. Third, policymakers may want to formulate many of the standards as tradable standards.

Most existing standards are expressed in terms of an energy efficiency requirement, for example, miles per gallon. In a climate program, policymakers would need to translate these standards from energy per unit of output to GHG emissions per unit of output, or at least adjust the standards to reflect the carbon content of different fuels. To achieve broad coverage of emissions, a sectoral hybrid program would necessitate the establishment of a range of new standards. While standards currently are in place for most major energy-using consumer products and equipment—including motor vehicles and residential and commercial natural gas and oil-fired equipment—standards do not apply to most commercial and industrial equipment.[219] Federal standards also do not apply to building envelopes, that is, heat loss and heat gain from buildings. For example, air conditioner standards will ultimately result in more efficient air conditioners replacing less efficient ones, but they do not deal with energy loss from uninsulated buildings. Most importantly, however, standards are not currently in place for a range of sources in the transportation sector, including locomotives, vessels, aircraft, buses, and heavy trucks; these uncovered sources accounted for nearly fifty percent of GHG emissions in the transportation sector in 2002.[220] For these reasons, combining a large-source cap-and-trade program with existing standards only would reach approximately eighty percent of the nation's energy-related CO_2 emissions.[221]

Another design consideration is the inflexibility of conventional standards. Typically, standards reflect a command-and-control approach—that is to say, they prescribe a uniform emissions limit or technology without regard to the varying circumstances of the regulated firms. Accordingly, reliance on conventional standards would mean forgoing the flexibility benefits of emissions trading.

One solution to this problem is to design tradable standards. How would such standards work? A tradable standards program would use estimates of the average life and use of a product to translate over-compliance with a standard into a stream of emission allowances assigned to particular years, known as "vintaged" allowances.[222] Con-

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[219] *See* Ctr. for Clean Air Policy, *supra* note 95, at 5–6.

[220] *See* U.S. EPA, *supra* note 2, at 1-20 tbl.1-14.

[221] The approximately 20% of emissions uncovered by a sectoral hybrid program comprise sources that neither use electricity, and therefore are not reached by the cap on power plants, nor are regulated by existing standards. These include sources in the transportation sector, such as locomotives, freight trucks, certain commercial vehicles, aircraft, ships and barges; the commercial buildings sector, such as natural gas-fired heating and cooling equipment; and the industrial sector, such as boilers and furnace heaters in industrial sources not participating in the cap-and-trade program.

[222] The reason to have vintaged allowances is to make clear when allowances may be used for compliance. If a U.S. domestic program sets a series of discrete compliance periods into the future, policymakers might want to allow only certain vintages of allowances to be used in certain periods. Absent such a restriction, the Corporate Average Carbon Efficiency approach would allow firms to meet their emission reduction obligations in a

versely, the program would translate a failure to achieve the standard into an annualized deficit of allowances. Box 5 provides a detailed description of how a tradable standards program for motor vehicles—referred to as "Corporate Average Carbon Efficiency" (CACE) standard—could work.

Tradable standards would increase flexibility and therefore reduce the cost for firms to comply with standards. Such an approach could provide for at least three levels of trading: (1) intra-firm trading, in which a firm could achieve an average level of efficiency across its product lines, instead of being required to meet the standard for each product line; (2) trading among firms subject to standards; and (3) trading between firms subject to standards and firms subject to the cap-and-trade program.

As discussed in greater detail below, a potential drawback of a tradable standards approach—and, indeed, any approach that relies on standards—is that it does not ensure that emissions will be limited at any particular level. An alternative approach that could address this drawback is a capped tradable standards program.[223] Under such an approach, policymakers would set a cap on the total emissions associated with particular types of newly manufactured products. To sell products subject to the capped standard, manufacturers would have to obtain and surrender allowances. In other words, it would not be sufficient merely to produce products that met the standard; manufacturers would have to account for the projected emissions associated with each product they sold. A capped tradable standards program would entail resolving a number of design issues, including issues related to allowance allocation, shutdowns, new market entrants, changes in manufacturer market share, and changes in overall level of output.

It is important to note that either tradable standards or capped tradable standards could raise intra-industry competitiveness issues. Firms with a wide range of product lines may be able to generate internal allowances from efficient product lines that can be used to "subsidize" inefficient products in other product lines—arguably to the competitive detriment of single product line manufacturers.[224]

near-term compliance period with allowances representing emission reductions that will not take place until many years later. *See* Winkelman et al., *supra* note 159, at 16.

[223] For descriptions of capped tradable standards approaches, see *id.*; Heinz Ctr., *supra* note 81, at app.5.

[224] In addition, it is important to note that the efficiency gains of making standards tradable do not always exceed the administrative costs. In some cases, it is equally, or even more cost-effective to simply prescribe a particular uniform emissions limit, technology, or

Box 5: Corporate Average Carbon Efficiency (CACE) Standard

Assume the vehicle efficiency standard were set at 30 mpg and the automaker had sold one million cars with an average fuel economy of 27 mpg, and estimated annual vehicle miles traveled for each car was 10,000 miles.[225]

Annual emissions at CACE level:

$$\frac{[(1{,}000{,}000 \text{ cars}) \times (10{,}000 \text{ miles})]}{\div \; [(30 \text{ mpg}) \times (.01 \text{ tons } CO_2/\text{gal})]} = 3{,}333{,}333 \text{ tons } CO_2$$

Actual annual emissions:

$$\frac{[(1{,}000{,}000 \text{ cars}) \times (10{,}000 \text{ miles})]}{\div \; [(27 \text{ mpg}) \times (.01 \text{ tons } CO_2/\text{gal})]} = 3{,}703{,}704 \text{ tons } CO_2$$

The automaker would have to buy 370,371 tons CO_2-equivalent of allowances each year to comply.

3. Integrating Tradable Standards with a Cap-and-Trade Program

Developing a domestic program that combines tradable standards with a cap-and-trade program raises an additional design issue. If trading is allowed between firms subject to standards and firms subject to a cap, how will such trading be regulated so as to prevent double-counting of reductions?

For example, if a firm that manufactured an electrical appliance, such as a refrigerator, exceeded the efficiency standard for that product, the resulting improvement in efficiency would reduce electricity use, and therefore reduce emissions by electricity generators. If the refrigerator manufacturer earned a tradable allowance for its over-compliance and the resultant emissions reduction by the electric generator also created a surplus allowance, the same ton of CO_2 reductions would generate two tons of allowances. To deal with this problem, manufacturers of electricity-consuming products that are subject to standards could be precluded from trading outside their own sectors. However, there would be no reason not to allow them to trade between electric product lines and with other firms subject to electric product efficiency standards.

practice. *See* Daniel H. Cole & Peter Z. Grossman, *When Is Command-and-Control Efficient? Institutions, Technology, and the Comparative Efficiency of Alternative Regulatory Regimes for Environmental Protection, in* 2001 Land Use & Env't L. Rev. 509.

[225] This example is adapted from Winkelman et al., *supra* note 159, at 22.

Double-counting would not be an issue for products that emit CO_2 directly, such as automobiles or gas appliances. Accordingly, a hybrid program could permit manufacturers of such products to trade freely into the cap-and-trade market.[226]

Box 6: Alternative Hybrid Options

While the focus of this section of the Article is on a program that would combine product efficiency standards with a large-source, downstream cap-and-trade program, it also would be possible to integrate product efficiency standards with an upstream cap-and-trade program.[227] Two such options are described below:

Product Efficiency Standards that Supplement an Upstream Cap-and-Trade Program: This hybrid would use product efficiency standards to *supplement* a full upstream cap-and-trade program. It would layer standards on top of the upstream program, that is, firms subject to the up-

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[226] Such trading, however, raises a separate issue. Some analysts argue that because tradable standards do not affect an absolute cap on emissions from firms subject to those standards, a hybrid program should not allow trading between firms subject to standards and firms subject to a cap, even though it is not clear that such trading could result in any increase in total emissions. *See* U.K. Dep't of the Env't, Transport & the Regions, Draft Framework Document for the U.K. Emissions Trading Scheme 24–26 (2001), *available at* http://www.defra.gov.uk/environment/climatechange/trading/uk/draft/pdf/trading.pdf. The United Kingdom has established an emissions trading program in which firms subject to a cap (referred to as an "absolute target") may trade with firms subject to a tradable standard (referred to as a "relative target.") *See id.* at 22. However, the U.K. requires such trades go through a mechanism called the "gateway." *See id.* at 26–27. The gateway tracks all allowance transfers and ensures that there is no net transfer of allowances from the relative to the absolute sector. *See id.* In other words, a firm in the relative sector may sell an excess allowance through the gateway to the absolute sector only when the net flow of allowances from the absolute sector into the relative sector is positive.

[227] Sectoral hybrid programs that combine standards with an upstream, rather than downstream, cap-and-trade program raise significant coordination issues. The predicate of such a program is that a fuel use is exempt from allowance requirements only if the product in which the fuel is used is covered by a product standard. However, this predicate may be unrealistic in practice because exclusions for particular types of fuel uses might not be feasible to administer. Gasoline suppliers will be unable to distinguish between fuel purchased for use in an automobile subject to fuel economy standards as opposed to a lawn mower not subject to these standards. Similarly, natural gas distributors may not be able to distinguish between gas used in a furnace subject to efficiency standards, and gas used at a distributed generation unit that is not. Finally, any program in which some fuel distributed is subject to an allowance requirement while other fuel is exempt, gives rise to risks of evasion. When faced with these problems, designers of such a program are likely to have three choices: (1) fine-tune the definitions of excluded fuel uses so that any fuel use not subject to standards is covered by the cap-and-trade program; (2) expand the standards program to cover all exempt uses; or (3) ignore fuel use by products not subject to standards where the use is not associated with significant emissions.

stream program still would be required to hold allowances for the carbon content of all fuel they distribute to downstream users, including fuel they send for use in products subject to standards.[228] Under this approach, the upstream program would still be subject to an economy wide cap; the standards would be there to help ensure that efficient products reach the market when consumers need them. Firms subject to standards could trade with one another, but to avoid double-counting, they could not trade into the cap-and-trade program.

Product Efficiency Standards that Complement an Upstream Cap-and-Trade Program: Under this hybrid option, an upstream cap-and-trade program would apply to all fuels except those used in products subject to standards. Thus, if product efficiency standards applied to automobiles and consumer products that used home heating fuels, then gasoline, home heating oils, and residential gas would be exempt from upstream allowance requirements. A broader standards program—one that included large trucks and commercial heating equipment—could be linked to broader exclusions from the upstream cap-and-trade program, thus allowing diesel fuel and fuel delivered for use in commercial buildings to be outside the cap-and-trade program. A variant of this approach would set up a product efficiency standards program, a downstream cap-and-trade program for electricity generators and other large stationary sources, and an upstream program applicable to fuel distributed for all uses other than automobile, residential, and commercial use, and electricity generators. Designing this hybrid approach also would require addressing double-counting risks.

4. Sectoral Hybrid Approach Issues

Even a well-designed sectoral hybrid program has some significant drawbacks compared to an economy-wide upstream cap-and-trade program.

First, standards provide no incentive to adopt what, in many cases, may be the lowest-cost abatement option: reduced use. As explained below, the absence of any incentive to reduce use means that a standards approach—even if the standards are tradable—may be a significantly less cost-effective means of meeting any emissions limit

[228] As used here, the term consumers "subject to standards" encompasses consumers directly subject to standards, such as electricity generators and consumers using products that are subject to standards, such as motorists.

compared to a cap-and-trade program that regulates fuel producers or end-users directly.

In the transportation sector, for example, standards would force lower-emitting vehicles into the marketplace, but they would not provide any incentive for motorists to drive less. Indeed, if gasoline prices were to stay the same, motorists that purchased compliant vehicles might increase their miles traveled because more fuel-efficient vehicles cost less to drive. This "rebound effect" could offset some of the projected emission reductions.[229] In addition, standards only apply to new products, not existing products. Accordingly, the effectiveness of standards in limiting emissions would depend on the rate at which consumers replaced their old, unregulated products with the new, regulated ones.[230] Gauging this rate is complicated by the "junker effect": subjecting products to standards may increase their price, thereby encouraging consumers to hold onto their unregulated, higher-emitting models.[231]

A third potential drawback of a standards approach is that it relies heavily on estimates. For each standard, policymakers would have to formulate various estimates of lifetime product use and associated emissions, as well as rates of adoption. Even a capped tradable standards program would cap only projected, not actual, lifetime emissions associated with covered products. The heavy reliance on estimates means that a hybrid program would offer substantially less certainty about meeting emission reduction goals than a cap-and-trade program.

Fourth, a hybrid program also would be more difficult to administer over time than an upstream cap-and-trade program. With an upstream cap-and-trade program in place, gradually phasing in more ambitious national emission targets would involve little more than gradually ratcheting down the economy-wide cap. Achieving the same result with a hybrid program, on the other hand, would involve continuously promulgating adjustments to multiple standards for multiple sectors.

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[229] Some studies suggest that a 10% increase in fuel efficiency for automobiles likely would result in a 1% to 2% increase in vehicle miles traveled. *See* TRANSP. RESEARCH BD., *supra* note 59, at 19.

[230] Winkelman et al. discuss an approach in which responsibility for emissions from the on-road fleet of vehicles would be distributed among automakers, but note several shortcomings of such an approach. WINKELMAN ET AL., *supra* note 159, at 14–16.

[231] *Id.* at 15. The "junker effect" also is sometimes referred to as "new source bias."

To date, none of the economic studies has modeled a sectoral hybrid with tradable standards. However, analysis of hybrid programs without the trading feature indicates that these programs entail significantly greater cost when compared with an upstream cap-and-trade program. It is possible that a sectoral hybrid program could be substantially less cost-effective, as well as more administratively burdensome, than an economy-wide upstream cap-and-trade or tax program.[232]

5. Evaluation of Sectoral Hybrid Approach

Environmental Effectiveness: A sectoral hybrid would have higher environmental effectiveness than a downstream program alone, because standards could address emissions from sources that could not be covered by a downstream cap-and-trade program. On the other hand, it would be less effective than an economy-wide upstream cap-and-trade program because standards would not address the intensity of product use or the replacement rate of new products for old. In addition, not all sources that fall outside a large-source cap-and-trade program could be regulated through standards.

Cost-Effectiveness: A sectoral hybrid program would be a more costly means of achieving any particular emissions target than an economy-wide upstream cap-and-trade program. The ultimate cost of the sectoral hybrid option also would depend on, among other things, whether the standards were tradable standards.

Administrative Feasibility: It would be relatively straight-forward to modify existing efficiency standards for purposes of a sectoral hybrid program. However, transforming such conventional standards into tradable standards would present some new complexities. Capped tradable standards present significant design issues. In addition, hybrid programs are significantly more complex administratively than are any of their individual elements because of the need for coordination. Trading would need to be carefully regulated to prevent double-counting of emission reductions and evasion of allowance requirements. In addition, promulgating new standards to cover products and practices not now subject to standards also would be an administrative burden.

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[232] The Congressional Budget Office arrived at this conclusion in a 2002 study assessing options for reducing gasoline consumption. *See* CBO, Reducing Gasoline Consumption, *supra* note 169.

Distributional Equity: A sectoral hybrid program could exclude households from the direct burden of regulation under the cap-and-trade program. However, such an approach would increase electricity prices and would put additional burdens on the manufacturing sector. These burdens would be felt indirectly by households in the form of higher product prices. The ultimate distribution of impacts from a sectoral hybrid program also would depend on how policymakers opted to distribute allowances, or the revenues from an allowance auction.

Political Acceptability: Hybrid programs offer policymakers options for addressing domestic GHG emissions while avoiding gasoline and home heating fuel price increases. In particular, a sectoral hybrid program would offer a means of largely avoiding these price increases—but not electric rate increases—albeit at some cost to environmental effectiveness. Also, the familiarity of the standards component may enhance its acceptability.

Conclusion

Policymakers in the United States face a plethora of choices for the design of a domestic GHG regulatory program—upstream or downstream cap-and-trade, GHG tax, product standards, and hybrid programs—as well as the myriad details of program design that must be addressed once the overall approach is chosen.

Using the criteria spelled out in Section IV, we evaluated the principal design options. The results of that evaluation are summarized below.

A. *Cap-and-Trade Programs*

1. All-Source Downstream Cap-and-Trade

An economy-wide downstream cap-and-trade program—because it implies the regulation of millions of individual GHG sources, including cars and homes—would be difficult and costly to administer. It would not be a viable prospect for a domestic GHG regulatory program.

2. Upstream Cap-and-Trade

An economy-wide upstream cap-and-trade program would be environmentally effective, could attain least-cost compliance if it incorporates flexibility measures, and would be administratively feasible. Its distributional consequences would depend on how allowances were allocated and, if auctioned, how the auction revenues were recycled back into the economy. These allocation and revenue recycling decisions would influence overall compliance costs. Some methods of allocating allowances, such as generation performance standards, can be less economically efficient than others, and can be less efficient than an auction. According to some economists, using auction revenues to reduce distortionary taxes could partially offset the costs of the program. Finally, because an economy-wide upstream cap-and-trade program would drive up the cost of gasoline and home heating fuels, it is likely to present a political challenge.

Thus, if policymakers were willing to accept a program that results in visible increases in gasoline and home heating fuel prices, one environmentally effective, efficient, and feasible option would be a comprehensive upstream cap-and-trade program. Such a program could be coupled with limited free distribution of allowances to compensate affected business, auction of the remaining allowances, and the use of auction revenues for tax reductions and other ends.

There are substantial theoretical benefits from such an approach. The near-term environmental outcome is clear, assuming that the government will maintain the emission limits in the face of possibly significant price uncertainty and volatility. Current analysis indicates that it would minimize economic costs to the economy, be manageable administratively, avoid over-compensating existing emitters, and perhaps capture some offsetting benefits from reduction of distortionary taxes.

Nevertheless, an economy-wide upstream cap-and-trade program raises a number of issues. First, critics may characterize it as a large, ambitious, and untried experiment in regulation, and may question how it will work in practice. Second, auction revenues may be difficult to predict, making it difficult to answer the question of whether, and when, Congress will enact such a system. Even in times of most compelling national circumstances, such as the 1973 Arab oil embargo, Congress has not been willing to allow fuel prices to increase sufficiently to bring demand in balance with supply.[233] On the other hand, adopting an upstream cap-and-trade program does not inevitably mean accepting a significant and immediate hike in consumer fuel prices. The price impacts could be limited to only a few cents per gallon if the program began with a moderate emissions target and

[233] Congress's response to the Arab oil embargo was to impose price controls rather than let prices rise to world market levels. *See supra* note 116.

then phased in a more stringent target gradually over time, or if it incorporated use of a safety valve.

A workable variant of the upstream cap-and-trade program described above is an upstream/downstream design that combines a downstream cap-and-trade program for electricity generators and other large sources with an upstream cap-and-trade program for other major sectors of the economy. The McCain-Lieberman bill reflects this approach.

3. Large-Source Downstream Cap-and-Trade

A large-source downstream cap-and-trade program—one applicable to electricity generators and large industrial sources of CO_2 and of certain other greenhouse gases—is administratively feasible and could be environmentally effective with respect to the sectors it covered. To be fully effective, however, such an approach would have to be coupled with a program to cover other sectors. A large-source downstream program might be more politically acceptable than an upstream economy-wide program because it would not result in price increases for gasoline and home heating fuels, though it still would result in price increases for electricity.

B. *GHG Tax*

An upstream GHG tax program would allow for adoption of least-cost mitigation strategies, offer short-term cost certainty, and be administratively feasible. A tax program would not provide certainty in meeting a particular short-term emissions target. However, because it is cumulative rather than annual emissions that are important, taxes should be able to provide almost equivalent long-term environmental certainty if there is political will to adjust them over time. The ultimate distributional consequences of a GHG tax would depend on how policymakers distributed revenues from the tax. However, political acceptability is likely to be a major obstacle since a GHG tax combines both new taxes and fuel price increases. A GHG tax may be more politically attractive as part of a larger tax reform program.

C. *Sectoral Hybrid Program*

A sectoral hybrid program such as the one outlined in Box 4 would consist of a large-source downstream program coupled with product efficiency standards. Such a program would be more environmentally effective than either a downstream program or standards alone, because standards could address emissions from sources—such as automobiles and appliances—that could not feasibly be covered by the downstream cap-and-trade program. Relying on existing standards programs, the first phase of such a program could attain coverage of about eighty percent of U.S. energy-related CO_2 emissions. A second phase of the program could address the remaining twenty percent through an upstream cap-and-trade program or through expanded product efficiency standards; the program could cover emissions of other greenhouse gases through other measures.

A sectoral hybrid program has the advantage of building on existing regulation, and in the case of CAFE and appliance standards, potentially improving on it by permitting manufacturers to trade among product lines, with each other, and with other sectors. It would avoid the politically difficult step of attaching a carbon cost to the price of gasoline and home heating. The tradable standard feature would capture some, but not all of the benefits of a full cap-and-trade system.

However, these largely political attractions of the hybrid program could come at some cost. Substituting product efficiency standards for the transportation fuel component of an upstream cap-and-trade program may downgrade the cost-effectiveness of such a program. Even with a trading feature that tries to equate marginal control costs among sectors, a product efficiency standards program lacks incentives to discourage product end-use. Indeed, it might actually encourage greater use—the rebound effect, or encourage consumers to replace their existing inefficient products for the more efficient new ones—the junker effect. The absence of such incentives is likely to make a domestic program that relies on product efficiency standards as an alternative to upstream regulation a more expensive approach to meeting any GHG reduction target. In addition, incorporating tradable standards would present significant administrative challenges because of the need to prevent double-counting of emission reductions and to deal with potential compliance evasion. Finally, any hybrid program is likely to give some beneficiaries of the program a vested interest in retaining it, significantly increasing the difficulty of ultimately converting the hybrid program into a simpler, more efficient economy-wide upstream cap-and-trade program.

In sum, the analysis suggests that an economy-wide downstream cap-and-trade program is difficult to administer, that a stand-alone, large-source cap-and-trade program is incomplete in coverage, and that a GHG tax that is not part of a larger tax reform initiative is unviable politically. The analysis does suggest that the comprehensive, upstream cap-and-trade approach and the sectoral hybrid approach are the most viable alternatives for a domestic GHG reduction program. While an economy-wide cap-and-trade approach may present the best option for low-cost reductions in greenhouse gases, there are a set of existing sector-based approaches that could be built upon to address greenhouse gases, such as the acid rain program for electricity generators, appliance efficiency standards, and motor vehicle fuel economy standards. For a variety of institutional, practical, and political reasons, a U.S. domestic emissions reduction program may evolve in this direction. If policymakers decide on that course, then careful attention will have to be given to minimizing the economic costs and administrative complexity, and assuring that the program can be effectively enforced.