CLIMATE CHANGE LEGISLATION DESIGN
WHITE PAPER

Scope of a Cap-and-Trade Program

The Committee on Energy and Commerce and its Subcommittee on Energy and Air Quality are issuing a series of Climate Change Legislation Design White Papers as the next step in the legislative process leading to enactment of a mandatory, economy-wide climate change program. While the hearings earlier in the year were designed to give the Committee an understanding of the status and projected path of climate change and potential ways to address it, these White Papers and the hearings on them will focus the Committee's attention on crafting mandatory, economy-wide climate change legislation. The White Papers will lay out the basic design and key principles of a program, and also identify issues about which further information and discussion is needed.

This White Paper addresses the scope and coverage of the climate change program. It discusses what sectors and activities are directly emitting greenhouse gases, and how those emissions could be included in a cap-and-trade program. Other White Papers will address a number of other cap-and-trade design elements and additional topics, including: cap levels and timetables, measures for containing costs in a cap-and-trade program, carbon sequestration, offsets and credits, developing countries, distribution of allowances, and additional measures to complement the cap-and-trade program.

Executive Summary

Based on the hearings earlier this year, the Committee and Subcommittee Chairmen have reached the following conclusions: The United States should reduce its greenhouse gas emissions by between 60 and 80 percent by 2050 to contribute to global efforts to address climate change. To do so, the United States should adopt an economy-wide, mandatory greenhouse gas reduction program. The central component of this program should be a cap-and-trade program. Given the breadth of the economy that will be affected by a national climate change program and the significant environmental consequences at stake, it is important to design a fair program that obtains the maximum emission reductions at the lowest cost and with the least economic disruption. The Subcommittee and full Committee will draft legislation to establish such a program.

The program will cover the following greenhouse gases: carbon dioxide (84% of U.S. greenhouse gas emissions in 2005), methane (7%), nitrous oxide (7%) and fluorinated gases (2%). Carbon dioxide (CO_2) comes largely from burning fossil fuels. Methane is from a variety of sources, including oil and gas systems, landfills, agricultural activities, coal mines, and wastewater treatment facilities. Nitrous oxide derives largely from agricultural practices.

Fluorinated gases are used largely for refrigeration and air conditioning. Industrial processes also produce some greenhouse gases as by-products. The following economic sectors directly emit greenhouse gases: electricity generation (34% of U.S. greenhouse gas emissions), transportation (28%), industrial (19%), commercial (6%), residential (5%), and agricultural (8%).

The cap-and-trade program will have increasingly stringent caps on greenhouse gas emissions, eventually reaching a level that reduces emissions by 60 to 80 percent in 2050. The Government will distribute allowances equal to the level of allowed greenhouse gas emissions. Allowances can then be bought and sold. Compliance is demonstrated by having regulated entities turn in a sufficient number of allowances to cover emissions. At its core, a cap-and-trade program is a method of tracking and accounting for greenhouse gas emissions and having the cost of those emissions factored into economic decisions.

We start with a strong presumption that all greenhouse gas emissions from all sectors should be covered by the cap-and-trade program. This desire must, however, be balanced with the need to have a workable program. There are practical limits to the number and type of entities that can be directly regulated by a cap-and-trade program. Accurate reporting and monitoring are critical to the program's success. If emissions from certain activities cannot be measured accurately, it may not be possible to require a regulated entity to turn in allowances to cover those emissions. In addition, it is impractical to require allowances to be turned in by a very large number of sources that are each responsible for very low emissions; it would increase the complexity and transaction costs of the program to an unacceptable level.

Selecting the regulated entities, or setting the point of regulation (the parties responsible for tracking emissions and turning in allowances), is very different for a cap-and-trade program than it is for more traditional forms of regulation. Traditionally, the regulated entity is the source that emits the pollution because it is capable of installing controls to reduce its emissions. This could also be the point of regulation in a cap-and-trade program, as it is in the Acid Rain Trading Program, which requires electricity generators to monitor emissions and turn in allowances. Alternatively, for some sectors or some activities, it would be impractical (if not impossible) for the cap-and-trade program to have the sources that emit greenhouse gases be the point of regulation. This obstacle is perhaps most apparent in the transportation sector, where the sources that emit greenhouse gases are individual vehicles.

In a cap-and-trade program, the point of regulation could be set at one of various points along the stream of economic activity that results in greenhouse gas emissions. For example, since the carbon content of fuel is an accurate measure of the CO_2 emitted when the fuel is burned, refiners or importers could be the point of regulation for the transportation sector. As long as emissions are accounted for once, and only once, the point of regulation does not have to be the same for all sectors and types of emissions. This White Paper explores the possible points of regulation for each sector.

Although the cap-and-trade program will be the central component of a national climate change program, other measures will also be necessary. The Committee Chairman has already indicated that tax policy could play an important role in reducing greenhouse gases.

Other possible measures include efficiency or other performance standards, incentives for the purchase of advanced technology, and funding for research, development, and deployment of advanced technology. Potential complementary measures will be explored more thoroughly later in this process.

Key Design Principles

Earlier this year, the Subcommittee on Energy and Air Quality held a series of climate change hearings. Based on those hearings, the Committee and Subcommittee Chairmen have concluded that:

- The United States needs to reduce its greenhouse gas emissions by 60 to 80 percent by 2050 to contribute to global efforts to address climate change.
- The United States needs an economy-wide, mandatory greenhouse gas reduction program.
- The central component of this program will be a cap-and-trade program, although other measures will also be needed.

A consensus is developing that the United States should reduce its greenhouse gas emissions by 60 to 80 percent by 2050 to contribute to global efforts to stabilize long term atmospheric greenhouse gas concentrations at a CO_2 equivalent level between 450 to 550 parts per million.[1] At this concentration range, global average surface warming would be very unlikely to be less than 1.5 degrees centigrade according to the Intergovernmental Panel on Climate Change.[2]

The climate change program must be an economy-wide program that accounts for all greenhouse gas emissions in the United States because (1) dramatic emissions reductions are required, (2) many economic sectors contribute to greenhouse gas emissions, and (3) everyone must fairly share responsibility for reductions. An economy-wide climate change program does not mean, however, that all sectors contribute their fair share in the same way.

The cornerstone of the program will be a cap-and-trade program. One key benefit of a cap-and-trade program is that it provides certainty that the selected level of greenhouse gas reductions will occur. In contrast, performance standards generally limit the rate of emissions (such as by controlling the average amount of carbon in motor vehicle fuel), but would allow emissions to increase (such as would happen if motor vehicle fuel use increased). A carbon or gasoline tax would provide an economic incentive to decrease the use of carbon fuels and would provide certainty about the cost of the program. Although a tax could be set at a level expected to produce the desired emissions decrease, it could not guarantee it. Another benefit of a cap-and-trade program is that it provides economic incentives for industry to find the lowest cost method of achieving the desired emissions reductions, encouraging and rewarding

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[1] United States Climate Action Partnership (USCAP), "A Call to Action," at pp. 6-7. Pre-industrial concentrations of CO_2 were approximately 280 ppm.

[2] IPCC, "Summary for Policymakers," *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change,* 2007 at p. 12.

innovation that might not otherwise occur under more traditional regulatory or government research programs.

Even with a broad-based cap-and-trade program, complementary measures (such as a carbon tax or other tax-based incentives, efficiency or other performance standards, or research and development programs) will also be needed. For example, funding for research, development, and deployment of new technologies would assist industries that will need to adopt new technologies. In addition, efficiency or other performance standards might be appropriate for some economic actors that would be inappropriate to include directly in a cap-and-trade program, but that should contribute to an economy-wide reduction program in some other way.[3]

Coverage -- Greenhouse Gases

The program will cover the following greenhouse gases:

- Carbon Dioxide (CO_2),
- Methane (CH_4),
- Nitrous Oxide (N_2O), and
- Fluorinated Gases: Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs), and Sulfur Hexafluoride (SF_6).

Figure 1 shows the relevant contribution of each gas to the United States total greenhouse gas emissions.[4] CO_2 emissions, largely the result of burning fossil fuels, are the biggest share (84%) of U.S. emissions. The two largest sources of methane emissions are oil and gas systems and landfills, followed by agricultural activities, coal mines, and wastewater treatment facilities. Nitrous oxide is primarily from agricultural soil management.

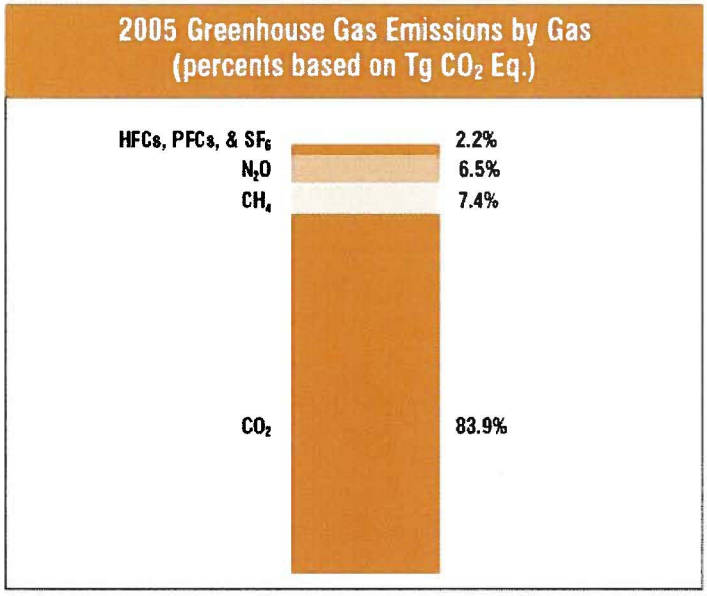
The fluorinated gases (HFCs, PFCs and SF_6) must be included in a climate change program even though they account for less than 3 percent of total U.S. greenhouse gas emissions. Fluorinated gases are very potent greenhouse gases, several with global

[3] For example, household appliances have a major effect on greenhouse gas emissions due to the electricity necessary to run them. Improving their energy efficiency significantly reduces greenhouse gas emissions. Nonetheless, appliance manufacturers should not be included in the cap-and-trade program for these indirect greenhouse gas emissions. That would result in double counting given that the electricity sector's emissions will be covered by the cap-and-trade program. Appliance manufacturers will, however, be required to participate in the national climate change program by meeting energy efficiency standards, which will achieve significant reductions without double counting. For example, the appliance and lighting efficiency standards in H.R. 3221, the House energy bill, are projected to reduce more than 2.5 billion tons CO_2eq cumulatively through 2030. (Note that direct emissions from the process of manufacturing appliances will need to be addressed consistently with other industrial sector emissions.)

[4] Greenhouse gases vary in the extent to which they cause global warming and in the amount of time they last in the atmosphere. A ton of methane does not have the same effect on the earth's temperature as a ton of CO_2. For ease of comparison, the accepted international and scientific convention is to compare greenhouse gases based on their contribution to global warming over a 100-year period compared to the contribution of CO_2. Thus, greenhouse gas emissions are reported as tons of CO_2-equivalent (or tons CO_2eq). (E.g., 1 ton of CH_4 = 21 tons $C0_2$eq).

Figure 1

U.S. Greenhouse Gas Emissions (2005)



• Total U.S. greenhouse gas emissions = 7,260 Million Metric Tons CO_2 Equivalent in 2005

Source: Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2005 (EPA, 2007)

warming potentials thousands of times greater than that of CO_2. These gases can play a larger role in addressing climate change than one would expect based on their share of the greenhouse gas inventory. The inventory is based on contribution to global warming over a 100-year time period,[5] but many of the fluorinated gases have atmospheric lifetimes much longer or much shorter than 100 years. Therefore, reducing emissions of these gases provides benefits that are not fully reflected by their contribution to the inventory. Some of these gases (e.g., HFCs) have relatively short lifetimes once emitted into the atmosphere. Reducing emissions of these short-lived gases would have a larger impact in the short run, slowing down the rate of temperature change more than reducing a comparable amount of other greenhouse gases with longer lifetimes. On the other end of the spectrum, some of these gases will stay in the atmosphere for thousands of years after they are emitted. SF_6, for example, has a lifetime of 3,200 years. It has a global warming potential almost 23,000 times that of CO_2 over a 100-year time period, but over a 500-year time period its global warming potential is more than 32,000 times that of CO_2.[6] SF_6 emitted today will contribute to global warming for centuries to come. It is also important to cover fluorinated gases in the climate change program because there are significant, cost-effective opportunities to reduce their emissions.

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[5] See n. 4. Although the comparison over a 100-year time period is a useful convention for developing climate change policy, at times it is helpful to have a deeper understanding of how different gases contribute to global warming.

[6] IPCC, *Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change*, 2001 at Table 6.7, p. 389.

Economic Sectors

Direct greenhouse gas emissions are attributable to the following sectors of the economy:

- Electricity Generation (34% of U.S. greenhouse gas emissions in 2005):
  The emissions from this sector predominantly consist of CO_2 emissions from the combustion of fossil fuels.

- Transportation (28%):
  The emissions from this sector are predominantly CO_2 emissions from the combustion of petroleum based fuels.

- Industrial (19%):
  This sector's emissions are largely CO_2 emissions from the combustion of fossil fuels to produce steam and/or heat for industrial processes.

- Commercial (6%):
  This sector's emissions are mainly CO_2 emissions due to consumption of natural gas and petroleum products for heating, cooking, and equipment needs of businesses, governments, and other private and public organizations.

- Residential (5%):
  This sector's emissions are mainly CO_2 emissions due to the consumption of natural gas and petroleum products for heating and cooking needs of private homes.

- Agricultural (8%):
  The emissions from this sector are primarily direct methane and nitrous oxide emissions from a variety of sources, including soil management practices.

Figure 2 shows the percentage of greenhouse gases directly emitted by each of these sectors. Figure 3 shows the primary type of sources of direct emissions from each sector.

These sectors contribute to greenhouse gas emissions in at least two ways – direct emissions (i.e., greenhouse gas emissions directly emitted by sources in that sector) and indirect emissions (e.g., CO_2 emitted as a result of electricity used by the sector, but generated outside the sector). For each sector, Figure 4 shows both the sector's direct emissions of each of the greenhouse gases and the indirect emissions from its electricity use.

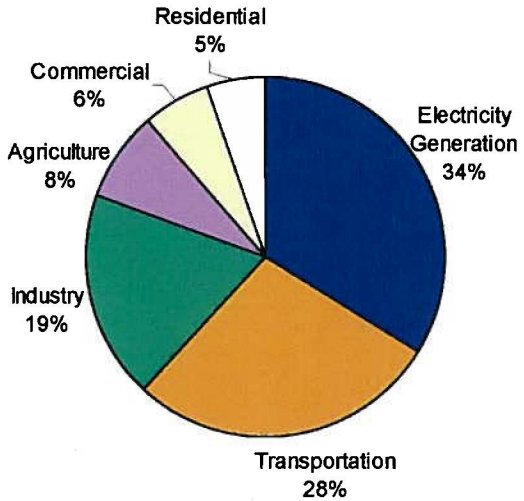
We start with a strong presumption that all U.S. greenhouse gas emissions should be covered by the cap-and-trade program. Excluding from the cap-and-trade program emissions from some sectors or their sources would likely increase the burden on the covered sectors and sources to achieve a 60 to 80 percent reduction in U.S. greenhouse gas emissions. This burden on covered sectors and sources could be exacerbated if the program were designed in a way that allowed a shift of emissions from covered to uncovered sources, often referred to

Figure 2

Direct U.S. Greenhouse Gas Emissions by Economic Sector (2005)

Sector/Source	2005 Emissions ($MMTCO_2eq$)
Electricity Generation	2,429.8
Transportation	2,008.9
Industry	1,352.8
Agriculture	595.4
Commercial	431.4
Residential	380.7
Total*	**7,199.0**

*excludes US Territories and emission sinks

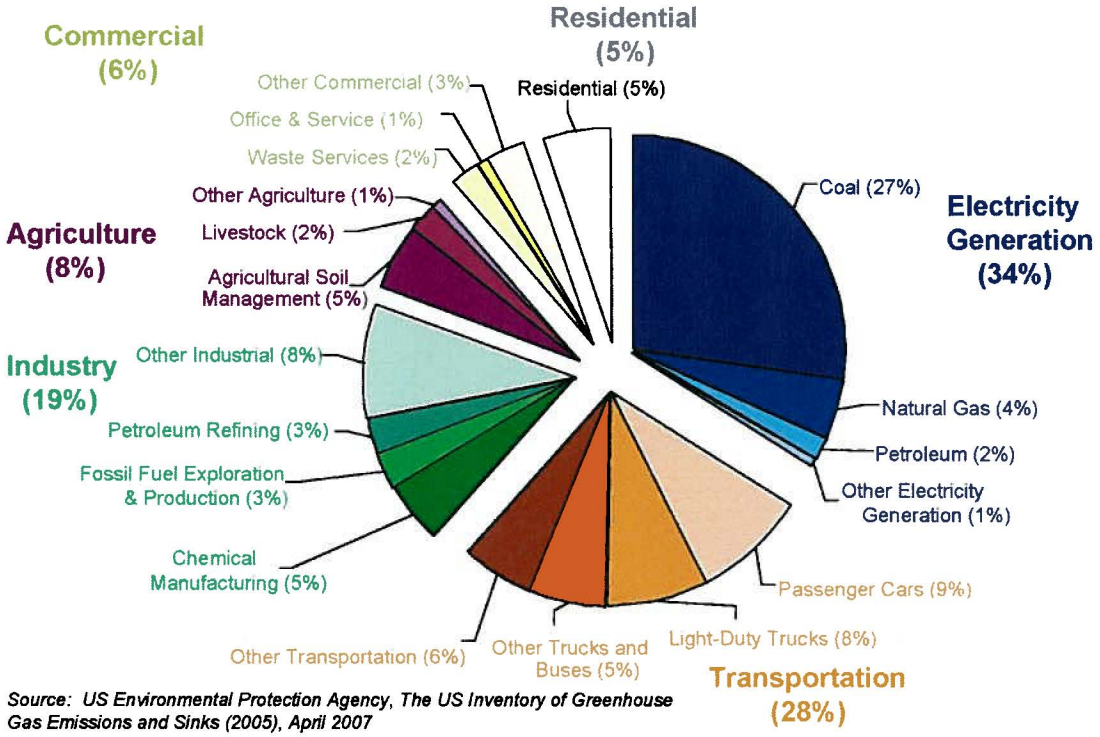


$MMTCO_2eq$ = Million Metric Tons Carbon Dioxide Equivalents

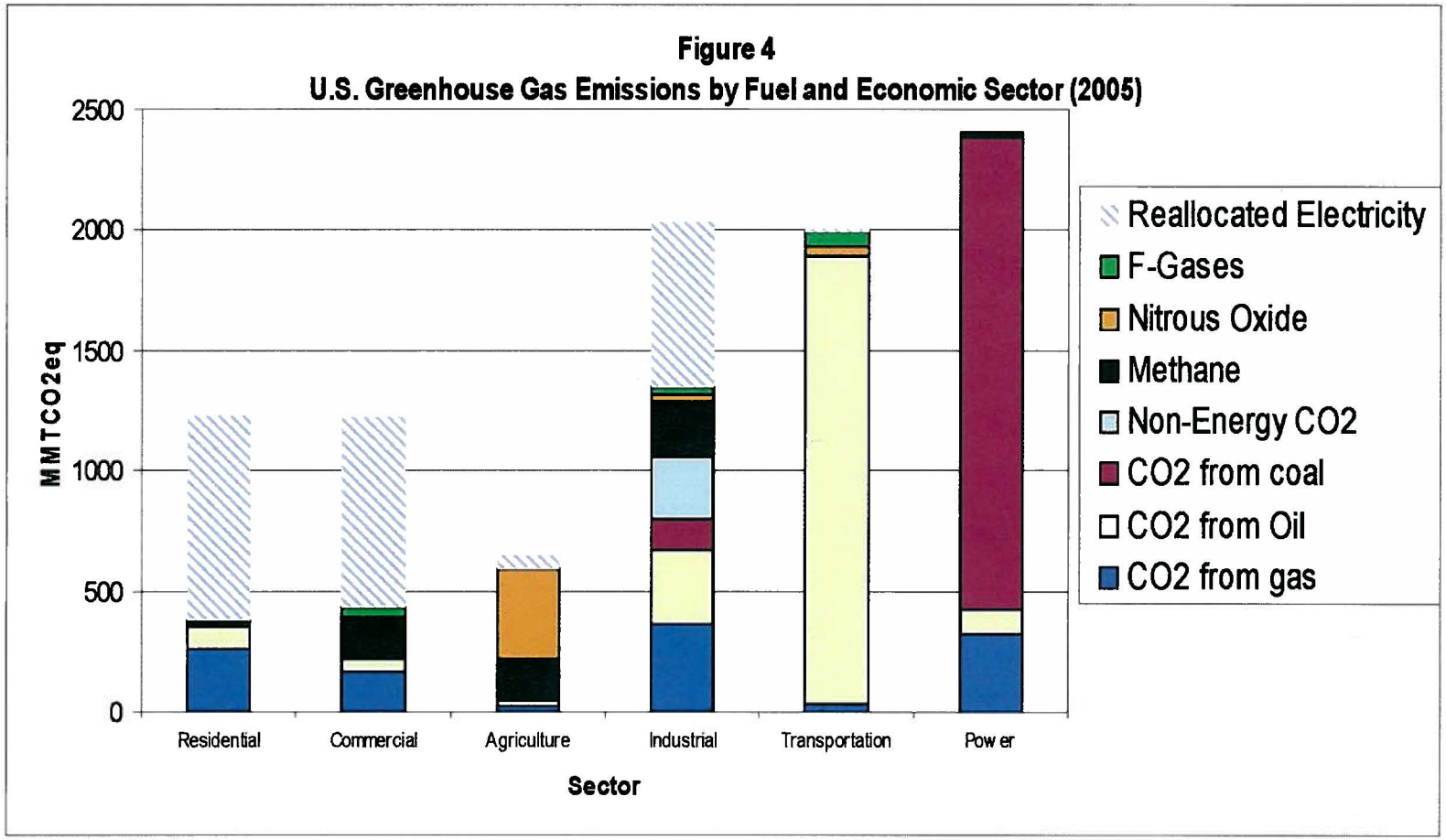
Source: US Environmental Protection Agency, The US Inventory of Greenhouse Gas Emissions and Sinks (2005), April 2007

Figure 3

Key Sources of Direct U.S. Greenhouse Gas Emissions by Economic Sector (2005)



Source: US Environmental Protection Agency, The US Inventory of Greenhouse Gas Emissions and Sinks (2005), April 2007



Source: US Environmental Protection Agency, The US Inventory of Greenhouse Gas Emissions and Sinks (2005), April 2007

as "leakage." Leakage would probably occur if there are different ways of obtaining a product and only one is covered by the cap. For example, including the emissions from electricity generators in the cap, but excluding emissions of large commercial or industrial facilities, could create a financial incentive for those facilities to generate their own electricity and avoid the costs incurred by electricity generators to comply with the cap-and-trade program.

An effective cap-and-trade program requires accurate accounting for emissions. Designing a cap-and-trade program requires an understanding for each sector of the chain of economic activity associated with each type of greenhouse gas emissions and selection of one point in the chain that can be responsible for tracking the emissions and turning in allowances to cover those emissions. This is often called the "point of regulation."[7]

The desire to cover all emissions under the cap-and-trade program must be balanced with the need to have a workable program. There are practical limits to the number and types of sources that could participate in a cap-and-trade program. Accurate monitoring and reporting are critical. An inability to determine accurately certain types of emissions may lead to the conclusion that sources of those emissions should not be required to turn in allowances equal to their emissions. If that were the case, other mechanisms to address those emissions should be explored. In addition, a sector with a very large number of sources that each have low emissions may increase the complexity and transaction costs of a cap-and-trade program. For example, for residential users (which directly emitted 5% of U.S. greenhouse gas emissions in 2005), the administrative burden (and perhaps the impossibility) of accurately determining and tracking emissions for each of the large number of small residential sources that burn natural gas, heating oil, or coal warrants their exclusion from the cap-and-trade program. In addition, transaction costs will likely be a greater administrative burden for small sources that have less reason than large sources to develop expertise in the market that will develop to trade allowances.

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[7] The "point of regulation" refers to the type of entity that is obligated to turn in allowances to cover emissions. Depending on the economic activity producing the greenhouse gas emissions, the point of regulation could be set "upstream" with the producer, "downstream" with the emitter, or somewhere in-between in the stream of commerce that moves the fuel from the producer to the emitter ("midstream").

In many regulatory programs, the point of regulation is the source that actually emits the pollutant. This is referred to as "downstream" regulation because the emitter is the end of the stream of commerce that results in the emissions. This is the point of regulation used in the Acid Rain Trading Program, in which electricity generators are required to report their sulfur dioxide (SO_2) emissions and then turn in the number of allowances that equals their emissions.

Under a cap-and-trade program, other points of regulation are possible, particularly to address greenhouse gas emissions from fossil fuel combustion. This is because the amount of carbon in fuel (e.g., in coal, gas, oil) determines the amount of CO_2 emissions that will result when the fuel is burned (unless the CO_2 is sequestered, which can be accounted for separately). Therefore, instead of setting the point of regulation with the emitter, the emissions could also be tracked and covered by setting the point of regulation with the company that produces a fuel, and that producer would be required to turn in allowances equal to the CO_2 emissions that will result when the fuel it sells is eventually burned. This is generally referred to as "upstream" regulation. Upstream regulation may also be appropriate for a large percentage of fluorinated gas emissions.

For certain sectors with numerous small emissions sources, selecting an appropriate point of regulation might allow the sector to be included in a cap-and-trade program. To cover a sector's emissions, theoretically, the point of regulation could be set at one of several different points in the stream of commercial activities that result in greenhouse gas emissions. It could be the downstream entity that actually emits greenhouse gases (e.g., electricity generating units burning coal). It could be an upstream or midstream entity that produces, imports, processes, or transports the fuel that, when used, emits greenhouse gases (e.g., the companies supplying the coal). Thus, even though residential users should not be included in a cap-and-trade program given the administrative burden that would impose, emissions from the residential sector could be included in the cap-and-trade program by establishing the point of regulation upstream, perhaps with the fuel producers, processors, or providers. It is possible that, in the same cap-and-trade program, the point of regulation could be set at different points in the stream of commerce for different sectors (e.g., with the electricity generators for their sector and with refineries for the transportation sector). To ensure a workable program that accurately tracks emissions, setting the point of regulation upstream or midstream will require a comprehensive understanding of the chain of economic activity from fuel extraction to fuel use.[8]

The administrative burden arising from a point of regulation that would directly regulate a large number of sources in the cap-and-trade program could also be addressed by only including in the program sources above a specific threshold. For example, more than 350,000 manufacturing sources are in industries that emit CO_2 from fossil fuel combustion, but fewer than 8,000 of those sources were estimated to emit more than 10,000 tons of CO_2 in a given year.[9] Theoretically, the same threshold could apply for all greenhouse gas emissions from all sectors, or different thresholds could apply for different sectors or different gases. If a threshold approach is used, care must be taken that the program does not cause a proliferation of uncovered sources just below the threshold.

In addition to the cap-and-trade program, complementary measures may be appropriate for some sectors, economic actors or types of sources. Complementary measures could either mandate or provide incentives for specific actions. They could be appropriate when certain types of emissions cannot be included in the cap-and-trade program or when the cap-and-trade program does not provide sufficient economic incentive for desired activity. For example, efficiency or other performance standards might be appropriate if some types of emissions cannot be included in the cap-and-trade program (e.g., if allowances are not required for emissions from industrial sources below a specified threshold). Technology development or deployment may need to be encouraged through incentives for the purchase of advanced technology, or through funding for research, development, and deployment. It might also be appropriate to allow uncovered sources to opt-in to the cap-and-trade program, provided that the integrity of the cap is maintained and double counting of emission reductions does not occur. Although this White Paper touches on some possible complementary measures, they will be explored more thoroughly later in this process.

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[8] A program with an upstream or midstream point of regulation would need to ensure appropriate treatment of imported and exported fuel so that covered fuel would be that fuel combusted in the United States.

[9] West, Tristam O. and Peña, Naomi, "Determining Thresholds for Mandatory Reporting of Greenhouse Gas Emissions," *Environmental Science & Technology*, Vol. 37, No. 6, 2003 at Table 1.

Following are sector-by-sector discussions of the extent to which each of the sectors should be included in the cap-and-trade program. For each sector, the following questions are considered:

- Are there administrative reasons related to the type of sources or activities generating emissions that would make it impracticable to include them in the cap-and-trade program?
- Even if the sector generally should be included, are there administrative reasons some sources within the sector or below certain thresholds should not be included in the cap-and-trade program?
- What is the appropriate point of regulation (i.e., where should the obligation be placed to turn in allowances to cover the sector's emissions)?

Electricity Generation Sector: This sector directly emitted approximately one-third of the U.S. greenhouse gas emissions in 2005. Most of these emissions were CO_2 emissions generated from burning fossil fuels in large power plants (81% of electricity generation greenhouse gas emissions come from burning coal, 13% from natural gas, and 4% from petroleum).[10] This sector includes all power generators whose primary business is the production of electricity for sale.[11] As shown in Figure 5, 72% of our electricity generation comes from burning fossil fuels, with the remainder coming from nuclear and renewable resources, including hydropower.

The cap-and-trade program will cover the electricity generation sector and establish generators as the point of regulation (i.e., the entities that must report emissions and turn in allowances sufficient to cover those emissions). This approach is based in large part on the successful Acid Rain cap-and-trade program that limits sulfur dioxide emissions from electricity generators.[12] The Acid Rain Program, which was adopted in the 1990 Clean Air Act Amendments, operates smoothly according to testimony presented to the Subcommittee. In addition to participating in the Acid Rain cap-and-trade program for sulfur dioxide emissions, electricity generators are also required to report CO_2 emissions to the Environmental Protection Agency (EPA). Accordingly, EPA and the electricity generators already have extensive experience relevant to, and much of the infrastructure necessary for, participation of this

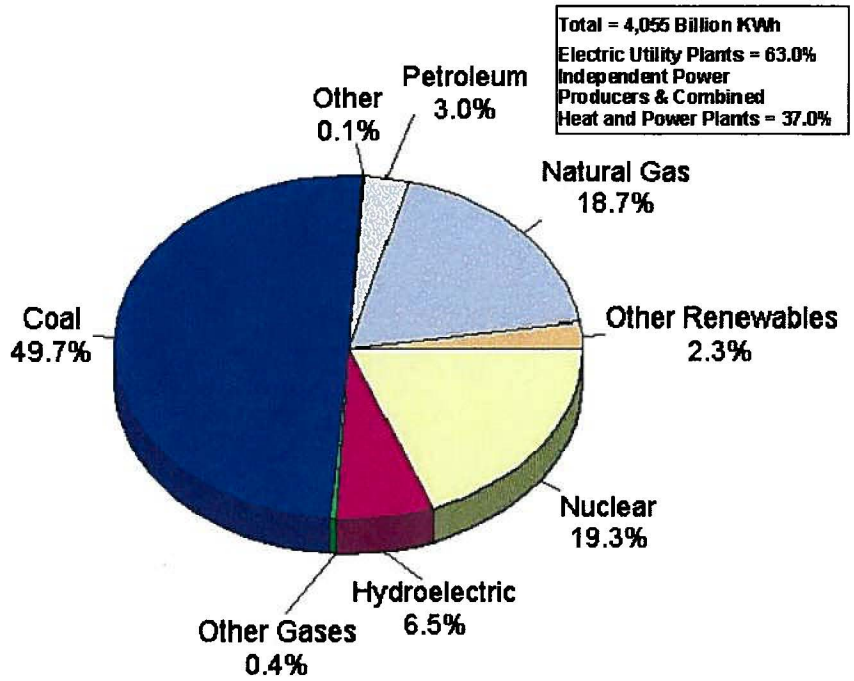
[10] For this and other sectors, this White Paper generally describes the types of sources and emissions that comprise the majority of the sector's emissions. This description, however, is not exhaustive. For example, the electricity sector emissions also include other types of emissions, such as SF_6 emissions from the transmission and distribution of electricity and nitrous oxide emissions from fossil fuel combustion. For more detailed information on each sector's emissions, see US Environmental Protection Agency, *The US Inventory of Greenhouse Gas Emissions and Sinks (2005),* April 2007.

[11] Emissions from electricity generated primarily for the generator's own use (e.g., a resort that generates its own electricity) are not included in the electricity generation sector. Rather, they are included in that generator's sector (e.g., in the commercial sector for emissions from a resort).

[12] Depending on their geographic location, power plants may also be subject to a nitrogen oxide trading program, a mercury trading program, and/or a sulfur dioxide trading program tighter than the acid rain program.

Figure 5

Electricity Generation by Fuel Type (2005)



Source: *Energy Information Administration, "Electric Power Annual 2005," November 2006, p1, http://www.eia.doe.gov/cneaf/electricity/epa/epa_sum.html*

sector in a greenhouse gas cap-and-trade program. By making electricity generators the point of regulation, the cap-and-trade program will build on this existing infrastructure and experience.[13]

Although most of the units in the electricity generation sector are large units with high emissions, some units are small enough that the administrative burden of including them in the cap-and-trade program may not be warranted. One possibility is to cover units above a certain capacity.[14] For example, the Acid Rain Program applies to units attached to a generator with a

[13] There are alternative ways to include electricity generation emissions in a greenhouse gas cap-and-trade program. For example, the electricity generation sector could be covered by using the carbon content of fuel as a proxy for carbon emissions instead of relying on monitored emissions. Coal, natural gas, and oil producers, processors or providers could be the point of regulation (rather than electricity generators) and would be required to turn in allowances based on the carbon content and amount of fuel they sold. Such a system would need to provide credits or some other mechanism of accounting for carbon captured and sequestered as part of the electricity generation process.

[14] Another possibility is to cover this sector based on capacity to emit CO_2 above a specified level. In 2002, all of the electricity generation sector's CO_2 emissions from fossil fuel combustion were from approximately 2,220 facilities (note that "facilities" are different than "units" used in the text) that each emitted more than 1,000 tons, and 99.9% came from approximately 1,600 facilities that each emitted more than 10,000 tons. Nicholas Institute for Environmental Policy Solutions, *Size Thresholds for Greenhouse Gas Regulation: Who Would be Affected by a 10,000-ton CO_2 Emissions Rule?*, September 2007 at p. 4.

nameplate capacity of 25MW or greater. This threshold would cover close to 4,900 units and 99.6% of the emissions from this sector.[15] If the threshold were set at 10 MW, it would cover an additional 2,000 units, collectively responsible for 0.3% of emissions from this sector.[16]

Transportation Sector: This sector directly emitted 28% of the U.S. greenhouse gas emissions in 2005. The emissions from this sector come from cars (32%), light duty trucks (28%), other trucks and buses (20%) and other transportation (20%, including planes, trains, and boats).[17] Over 90% of the emissions from this sector are from burning petroleum products.

Although this sector must be included in the cap, having a downstream point of regulation (i.e., the point where the emissions occur) is not workable. Owners or operators of vehicles, the sources that actually emit greenhouse gases in this sector, are too numerous to include in a cap-and-trade program.

One possible point of regulation under a cap-and-trade program would be manufacturers of vehicles and other transportation equipment. This would require each vehicle (or other transportation equipment) manufacturer to submit allowances equal to the expected greenhouse gas emissions from the vehicles or equipment it sells. As compared to regulating consumers, this approach offers the benefit of making far fewer parties responsible for turning in allowances to cover this sector's emissions given the relatively small number of manufacturers of transportation equipment compared to users. The greenhouse gas emissions could be estimated for each vehicle or piece of equipment based on assumptions about its useful life, use patterns, and fuel consumption. Given the amount of estimation that would be required, however, this is not an ideal way of accounting for all greenhouse gas emissions from this sector. The accuracy of this method would be improved by periodically revising these assumptions.

A more promising point of regulation for this sector is upstream, i.e., refiners and importers. Adopting this point of regulation would require refiners and importers to turn in allowances to cover the carbon content of the transportation fuel they sell. Regulating refiners and importers would result in far fewer regulated entities than regulating vehicle owners or operators.[18] It would also provide for highly accurate accounting for carbon dioxide emissions because those emissions directly correspond to the carbon content of the fuel (which can be accurately determined).

If refiners and importers are designated as the "point of regulation" for the transportation sector in the cap-and-trade program, a comprehensive climate change program will also regulate motor vehicle manufacturers through efficiency or other performance standards for vehicles. Such a program will also incorporate other complementary measures such as a low carbon fuel program, and tax or other incentives to increase the use of low-emitting vehicles and to decrease vehicle usage. The design of measures to limit emissions from this sector should be informed by the lessons learned from fuel efficiency requirements

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[15] Environmental Protection Agency, eGRID2006 Version 2.1 (April 30, 2007).
[16] Ibid.
[17] See n. 10.
[18] 149 refineries cover 90% of the refined products sold in the United States. Energy Information Agency, Form-820, Annual Refinery Report (http://www.eia.doe.gov/oss/forms.html#top).

for passenger vehicles, which is the only current program that essentially puts a soft cap on greenhouse gas emissions from any sector. One lesson is that the program must address all parties that contribute to emissions from this sector. Vehicles and fuels should be treated as a system, as EPA does for clean air regulations, because a vehicle's emissions depend on what goes into the car, as well as how efficient the car is. Consumer demand is also an important piece of the puzzle that must be addressed.

Industrial Sector: This sector directly emitted 19% of the United States greenhouse gas emissions in 2005. It includes manufacturing, construction and mining.[19] The types of emissions and the activities that generate them vary significantly from one industry to another. They include, for example, CO_2 emissions from fuel combustion (e.g., on-site electricity generation or steam and/or heat production for industrial processes), by-products from industrial process activities (e.g., iron and steel production, cement manufacture), and methane emissions from fossil fuel production and exploration.

Of all the sectors covered in this White Paper, this is the most complex. It includes hundreds of thousands of sources. The types of facilities vary dramatically by size, type of product produced, type and amount of emissions, the process that causes the emissions, and other characteristics. Excluding this entire sector from an economy-wide program is not an option because it emits almost a fifth of the U.S. greenhouse gas emissions, but this is one of the key parts of the program that must be designed with attention to retention of manufacturing and other industrial jobs in the United States.[20]

The complexity of and regulatory issues presented by this sector are illustrated by looking just at options for covering CO_2 emissions from fossil fuel combustion from the manufacturing portion of the industrial sector (representing half of this sector's direct greenhouse gas emissions). Figure 6 shows both the number of facilities and estimated CO_2 emissions from fuel combustion for the 21 different manufacturing industries that emit CO_2 as a result of fuel combustion.[21] Some industries have a large number of facilities, but very low emissions.

If the point of regulation for the manufacturing sector's CO_2 emissions from fossil fuel combustion were placed downstream, at the source of the emissions, the cap-and-trade program could not include all of the approximately 350,000 manufacturing facilities in industries that emit CO_2 from fossil fuel combustion. Trying to include all those sources in the cap-and-trade program would add undue administrative complexity to the program, particularly since many of the sources have low emissions. Covering only sources capable of emitting above a specified threshold would dramatically reduce the number of covered entities yet still include in the cap a significant portion of the manufacturing CO_2 emissions from fossil fuel combustion. One possible threshold approach would be to cover only large emitters in high-emitting sectors

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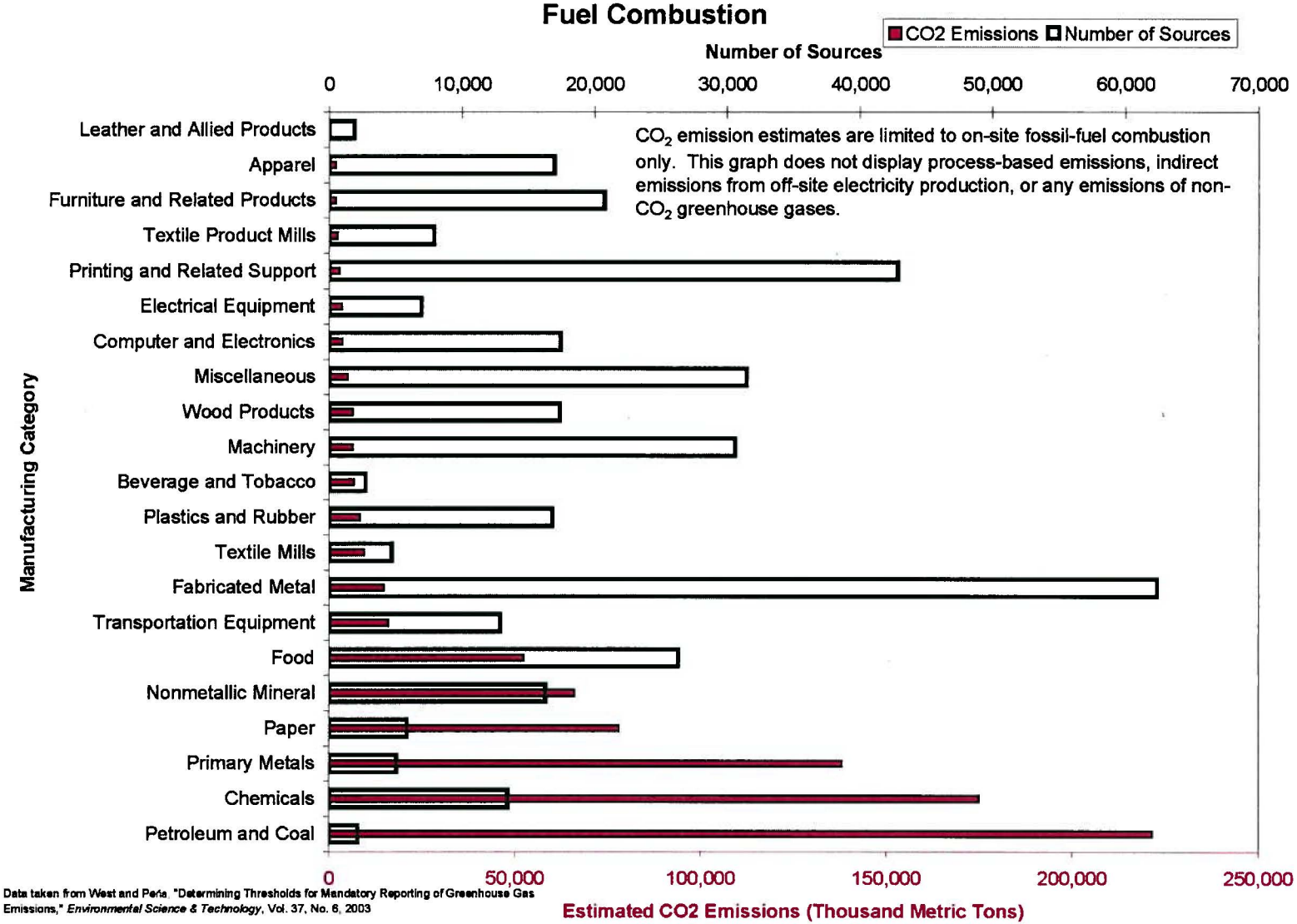
[19] See n. 10.

[20] For example, the mechanisms for distributing allowances and addressing developing countries' obligations regarding their emissions could play critical roles in how a U.S. climate program affects the industrial sector.

[21] The findings presented in Figure 6 are consistent with a more recent study. Nicholas Institute, September 2007.

Figure 6: Number of Manufacturing Facilities and CO_2 Emissions from Fossil Fuel Combustion



Data taken from West and Peña, "Determining Thresholds for Mandatory Reporting of Greenhouse Gas Emissions," *Environmental Science & Technology*, Vol. 37, No. 6, 2003

(using a source-specific threshold comparable to that selected for the electricity generation sector). Figure 7 demonstrates the number of facilities above certain emissions thresholds and the total emissions from those facilities for each of the 21 manufacturing industries. A recent study estimated that 90% of the industrial sector's CO_2 emissions from fossil fuel combustion came from 6 industries (petroleum and coke, chemicals, primary metals, paper, nonmetallic mineral, and food), and 7,460 (11%) of the sources in these industries each emitted over 10,000 tons of CO_2 from fossil fuel combustion.[22] Another possible threshold approach would be to cover all large emitters in all industrial sectors. Another study estimated that approximately 95% of the manufacturing industries' CO_2 emissions from fuel combustion came from approximately 47,000 manufacturing facilities that each emitted more than 1,000 tons of CO_2, and approximately 80% came from approximately 7,800 manufacturing facilities that each emitted more than 10,000 tons of CO_2.[23]

Alternatively, if the point of regulation for manufacturers' CO_2 emissions from fossil fuel combustion were placed upstream or midstream with fuel producers, processors, or providers, the cap-and-trade program could have broader coverage of these emissions.[24] This approach would require fuel producers, processors, or providers to turn in allowances to cover the carbon content of the fuel ultimately combusted by manufacturing users. Provided there are mechanisms for distinguishing between fuel sold to manufacturing users for combustion rather than as feedstock (e.g., natural gas for manufacturing chemicals),[25] regulating fuel producers, processors or providers would provide for accurate accounting for CO_2 emissions from fossil fuel combustion because those emissions directly correspond to the carbon content of the fuel (which can be accurately determined). The feasibility of regulating manufacturers' CO_2 emissions from fossil fuel combustion by covering fuel producers, processors, or providers needs to be explored further and may depend on whether the same point of regulation is used for other sectors. One question is whether there is a point in the fuel distribution chain where it would be easy to determine and track whether fuel was being provided to a source not covered by the cap-and-trade program (e.g., an industrial user) or to a covered source (e.g., an electricity generator).

The preceding discussion focused on manufacturers' CO_2 emissions from fossil fuel combustion in part because it is the largest component of the industrial sector's emissions and in part because the available data is more robust than it is for most other types of emissions in this sector. There is good aggregate national inventory information for these other emissions, but information on emission levels from most individual facilities is generally not reported and is difficult to estimate.

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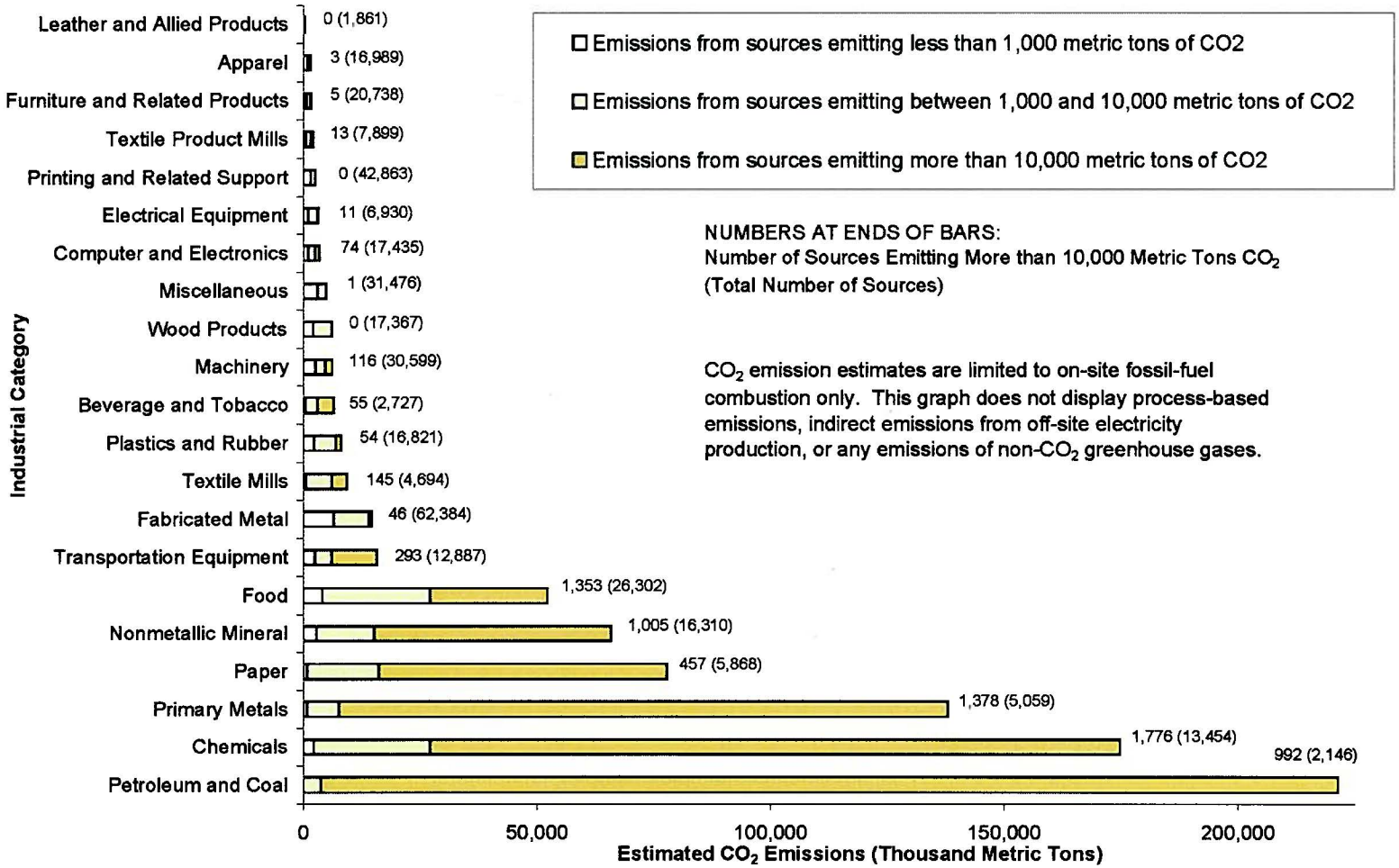
[22] Nicholas Institute, 2007 at Table 5.

[23] West and Pena, 2003 at Table 3. A more recent study found that about 8,000 manufacturing facilities (2.3% of all United States manufacturing facilities) each emitted more than 10,000 tons of CO_2 from fossil fuel combustion and accounted for 85% of the manufacturing industry's CO_2 emissions from fossil fuel combustion. Nicholas Institute, 2007 at Table 5.

[24] See n. 8.

[25] One possibility is information currently provided to the Energy Information Administration regarding end uses of fossil fuels.

Figure 7: Large Emitters of CO_2 from Fossil Fuel Combustion in Each Manufacturing Industry



Data taken from West and Perie, "Determining Thresholds for Mandatory Reporting of Greenhouse Gas Emissions," *Environmental Science & Technology*, Vol. 37, No. 6, 2003

Within the industrial sector, the appropriate point of regulation and the appropriate level of emissions for coverage might vary based on the nature of the emissions and the activities that generate them. CO_2 emissions from fossil fuel combustion might be covered differently than methane emissions from coal mining, which might be covered differently than fluorinated gases emitted during production, either as a by-product or from the use of the gas in the industrial process. The appropriate thresholds and points of regulation for the industrial sector must take into account the potential for leakage from the electricity generation sector and the competitiveness concerns raised when some industrial facilities generate their own electricity and others (even in the same industry) buy power from other generators.

The complexity of this sector might make it appropriate for Congress to make initial decisions about how some industries or types of emissions should be covered, and then provide carefully circumscribed statutory authority to add other industries or types of emissions as the program matures. There may also be a role for performance standards, best management practice requirements, or other complementary measures.

Commercial Sector: This sector directly emitted 6% of U.S. greenhouse gas emissions in 2005. Approximately half of the emissions from this sector are due to consumption of natural gas and petroleum products for heating, cooking, and equipment needs of businesses, Federal, State and local Governments, and other private and public institutions.[26] This sector also includes landfills, which emit methane and account for approximately one-third of this sector's emissions, and wastewater treatment facilities. Given the variety in the types of sources and emissions in this sector, it is possible that the same approach will not work for all types of sources in this sector.

Whether the direct emissions from commercial buildings[27] could be included in the cap-and-trade program would depend, in part, on the point of regulation. Commercial buildings generally do not lend themselves to being the point of regulation in a cap-and-trade program given the large number of sources that each have low emissions. A 2003 study estimated that 6,000 commercial facilities emitted more than 1,000 tons CO_2 eq annually, but none emitted more than 10,000 tons CO_2 eq.[28] Another study noted that some large universities or hospitals that run large boilers for central heat might emit more than 10,000 tons of CO_2 a year.[29] Large sources, such as these types of boilers, could be included in the cap-and-trade program even though the cap-and-trade program will not include small emitters in this sector given the administrative burden that would impose.

A cap-and-trade program might be able to provide broad coverage of emissions from commercial buildings if the point of regulation were upstream or midstream, which would require fuel producers, processors, or providers to turn in allowances to cover the carbon content of the fuel that ultimately is sold to commercial buildings.[30] Using an upstream or midstream point of regulation would provide for accurate accounting for carbon dioxide emissions, which

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[26] See n. 10.
[27] This White Paper will use "commercial buildings" to describe the sources of direct emissions from heating, cooking, and equipment needs of businesses, Federal, State and local Governments, and other private and public institutions. Common types of commercial buildings are office buildings, universities, hospitals, hotels, and resorts.
[28] West and Pena, 2003 at Table 3.
[29] Nicholas Institute, September 2007 at p. 4.
[30] See n. 8.

directly correspond to the carbon content of the fuel (which can be accurately determined). The feasibility of using an upstream or midstream point of regulation to cover emissions from commercial buildings needs to be explored further and may depend on whether the same point of regulation is used for other sectors. One question is whether there is a point in the fuel distribution chain where it would be easy to determine and track whether fuel ultimately would be burned by a source not covered by the cap-and-trade program (e.g., a residential user or commercial building) or to a covered source (e.g., an electricity generator).

Rather than including emissions from commercial buildings in the cap-and-trade program, it might be appropriate to reduce their emissions through building codes and efficiency or other performance standards (e.g., for furnaces).[31] If the emissions from this sector cannot generally be included in the cap-and-trade program, it might also be possible to allow commercial buildings to opt-in as a way of providing incentives for the construction of very efficient buildings, provided that this does not impair the integrity of the cap.

Approximately 10 percent of the emissions from the commercial sector come from the use of fluorinated gases, primarily HFCs, used to replace ozone depleting substances that are being phased out under the Montreal Protocol.[32] These gases are used primarily for refrigeration and air conditioning. Fluorinated gases used as substitutes for ozone depleting substances are also in the emissions inventories for the transportation, commercial, and industrial sectors. A small number of companies make fluorinated gases used as substitutes for ozone depleting substances, which should make an upstream point of regulation an efficient way to account for these gases in the cap-and-trade program.

Greenhouse gas emissions from other sources in this sector (such as landfills) generally may not lend themselves to regulation under a cap-and-trade program if there is difficulty in measuring the emissions accurately. Such sources may, however, provide significant opportunities to reduce emissions in a way that allows the reductions to be determined accurately. This could make them appropriate as a source of credits or offsets in a cap-and-trade program. For example, EPA currently operates methane programs that encourages landfills and other sources to capture gas and use it for electricity generation.[33] This program has protocols for accurately determining the resulting reduction in greenhouse gas emissions. A later White Paper will discuss the potential for using such reductions as offsets or credits as part of the cap-and-trade program.

Residential Sector: This sector directly emitted 5% of U.S. greenhouse gas emissions in 2005. The emissions from this sector are primarily from burning natural gas or petroleum products for heating and cooking in private homes.[34]

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[31] Such programs, which would not necessarily be federal programs, could also be adopted in addition to a cap-and-trade program as a way of ensuring that the market provides high efficiency products for commercial buildings facing increases in fuel costs. Building codes and efficiency or other performance standards could also be used to reduce the commercial buildings' indirect emissions from their use of electricity.

[32] The gases that are being replaced are even more potent greenhouse gases than the fluorinated gases. EPA, *Achievements in Stratospheric Ozone Protection: Progress Report*, April 2007 at p. 33. Although chemicals being phased out under the Montreal Protocol contribute to global warming, they are not addressed in the U.S. greenhouse gas emissions inventory because they are already addressed internationally under the Montreal Protocol. EPA, *The U.S. Inventory of Greenhouse Gas Emissions and Sinks (2005),* April 2007 at p. ES-2.

[33] EPA, "Methane-to-Markets." http://www.epa.gov/methanetomarkets/

[34] See n. 10.

Inclusion of emissions from the residential sector raises essentially the same issues raised by the commercial sector. The cap-and-trade program will not regulate the residential sector's emissions with a downstream point of regulation (i.e., where the emissions actually occur) given the large number of residential sources that each have very small emissions. A cap-and-trade program might, however, be able to cover emissions from the residential sector if the point of regulation were upstream or midstream (with fuel producers or some other entity in the fuel processing and distribution chain). The feasibility of regulating this sector through fuel producers, processors, or providers needs to be explored further and may depend on the point of regulation chosen for other sectors, including the commercial sector. As with emissions from the commercial sector, it might be appropriate to address this sector's emissions through building codes and efficiency or other performance standards (e.g., for furnaces and water heaters).[35]

Agricultural Sector: This sector directly emitted 8% of U.S. greenhouse gas emissions in 2005. Approximately two-thirds of the emissions were nitrous oxide (N_2O), largely the result of agricultural soil management (e.g., fertilizer application) and manure management. Approximately one-third of the emissions were methane, largely from enteric fermentation (a digestive process of ruminant animals) and manure management.[36]

Greenhouse gas emissions from the agricultural sector generally do not lend themselves to regulation under a cap-and-trade program. There are a large number of sources with small individual emissions that would be impractical to measure. A 2003 study estimated that 19,000 farms emitted more than 1,000 tons CO_2 eq, but that none of those farms emitted more than 10,000 tons CO_2 eq annually.[37] Accurately determining emissions is also an issue. For example, N_2O released from fertilizer use cannot be measured directly by putting a monitor on the field, and there do not appear to be good proxies for measuring N_2O emissions.[38]

The agricultural sector, however, does have significant opportunities to reduce emissions that may lend themselves to measurement, which could make them appropriate as a source of credits or offsets in a cap-and-trade program. For example, EPA currently operates a methane capture program that encourages large animal feeding operations to treat manure in a way that maximizes the amount of methane that could then be burned to generate electricity.[39] This program has protocols for accurately determining the resulting reduction in greenhouse gas emissions Cropland, when properly managed, can serve as a biological sink by pulling carbon out of the atmosphere. A later White Paper will discuss the potential for using such reductions as offsets or credits as part of the cap-and-trade program.

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[35] Such programs, which would not necessarily be Federal programs, could be adopted in addition to a cap-and-trade program as a way of ensuring that the market provides high efficiency products for residential customers facing increases in fuel costs. Building codes and performance or other efficiency standards could also be used to reduce the residential sector's indirect emissions from its use of electricity.

[36] See n. 10.

[37] West and Pena, 2003 at Table 2.

[38] Differences in fertilizers, soil conditions, and farming practices make it difficult to measure or report on factors that could be used as a proxy for measuring emissions. This is in contrast to the carbon content of fuel, which is a good proxy for the amount of carbon that will be released when the fuel is burned.

[39] EPA, "Methane-to-Markets." http://www.epa.gov/methanetomarkets/

Summary

- The United States needs to reduce its greenhouse gas emissions by 60 to 80 percent by 2050 to contribute to global efforts to address climate change.
- The United States needs an economy-wide, mandatory greenhouse gas reduction program.
- Primary reliance will be placed on the use of a cap-and-trade program, but complementary programs will also be needed.
- The following greenhouse gases will be included in the cap-and-trade program:
    - Carbon dioxide (CO_2);
    - Methane (CH_4);
    - Nitrous oxide (N_2O); and
    - Fluorinated Gases: Hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6).
- The desire to cover all greenhouse gas emissions in a cap-and-trade program must be balanced against the need to have an efficiently administered program. The inability to determine emissions (or a proxy) from sources within a given sector and/or having a large number of sources that each have low emissions may render their direct coverage by the program untenable.
- The point of regulation (i.e., the parties responsible for tracking emissions and turning in allowances) in a cap-and-trade program for any particular sector does not have to be the source that emits the greenhouse gases.
- The sectors that directly emit greenhouse gases are:
    - Electricity generation;
    - Transportation;
    - Industrial;
    - Commercial;
    - Residential; and
    - Agricultural.
- The electricity generation sector should be included in the cap-and-trade program.
    - The point of regulation should be the electricity generating facilities.
    - Only units above a specified threshold should be included in the program. The threshold could be based on generation capacity (e.g., 25 MW, as in the Acid Rain Program, or 10 MW) or on the potential annual CO_2 emissions (e.g., 10,000 tons CO_2).
- The transportation sector should be included in the cap-and-trade program.
    - The most comprehensive point of regulation for the cap-and-trade program would be the refiners and importers of transportation fuel.
    - A comprehensive climate change program will also regulate motor vehicle manufacturers through efficiency or other performance standards for vehicles. Such a program will also incorporate other complementary measures such as a low carbon fuel program, and tax or other incentives to increase the use of low-emitting vehicles and to decrease vehicle usage.
- The industrial sector should be included in the cap-and-trade program.
    - A large number of facilities in this sector have very low emissions and should not be directly included in the cap-and-trade program.

    - Additional information is needed on the types of emissions, the activities that produce them, and the types of facilities to determine the appropriate point of regulation and threshold for coverage.
- The commercial sector's treatment in a cap-and-trade program may depend on the point of regulation and type of facility.
    - For commercial buildings, if the point of regulation is downstream (i.e., the emitters), then a threshold would be needed so that only large emitters are included in the cap-and-trade program.
    - For commercial buildings, an upstream or midstream point of regulation (i.e., fuel producers, processors or providers) would allow greater coverage of this sector's emissions, but additional information on the feasibility of this approach is needed.
    - For commercial buildings, building codes, and efficiency or other performance standards might be appropriate in addition to or instead of including this sector in the cap-and-trade program. If emissions from this sector cannot generally be addressed through the cap-and-trade program, there may be opportunities to allow commercial buildings to opt-in, provided that the integrity of the cap is maintained.
    - Fluorinated gases used as substitutes for ozone depleting substances (e.g., for refrigeration and air conditioning) should be covered in a cap-and-trade program, perhaps using the manufacturers (and importers) as the point of regulation. This same approach could apply to substitutes for ozone depleting substances used in other sectors.
    - For landfills (and perhaps other sources in this sector), an inability to measure direct emissions may preclude their inclusion in the cap. They might, however, provide opportunities for offsets and credits if emission reductions can be determined accurately.
- The residential sector's treatment in a cap-and-trade program may depend on the point of regulation.
    - A downstream point of regulation (i.e., residential users) would preclude inclusion of this sector in the cap-and-trade program because of the large number of residential users, each with low emissions.
    - An upstream or midstream point of regulation (i.e., fuel producers, processors or providers) would allow broad coverage of this sector's emissions, but additional information about the feasibility of this approach is needed.
    - Building codes and efficiency or other performance standards might be appropriate in addition to or instead of including this sector in the cap-and-trade program.
- The agricultural sector's direct emissions generally should not be included in the cap-and-trade program because of difficulties monitoring the emissions and the large number of sources each with low emissions.
    - This sector may present opportunities for emission reductions that would be measurable and might then provide offset or credit opportunities.