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Current Directions in the Climate Change Debate in the United States

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The United States – with 5 percent of the world's population – is responsible for approximately 25 percent of global greenhouse gas (GHG) emissions and its emissions continue to increase.[1] Having declined to ratify the Kyoto Protocol, and as the world's largest economy and biggest emitter of greenhouse gases, the United States is central to any long-term global strategy to address climate change. As the international community works to agree on actions appropriate after the Protocol's first commitment period ends in 2012, the domestic actions and international positions taken by United States are vitally important. Accordingly, this chapter of the 2007 Human Development Report aims to provide a global audience with an overview of the climate change debate in the United States.

This chapter describes the debate across several dimensions. To provide necessary context, the chapter begins with a review of historical and projected emission patterns and then moves to an analysis of the structure and drivers of U.S. GHG emissions. Next, it explores the options for deep cuts in emissions from certain high-emitting sectors such as the electric power industry and the transportation sector. Given limited action by the U.S. federal (i.e., national) government on the climate change issue, initiatives undertaken by state (i.e., sub-national) and local governments, as well as by the private sector, have been noteworthy and are briefly summarized in this chapter. Next, broad policy measures being considered at the national level are described and the potential impact on the U.S. economy of deep cuts in GHG emissions is assessed. The chapter concludes with a summary of how the United States might approach the post-2012 era, from both a policy and a political perspective.

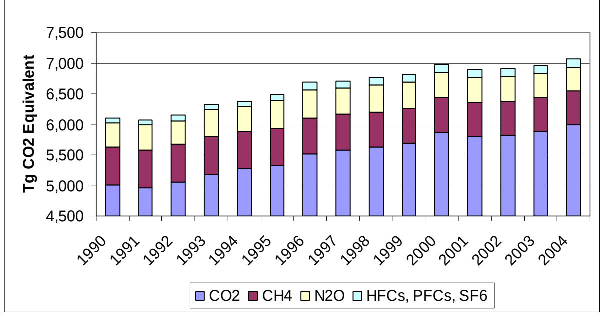
1. Overview of US Greenhouse Gas Emissions

The climate change debate in the United States has taken place in the context of steadily increasing U.S. emissions of greenhouse gases. In turn, because binding targets for emission reductions have been adopted by only a few state governments and because a modest non-binding goal exists at the national level, emissions are forecast to continue increasing in the years to come unless major new policy measures are enacted.

1.1 Historical Emission Trends[2]

U.S. emissions of GHGs have increased just about every year between 1990 and 2004. As shown in Figure 1, the only exceptions are two years characterized by economic slowdowns (1991 and 2001). Total emissions went from 6,109 Tg CO_2 eq to 7,074 Tg CO_2 eq, an increase of almost 16 percent over the 14 year period, or 1.1 percent per year.[3]

Figure 1:
U.S. GHG Emissions



As shown in Figure 2, CO_2 is the dominant greenhouse gas emitted by the United States, comprising about 85 percent of total emissions, mostly from fossil fuel combustion. Between 1990 and 2004, CO_2 emissions increased at a rate faster than aggregate emissions, climbing by almost 20 percent, or on an annual basis, by 1.3 percent. U.S. emissions of CH_4 and N_2O emissions, however, fell over the same 14 year period: CH_4 emissions by 10 percent and N_2O emissions by 2 percent. Emissions of industrial greenhouse gases (i.e., HFCs, PFCs, and SF_6) have increased rapidly, climbing over 57 percent between 1990 and 2004, for an annual growth rate of 3.3 percent.

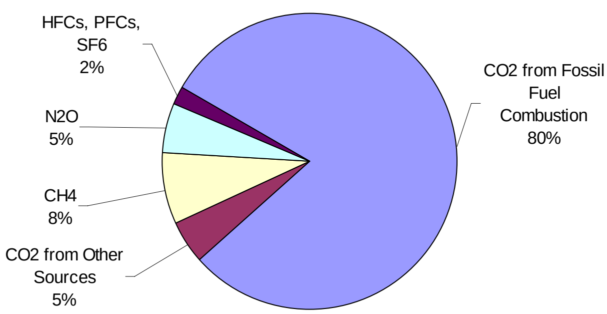


Figure 2: U.S. 2004 GHG Emissions by Gas

All major sectors of the United States economy contribute to the country's GHG emissions. Figure 3 displays emissions by sector and demonstrates the substantial contributions to emissions made by electricity generation, transportation, and industry. Because fossil-fuel-generated electricity is a major emission source, and because options for emissions reduction rest in part on increased efficiency in the use of electricity, another sectoral perspective can be obtained by allocating emissions from electricity generation to the sectors that use the electricity. Figure 4 presents this view. In this perspective, the transportation and industry sector remain major emitters while the commercial and residential sectors, due to their consumption of electricity, combine to represent about a third of national emissions.

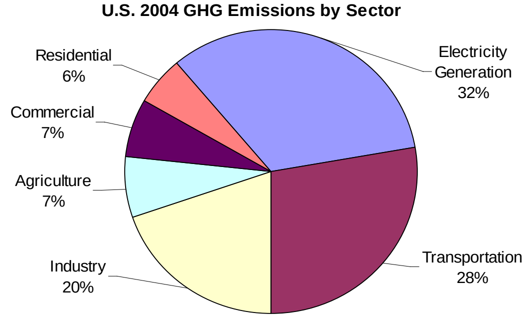


Figure 3: U.S. 2004 GHG Emissions by Sector

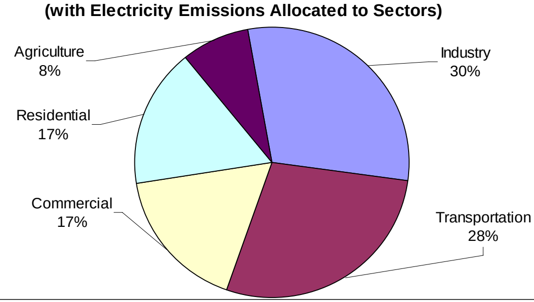


Figure 4: U.S. GHG Emissions by Sector (with Electricity Emissions Allocated to Sectors)

1.2 Current Emission Targets

The United States – at the national level – has not enacted binding limits on the emission of greenhouse gases, although several states have or are in the process of doing so. When it comes to federal action, the only national target is a non-binding goal announced by President Bush on February 2002: an 18 percent reduction in emissions intensity between by 2012. Emissions intensity is defined as the ratio of greenhouse gas emissions to economic output as measured by gross domestic product (GDP). This approach minimizes economic impact by allowing emissions to rise or fall with economic output; however, it provides no assurance that a given level of environmental protection will be achieved since the degree of environmental protection is measured in relation to GDP.

A GHG intensity target can lead to a net reduction in emissions, but only if it is sufficiently stringent. Cutting greenhouse gas intensity by 18 percent from its 2002 level, however, represents only a very modest improvement over historical patterns. While U.S. emissions *increased* over the last two decades, greenhouse gas intensity actually *decreased*. Thanks to energy efficiency improvements, the introduction of new information technologies, and the continued transition from heavy industry to less energy-intensive industries, greenhouse gas intensity in the United States fell by 21 percent in the 1980s and by 16 percent in the 1990s.[4]

In addition, because significant growth in U.S. GDP is expected between now and 2012, total GHG emissions are likely to increase under the Administration's policy, even as emissions intensity falls. For example, U.S. GDP is forecast to increase by almost 25 percent between 2002 and 2012.[5] A GHG intensity reduction target of 18 percent over the same period is insufficiently stringent to fully offset the impact of such growth. What's more, because the target is not binding, and is being implementing only through voluntary policy measures, there is little assurance that even this modest intensity target will be achieved.

In the absence of strong federal action, several state and local governments have moved forward with climate change policies. As of April 2007, 14 U.S. states have established greenhouse gas emissions targets.[6] These programs differ with respect to sectors and gases covered, implementation mechanisms, and the speed and extent of the emissions reductions. Two noteworthy initiatives are in the Western States and in the Northeast/Mid-Atlantic region.

The California Global Warming Solutions Act of September 2006 caps California's greenhouse gas emissions at 1990 levels by 2020. This legislation represents the first enforceable state-wide program in the U.S. to cap all GHG emissions from major industries that includes penalties for non-compliance. The Act authorizes the State Air Resources Board to adopt market-based compliance mechanisms including a cap-and-trade program.[7] In addition, on February 26, 2007, Arizona, California, New Mexico, Oregon, and Washington formed the Western Regional Climate Action Initiative to implement a joint emission reduction strategy. Within two years, these states will set a regional emission target and devise a market-based program, such as a cap and trade program to reach the target.[8]

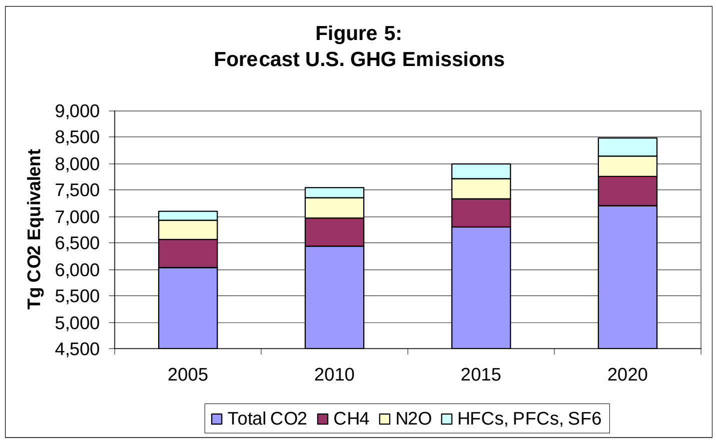
Established in December 2005 by the governors of seven Northeastern and Mid-Atlantic states, the Regional Greenhouse Gas Initiative (RGGI) is the first mandatory U.S. cap-and-trade program for carbon dioxide. It sets a cap on emissions of carbon dioxide from power plants, and allows sources to trade emissions allowances. Massachusetts and Maryland joined in 2007 and Rhode Island has announced its intent to join.[9] In addition to emission reduction targets, state and local governments across the U.S. have taken a wide range of other steps to address the issue of climate change. These activities are described in more detail in Section 4 below.

1.3 Future Emission Forecasts and Scenarios

During the past several years, the United States federal government has generated multiple forecasts of the country's greenhouse gas emissions. Such estimates always include a baseline, or a reference case, which assumes that no new policy measures are adopted and that firms, consumers, and government behave in a "business as usual" (BAU) manner. Alternative emission forecasts are also often generated to reflect different assumptions about economic, technological, and/or policy factors. Because of the diversity of such alternate forecasts and their dependence on specific, potentially unique, input assumptions, they are not discussed here.[10] Instead, the latest U.S. BAU forecast – which assumes no new policy initiatives or emission targets are adopted – is presented. This BAU forecast (in Section 1.3.1) is complemented (in Section 1.3.2) by the results of an exercise conducted by the Pew Center on Global Climate Change in which three scenarios were assessed with respect to GHG emissions over time.

1.3.1 Emission Forecasts

Responsibility for predicting U.S. GHG emissions is shared by two Federal agencies, the Department of Energy (DOE) and the Environmental Protection Agency (EPA). DOE produces annual CO_2 emission forecasts using the National Energy Modeling System. The Department's reference case incorporates baseline assumptions about economic growth, energy prices, energy consumption, energy intensity, electricity generation, and energy production and imports. The latest EPA forecast of U.S. emissions of non-CO_2 GHGs is embedded in a 2006 study to characterize emissions from 90 individual countries from 1990 to 2020.[11] To forecast U.S. emissions, EPA uses multiple projection techniques depending on the sector and gas under analysis. EPA's BAU scenario assumes full implementation of a set of industry-agreed reduction goals for emissions of CH_4, HFCs, PFCs, and SF_6. DOE's 2006 reference case and EPA's business as usual forecasts have been combined in Figure 5 to show annual U.S. emissions projected over the 15 year period from 2005 to 2020.



The data indicate that in the absence of significant policy changes, U.S. emissions are likely to grow at 1.2 percent per year, roughly the same rate as the period from 1990 to 2004. Emissions climb to over 8,600 Tg CO_2 eq by 2020, with CO_2 continuing to dominate emissions. Despite falling over the prior 14 years, CH_4 and N_2O emissions are forecast to begin rising, both experiencing an annual growth rate of 0.4 percent. Given historical reductions and this modest growth rate, 2020 emissions of both CH_4 and N_20 are forecast to be less than 2000 emissions. Emissions of high-GWP industrial gases rise faster than other GHGs, driven in large measure by the substitution of HFCs and PFCs for ozone depleting substances being phased out under the Montreal Protocol. Despite rising at an annual rate of over 5 percent, high-GWP industrial gases are projected to comprise only about 3.5 percent of U.S. GHG emissions in 2020.

1.3.2 U.S. Energy Scenarios for the 21st Century

The question of how U.S. energy supply and use – which account for over 80 percent of US greenhouse gas emissions – will evolve over the next several decades is fundamental to understanding future emissions. Because the largest component of GHG emissions is carbon dioxide from energy use, it is informative to conduct scenario analyses to determine plausible energy and emissions profiles, looking beyond standard business as usual forecasts.

With the help of the Global Business Network and several stakeholders, the Pew Center conducted such an analysis of three divergent paths for U.S. energy supply and use from 2000 through 2035.[12] The three scenarios are not predictions; however, they can help describe plausible futures and identify implications of various futures and key technologies, energy policy decisions, and strategic investment choices that can enhance (or complicate) energy security, environmental protection, and economic development goals.

- **Awash in Oil and Gas** is a scenario in which abundant supplies of oil and natural gas remain available to U.S. consumers at low prices. Energy consumption rises considerably and conventional technologies dominate the energy sector. In this low energy price scenario, there are few incentives to improve energy efficiency and little concern for energy issues. Carbon emissions rise 50 percent above the year 2000 level by 2035.

- **Technology Triumphs** is a scenario in which an array of driving forces converge to accelerate the successful commercialization in the U.S. market of many technologies that improve energy efficiency and produce lower carbon emissions, and in which U.S. companies play a key role in the subsequent development of an international market for these technologies. Despite sustained economic growth and an increase in energy consumption, carbon emissions rise 15 percent above the year 2000 level by 2035.

- **Turbulent World** is a scenario in which U.S. energy markets are repeatedly buffeted by developments at home and abroad, with unsettling effects on energy prices and mounting threats to U.S. energy security. High energy prices and uncertainty about energy supplies slow economic growth, and the country moves from one technological "solution" to another, finding serious flaws with each, until finally settling on a program to accelerate the commercialization of hydrogen and fuel cells. Despite slower economic growth in Turbulent World, carbon emissions rise 20 percent above the year 2000 level by 2035.

Climate change policy was deliberately excluded from these three scenarios. It was important to determine what might happen to emissions under these scenarios in the absence of US policy. However, it became clear that under all scenarios – even those with optimistic assumptions regarding technology, emissions would continue to increase. Once this consistent outcome became apparent, the participants in the scenario development process formulated a hypothetical climate policy overlay. The policy overlay postulated a freeze of U.S. CO_2 emissions in 2010 and subsequent 2 percent per year decreases from 2010 to 2025, followed by 3 percent per year decreases to 2035. The policy overlay is neither a prediction nor a recommendation. To achieve the targeted emissions reductions trajectory and create the policy overlay cases, the same portfolio of primarily market-oriented policies and programs was imposed on each base case scenario.[13]

When the policy overlay is applied to each of the base case scenarios, it modifies the pattern of energy technology development. For example, in the base case of the **Turbulent World** scenario, concerns about energy security stimulate a major national commitment to expanding production of hydrogen from coal and to accelerating the development of hydrogen fuel cells, both for transportation and in stationary power applications. In the policy overlay case for the Turbulent World scenario, the carbon constraint combines with growing public and private concerns about the security of energy facilities to stimulate demand for distributed generation (DG) and for combined heat and power (CHP) systems.

In the **Technology Triumphs** base case, new technologies already contribute to a slowing in the growth of carbon emissions. In the policy overlay case for Technology Triumphs, the carbon emissions limit forces faster reductions in oil demand, especially in the transportation sector, compared to the Technology Triumphs base case, resulting in accelerated market penetration by hybrid gasoline-electric and diesel-electric vehicles. Imposition of the carbon constraint in the policy overlay case expedites efforts to lower the barriers that typically hold back distributed generation, end-use efficiency improvements, and renewable energy technologies from large-scale commercialization in the United States.

In **Awash in Oil and Gas**, imposing carbon policies is more complex and more challenging. The base case scenario, built around cheap and abundant resources of oil and gas, includes little private investment in the technologies that improve end-use efficiency or reduce carbon emissions. Thus, meeting the carbon emissions target of the policy overlay introduces tremendous tension into this scenario. Major federal programs are needed to mandate carbon reductions and educate individual and industrial consumers about the climate consequences of their energy use. Yet cheap fuel encourages consumers to drive inefficient vehicles and stimulates air travel. Facing an exceedingly tight constraint on emissions and with little time to upgrade capital stock, public and private decision-makers move aggressively (but late in the scenario period) to develop carbon capture and geological sequestration technology so as to keep combustion-derived carbon dioxide out of the atmosphere.

Taken together, this scenario analysis revealed three important conclusions:

- Without emission reduction policies, emissions increase over the next three decades in all three scenarios, even those with optimistic assumptions about the future cost and performance of energy technologies. Climate change policy is needed to stem future emissions growth, regardless of which path the U.S. energy future ultimately takes.

- Policy and investment decisions today will have a significant impact on the difficulty of reducing energy-related carbon emissions tomorrow. Early and sustained investment, engineering success, and consumer acceptance of low-carbon and efficiency-improving technologies make the task of reducing emissions easier, as do energy security policies that reduce oil import dependence. Low fossil fuel prices make the task harder by encouraging high-carbon and energy-inefficient investments. Other scenario conditions, such as external events, play a major role as well.

- A portfolio of policies combining technology performance targets, market incentives, and price-oriented measures can help the U.S. meet complementary energy security, climate protection, and economic objectives. Targeted policies can stimulate investment, accelerate the turnover of capital stock, and encourage emissions reductions. Emissions allowance trading, along with informational and other programs designed to address market imperfections, can lower the barriers to commercialization of efficiency-improving measures and new low-emissions technologies. However, policies designed to reduce carbon emissions can entail significant costs for the energy and energy-intensive sectors of the economy. Flexible program design, as well as successful development of major new technologies, can help to reduce these costs.

2. Structure and Drivers of U.S. Greenhouse Gas Emissions

The broad emission trends described above reflect the dynamic structure of the U.S. economy and the cumulative effect of changes in emissions from each sector of the economy. When it comes to understanding what drives U.S. GHG emissions, four sectors – electric power generation and use, transportation, manufacturing, and agriculture – are especially important.

2.1 Structure & Drivers of Emissions from Electric Power Generation

GHG emissions from the power sector, which produces 32 percent of all U.S. emissions,[14] have grown from 1,803 Tg CO_2 in 1990 to 2,309 Tg CO_2 in 2004 – an annual increase of 1.8 percent.[15] Under a BAU scenario, emissions from the sector are projected to increase annually at 1.4 percent between 2005 and 2030, substantially outpacing the 1.0 percent growth rate of CO_2 emissions from all other sources.[16] Power-sector emissions are driven by two factors: the demand for electricity and the carbon content of fuels used to generate electricity.[17]

Energy Demand: Continued Growth in Electricity

The efficiency of electricity end-uses has improved substantially since the early 1970s.[18] Key drivers include technological innovation and higher electricity prices. In addition, the Federal government sets appliance efficiency standards, annually funds $963 million in research and development related to energy efficiency and renewables,[19] and operates the Energy Star programs (with savings of 170 billion kilowatt-hours in 2006[20]). Electric utilities also implement programs to encourage conservation and enhance efficiency; industry spending in this arena is estimated at $14.7 billion between 1989 and 1999.[21] State regulators play a key role by requiring utility investments in efficiency and authorizing pricing strategies to moderate demand; many states – some using federal models – have also adopted building codes that enhance efficiency.[22]

Efficiency improvements notwithstanding, however, demand is likely to continue to grow substantially. Electricity sales are expected to climb from 3,660 billion kilowatt-hours in 2005 to 5,168 billion kilowatt-hours in 2030, for an annual increase of 1.4 percent.[23]

- The fastest growth is expected in the commercial sector where electricity demand is forecast to grow by 2.0 percent per year. Population and income growth will increase demand for goods and services, in turn pushing up commercial floor space and the associated heating and cooling costs, along with energy consumed by appliances and equipment used in commerce.

- Through 2030, residential electricity demand is projected to grow annually by 1.3 percent, driven in part by population growth from 296 million in 2005 to 364 million in 2030.[24] Home sizes (and the associated heating and cooling loads) are also increasing; the average new home went from 1,500 square feet to 2,300 square feet over the past 30 years.[25] Population growth in warm regions of the U.S. will make residential air conditioning even more widespread; electronic equipment and appliance use in homes is also increasing.[26]

- Industrial demand is forecast to grow at a 0.6 percent rate. The relatively slow growth of industrial demand for purchased electricity, however, occurs in tandem with an expansion of on-site generation of electricity by industry. Accordingly, the emissions impact of the slower growth will be offset by the level and carbon intensity of industrial on-site generation.

Energy Supply: Carbon Content of Fuels Used to Generate Electricity

As shown in Figure 6, while coal is used to produce about half of the electricity in the U.S., several other fuels are also used. Each fuel emits significantly different amounts of CO_2. Nuclear power, hydropower, and other renewable resources release no carbon and, among fossil fuels, coal contains the most carbon and natural gas the least. Consequently, coal is by far the biggest source of CO_2 emissions associated with electricity. As indicated in Figure 7, coal's share of U.S. emissions is 82 percent while gas and petroleum contribute significantly less.

Figure 6
2005 Fuel Sources for Electric Generation (Billion KWH)

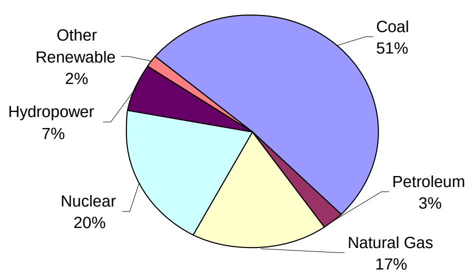
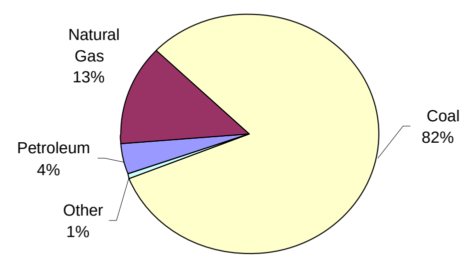


Figure 7
Source of 2005 CO_2 Emissions in Electric Generation (Tg CO_2)



Changes over the coming years in the fuel mix for electric power generation in the United States will be driven by factors unique to each fuel source.

- Coal: Large domestic supplies and low operating costs make coal an attractive choice for electric utilities.[27] In the absence of climate policy, more than half of the generation capacity added in the next 25 years is expected to be coal-fired. Electricity generated with coal is expected to grow by 1.9 percent per year between 2005 and 2030.[28]

- Natural Gas: In recent years, natural gas prices jumped significantly and the power industry has become more cautious about investing in gas-fired generation capacity.[29] Investments are expected to continue, but as gas prices rise, fewer plants will be built. Electricity generated with gas is expected to grow annually by only 0.3 percent between 2005 and 2030.

- Petroleum: Use of oil to generate electricity in the U.S. has dropped dramatically. This is partly due to environmental regulations, as well as to price and supply volatility. Electricity generated with oil is expected to shrink by 0.9 percent per year between 2005 and 2030.

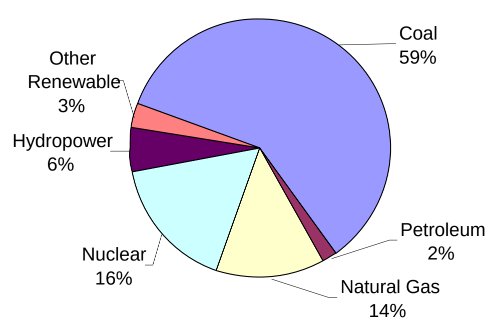
- Nuclear: About a fifth of the electricity generated in the U.S. comes from nuclear power, but due to high initial costs and uncertain approvals for new plants (due to public concerns about safety, waste disposal, and security of nuclear materials), no new nuclear plant has come on-line since 1996.[30] Federal legislation in 2005, however, provides tax credits that are expected to stimulate some new construction. In turn, nuclear-generated electricity is expected to grow by 0.6 percent per year between 2005 and 2030.

- Hydropower: Between a concern about its environmental consequences and few suitable dam sites, there is only limited scope for expanding the U.S. capacity to generate electricity using hydropower. The amount of electricity generated with hydropower is expected to grow 0.6 percent per year between 2005 and 2030.

- Other Renewables: Driven in part by regulations in several states requiring utilities to generate a specified minimum fraction of their power from renewable resources and, in some cases by favorable tax treatment, use of renewable resources, especially biomass, is expected to increase. The amount of electricity generated with non-hydropower renewable fuels is expected to grow at a high rate – 4.0 percent per year between 2005 and 2030.

As shown in Figure 8, given these trends in the fuel mix used to generate electricity, the sector is expected to become even more carbon intensive over the next 25 years. If projections hold, coal will produce 59 percent of all electricity, up from 51 percent in 2005. Nuclear power, natural gas, and petroleum will shrink, in relative terms. Renewable energy will remain constant at about 9 percent of the total mix, although hydropower will shrink and be replaced by other renewables. In the absence of major policy changes or technological innovations, the increasing carbon intensity of electric power generation and continually growing demand for electricity explain the significant CO_2 increases likely to be seen in this sector in coming years.

Figure 8
2030 Fuel Sources for Electric Generation (Billion KWH)



2.2 Structure & Drivers of Emissions from the Transportation Sector[31]

GHG emissions from the transportation sector, which produces 28 percent of all U.S. emissions, grew more rapidly than any other sector between 1990 and 2004. Emissions grew from 1,523 Tg CO_2 eq to 1,960 Tg CO_2 eq – an annual increase of 1.8 percent.[32] Under a BAU scenario, CO_2 emissions from the sector are projected to increase annually at 1.3 percent between 2005 and 2030, outpacing the 1.1 percent growth rate of CO_2 emissions from all other sources.[33]

Highway vehicles are responsible for about 81 percent of the emissions from the transportation sector with aircraft (9 percent), waterborne shipping (3 percent), and rail (2 percent) comprising most of the balance. The discussion below – focused on highway vehicles – distinguishes "light-duty" vehicles (passenger cars, vans, pickup trucks, and sport utility vehicles, or SUVs) from "heavy duty vehicles" (freight trucks and buses).

Aggregate emissions from any particular type of vehicle is a function of three factors: the vehicle miles traveled (VMT), the efficiency of the vehicle (typically expressed as miles per gallon or mpg), and the carbon content of the fuel. In broad terms, while there were significant decreases in the energy intensity of the sector during 1970s –1980s (due to oil shocks and related imposition of stricter federal mileage standards), emissions have risen in recent decades because vehicle miles traveled have grown faster than efficiency has improved and because little low-carbon fuel is used.

Light Duty Vehicles

The 136 million passenger cars on the U.S. roads contributed 35 percent of transportation emissions while the 87 million light duty trucks (i.e., vans, pickup trucks, and SUVs) contributed 27 percent. GHG emissions from these vehicles grew 19 percent between 1990 and 2003. The primary driver of the emission upsurge is the increase in VMT, which climbed by 34 percent over the same period, or more than twice the increase in population. VMT has increased rapidly for several reasons: population growth, higher vehicle ownership rates, less commuter use of public transit, decreases in vehicle occupancy, more trips per household, and longer trip lengths.

Historically, the Federal Corporate Average Fuel Economy (CAFE) requirement has driven changes in vehicle efficiency.[34] CAFE standards for passenger cars increased from 18.0 mpg in 1978 to 27.5 mpg in 1985 (still in place today). Light trucks (which include SUVs and minivans) have lower targets – 20.5 mpg in 1987 and 20.7 mpg today, although a March 2006 regulation will tighten and extend standards for light trucks.[35] Between 1975 and 1988, CAFE standards resulted in significant efficiency improvements as new passenger car mileage increased from 15.8 to 28.6 mpg and light truck mileage grew from 13.7 to 21.2 mpg.

In recent years, however, the differential CAFE standards for cars and light trucks, respectively, 27.5 mpg and 20.7 mpg – coupled with a shift to more purchases of light trucks, including SUVs -- have had a significant effect on overall mileage level of light duty vehicles. In 1976, only about one in five light duty vehicles sold was a light truck. In 2002, the number of light trucks sold exceeded new passenger cars sold. The fuel economy of new light duty vehicles peaked in 1987 at 22.1 mpg and decreased to 20.8 mpg in 2004.

In his January 2007 State of the Union address, President Bush proposed revisiting the light duty vehicle fuel economy standards, but stopped short of committing to actual improvements. To generate his target savings in gasoline use, he cited an example of a 4 percent annual improvement in CAFE standards. However, the President's proposal does not commit to a new fuel economy standard for cars. He asked Congress to give the Administration authority to revisit the automobile standard but not to specify an actual numerical target.

While recent years have seen significant improvements in engine technologies and vehicle design, such improvements have been used to increase the power, performance, and safety of new vehicles rather than to enhance fuel economy. In addition, although alternative vehicle technologies and fuels are being introduced in the U.S. and offer the potential to significantly reduce GHG emissions, the current market penetration of such alternatives is limited. Examples include:

- Hybrid vehicles couple an internal combustion engine with an electric motor. The electric motor provides peak power for acceleration and allows the internal combustion engine to be shut down rather than idling or decelerating. Currently, hybrids represent a very small, but growing, fraction of new vehicles sold.

- Ethanol is also being more widely used as a supplement to gasoline and more vehicles that can operate on either gasoline or ethanol are being marketed. In the U.S., ethanol competes in the fuel market as a gasoline additive at levels of up to 10 percent by volume. There is currently a federal tax incentive of roughly 51 cents per gallon of ethanol, which makes it competitive with gasoline, particularly with recent high gasoline prices.

Looking to the future,[36] VMT by light duty vehicles is expected to continue to grow quickly, at a rate of 1.9 percent per year between 2005 and 2030. At the same time, market penetration of unconventional vehicle technologies and fuels (primarily flex-fuel, electric hybrid, advanced diesel, and natural gas) is expected to climb to 27 percent of total light duty vehicle sales in 2030.[37] Driven by mandated improvements in the fuel economy of the increasingly popular light trucks and greater penetration of alternative technology vehicles, fuel economy of the fleet of light duty vehicles is likely to improve somewhat. The projected annual improvement in mileage of 0.6 percent is, however, insufficient to fully offset the VMT increase.

Heavy Duty Vehicles

In 2003, there were about 8 million heavy duty vehicles on the U.S. roads, accounting for about 19 percent of transportation GHG emissions. Emissions from these vehicles jumped by 57 percent between 1990 and 2003, more than any other major transportation source. Virtually all of these emissions come from freight trucks, with only 3 percent coming from buses.

Heavy duty truck VMT increased by 48 percent between 1990 and 2003. In addition to economic growth, VMT has been pushed up by a growing business preference for trucking over rail and water-borne shipping owing to its flexibility to accommodate shifts in warehouse and manufacturing locations, the decline in its cost relative to other modes after price deregulation in 1980, and increased shipment of higher value, lower weight products which are better suited to carriage by truck than by rail or water.

The average fuel economy of the heavy-duty truck fleet decreased to 5.7 mpg in 2003, as compared to 6.0 mpg in 1990. While the factors underlying this change are somewhat unclear, it appears that both average size and weight of heavy duty trucks has increased over this time period. The government does not set fuel economy standards for heavy duty trucks.

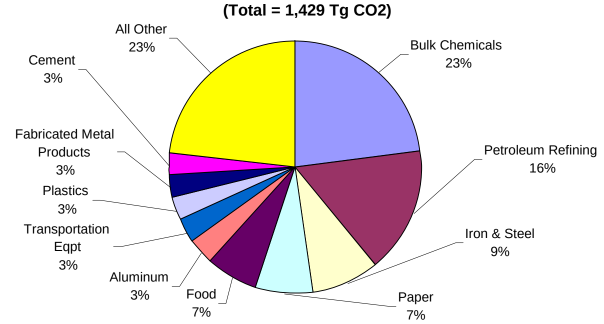
The use of biodiesel offers an opportunity to reduce the amount of non-renewable carbon emitted from the U.S. truck fleet. Biodiesel today is roughly where corn ethanol was in the U.S. a few decades ago. Production capacity in 2006 reached almost 400 million gallons.[38] The bulk of biodiesel sold in the U.S. is made from soybean oil, with some production using waste greases and fats. Tax incentives offered in the form of commodity credit payments by the Department of Agriculture to soybean producers and federal tax breaks have dramatically increased interest in biodiesel in the U.S. Like corn ethanol, biodiesel requires fossil energy to produce; however, soybean farming requires little nitrogen fertilizer and processing is not very energy-intensive. Biodiesel is currently more costly than conventional diesel.

Looking to the future,[39] VMT by freight trucks is expected to continue to grow quickly, at a rate of 2.2 percent per year between 2005 and 2030. Over the same time, however, fleet fuel economy is only expected to climb from 6.0 mpg in 2005 to 6.7 mpg in 2030, a rate of 0.4 percent per year and an improvement insufficient to fully offset the increase in VMT.

2.3 Structure & Drivers of Emissions from the Manufacturing Sector[40]

The manufacturing sector is a significant source of GHG emissions in the United States. When it comes to energy-related CO_2, for example, manufacturing emitted 1,429 Tg CO_2 in 2005, about 24 percent of total U.S. emissions of 5,945 Tg CO_2.[41] In addition, a large fraction of the 321 Tg CO_2 eq in 2004 industrial process emissions came from the manufacturing sector.[42] As shown in Figure 9, the three manufacturing industries with the highest energy-related carbon dioxide emissions are bulk chemical production, petroleum refining, and iron and steel manufacturing.[43]

Figure 9: 2005 Energy-Related CO2 Manufacturing Emissions (Total = 1,429 Tg CO2)



Manufacturing emissions, however, have not grown as fast as overall national emissions. For example, CO_2 emissions from all sources climbed by 20 percent between 1991 and 2005[44] while energy-related CO_2 emissions from manufacturing went up by only 14 percent in the same period (i.e., from 1,251 Tg CO_2[45] to 1,429 Tg CO_2).

What *are* the drivers of emissions in the U.S. manufacturing sector? The answer is not straightforward. Some drivers create upward pressure on emissions while others push emissions downward. In addition, countervailing forces produce different results across different manufacturing industries. Several of the key drivers are noted below.

As measured by the economic value of its products, the U.S. manufacturing sector grew more slowly than the U.S. economy as a whole over the past fifteen years. Between 1990 and

2005, the manufacturing portion of Gross Domestic Product (GDP) rose by 60 percent while total GDP rose by 115 percent, almost twice as much. As a consequence, manufacturing fell to only 12 percent of the 2005 American economy from its 1990 level of over 16 percent. [46]

Not only is the manufacturing sector becoming a smaller proportion of the total economy, the structure of the sector itself is changing.[47] Five manufacturing industries (computer products, petroleum and coal products, motor vehicles, miscellaneous manufacturing, and plastics and rubber products) have grown faster in real terms between 1990 and 2005 than the sector as a whole, but all other manufacturing industries, including nonmetallic mineral products (of which cement manufacturing is a part), chemical products, primary metals, and paper products grew more slowly than the sector as a whole. Four industries – wood products, printing, transportation other than vehicles, and apparel – actually shrank in real terms. As a consequence of these intra-sectoral shifts, the composition of the sector itself has changed appreciably during the 15 year period ending in 2005. Between 1990 and 2005, the petroleum and chemicals industries each increased its economic share of the manufacturing sector while the shares of primary metals and food remained virtually unchanged and the paper industry's share of the sector decreased.

The changing composition of the manufacturing sector has important implications when it comes to GHG emissions. Some manufacturing industries emit significantly more greenhouse gases per dollar of economic activity (i.e., have a higher "carbon-intensity") than do others. In 2002, for example, for every million dollars of gross output, the primary metals industry emitted 1,532 tons of carbon dioxide and the petroleum industry emitted 1,312 tons. On the other hand, the paper industry emitted 668 tons of CO_2 per million dollars of gross output and the "other manufacturing" category emitted just 131 tons.[49]

Figure 10
Energy Related CO_2 Emissions

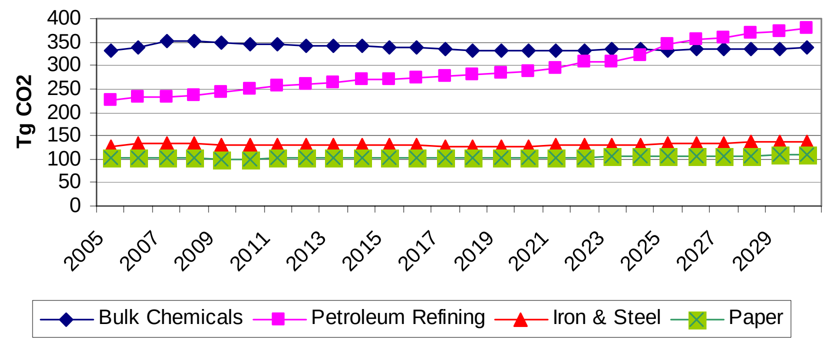


Table 1 Energy-Related Emissions in the Manufacturing Sector[48]			
Industry	**2005 CO_2 Emissions (Tg)**	**Share of 2005 Emissions**	**Annual Emissions Growth (2005-2030)**
Bulk Chemicals	330.7	23.1%	0.1%
Petroleum Refining	224.5	15.7%	2.1%
Iron and Steel	127.3	8.9%	0.3%
Paper	104.1	7.3%	0.2%
Food	95.5	6.7%	0.9%
Aluminum	45.6	3.2%	-0.9%
Transportation Equipment	44.0	3.1%	1.1%
Plastics	43.7	3.1%	0.6%
Fabricated Metal Products	41.8	2.9%	0.6%
Cement	39.9	2.8%	0.5%

Another important consideration is whether a particular manufacturing industry is becoming more or less carbon intensive over time. Here again there is considerable variation within the sector. The primary metals industry, for example, has become less carbon intensive over time, reducing its emissions from 1,688 tons of energy-related CO_2 per million dollars of gross output in 1991 to the aforementioned 1,532 tons in 2002 (an average annual decline of 0.9 percent). Over the same period, the carbon intensity of the chemicals industry increased by an average 0.6 percent per year (i.e., from 708 tons per million dollars of gross output in 1991 to 758 tons in 2002) while the carbon intensity of the petroleum industry remained unchanged.

Looking to the future, DOE's 2007 Annual Energy Outlook projected the combined effect of these drivers when it generated a 25 year forecast of CO_2 emission from major manufacturing industries. Table 1 presents the DOE forecast. The industry with the greatest emissions – bulk chemicals – is projected to experience emissions growth of only about 0.1 percent per year. Emissions from petroleum refining, on the other hand, are expected to grow dramatically, at a rate of 2.1 percent per year, while emissions from aluminum manufacture drop by 0.9 percent per year. Twenty-five year emission trends for the top four CO_2 emitting manufacturing industries are shown in Figure 10.

When it comes to process emissions of GHGs – emissions not related to energy but to the releases during the manufacturing process itself – historical changes in emissions within the manufacturing sector again demonstrate the diversity within the sector. For example, the two largest U.S. sources of industrial process emissions are iron and steel production, which emitted 52 Tg CO_2 eq in 2004 (*down* 39 percent from 1990) and cement manufacture which emitted 46 Tg CO_2 eq (*up* 37 percent from 1990).

In summary, several drivers are affecting GHG emissions from the U.S. manufacturing sector. The sector is becoming a smaller part of the U.S. economy over time and the composition of the sector itself is changing with some of the highest-emitting industries increasing their share of the sector's economic activity, some holding their share of the sector steady, and others decreasing their share. Improvements in energy efficiency have reduced the carbon intensity of some but not all manufacturing industries. Taken together, these drivers indicate that an industry like petroleum refining is projected to increase its energy-related CO_2 emissions by 68 percent in the next 25 years while emissions from bulk chemical manufacturing are expected to go up by only 2 percent over the same period. Similarly, process emissions have been reduced in some manufacturing industries, but have increased in others. In short, it is virtually impossible to generalize about the GHG emissions of the manufacturing sector as a whole. Each industry within the sector has unique characteristics related the drivers of both its economic performance and its emissions patterns.

2.4 Structure & Drivers of GHG Emissions from the Agriculture Sector[50]

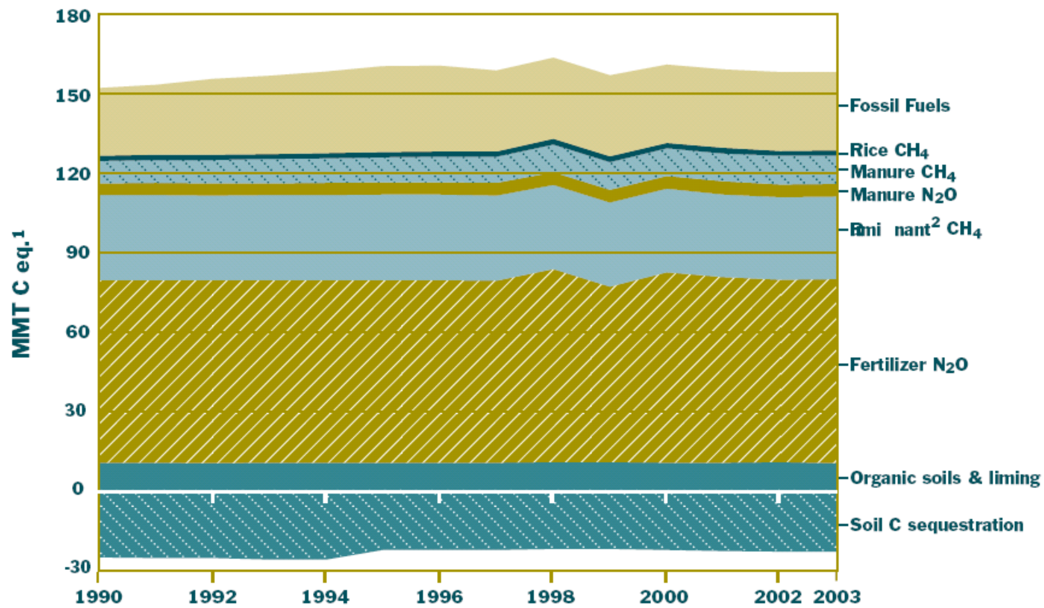
All three of the major greenhouse gases— carbon dioxide, methane, and nitrous oxide – are components of the earth's natural cycling of carbon and nitrogen. Agricultural lands, because of their large extent and intensive management,[51] have a significant impact on the earth's carbon and nitrogen cycles, and agricultural activities result in releases of all three of these greenhouse gases. While currently a substantial source of GHGs, agriculture has great potential to reduce the buildup of these gases in the atmosphere. Importantly, studies to date suggest that a significant portion of the agricultural practices that could reduce emissions or remove CO_2 from the atmosphere are relatively low-cost.

GHG emissions and sinks due to U.S. agriculture, as shown in Figure 11, are reported annually by EPA as part of the U.S. commitment to the United Nations Framework Convention on Climate Change. While these estimates of emissions and sinks are based on the best available scientific information, and are derived by using internationally accepted accounting procedures, there is considerable uncertainty in their magnitude.

Figure 11

Sources of U.S. Agricultural GHG Emissions

and Sinks (Shown as Negative Emissions) Since 1990



Sources: USEPA 2005, USDA 2003.

Note: fossil fuel use by agriculture is shown here, although it is reported as part of the energy sector of the U.S. national GHG inventory.

[1]C eq. stands for carbon equivalent. The carbon equivalents for CH_4 and N_2O are calculated by using GWPs and carbon equivalents (see Box 1).

[2]Animals that release methane as part of their normal digestive processes, e.g. cows and sheep.

Over the past decade, U.S. agricultural soils overall have acted as a small net sink of approximately 12 million metric tons (MMT) of carbon per year, mainly due to improved soil management practices and the establishment of conservation reserve lands (USEPA 2006). These practices are helping to sequester about 23 MMT of carbon per year in mineral soils, which make up greater than 99 percent of annual cropland area. However, net carbon emissions of about ten MMT of carbon per year from the small area (about 1.3 million hectares [Mha]) of cultivated organic (i.e., peat and muck) soils[52] offset 40 percent of the carbon gain in non-organic (mineral) soils. Emissions from agricultural liming contribute an additional one MMT of carbon per year, so that–taking into account both soil emissions and sinks–the result is a net sink of about 12 MMT of carbon per year.

CO_2 emissions from U.S. agricultural energy use amount to about 25 to 30 MMT of carbon per year. Nitrous oxide emissions (76 MMT carbon-equivalent per year in 2004) are the dominant agricultural contribution to the greenhouse effect when expressed on the basis of their global warming potential (GWP), a measure commonly used to equate the warming effects of different GHGs. The main sources of nitrous oxide are nitrogen fertilizers and manure applied to cropland and pastures, leguminous crops, and crop residues. Some nitrous oxide emissions also occur from stored manure. Annual U.S. agricultural methane emissions are approximately 44 MMT carbon-equivalent per year (2004 estimate) and stem mainly from livestock, animal waste, and rice cultivation. In aggregate, agricultural GHG emissions account for roughly 8 percent of total U.S. emissions from all sources (USEPA 2006), on a carbon-equivalent basis.

3. Scope for Deep Cuts in Sectoral Emissions

Globally addressing the issue of climate change requires the United States – as the world's largest emitter of GHGs – to make deep cuts in its emissions. According to the Intergovernmental Panel on Climate Change, global GHG emissions need to be cut by about 50 to 80 percent (relative to a Business as Usual, or BAU, scenario) to stabilize atmospheric concentrations and avoid dangerous climate change.[53] Immediate reductions of this magnitude would have enormous cost; instead, interim reductions must be made over a longer time period. One domestic target for interim reductions comes from California, which capped its GHG emissions at 1990 levels by 2020.[54] A second, international, target is the recent commitment by the European Union to reduce emissions by 20 percent from 1990 levels by 2020 and to increase that reduction to 30 percent if other industrialized nations agreed to similar reductions.[55] These targets are combined in Table 1 with actual 1990 U.S. emissions and forecast 2020 emissions under a BAU scenario to develop indicative interim U.S. reduction levels for 2020.

Table 2
Applying Emission Reduction Benchmarks to U.S. GHG Emissions in 2020 (Tg CO_2 eq)

Target (Reduction over 1990 by 2020)	Actual 1990 U.S. Emissions	BAU U.S. Emissions in 2020	Target for U.S. 2020 Emissions	Reduction from BAU to Target
EU (20%)	6,109	8,483	4,887	42%
EU (30%)	6,109	8,483	4,276	50%
California (0%)	6,109	8,483	6,109	28%

As Table 2 demonstrates, extending the California target nationally would require a reduction of 28 percent in 2020 from what GHG emissions would otherwise have been. Applying the European benchmarks would necessitate even greater reductions – between 42 and 50 percent. These interim reductions are significant and immediately raise questions about their feasibility. Accordingly, the scope for deep cuts in U.S. emissions is explored below on a sector by sector basis, using the same four sectors discussed in Section 2.

3.1 Scope for Deep Cuts in Emissions from Electric Power Generation

When it comes to limiting GHG emissions from electric power generation, there are three basic approaches, all of which will likely be required if the U.S. is to make deep cuts in its emissions. The first is a substantial increase in electric end-use efficiency, thereby reducing the amount of electricity that is generated (and the associated carbon that is emitted). The second is to reduce the carbon intensity of the fuel mix used to generate electricity, so that for any given amount of electricity produced, emissions are lower. Finally, because fossil fuels will almost certainly be used in the U.S. for decades to come to generate electricity, options for capturing and sequestering carbon before it is emitted need to further developed and deployed.

Demand Side: Opportunities from End-Use Efficiency

The prospects for deep cuts in the use of electricity exist primarily in the buildings sector – both residential and commercial – and in the industrial sector. Industrial energy efficiency is addressed in Section 3.2, so the discussion below focuses on the building sector and then reviews options related to combined heat and power, and distributed generation.

Buildings[56]

In any particular location, the electricity consumed by a building – residential or commercial – is a function of both its shell integrity, meaning its ability to keep unwanted heat transfers in or out of the building, and the electrical equipment used in the building. Buildings may be in use for up to 75 years and the equipment therein is typically in use for 10 to 30 years. Because retrofits to increase efficiency can be infeasible or costly, the most cost-effective means to improve efficiency is usually to initially build to high-efficiency specifications and to replace equipment and appliances at the end of their natural life with high-efficiency models. Greater reductions could be achieved if existing capital stock were replaced immediately, but premature retirement of plant and equipment can drive up costs significantly. Some efficiency upgrades, however, like use of high efficiency lighting, programmable thermostats, and weatherization, offer a quick payback and don't need to wait for building or equipment replacement.

The Energy Information Administration (EIA) estimates that if all future residential equipment purchases were of the most efficient models available in any given year (regardless of cost) and if, beginning in 2006, all homes were constructed to meet the highest efficiency criteria, then annual residential consumption of electricity would drop by 27 percent in 2020 compared to the BAU forecast, and by 30 percent in 2030.

When it comes to commercial buildings, EIA estimates that if all future commercial equipment purchases were of the most efficient models available in any given year (regardless of cost) and if building shell efficiency of new and existing commercial buildings increased by 10.5 percent and 7.5 percent, respectively, by 2030, then annual commercial consumption of electricity be 17 percent less in 2020 and 32 percent less in 2030 compared to business as usual.

A recent study sponsored by the Pew Center on Global Climate Change estimated that a series of policy and technical efficiency measures in the building sector (including both the residential and commercial sectors) could reduce CO_2 emission by 23 percent over forecast levels in 2025.[57] This estimate included reductions in use of electricity, gas, and oil while the two references above to EIA analyses are limited to electricity reductions. Both are instructive regarding the scope for emission reductions in the buildings sector.

A number of policy tools can be used to reduce energy consumption through efficiency.[58] Efficiency standards can be strengthened for appliances and other electronic equipment. The Department of Energy, for example, already administers regulatory efficiency standards for appliances such as refrigerators, dishwashers, and water heaters and the EPA/DOE Energy Star program has set voluntary standards for televisions, computers, and other equipment. There is also an Energy Star Homes program focused on efficiency in residential settings. Such programs can be broadened and made more stringent. In addition, building codes (typically enacted at the state or local level) can require that new buildings achieve a specific level of efficiency. The federal government can encourage states and localities to adopt revised codes by providing technical support and training to designers, builders, and code officials and by potentially withholding federal funds from states that fail to update their codes. Both DOE and EPA have substantial expertise – and existing programs – when it comes to energy efficiency in the residential, commercial, and industrial sectors that could be used to improve corporate, consumer, builder, and state/local government awareness of and implementation of energy efficiency measures. These DOE and EPA programs could be expanded substantially.

Combined Heat and Power / Distributed Generation

Other means of reducing the demand for centrally generated electricity include the use of combined heat and power (CHP) installations which use the waste heat from on-site (or local) electricity generation for industrial processes, heating, and cooling. Another is distributed generation (DG) which entails generation of electricity and heat at or close to the point of use. Examples include rooftop solar panels, solar water heating, small-scale wind generation, stationary fuel cells, and geothermal heat pumps. Low-carbon fuels like biomass and natural gas are also options for DG installations. Because of the prospects to combine CHP and DG for maximum benefit, such project should be developed in tandem whenever feasible. In many locations, regulatory barriers exist to the deployment of DG systems; streamlining and relaxing such regulations will stimulate additional DG installations.

Supply Side: Carbon Intensity of the Fuel Mix[59]

Coal provides the fuel source for about half of the electricity generated in the U.S. Because of its high carbon content, however, it is responsible for over 80 percent of the CO_2 emissions from power generation. Accordingly, changing the mix of fuels used to generate power to less carbon-intensive sources offers significant opportunities for emission reductions.

Natural Gas

Natural gas is already widely used in the U.S. to generate electricity. The carbon content of natural gas is less than half that of coal per unit of energy supplied, making gas – especially gas used to fuel highly efficient natural gas combined cycle turbines – an attractive option from a climate change perspective. Supply constraints and increased demand have, however, produced substantial gas price increases in recent years. If gas were to become less costly, either through increased domestic supply or higher imports, its use to generate power could grow significantly. Options for doing so include rate incentives, streamlined permitting of gas pipelines and facilities, expedited construction of an Alaskan natural gas pipeline, enhanced gas infrastructure in the lower 48 states, increased access to gas on public lands, and expanded production from non-conventional sources such as coal bed methane, deep water and wells, and landfill gas.

Nuclear Power

Nuclear power – which emits no carbon – is currently used to produce about 20 percent of the electricity used in the U.S. For nuclear power to materially reduce the overall carbon intensity of power generation, its use must be expanded significantly. [60] The 2005 Energy Policy Act provided some incentives for expansion of nuclear power, including tax credits and loan guarantees, and risk protection to encourage new plant construction. The production tax credit placed nuclear energy on equal footing with other sources of emission-free power, including wind and closed-loop biomass, with a tax credit of 1.8 cents per kilowatt-hour for 6000 MW of capacity from new nuclear power plants for their first eight years of operation. In addition, the bill extended the Price-Anderson Act, which limits liability and provides insurance, for 20 years.

Because no nuclear plants have been ordered in the U.S. since 1977, there is significant uncertainty about their cost. If such costs were 10 percent lower than assumed in the BAU scenario, EIA estimates that more than twice as much nuclear generating capacity would be added between 2005 and 2030.[61] Further research on the current cost of constructing nuclear plants is needed to more accurately characterize emission reduction possibilities.

Significant increases in nuclear power, however, require resolution of multiple cost, safety, and waste storage issues.[62] To address concerns about proliferation of nuclear materials, the Federal government needs to work internationally to strengthen the world wide nuclear non-proliferation regime; in addition, increased R&D on "once-through" nuclear fuel that is not re-processed after its first use may yield technological solutions to proliferation concerns. When it comes to spent fuel management and waste storage, the existing program could be expanded beyond its current focus on the Yucca Mountain site as the only option in the country for long-term waste storage.

Renewable Energy

As noted in Section 2.1, there is little scope for expanding the use of hydropower in the U.S. Three other sources of renewable energy – biomass, wind power, and solar photovoltaic power – do offer opportunities to reduce carbon emissions from electric power generation. Biomass is already being co-fired with coal in some conventional steam boilers, thereby producing modest reductions in CO_2 emissions. Biomass can also be used in plants designed to burn all biomass. In the long run, however, a recent study commissioned by the Pew Center on Global Climate Change concluded that "biomass use should be encouraged" but that "biomass is unlikely to play a dominant role in reducing GHG emissions from the electricity sector towards the middle of the century."[63] That said, co-firing with biomass can be implemented quickly and at low cost; accordingly, it can play a key role in coming years as a transition strategy while other low-carbon technologies are developed and deployed. In addition, because of the potential for DG to reduce electricity demand, biomass has an important role to play in U.S. emission reductions.

Wind power is cost competitive with fossil fired power generation, but it is intermittent due to variation in wind speeds. Accordingly, it needs to be linked with more consistent, and expensive, sources of back-up generation, thereby pushing its cost above that of conventional fossil fuel. In addition, there has been some public objection to the aesthetics of large scale wind power facilities.

Solar photovoltaic (PV) power also suffers from an intermittency problem because the sun does not shine all the time. Without a basic technology breakthrough, it will remain cost-ineffective for grid-connected applications. EIA expects, however, that over the next 25 years, there will be some growth in central-station solar power and that small-scale customer-sited PV applications will grow rapidly.[64]

Continued research and development, and incentives for deployment, are necessary to stimulate substitution of renewable resources for carbon-intensive fuels in the generation of electricity. One way of doing so is through the use of a national Renewable Portfolio Standard (RPS). About two dozen states already have instituted RPS's which require power generators to include a minimum fraction – typically between 10 and 20 percent – of renewable energy in their fuel mix.   A national RPS would further enhance efforts to promote renewable sources, although a national standard would need to recognize regional variations in the availability and feasibility of different renewable technologies, as well as existing state RPS programs.

Carbon Capture and Sequestration (CCS)

Irrespective of the success of energy efficiency programs and of efforts to reduce the carbon intensity of the fuel mix, fossil fuels will continue to provide a substantial source of electric power in the U.S. To the extent that the carbon from such fuels can be captured and sequestered over the long term, rather than emitted, deep cuts in GHG emissions may be feasible. Accordingly, there is considerable interest in technologies to capture and sequester carbon. These technologies are in their infancy and have yet to be deployed commercially in the U.S. (other than in test applications). CSS is therefore a long-term opportunity to reduce emissions.

The cost and efficiency of carbon capture technologies are likely to vary as a function of the underlying generation technology in use: conventional coal-fired, integrated gasification combined cycle (IGCC), or natural gas fired combined cycle (NGCC). A recent MIT study, "The Future of Coal," cautions that because carbon capture technologies have not been demonstrated with different generation technologies, and because there is significant research underway around the world, conclusions about the cost superiority of one approach over another are likely premature. That notwithstanding, the MIT study argues that federal research assistance to coal projects should be limited to those that employ carbon capture and sequestration techniques.[65]

Once the carbon has been captured during power generation, it must be transported and sequestered in a location where it cannot be released to the atmosphere. The Electric Power Research Institute notes that while the individual technologies likely to be used in the transport of captured carbon are proven, "integrating and deploying them on a massive scale will be a complex task."[66]

Current sequestration efforts are focused on injection into deep geological formations from which the carbon cannot escape. The feasibility of sequestration needs to be confirmed by large scale demonstration projects in a range of geologic settings; the federal government has initiated work in this arena but it could be better funded, more effectively managed, and expedited. In addition, to ensure the safety and effectiveness of sequestration, a regulatory program will be required to address site selection, design and operating requirements, monitoring, and public engagement.

The task of researching, developing, demonstrating, and deploying widespread carbon capture and sequestration is daunting. It will require leadership, substantial funding, and engagement by stakeholders. But its potential is profound. The MIT Coal Study concludes "CO_2 capture and sequestration is the critical enabling technology that would reduce CO_2 emissions significantly while also allowing coal to meet the world's pressing energy needs."[67]

One note of caution, however, is offered by a recent study that estimates that CCS will not be commercially available for at least 15 years.[68] In the interim, other steps to enhance efficiency and reduce the carbon content of the fuel mix will be critically important to making the transition and also provide an insurance policy in case CCS encounters unforeseen technical or other difficulties that delay or prevent its widespread deployment.

3.2 Scope for Deep Cuts in Emissions from the Transportation Sector[69]

While GHG emissions from the transportation sector are high and growing quickly, there are substantial opportunities to limit emissions in coming years. A recent study concluded that CO_2 emissions could be cut by 20 to 25 percent by 2015 and by 45 to 50 percent by 2030 relative to a future without additional efforts to control emissions. Given underlying growth in transportation demand, CO_2 emissions in 2030 would then be about the same as current levels. The primary technical means for achieving such reductions are increased efficiency and the use of alternative, lower-carbon, fuels and technologies. In turn, such technical options can be driven by several policy tools. Both technical and policy options are discussed below.

Increased Efficiency

By 2015, the fuel economy of light-duty vehicles can be increased by up to one-third with existing technology at a cost less than the value of the fuel saved. By 2030, it is likely that fuel economy can be increased to significantly higher levels (50 – 100 percent) at possibly greater costs, depending on technological progress. Opportunities for increased fuel economy include improving energy efficiency of the drive train (engine and transmission and by reducing the amount of energy necessary to move the vehicle by reducing weight, aerodynamic drag, and rolling resistance). A combination of technologies can increase engine efficiency by up to 25 percent. Opportunities exist to reduce vehicle weight with no loss of crash-worthiness or performance.

By combining both proven and near-term technologies (excluding weight reduction), a National Research Council study of fuel economy concluded that existing technologies could significantly reduce fuel consumption in 15 years, finding passenger fuel economy could be increased by 12 to 27 percent and light truck fuel economy by 25 to 42 percent (the ranges reflect the size of the cars and trucks from small to large). Looking further into the future, greater increases in fuel economy could be achieved by 2020.

Alternative Vehicle Technologies

Further improvements in hybrid design, compression-ignition diesels, and other technologies can stimulate advances. For example, in hybrid vehicles, batteries allow energy captured during regenerative braking to be stored for use to power the electric motor and accessories. Advanced hybrid designs coupled with continuously variable transmissions can improve fuel economy by 40 to 50 percent. When it comes to diesel engines, American motorists often associate them with poor driving performance, soot, noise and unpleasant odors; however they are more energy efficient compared to gasoline powered cars. Significant improvement in diesel engine and emissions control technology and fuels have improved performance and other environmental impacts.

Hydrogen-fueled and electric vehicles are also long-term options and can be powered by a variety of energy sources – including some fuels that do not contain any carbon and others that do. Depending on the type of fuel used to generate them, such vehicles can substantially reduce or increase GHG emissions over the full fuel life cycle.

Alternative Fuels

Alternative fuels such as liquefied petroleum gas (LPG), compressed natural gas (CNG), and biofuels can provide GHG benefits but face challenges. LPG vehicles can reduce GHG emissions by almost 20 percent, however, quantities produced and reserves are relatively small. A vast natural gas supply infrastructure is an advantage for CNG, although there are limited refueling stations and concerns about safety. Agriculture-based fuels, also known as biofuels, may offer promising opportunities to reduce emissions.[70]

As a near-term option, there is significant enthusiasm in the U.S. for corn-based ethanol as a vehicle fuel. The sources of feedstock (e.g., corn vs. switchgrass) and fuels used in ethanol production (e.g., coal vs. natural gas), however, have important implications for how climate-friendly it is. The net energy balance of ethanol has long been the subject of controversy, with some experts claiming that it takes more energy to make ethanol than the fuel actually contains or that it merely breaks even. While this was true early on, improvements in technology have turned ethanol into a net provider of energy, even from corn grain. Although efficiency of grain-based ethanol production has improved, fossil energy use is still high, and there is likely to be an upper limit on the amount of corn-grain ethanol that can be produced economically, currently estimated at 10 billion gallons per year (or less than 1% of current energy demand).

Looking to future, the energy balance from sources of ethanol other than corn (e.g., sugarcane or switchgrass) can be much better than that from corn ethanol. A number of estimates of the GHG implications of using ethanol in cars and light trucks are available. The degree of GHG savings closely tracks the savings in fossil fuel energy use. Replacing gasoline with ethanol made from corn grains reduces GHG emissions by 20 to 40 percent, compared with savings of around 100 percent from ethanol made from Brazilian sugarcane or lignocellulosic biomass such as corn stover or energy crops.

Responsible use of agricultural residues like corn stover or wheat straw for biofuel production could supply 2 to 6 percent of current total US energy demand or 7 to 24 percent of total U.S. petroleum energy demand in the on-road transportation sector. Production of energy crops such as switchgrass could displace an additional 3 percent of current energy supply while using roughly 10 percent of total US agricultural area. Improvements in genetics could boost this up to 12 percent of supply using 15 percent of available land.

Research and development in the biofuels arena is moving quickly. One example is a partnership between DuPont and BP to develop, produce, and market a next generation of biofuels. The two companies have been working together since 2003 to develop products that will overcome the limitations of existing biofuels. The first product to market will be biobutanol, which is targeted for introduction in 2007 in the U.K. as a gasoline bio-component. This biofuel offers better fuel economy than gasoline-ethanol blends and has a higher tolerance to water contamination than ethanol.[71]

For all alternative fuels, a "wells to wheels" life cycle analysis is important in considering the relative climate benefits from any shift from gasoline to an alternative fuels. While an alternative fuel may reduce GHG emissions from the vehicle itself compared to use of gasoline, GHG emissions associated with the development, production, and distribution of the alternative fuel may be higher than those of gasoline, resulting in a net increase in total GHG emissions. When it comes to coal-to-liquids (CTL) technologies, for example, unless CO_2 emissions are fully captured during creation of the fuel, CTL will increase GHG emissions because more emissions will be generated in producing fuel, and the same in driving the vehicle.

Policy Options in the Transportation Sector

Policies are critical to stimulating improvement in all sources of transportation emissions. Improved fuel efficiency standards for vehicles (e.g., CAFE standards) or GHG emissions standards could drive significant reductions in emissions. Alternative fuels often require government involvement in providing consistent subsidies in the face of shifting petroleum prices, policy direction and building relevant infrastructure. A price signal on gasoline from taxes or carbon caps will make low-carbon fuels more competitive and encourage choices of more efficient vehicles over time. Land-use planning, congestion charges, and investment in public transportation – accompanied by public education are also critical to shaping behaviors.

In combination, such policies can make an important difference in overall emissions. As noted at the outset of this section, emission reductions in the range of 20 to 25 percent are feasible by 2015. In 2030, reductions could approach 50 percent.

3.3 Scope for Deep Cuts in Emissions from the Manufacturing Sector

The manufacturing sector is a major contributor to U.S. greenhouse gas emissions. Many industries within the sector are energy-intensive and create emissions directly thorough their own fossil fuel combustion or indirectly through the purchase of electricity from generators that emit GHGs. In addition, the production technologies and practices employed by some industries create emissions directly from the production process itself. As demonstrated by Table 3, the four manufacturing industries that emit more than 100 Tg of energy-related CO_2 per year collectively emit about 57 percent of all manufacturing emissions. As such, these industries deserve special attention when it comes to assessing the prospects for deep cuts in manufacturing emissions.

Table 3
Manufacturing Industries with More than 100 Tg Energy Related CO_2 Emissions per Year[72]

Industry	2005 CO_2 Emissions (Tg)	Share of All Manufacturing Emissions	Annual Emissions Growth (2005-2030)
Bulk Chemicals	330.7	24.0%	0.1%
Petroleum Refining	224.5	16.3%	2.1%
Iron and Steel	127.3	9.2%	0.3%
Paper	104.1	7.5%	0.2%

Over the past two years, the Department of Energy's Office of Energy Efficiency and Renewable Energy has commissioned a series of studies on the "bandwidth," or opportunity, for energy savings potential in each of several U.S. industries. Typically, these studies begin by estimating – for a particular industry and the processes it uses – the current actual energy used at the average U.S. plant. Next, the best practice energy use that would result if state of the art, commercially available technologies were used in all U.S. plants is determined. Another way to think about the best practice energy use scenario is that it implies all U.S. plants operate at a "best in the world" level when it comes to energy use. Finally, the bandwidth studies determine the practical minimum energy needed to carry out a particular manufacturing process using technologies and practices that still require additional research and development (i.e., are under development or that have been developed but are not yet commercially viable).

Table 4 presents the results of these bandwidth studies for the four U.S. manufacturing industries with the highest levels of energy-related CO_2 emissions. Energy savings associated with bringing all U.S. plants to a "best in the world" level range from 18 to 26 percent depending on the industry.[78] When it comes to achieving the practical minimum energy use, three of the four industries could save about 39 percent of current energy used while the fourth – bulk chemicals – could achieve savings of 71 percent. By definition, such savings require continued investment in research and development, and success in deploying as-yet-unproven technologies in the field. Nonetheless, these results are indicative of the scope for deep cuts in energy use and reductions in GHG emissions from the U.S. manufacturing sector.

Table 4
Bandwidth for Energy Savings by Industry

Industry	Current Actual Energy Use[73]	Best Practice Energy Use	Practical Minimum Energy Use
Bulk Chemicals[74]	1,700 TBtu/yr	1,400 TBtu/yr (-18%)	500 TBtu/yr (-71%)
Petroleum Refining[75]	2,101 TBtu/yr	Not estimated	1,306 TBtu/yr (-38%)
Iron and Steel[76]	12.6 MBtu/ton	10.2 MBtu/ton (-19%)	7.7 MBtu/ton (-39%)
Paper[77]	2,361 TBtu/yr	1,749 TBtu/yr (-26%)	1,447 TBtu/yr (-39%)

It is also important to note, however, that DOE's bandwidth studies generally do not quantify the economic impact or return on investment of these energy saving approaches. While energy saving measures do reduce a firm's energy costs, most require an upfront investment. In addition, most manufacturing processes are capital intensive and rely on long-lived plant and equipment. While smaller changes can be made relatively quickly and may yield compensating savings, significant process changes often have to wait until the facilities require major overhaul or are expanded to increase capacity. For competitive reasons – both domestic and international – firms are often reluctant to go it alone in making investments that other firms are not compelled to also make, unless there is a relatively quick payback.

Another avenue for energy-related emissions savings comes from the sector's purchases of electricity from commercial generators. As shown in Table 5, such purchases can represent a significant fraction of an industry's energy use and indirect greenhouse gas emissions. Because they are buyers, rather than producers, manufacturers typically have little control over the fuel mix or carbon content of the electricity they purchase. As such, the prospects for deep cuts in GHG emissions from the manufacturing sector are indirectly linked to prospects for cuts in emissions from electricity generation (for example, as discussed in Section 3.1.2, through fuel switching or use of carbon capture and sequestration).

Table 5
Relative Contribution of Purchased Electricity to Energy Consumption[79]

Industry	2005 Energy Consumed (TBtu)	Purchased Electricity (TBtu)	Energy from Purchased Electricity
Bulk Chemicals	2,516.6	463.6	18.4%
Petroleum Refining	3,717.8	132.1	3.6%
Iron and Steel	1,365.0	190.8	14.0%
Paper	2,265.4	224.7	9.9%

Another opportunity for significant cuts in manufacturing emissions is in the cement industry which is both very energy-intensive and one of the country's biggest sources of process emissions. The industry's annual process emissions are 46 Tg CO_2[80] and its energy use accounts for another 40 Tg CO_2[81] per year. The process of creating cement from raw materials entails the calcination of limestone to form clinker (the primary ingredient in cement.) The calcination process releases CO_2 from the limestone as $CaCO_3$ is converted to CaO. Because there appear to be no feasible options for reducing process emissions per unit of clinker produced, prospects for emission reduction rest on approaches that reduce the amount of clinker in finished cement. Pozzolanic additives such as fly ash, blast furnace slag, silica fume, and volcanic ash, can reduce the proportion of clinker in cement.[82] The U.S., however, lags behind many foreign countries in the use of such additives.[83] Ground limestone can also be combined with clinker to produce cement.[84] A recent revision of a major industry standard (ASTM-C 150) allows up to 5 percent ground limestone to be added to cement, but the practice has yet to widely penetrate the industry because another U.S. standard setting organization – one responsible for cement specifications for public transportation projects – has yet to adopt the ASTM standard.[85]

When it comes to energy-related emissions from cement manufacture, the LBNL study cited above is noteworthy.[86] The study reviewed over 40 energy efficient technologies and measures across all phases of the cement manufacturing process including raw materials preparation, clinker making, and finish grinding. The LBNL study concluded that "there is ample room for energy efficiency improvement. … Substantial potential for energy efficiency improvement exists in the cement industry, and in individual plants." The study did, however, caution that such improvements may only be achievable in conjunction with natural turnover of capital plant and equipment, or during plant expansions.

3.4 Scope for Deep Cuts in Emissions from the Agriculture Sector[87]

Nitrous oxide and methane emissions result from both crop and livestock operations and account for approximately 80 percent of U.S. agricultural greenhouse gas emissions on a GWP basis. Despite challenges, there is considerable scope for reducing these emissions. Nitrous oxide constitutes the largest agricultural source of GHG emissions in terms of warming potential (48 percent), and almost 70 percent of total U.S. nitrous oxide emissions are from soils. The best option for reducing these emissions is to use fertilizers more efficiently; adoption of best fertilization practices could reduce agricultural N_2O emissions by 30 to 40 percent.[88] Livestock are the main source of agricultural CH_4 emissions. Increasing the efficiency of production per animal can decrease these emissions and also reduce costs. Manure management accounts for 25 percent of U.S. agricultural CH_4 emissions; anaerobic (i.e., oxygen-free) digesters that capture and use the methane as an energy source—thereby displacing fossil fuels – offer a good solution to these emissions. Adoption of best practices could reduce total U.S. agricultural methane emissions by 20 to 40 percent.[89]

In addition to options to reduce agricultural emissions, it is technically feasible that 70 to 220 million metric tons (MMT) of carbon could be added to U.S. agricultural soils annually over two to three decades. This would remove 260 to 810 MMT of carbon dioxide from the atmosphere annually, offsetting 4 to 11 percent of current U.S. GHG emissions. Economic potential to store carbon varies substantially by region, and current studies suggest that at prices of \$50 per metric ton of carbon (\$13 per metric ton of CO_2), soil carbon increases would be limited to 70 MMT per year.

If an aggressive research and development (R&D) program succeeds in substantially improving per-acre yields of energy crops and reducing costs of conversion technologies, biomass from agricultural sources could supply up to 19 percent of total current U.S. energy consumption. This would yield GHG savings on the order of 180 to 470 MMT of carbon, which is equivalent to reducing CO_2 emissions by 670 to 1,710 MMT CO_2 per year (by substituting for fossil fuels) or 9 to 24 percent of total U.S. year-2004 GHG emissions.

Overall, studies so far indicate that agriculture is likely to be a competitive supplier of emission reductions if and when farmers are offered suitable payments. Among agricultural mitigation options, soil carbon sequestration will likely be most significant for lower carbon prices (less than \$50 per metric ton of carbon or \$13 per metric ton of CO_2). At higher prices, afforestation and biofuel options become increasingly more competitive.

4. State and Regional Initiatives[90]

The past six years have provided a window of opportunity for state leadership on climate policy. With federal policy stalled, increasing scientific certainty that humans are contributing to a changing climate, and a steady groundswell of public opinion favoring action, many US states have found a supportive constituency and clear justification for action on climate change. Many policymakers have seized on this opportunity to take action on climate change using a variety of methods, from directly reducing greenhouse gas emissions from electricity generation and transportation, to indirectly reducing GHG emissions by setting energy efficiency standards, to providing incentives for deploying climate-friendly technologies.

Such experimentation has followed the traditional federalist path of environmental policymaking in the United States. States have often been “laboratories” of possible federal action -- creating policies that may lead by example and inform through experimentation. Simultaneously, by creating a “patchwork” of regulatory regimes for companies operating in multiple states, the leadership of states often catalyzes calls for more uniform federal action.

Across the country, legislators and governors have undertaken strategies to reduce their states’ greenhouse gas emissions. California has the most comprehensive and aggressive state effort, and some other states are not far behind in addressing emissions from across the economy. Emerging regional climate initiatives allow states to pool their resources, achieve greater emission reductions, and provide the federal government with blueprints for action. The highest concentrations of activity occur in Western and Northeastern states that are traditional environmental leaders, but some “unusual suspects” are also tackling climate change individually and through regional agreements.

California

California’s recent climate initiatives demonstrate the state’s continued leadership in environmental policy. Over the past four years, California pioneered vehicle greenhouse gas emission standards (AB 1493), enforceable economy-wide GHG emission limits (AB 32), and GHG performance standards for long-term electricity contracts (SB 1368) and transportation fuels. California's vehicle standard requires a 30% reduction in GHG emissions from new vehicles by 2016; more than a dozen states will adopt the standard if it survives legal challenge by auto manufacturers. With the passage of AB 32, the Global Warming Solutions Act of 2006, California set an enforceable target of achieving 1990 levels of greenhouse gas emissions by 2020. The legislation gives the California Air Resources Board responsibility for adopting the necessary measures to achieve the target and allows the use of market mechanisms such as cap and trade. An executive order by Governor Arnold Schwarzenegger established a committee to advise California on greenhouse gas market design.

California's GHG emissions performance standard for electricity, SB 1368, has received less public attention than the Global Warming Solutions Act, but it has important implications for power generation in the West. The law directs the California Energy Commission to set a greenhouse gas performance standard for electricity procured under any new long-term contract by local publicly-owned utilities by June 30th, 2007, whether the power is generated within state borders or imported from plants in other states. The standard will drive low-carbon electric generation, including research and investment in coal power plants that capture and store carbon dioxide, as generators in states that export electricity to California seek to comply.

In addition, Governor Schwarzenegger pledged in January that he would apply the world's first Low Carbon Fuel Standard to transportation fuels sold in California, with the goal of reducing the carbon intensity of California's passenger vehicle fuels at least 10 percent by 2020. The standard applies to the so-called "well-to-wheel" lifecycle emissions of fuel, providing both an incentive for GHG emission reductions in petroleum processing as well as for an increase in the use of biofuels and electricity as transportation energy sources. This approach to reducing fuel carbon content represents an innovative step beyond previous transportation initiatives focusing on fuel efficiency.

Regional Initiatives

Climate policy provides a welcome forum for interstate cooperation because the geographic location of an emissions reduction is immaterial, and states can combine purchasing power, analytic capacity, and reduction opportunities to their mutual benefit. Greenhouse gases mix rapidly in the atmosphere, so a ton of CO_2 from Sacramento has the same effect on the global climate as a ton from Albany. For cap-and-trade programs, more participants lower the cost of achieving a given level of emission reduction by providing additional opportunities for reductions. Increasing the number of participants also reduces the possibility of emissions increasing in states or sectors not included in the cap. For instance, this process of "leakage" could occur if a cap results in a shift of electricity generation to uncapped states, thus negating some of the program's actual emission reductions.

The Regional Greenhouse Gas Initiative (RGGI) is establishing the first mandatory U.S. cap-and-trade program for carbon dioxide, which currently includes ten Northeastern and Mid-Atlantic States. The governors of Connecticut, Delaware, Maine, New Hampshire, New Jersey, New York, and Vermont established RGGI in December 2005. Massachusetts and Maryland joined in January and April 2007 respectively and Rhode Island has announced it will join. Additional states can join the program with the agreement of the participating states. RGGI sets a cap on carbon dioxide emissions from power plants and allows sources to trade emission allowances. The program will cap emissions at current levels in 2009 and then reduce emissions 10% by 2019. Each state that intends to participate in RGGI must adopt a model rule through legislation or regulation and determine how to distribute emissions allowances. Indeed, each member state has agreed to set aside 25% of its emission allowances for public benefit. One of the major developments in RGGI has been proposals by New York, Massachusetts, Maine and Vermont to auction 100% of their emission allowances rather than directly allocating allowances to covered entities. Federal policymakers may look to states' allocation decisions to inform their own allocation choices. The RGGI states are also considering options for addressing emissions leakage (that is, energy coming from neighboring uncapped states) but have not yet settled on an approach.

On February 26, 2007, Governors Janet Napolitano of Arizona, Arnold Schwarzenegger of California, Bill Richardson of New Mexico, Ted Kulongoski of Oregon, and Christine Gregoire of Washington signed an agreement establishing the Western Regional Climate Action Initiative, a joint effort to reduce greenhouse gas emissions and address climate change. Under the agreement, the five states will jointly set a regional emissions target within six months, and will establish a market-based system by August 2008 to meet the target, such as a cap-and-trade program covering multiple economic sectors. This ambitious schedule will coincide with the implementation of AB 32 in California, and the coordination of these efforts could present challenges for the states.

State Action: Usual and Unusual Suspects

State action on climate change has moved beyond the usual coastal suspects of California and New England. Recent executive orders by the Governors of New Jersey, Illinois, and Washington bring the number of states with emission targets to fourteen. Over a dozen states have active legislative commissions or Governor advisory councils charged with developing a climate strategy, including Alaska, Montana, and North and South Carolina. In the most recent examples of states adopting and strengthening their renewable requirements, Minnesota and New Mexico have both passed expanded Renewable Portfolio Standards. Twenty-three states and the District of Columbia have set these standards specifying that electric utilities generate a certain amount of electricity from renewable sources. States (and many municipalities) are moving on other fronts in the absence of federal action, creating appliance efficiency standards, encouraging renewable fuel sources, and improving the carbon footprint of state fleets and government buildings.

States have already built a sizable knowledge base that will be vital to federal policymakers negotiating the passage of climate bills. For example, RGGI has considered many of the cap and trade design decisions relevant to federal policy, such as the inclusion of emission offsets, allocation of emission allowances, and cost containment mechanisms.

State experiments with policy approaches to climate change have done much to show that strong leadership on climate policy can be politically attractive and technically feasible. Some state approaches may even provide building blocks for a federal program: a federal greenhouse gas cap-and-trade system, renewable portfolio standard, and GHG emission registry could build directly on existing state models with only slight modifications. Innovative state actions to address climate change will provide both early lessons and a strong impetus for federal policy.

5. Corporate Initiatives

Major U.S. businesses increasingly believe that climate change regulations are inevitable and are responding by engaging in the policy arena. Some of the most progressive companies are openly calling for national greenhouse gas emissions limits, while other businesses and trade associations have been transitioning away from their historical stances against mandatory climate policies to a more neutral position. The shifting winds in the business community are both a reaction to and a driver of increased congressional action on climate change. On one hand, the priority given to the issue by the new Democratic leadership in the 110th Congress has convinced the corporate world that it needs to get involved in the debate or risk being left behind as crucial policy decisions get hashed out. On the other hand, support from the business community is necessary to provide enough votes in Congress to enact mandatory national climate change legislation.

The U.S. Climate Action Partnership

One visible example of corporate engagement in US policymaking came with the January 2007 announcement of a U.S. Climate Action Partnership (or "US CAP"). US CAP is an unprecedented alliance of ten major companies (Alcoa, BP America, Caterpillar, Duke Energy, DuPont, FPL Group, GE, Lehman Brothers, PG&E and PNM Resources) and four leading NGOs (Environmental Defense, Natural Resources Defense Council, the Pew Center and the World Resources Institute). US CAP is a nonpartisan effort, driven by the top executives from member organizations—companies with a combined market capitalization of more than $750 billion and environmental and climate groups with global policy influence and more than one million members worldwide. This unique collaboration involving business and NGO leaders sends a clear message to lawmakers that America needs national policies to address climate change now.

The group's work is the result of an intense, year-long collaboration. The report, titled A Call for Action, was released in January 2007. The coalition was founded with the shared goal of slowing, stopping and reversing the growth of greenhouse gas emissions over the shortest period of time reasonably achievable, and the rapid enactment of federal climate legislation. Its recommendations are stronger and more specific than any business group has ever been on climate policy in the U.S. Together, the US CAP members announced their shared support of not only principles but also specific policy recommendations aimed at preserving the option of 450 - 550 ppm CO_2 levels globally.

US CAP's recommendations are based on six guiding principles. These principles state that sensible climate legislation must do the following:

- Account for the global dimensions of climate change;
- Recognize the importance of technology;

- Be environmentally effective;
- Create economic opportunity and advantage;
- Be fair to sectors disproportionately impacted; and
- Recognize and encourage early action.

US CAP urges policy makers to enact a policy framework for mandatory reductions of GHG emissions from major emitting sectors, including large stationary sources and transportation, and energy use in commercial and residential buildings. The cornerstone of this economy-wide approach would be a cap-and-trade program that ensures emission reduction targets will be met while simultaneously generating a price signal for greenhouse gases. This price signal will stimulate investment and innovation in the technologies necessary to achieve our environmental goal, which is to stabilize atmospheric GHG concentrations at between 450-550 parts per million—a level that minimizes large-scale adverse impacts to humans and the natural environment.

Achieving this goal will require a fundamental transformation of the energy system over the long-term, yet it cannot be predicted with accuracy all the technological developments between now and 2100. Legislation should focus on what we know can be cost-effectively achieved over the next 20-30 years while putting us on a trajectory for deeper emissions reductions by mid-century. Accordingly, A Call for Action recommends Congress establish the following specific short- and mid-term emission reduction targets:

- Between 100–105 percent of today's levels within five years of rapid enactment
- Between 90–100 percent of today's levels within ten years of rapid enactment
- Between 70–90 percent of today's levels within fifteen years of rapid enactment
- Congress should specify an emission target zone aimed at reducing emissions by 60 to 80 percent from current levels by 2050.

Additional Corporate Actions

Following the widely publicized US CAP announcement, other firms and trade associations began to take more constructive positions on policy issues. For example, the President of Public Service Enterprise Group (PSEG), parent company of New Jersey's biggest utility, testified before a House Energy and Commerce Subcommittee that greenhouse gas reductions should be mandatory and should be achieved by a system of caps and pollution trading. In addition, the Alliance of Automobile Manufacturers, which represents General Motors, Ford Motor Company, and others and has historically resisted carbon caps, released a statement that there "needs to a be a national, federal, economy-wide approach to addressing greenhouse gases."[91] In addition, in February 2007, the Electric Power Supply Association (trade association for competitive suppliers of electricity) announced their support for "comprehensive, mandatory federal legislation to require steps to minimize the impact of greenhouse gases on the environment."[92]

Movement can also be seen on the financial front, as mainstream investors such as Goldman Sachs, Bank of America, JPMorgan Chase, and Citigroup are adopting guidelines for lending and asset management aimed at promoting clean-energy and climate-friendly technologies. For example, Goldman Sachs has pledged to make available up to $1 billion to invest in renewable energy and energy efficiency projects, as well as exploring investment opportunities in cleaner burning alternative fuels such as renewable diesel, ethanol, and biomass. In March 2007, Bank of America announced a $20 billion initiative to help foster green business practices. The bank says it will set aside funds to lend to companies offering environmentally superior services and products, and offer lower mortgage rates on energy-efficient homes.

The recently proposed $45 billion buyout of TXU, a major Texas electric utility company, by two private equity groups and related decision to scale back proposed coal-fired power plant construction provides compelling evidence that the financial world is taking the risks from climate change seriously. As part of the proposed deal, which has been endorsed by the Natural Resources Defense Council and Environmental Defense, the private equity firms have agreed to significantly reduce the number of proposed new coal-fired power plants, to support federal climate protection legislation, to invest hundreds of millions of dollars in demand-side management initiatives, and to work to reduce greenhouse gas emissions to 1990 levels by 2020. The deal reflects the growing certainty within the business and financial community that carbon emissions will eventually be regulated. The TXU deal is just one example of a business that is positioning itself to prosper in an environment where carbon emissions have a price tag attached to them.

6. Prospects for U.S. Policy

As evidenced by the preceding section, pressure is mounting for a comprehensive, mandatory federal response to climate change in the U.S. One of the leading contenders for a U.S. policy approach is cap and trade. An emerging policy is likely to be informed by previous efforts to control traditional air pollutants (such as sulfur dioxide (SO_2) in controlling acid rain), as well as international (the European Union's Emissions Trading Scheme) and emerging regional market-based efforts (RGGI, California, Chicago Climate Exchange) to address climate change. The experience with these will likely inform the design of a cap-and-trade program should that be the favored approach.

The U.S. launched the first national emissions trading program under the Clean Air Act Amendments of 1990 to curb sulfur dioxide emissions that cause acid rain. This program is credited with achieving substantial environmental benefits at less than half the costs of traditional command and control regulation.[93] The U.S.'s SO_2 trading program has served as a model for GHG trading proposals.

The European Union (EU) now boasts the largest emissions market for carbon under its Emissions Trading Scheme (EU-ETS). Approximately 11,500 installations in 25 EU Member States were covered under the first phase of the program – amounting to roughly one half of the EU's carbon dioxide emissions. Combined with other policy efforts, the EU-ETS is providing a mechanism to assist the EU in meeting its Kyoto Protocol target.

In North America, a voluntary pilot market was created through the Chicago Climate Exchange (CCX). CCX provides a GHG trading system for entities willing to sign up for contractually binding reductions. Emissions reductions targets are modest, and prices have tended to be low (in the $2 - $4 range), but it is providing important experience to firms anticipating a domestic market. State and regional trading programs (discussed in Section 4) are also building support for a national trading-based program although important questions about harmonizing programs and linkage must be resolved.

These programs and others will provide foundation and insight for federal policy proposals. These proposals are discussed more fully in the sections that follow an exploration of current U.S. policy.

Existing Federal Initiatives

In 2002, President Bush announced his program of voluntary intensity-based targets, revisiting voluntary reporting protocols and R&D. His intensity target provided for growth in emissions through 2012 (beyond his term in office), as discussed in Section 1.2. The inadequacy of the Bush program for achieving real reductions was apparent from the outset and pressure has been mounting for further action. Voices ranging from the business community,[94] to evangelical Christians,[95] to military leaders,[96] are calling for absolute cuts in emissions. Coupled with state action, growing public concern, the recent takeover of Congress by the Democratic Party, and mounting scientific evidence, this support is stirring record movement on Capitol Hill.

The first vote on a federal cap and trade program for greenhouse gas emissions took place in October 2003, on the Climate Stewardship Act sponsored by Senators John McCain (Republican of Arizona) and Joseph Lieberman (then Democrat of Connecticut). The bill was less aggressive than the Kyoto Protocol limits in that it called for a return of greenhouse has emissions to 2000 levels by 2010 rather than cutting emissions to 7 percent below 1990 levels by 2012. Despite the bill's moderation, many environmental groups endorsed it and the bill won the support of 43 Senators.

The Climate Stewardship Act was reintroduced in February 2005 with a new technology title that included support for low-GHG technologies, including subsidies for advanced nuclear power plants. Four Senators supporting the previous version of the bill opposed this new version due to its support for nuclear power, and it lost in a vote of 38 – 60. However, in the same Congress, Senator Bingaman offered a resolution (S Res. 866) expressing the sense of the Senate that Congress should enact a comprehensive and effective national program of mandatory, market-based limits and incentives that slow, stop, and reverse the growth of GHG emissions. The Resolution said this goal should be achieved in a manner that will not significantly harm the US economy and will encourage comparable actions by other nations that are major trading partners and key contributors to emissions. The Senate Resolution passed with a vote of 54-43, putting the Senate on record in support of mandatory climate change mitigation for the first time.

Measures under Consideration

A new version of the Lieberman-McCain bill as well as several alternatives addressing climate change have been introduced in recent months. Most are designed as economy-wide cap-and-trade programs. The new Climate Stewardship and Innovation Act (S. 280) provides for phased emissions reductions over a longer period of time, increases the offsets available, and retains the technology titles. One bill (S. 317) introduced by Senators Feinstein and Carper is focused on setting up a cap-and-trade program for the utility sector. Only one (Senator Bingaman's discussion draft) allows for continued emissions growth through an intensity-based target and a "safety valve" (or price cap). A low safety valve may compromise the environmental target and hinder linkage to other global trading programs.

The Global Warming Pollution Reduction Act (S. 309) introduced by Senators Sanders and Boxer is based on California targets and timetables (reducing greenhouse gas emissions to 1990 levels by 2020). Many of the bills provide flexibility in trading across time periods, sectors, and greenhouse gases, and some provide for offsets (including international offsets). Key variables, such as how permits under the cap are distributed (auction vs. free allocation); whether the allocations are based on historic emissions or input-based; and whether and to what extent offsets are included, are handled differently across proposals, with some refraining from making these political decisions for now.

While there is growing support for a GHG cap-and-trade program (see Table 6 for pending legislative proposals as of April 2007), it is possible that other regulatory tools will be considered. Recently, there have been discussions of a possible carbon tax. Taxes provide a market signal and may be suitable for some applications – including for parts of the economy that do not lend themselves to cap and trade. Revenues from taxes could theoretically be recycled, given to consumers to offset energy prices, or invested in technology. Limitations of this approach include a lack of the environmental certainty afforded by quantity-based emissions caps, lack of market opportunities that cap-and-trade provides firms that can sell allowances, and the inability to link with a global system. Taxes are also generally politically unpopular in the U.S. and it is also unclear how taxes will be shifted to provide the theoretical relief from existing obligations as new revenues are generated from this mechanism.

Other complementary policies are being considered. There is also an important role for efficiency and performance standards in some sectors: for example, for automobiles and appliances. Indeed, a comprehensive policy approach that includes both mandates and support for innovative technology is needed to achieve absolute reductions in emissions.

Between January and April 2007, there have been approximately 50 climate-related hearings in the U.S. Congress. As shown in Table 6, several bills have been submitted, and more are expected.

Political Constraints: Cost and Competitiveness Concerns

Historically, U.S. concerns about moving forward with a domestic program have focused on economic impacts and competitiveness (particularly the lack of emissions reductions requirements placed on developing countries such as China and India).

While the U.S. ratified the UNFCCC under the first President Bush in 1992 with the goal of returning emissions to 1990 levels, U.S. emissions have continued to grow steadily (now 16% above 1990 levels). In 2001, the second President Bush abandoned the Kyoto Protocol negotiations and his campaign pledge to reduce emissions of carbon dioxide from utilities, citing the California energy crisis, lack of developing country targets, and potential for adverse economic impacts. U.S. disengagement from the international efforts spurred action by other countries and helped catalyze the Protocol's eventual entry into force without the United States.

The Kyoto Protocol was never offered up for a Senate confirmation vote by either the Clinton or Bush Administrations. In large measure, this reflects the fact that prior to negotiation of the Kyoto Protocol, the Byrd/Hagel resolution unanimously passed the U.S. Senate. This resolution (S. Res. 98) expressed the sense of the Senate that the U.S. should not be a signatory to any protocol or other agreement which would limit developed countries' GHG emissions unless the treaty also "mandate[d] new specific scheduled commitments to limit or reduce GHG emissions for developing country parties within the same compliance period." In addition, it stipulated that any agreement or mandate should not result in serious harm to the economy of the United States. In the face of overwhelming support for the resolution, the Clinton Administration chose to avoid an embarrassing defeat by urging its Senate allies to support the resolution but claim a broader interpretation of the language. As a result, the Byrd-Hagel resolution passed unanimously, 95-0.

Concerns about costs and competitiveness persist. Bills vary in how they address these concerns. Economic impacts could be mitigated through the scope and timing of the program, allowing trading across sectors, use of offsets and international trading, or a safety valve. Competitiveness impacts are taken into account in allocation of permits in at least one bill (the Climate Stewardship Act) and explicitly by requiring comparable steps in a reasonable timeframe (Bingaman discussion draft). Additional options – ranging from technology support to border adjustments -- are being considered.

It is interesting to note that while the US CAP acknowledges the need for a global response to a global problem such as climate change, the companies and NGOs stopped short of saying commitments should be comparable. In fact, they call on the U.S. to take the lead on enacting a mandatory climate policy. Similarly, a report released in April 2007 by the National Commission on Energy Policy expresses the view that "rapidly industrializing but still far poorer nations are likely to accept emissions limits only after the United States and other wealthy countries have demonstrated a willingness to take the lead."[97]

The next section addresses one of these issues -- economic implications -- in greater detail.

Table 6

PEW CENTER ON Global CLIMATE CHANGE

Greenhouse Gas Cap-And-Trade Proposals in the 110th Congress

Bill	Scope of Coverage	2010-2019 Cap	2020-2029 Cap	2030-2050 Cap	Offsets	Allocation	Other Cost Controls	Early Action	Technology and Misc.
Bingaman Discussion draft As evaluated by EIA on 1/11/2007	All 6 GHGs Economy-wide, upstream	2.6%/year reduction in emissions **intensity** from 2012-2021	2.6%/year **intensity** reduction from 2012-2021. 3%/year **intensity** reduction starting 2022.	3.0%/year reduction in emissions **intensity** starting in 2022.	5% set-aside of allowances for agricultural sequestration	Increasing auction: 10% in 2012; 20% in 2021; 65% in 2044. Some sectors' allocation specified; 29-30% to states.	\$7/ton CO_2 "safety valve," increasing 5%/year (adjusted for inflation) *Projected to be triggered in 2026, causing emissions to continue to rise.*	From 2012-2021, 1% set-aside of allowances	Funds and incentives for technology R&D. Target subject to 5-year review of actions by other nations.
Feinstein-Carper S.317 1/17/2007	All 6 GHGs Electricity sector, downstream	2006 level in 2011. 2001 level in 2015, 1%/year reduction from 2016-2019.	1.5%/year reduction starting in 2020 (may be adjusted by Administrator)	1.5%/year reduction starting in 2020 (may be adjusted by Administrator)	Certain categories of bio seques and industrial offsets; 5% limit on forest mgmt; 25% limit on intl.	Increasing auction: 15% in 2011; 60% in 2026; 100% in 2036. Output-based allocation to generators.	If economic harm, potential for borrowing and/or increased intl offsets. Borrowing of offsets.	Credit for reductions from 2000-2010, limit 10% of cap	Funds for tech R&D, habitat protection, and adaptation. Bills expected on industry, efficiency, fuels, and vehicles.
Kerry-Snowe S.485 2/1/2007	All 6 GHGs Economy-wide, point of regulation not specified	2010 level in 2010	1990 level in 2020. 2.5%/year reduction from 2020-2029.	3.5%/year reduction from 2030-2050. 62% below 1990 level in 2050.	Not specified	Determined by the President	Not specified	Goal to "recognize and reward early reductions"	Funds for tech. R&D, consumer impacts, adaptation. Standards for vehicles, efficiency, renewables.
Lieberman-McCain S.280 1/12/2007	All 6 GHGs Economy-wide, "hybrid"[1]	2004 level in 2012	1990 level in 2020	20% below 1990 level in 2030. 60% below 1990 level in 2050.	30% limit on use of intl credits and domestic reduction or seques offsets	Administrator determines; considering consumer impact, competitiveness, etc.	Borrowing for 5-year periods with interest	Credit for reductions before 2012	Funds and incentives for tech R&D, adaptation, mitigating effects on poor
Sanders-Boxer S.309 1/15/2007	All 6 GHGs Economy-wide, point of regulation not specified	2010 level in 2010. 2%/year reduction from 2010-2020.	1990 level in 2020	27% below 1990 level in 2030. 53% below 1990 level in 2040. 80% below 1990 level in 2050.	Not specified	Cap and trade permitted but not required. Allocation criteria include transition assistance and consumer impacts.	"Technology-indexed stop price" freezes cap if prices high relative to tech options	Not specified	Standards for vehicles, power plants, efficiency, renewables
Olver-Gilchrest H.R.620 1/22/2007	All 6 GHGs Economy-wide, "hybrid"[1]	2006 level in 2012	1990 level in 2020	22% below 1990 level in 2030. 70% below 1990 level in 2050.	15% limit on use of intl credits and domestic reduction or seques offsets	Administrator determines; considering consumer impact, competitiveness, etc. 10% for tech R&D. 10% for habitat restoration.	Borrowing for 5-year periods with interest	Credit for reductions before 2012	Funds for tech R&D, specifically coal gasification with geologic storage; adaptation; mitigating effects on poor

7. Economic Impact of Emissions Cuts[98]

A common argument for not taking action—or at least delaying action—on climate change is that the cost of action is too high. President Bush, for example, justified rejecting the Kyoto Protocol because of the expense, stating that it would cost the U.S. $400 billion and 4.9 million jobs.[99] The American Council for Capital Formation (ACCF), an industry funded advocacy group, also often cites high cost, job losses, and damaging economic consequences, as justification for rejecting any type of mandatory climate policy at the state or federal level.[100]

Economic models typically provide the foundation for these high cost projections but it is important to realize that a variety of models have been used to predict the implications of climate policy and not all suggest devastating consequences. While models have much to offer the policy realm, their results are only as reliable as the assumptions, the data, and the model structure allow. Unfortunately, many of the models which have looked at climate policy have been limited in scope, make draconian assumptions about our ability to change and lead to results which suggest that *any* effort is too costly. Furthermore, these models have typically done a poor job of accounting for the long-term benefits of taking action (i.e., avoiding the damages of climate change) and in many cases, these benefits are not even included and so are one-sided in their approach. In fact, as the science becomes more compelling and actual impacts are being observed, it has become clear that the costs of inaction greatly exceed costs of reasonable policy approaches.[101]

Economic Models of Climate Policy

Hundreds of analyses, using a variety of economic models and assumptions about how the economy will behave, how technology will develop, etc. have been published on the macroeconomic implications of climate policy in the last decade.[102] Many of the initial cost estimates of climate policy looked at economy-wide implications associated with implementation of the Kyoto Protocol. The Protocol requires developed countries to reduce emissions on average 5% and the U.S. to reduce its emissions on average 7% below 1990 emission levels during the 2008-2012 timeframe.[103] A wide range of cost projections associated with meeting the Kyoto target were produced by Computerized General Equilibrium (CGE) models – also known as “top down” models -- in the late 1990s. CGE models are composed of systems of mathematical equations and large amounts of data that refer to separate but connected elements relevant to the entire economy, like production and consumption; inputs of capital, labor, and energy; investment; taxes; etc.

In 2010, the studies projected that the price of one metric ton of carbon would range from $23/ton to $393/ton. The projected range of impacts on GDP was predicted to be similarly diverse. In 2010, GDP impacts relative to our projected GDP without Kyoto ranged from +0.15 percent at the low end, suggesting economic gains from the policy to - 4.2 percent at the high end of costs.

More recently, MIT, EIA, The Tellus Institute, and CRA have modeled the economic consequences of the more moderate domestic climate policy. For example, various versions of the bill sponsored by Senators' McCain and Lieberman – known as the Climate Stewardship Act (SA2028) of 2004 and a revised version known as the Stewardship and Innovation Act (S1151) of 2005 have been analyzed. The cap required by these proposals was stabilization of year 2000 emission levels by 2010.

Because of the assumptions and the inherent differences in the model used, the ranges of impacts suggested by the economic models vary widely, as they did for the Kyoto Protocol impacts. Carbon price estimates in 2010 ranged from the low Tellus estimate of $29/ton to the high CRA estimate of $69/ton. The range was even wider in terms of the expected impact on economic activity. CRA projected that the economy would lose $311 billion per year by 2020; in contrast, Tellus projected that the economy would see a net benefit of $30 billion.

It is important to note that these models project economic impacts against a baseline of anticipated strong economic growth. Hence, projections of economic losses are relative to expected improvements in GDP – and do not represent absolute reductions from current economic performance. Rather, they suggest that economic growth will be tempered by a price on carbon or GHG emissions. Further, economic models only estimate how the economy will perform given very specific assumptions and only as allowed by the structure of the model. As can be seen from the previous examples, different assumptions and different structures yield very different results.

Again, because of the assumptions and the inherent differences in the model used, the ranges of impacts suggested by the economic models vary widely, as they did for the Kyoto Protocol.

Model Assumptions

In general, estimates of the costs of reducing greenhouse gas emissions in the various models depends critically on the assumptions about how the economy works and how the following elements are represented: (1) the degree of foresight that decision-makers have in the marketplace; (2) the degree of flexibility in the economy (how easily it can adapt to change); (3) how technological change is characterized; (4) the sensitivity of energy demand to price changes; (5) the specific policies included; (6) how economy and environment will perform in the absence of climate policy (the baseline or reference case); and (7) whether the benefits of avoided climate damage are included. With respect to how the above elements impact the modeling results of climate policies, Weyant found generally that:

- the more optimistic models are about the degree of flexibility in the economy (ease of substitution between old and new technologies), the lower the economic impact;
- the more responsive emission reductions are to energy price increases, the lower the costs;
- including the impacts of induced technological change will have modest impacts in the short run but more significant impacts in the longer term;
- how revenues raised through carbon taxes are reused will affect program costs;

- the lower the assumed baseline or reference case forecast of emissions, the lower the cost of achieving any specific target (but this may also decrease reduction options);
- the more the model accounts for the benefits of emissions reductions, the lower the net economic impact; and finally
- assumptions about the specific policies included – in particular, the inclusion of multiple gases and global trading will produce lower cost estimates.[104]

Tellus had by far the most optimistic model results for the above elements. Without even factoring in the benefits of avoided climate change, Tellus concludes that in 2020 there is a net benefit associated with a multi-pronged approach like that suggested by the McCain-Lieberman climate change policy proposal.[105] In stark contrast, WEFA appears the least optimistic. Specifically, the WEFA study assumed a higher level of economic growth in its baseline, higher resulting emissions, and no complementary programs to reduce emissions and specifically no use of carbon sinks, international trading or offsetting emissions (in spite of the fact that policy allows such cost-saving opportunities).[106]

Consideration of all relevant policies can make a large difference in modeling results. Inclusion of factors such as international trading of greenhouse gases, offsets and non-CO_2 gases reduce policy costs. The European Union has just completed its first full year of its emissions trading program, which included all 25 member countries and will include in its next phase reductions from the lesser-developed countries through the Clean Development Mechanism (CDM).[107] Use of carbon sinks is allowed as part of Kyoto and even in the U.S. sinks and other offsets are recognized as legitimate offsets by a number of state climate programs and federal policy proposals.

The sheer number of state climate related programs that are in development today also supports the assumption made by the Tellus model developers that complementary programs would be implemented. EIA and CRA, while they assumed trading was allowed, assume that no other climate related policies (at the state or federal level) would be enacted (even though several states including nine northeastern states had already announced their intention to develop a regional cap and trade program). EIA and CRA also structured their model to focus only on CO_2 emissions and thus were not able to capture significant low cost opportunities to reduce non-CO_2 greenhouse gases in their models.[108] MIT, in contrast, allowed trading and non-CO_2 gases to be reduced. As such, MIT found considerably less fuel switching in our energy supply was required to meet the target, and their result was a lower cost estimate.

The importance of the scenario (and policy) modeled cannot be overstated. As Weyant found, models (and policies) that include international trading will result in lower costs. More recent efforts by MIT and others at Stanford's Energy Modeling Forum have also found that including non-CO_2 gases in the models (and in policy) reduces program costs.[109] By not including these other gases, EIA and CRA results thus likely overstate the costs of taking action. Clearly, the importance of including these other gases has not been lost on state climate policy efforts. For example, the Regional Greenhouse Gas Initiative (RGGI) just launched in seven New England states intends to allow reductions of non-CO_2 gases as offsets and their modeling projects that an ample supply is available in the $2 to $4 per ton price range.

The experience with individual companies taking on even more ambitious targets illustrates that reductions are often possible at no net cost – or even cost savings.[110] Historically, cost estimates for environmental policy have been overstated when compared to actual costs once a program is implemented. For example, early estimates of the cost of the U.S. acid rain program were more than double the actual program costs.[111] Further, the benefits of previous environmental regulation have consistently been found to exceed the costs.[112]

With the implications of climate change on sea levels, droughts and storms, and its potentially devastating effects on human health and national security – the costs of moderate, well-designed policy phased-in over time is preferable to more draconian measures -- with much higher costs -- later.

8. Moving Forward: U.S. Participation in New Global Agreements after 2012

Meaningful U.S. engagement in international efforts to address climate change depends not only on the perspectives and positions of the U.S. government but also on the international context in which such efforts takes place. Accordingly, Section 8.1 starts with a global, rather than U.S.-centric, perspective on the conditions most conducive to a multilateral agreement on climate change. Section 8.2 then focuses on the U.S. and describes options for how the U.S. might participate in the development of new global agreements on climate change.

8.1 New Agreements: An International Path Forward

Developing a coherent vision of how the international community might address climate change is no small task. Meeting the needs of an extraordinarily diverse group of countries, while also taking steps sufficient to protect the global environment requires determination, creativity, and good-faith engagement. One vision of the path forward was developed during the recent Climate Dialogue at Pocantico which was convened by the Pew Center on Global Climate Change. In a series of sessions over a year-long period, senior policy-makers and stakeholders from 15 countries worked through options for advancing the international climate effort beyond 2012. Those deliberations yielded a framework comprising six core elements which, participants believed, are a prerequisite to effective international action. Within this framework, Dialogue participants identified several options for strengthening multilateral action and also suggested new approaches to enhance international engagement. A slightly abridged version of the summary of the final report of the Climate Dialogue is presented below.[113]

Framing the Future Effort

Meeting the challenge of climate change requires concerted international action and Dialogue participants affirmed that the UN Framework Convention on Climate Change provides a foundation for taking such action, as well as the core principles to guide such action. Within this context, Dialogue participants agreed that a global agreement for 2012 and beyond should:

- <u>Engage Major Economies</u>: The immediate imperative is successfully engaging the world's major economies. Twenty-five countries account for 83 percent of global greenhouse gas emissions, 71 percent of global population, and 86 percent of global income. There is tremendous diversity within this group. While all should be prepared to commit to stronger action, an equitable approach must be consistent with the principle of "common but differentiated responsibilities."

- Provide Flexibility: To broaden participation, the multilateral framework must be flexible enough to accommodate different types of national strategies by allowing different types of commitments. Each country must be able to choose a pathway that best aligns its national interests with the global interest in climate action.

- Couple Near-Term Action with a Long-Term Focus: Near-term action is urgently needed on three fronts: achieving immediate, cost-effective emission reductions; fostering the development of breakthrough technologies to achieve deeper reductions in the future; and strengthening resilience to the adverse effects of a changing climate. These efforts should be guided to the degree possible by a common view of the long-term objectives.

- Integrate Climate and Development: Countries can contribute to the international effort through actions that serve their development goals while simultaneously delivering climate benefits. In developing countries, efforts will be most successful if complemented by assistance, investment, and access to clean technologies.

- Address Adaptation Needs: The impacts of climate change are being felt already and are certain to intensify, even if immediate steps are taken to dramatically reduce emissions. These impacts fall disproportionately on the poor, particularly in developing countries. Fairness demands that they be assisted.

- Be Viewed as Fair: A new global bargain on climate change will be possible only if each participating country perceives it to be reasonably fair. This assessment is ultimately a political one. Each country will judge fairness in terms it believes it can defend both to its own citizens and to the global community

Options for Strengthening Multilateral Action

Within the broad framework outlined above, Dialogue participants identified additional approaches that could facilitate concerted international action. The most promising include:

- Aspirational Long-Term Goal: Rather than attempt to negotiate a quantified long-term target, governments and others should continue to articulate their own visions of a long-term objective. In time, these may coalesce into a more concrete common view informally guiding the international effort.

- Adaptation: New assistance could support the development of national adaptation strategies and help highly vulnerable countries cope with urgent adaptation needs. Further steps are needed to discourage investments increasing climate vulnerability and promote those strengthening climate resilience.

- Targets and Trading: Emission targets coupled with international emissions trading should remain a core element of the multilateral effort. Future targets could vary in time, form, and stringency. In addition to binding absolute targets, other types could include intensity, "no-lose," or conditional targets. Other market-based approaches could include a mechanism crediting policy-driven emission reductions in developing countries.

- Sectoral Approaches: Commitments structured around key sectors such as power, transportation, or land use could take a variety of forms: emission targets, performance- or technology-based standards, or "best practice" agreements.

- Policy-based Approaches: Countries could commit to broad goals integrating climate and development objectives, then pledge national measures to achieve them and report periodically on implementation and results.

- Technology Cooperation: Governments could coordinate and increase support for research and development of long-term technologies. Stronger cooperation also is needed to facilitate the deployment of clean technologies in developing countries.

New Forms and Forums of Engagement

Forging new approaches that draw on these elements will pose extraordinary political, design, and negotiating challenges. Meeting them may require new forms—and new forums—of engagement:

- A Dialogue Among Major Economies: On the political front, leaders of the major economies should convene an informal dialogue to seek consensus on the general nature and scope of multilateral efforts post-2012. While this dialogue could be convened within the UNFCCC process, it may be more practical and productive to convene it outside the process, with the understanding that formal agreements would be negotiated under the Framework Convention.

- Linking Approaches: Multiple approaches could be pursued in parallel as different groups of countries engage with one another along different tracks. Such efforts could launch action on multiple fronts and yield valuable lessons to guide future steps. But an ad hoc assemblage of initiatives may not produce an overall effort that is sufficiently timely or robust. A more integrated approach could produce a stronger outcome. By linking and negotiating across tracks, governments may arrive at an arrangement flexible enough to accommodate different approaches and reciprocal enough to achieve higher levels of effort. It may help to agree at the outset that certain countries will negotiate within designated tracks appropriate to their circumstances.

8.2 U.S. Participation in a New Global Agreement

President Bush repudiated the Kyoto Protocol in March 2001 and the U.S. effectively disengaged from international negotiations aimed at its implementation. Once the Protocol entered into force in February 2005, the U.S. – having declined to ratify it – became ineligible under the terms of the Protocol, to participate in the annual Meetings of the Parties (MOP). As a party to the 1992 UN Framework Convention on Climate Change, however, the U.S. continues to participate in sessions of the Conference of the Parties (COP) to the Framework Convention. In a joint COP/MOP meeting in Montreal in late 2005, participants established parallel processes under the Convention and the Protocol to consider next steps in the international effort, thereby opening the door to U.S. participation in ongoing international negotiations. Unfortunately, at the next COP/MOP meeting in Nairobi in November 2006, the U.S. (and developing countries) still strongly opposed any discussion of taking on binding commitments and the conference made little measurable progress toward new agreements on international action beyond 2012.

Despite Bush Administration opposition to negotiation of a new global climate change agreement, however, a growing number of powerful voices in the U.S. have called for re-engagement in international discussions. For example, on March 29, 2007, the Senate Foreign Relations Committee, on a bi-partisan basis, adopted the Biden-Lugar resolution on "American Leadership on Climate Change." Though non-binding, the resolution calls for the U.S. to resume its role as a leader in international efforts to address global warming and endorses a "significant long-term reduction in global emissions." While calling for mitigation commitments by all countries that are major emitters, the resolution explicitly accepts the principle of "common but differentiated responsibilities" when setting such commitments. What's more, the resolution does not set any preconditions for U.S. re-engagement in international negotiations. The resolution will likely go to the full Senate for a vote at some point in the coming months and prospects for passage are very good.

The business sector has also increasingly advocated a change in the U.S. posture toward international negotiations. The U.S. CAP coalition (discussed in Section 5) made a strong statement about international negotiations, saying that "U.S. action to implement mandatory measures and incentives for reducing emissions should not be contingent on simultaneous action by other countries. Rather, we believe that U.S. leadership is essential for establishing an equitable and effective international policy framework for robust action by all major emitting countries."[114]

States are reaching out to other countries, indicating a desire to be part of a global solution. California has taken several steps to engage in international efforts to address climate change. In July 2006, Governor Arnold Schwarzenegger and British Prime Minister Tony Blair signed an agreement to implement market-based mechanisms to limit emissions and to collaborate on science, technology, and economic research. In December 2006, California and the Canadian province of Manitoba agreed to work cooperatively to reduce greenhouse gas emissions and to explore linking future carbon trading markets.

While California, of course, lacks the authority to commit the United States to international agreements, the state's action – along with positions advocated by prominent Congressional leaders, major U.S. corporations, and large NGOs – is indicative of a growing dissatisfaction with the Bush Administration's refusal to engage in international negotiations to agree on climate measures for the post-2012 period. Many Presidential candidates are making climate change an issue. Surveys show increasing public concern about global warming: double the number of people rank it first among environmental concerns from just one year ago, and the public indicates that they have more trust that the Democratic Congress on this issue than President Bush (59% vs. 19% respectively).[115] Given these trends, prospects for U.S. re-engagement in international negotiations are likely to improve significantly in the coming two or three years.

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[1] Pew Center on Global Climate Change, "Climate Change 101: Overview," page 5.
[2] Unless noted, all data in this section come from the U.S. Environmental Protection Agency's April 2006 U.S. Inventory of Greenhouse Gas Emissions and Sinks: 1990-2004, available at http://www.epa.gov/climatechange/emissions/usinventoryreport.
[3] Tg CO_2 eq: Teragrams of carbon dioxide equivalents, with the emission of each non-CO_2 gas weighted by its associated global warming potential (GWP).
[4] http://www.pewclimate.org/policy_center/analyses/response_bushpolicy.cfm.
[5] Data taken from DOE/EIA, 2007 Annual Energy Outlook, Table 19, where GDP index for 2012 is forecast at 1.299 and from DOE/EIA, 2005 Annual Energy Outlook, Table 19, where 2002 GDP index is reported at 1.041. The ratio of 1.299 to 1.041 is 1.2478, hence the reference to a 25% increase in GDP.
[6] http://www.pewclimate.org/what_s_being_done/in_the_states/emissionstargets_map.cfm.
[7] http://www.pewclimate.org/what_s_being_done/in_the_states/ab32/index.cfm.
[8] Juliet Elperin, The Washington Post, "Western States Agree to Cut Greenhouse Gases," February 27, 2007, p A08.
[9] http://www.pewclimate.org/what_s_being_done/in_the_states/rggi/index.cfm.
[10] More information can be obtained at www.eia.doe.gov/environment and at www.epa.gov/climatechange/emissions/index.
[11] EPA, Global Anthropogenic Non-CO2 Greenhouse Gas Emissions: 1990 – 2020, June 2006.
[12] See "US Energy Scenarios for the 21st Century," by Irving Mintzer, J. Amber Leonard, Peter Schwartz, Global Business Network, published by the Pew Center on Global Climate Change, July 2003.
[13] CO_2 reductions in other countries, carbon sequestration, and reductions of other GHGs were beyond the scope of this analysis.
[14] Methane and N_2O comprise a negligible share of emissions from power generation.
[15] www.eia.doe.gov/oiaf/1605/ggrpt/excel/historical_co2.
[16] DOE/EIA, 2007 Annual Energy Outlook, February 2007, Table 18.
[17] Carbon sequestration is discussed in Section 3.
[18] *The U.S. Electric Power Sector and Climate Change Mitigation*, by Granger Morgan et al (Carnegie Mellon University), published by the Pew Center on Global Climate Change, June 2005, p 26.
[19] U.S. Office of Management and Budget, Budget of the United States: 2008, Table 5-2.
[20] EPA, "Energy Star Overview of 2006 Achievements," www.energystar.gov, accessed 25 March 2007.
[21] Morgan et al., p. 28.
[22] DOE, see www.energycodes.gov
[23] Electricity demand data from DOE/EIA, 2007 Annual Energy Outlook, February 2007, pp 82-88 and Table 8.
[24] Census Bureau, Statistical Abstract of the United States: 2007, Tables 2 and 3.
[25] National Association of Homebuilders, cited in "Towards a Climate-Friendly Built Environment," by Marilyn Brown et al, (Oak Ridge National Laboratory), published by the Pew Center on Global Climate Change, June 2005, p 3.
[26] Brown et al, p 3.
[27] Resources for the Future, "Electricity Generation," at www.weathervane.rff.org.
[28] Unless noted, all estimates of changes in fuels for electric power are taken from DOE/EIA, 2007 Annual Energy Outlook, February 2007, pp 82-88, and Tables 8 and 91.
[29] Resources for the Future, "Electricity Generation," at www.weathervane.rff.org.
[30] DOE/EIA, "Nuclear Power," www.eia.doe.gov/cneaf/nuclear/page/analysis/nuclearpower, accessed 25 March 2007.
[31] Unless otherwise noted, information contained in this section is from U.S. EPA, "Greenhouse Gas Emissions from the U.S. Transportation Sector: 1990-2003," March 2006.
[32] EPA, "Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2004," April 2006, Table ES-7.
[33] DOE/EIA, 2007 Annual Energy Outlook, February 2007, Table 18.
[34] "Reducing Greenhouse Gas Emissions from U.S. Transportation," by Greene (Oak Ridge National Laboratory) and Schafer (Massachusetts Institute of Technology), published by the Pew Center on Global Climate Change, May 2003.
[35] DOE/EIA, 2007 Annual Energy Outlook, February 2007, p 21.
[36] DOE/EIA, 2007 Annual Energy Outlook, February 2007, Table A7.
[37] DOE/EIA, 2007 Annual Energy Outlook, February 2007, p 81.
[38] http://genomicsgtl.energy.gov/biofuels/transportation.shtml.
[39] DOE/EIA, 2007 Annual Energy Outlook, February 2007, Table A7
[40] U.S. government statisticians define manufacturing be a part of the industrial sector. Other, non-manufacturing, components of the industrial sector include agriculture, forestry, fisheries, mining, and construction.
[41] DOE/EIA, 2007Annual Energy Outlook, February 2007, Tables 18 and 34.
[42] U.S. EPA, "Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2004," April 2006, Table 4-1, p 4-2.

[43] DOE/EIA, 2007Annual Energy Outlook, February 2007, Tables 24 through 34. These data do not include emission of non-CO_2 GHGs or of process-related CO_2 emissions. CO_2 emissions from generation of electricity to supply the manufacturing sector are included.
[44] DOE/EIA, analysis of data available at http://www.eia.doe.gov/oiaf/1605/ggrpt/excel/historical_co2.xls
[45] "Energy-Related Carbon Dioxide Emissions in U.S. Manufacturing," Mark Schipper, Energy Information Administration, November 2006, Table 6, p 12.
[46] See http://www.bea.gov/industry.
[47] Economic data readily available from the Bureau of Economic Analysis do not reflect the same definition of specific industries as used by the Energy Information Administration. For example, CO_2 emission data are presented by EIA separately for the iron and steel industry and the aluminum industry, while BEA combines these two into the primary metals industry when it comes to economic data. Accordingly, direct comparisons between industry economic data and emission data must be made with caution.
[48] DOE/EIA, 2007 Annual Energy Outlook, February 2007, Tables 24 through 34.
[49] "Energy-Related Carbon Dioxide Emissions in U.S. Manufacturing," Mark Schipper, Energy Information Administration, November 2006, Table 7, p 13.
[50] Unless noted, this section draws heavily from *Agriculture's Role in Greenhouse Gas Mitigation*, by Paustian, et al, published by the Pew Center on Global Climate Change, September 2006.
[51] Agricultural lands, defined here as croplands and managed pastures, occupy about 25 percent of the vegetated area of the earth's surface and 27 percent of the lower 48 United States.
[52] Organic soils, referred to scientifically as *Histosols*, are soils formed under water-logged conditions such as those found in bogs and wetlands, forming deep layers of mainly partially decomposed plant materials. When artificially drained, such soils can be used for agricultural production. However, the term "organic" does *not* denote any particular type of management system (i.e., organic agriculture).
[53] Cited in "Climate Change 101: The Science and Impacts," by the Pew Center on Global Climate Change and the Pew Center on the States, undated, p 7.
[54] See Section 1.
[55] "Climate Control," *The Economist*, March 15, 2007, p 60.
[56] Unless noted, this section is based on analysis provided by DOE/EIA, 2007 Annual Energy Outlook, February 2007, p 72 – 77 and Table D-1.
[57] *Towards a Climate-Friendly Built Environment*, by Brown et al, p 58.
[58] This section draws on the *Agenda for Climate Action* by the Pew Center on Global Climate Change, February 2006, p 10.
[59] Unless noted, material on the carbon intensity of the fuel mix and on carbon capture and sequestration is taken from *The U.S. Electric Power Sector and Climate Change Mitigation*, by Morgan et al, 2005.
[60] The Future of Nuclear Power, MIT, 2003, cited in *Agenda for Climate Action* by Pew Center on Global Climate Change, February 2006, p 9.
[61] DOE/EIA, 2007 Annual Energy Outlook, February 2007, p 85 and p 195.
[62] The Future of Nuclear Power, MIT, 2003, cited in *Agenda for Climate Action* by Pew Center on Global Climate Change, February 2006, p 9.
[63] *The U.S. Electric Power Sector and Climate Change Mitigation*, by Morgan et al, p 37.
[64] DOE/EIA, 2007 Annual Energy Outlook, February 2007, p 85.
[65] "The Future of Coal: An Interdisciplinary MIT Study," Massachusetts Institute of Technology, 2007, p xiii.
[66] "Expanding Options for CO_2 Storage," EPRI Journal, Spring 2007, p 24.
[67] "The Future of Coal: An Interdisciplinary MIT Study," Massachusetts Institute of Technology, 2007, p x.
[68] *The U.S. Electric Power Sector and Climate Change Mitigation*, by Morgan et al, p 32.
[69] Unless noted, information in this section is drawn from *Reducing Greenhouse Gas Emissions from U.S. Transportation*, by Greene (Oak Ridge National Laboratory) and Schafer (Massachusetts Institute of Technology), published by the Pew Center on Global Climate Change, May 2003.
70 Unless otherwise noted, the material in this section relating to biofuels is based on *Agriculture's Role in Greenhouse Gas Mitigation,* by Paustian et al, published by the Pew Center on Global Climate Change, September 2006.
[71] Getting *Ahead of the Curve: Corporate Strategies that Address Climate Change*, by Hoffman (University of Michigan), published by the Pew Center on Global Climate Change, October 2006.
[72] DOE/EIA, 2007 Annual Energy Outlook, February 2007, Tables 24, 26, 27, and 30.
[73] DOE's Bandwidth Studies typically do not investigate all products, processes, and energy uses within a particular industry; instead, they focus on the biggest energy uses and most common practices and technologies in use. As such, the industry energy use reported in Table 2 is usually less than actual energy use in the industry as a whole. Note also that results for the iron and steel industry are presented on a per-unit basis (i.e., per ton of steel produced).
[74] DOE/EERE, "Chemical Bandwidth Study," JVP International Inc., Psage Research, LLC, and Energetics Inc., Draft Summary Report, December 2006, p. 4.
[75] DOE/EERE, "Energy Bandwidth for Petroleum Refining Processes," Energetics Inc., October 2006, p. 17.
[76] DOE/EERE, "Steel Industry Marginal Opportunity Study," Energetics Inc., September 2005, as summarized by the American Iron and Steel Institute in "Saving One Barrel of Oil Per Ton: A New Roadmap for Transformation of Steelmaking Process," October 2005, Figure 1.

[77] DOE/EERE, "Pulp & Paper Industry – Energy Bandwidth Study," Jacobs Engineering and Georgia Institute of Technology, August 2006, p. 11.
[78] Note that DOE did not estimate a "best practice energy use" for the petroleum refining industry.
[79] DOE/EIA, 2007 Annual Energy Outlook, February 2007, Tables 24, 26, 27, and 30.
[80] EPA, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2004, April 2006, Table 4-1, page 4-2.
[81] DOE/EIA, 2007 Annual Energy Outlook, February 2007, Table 29.
[82] EPA, "Energy Efficiency Improvement Opportunities for Cement Making," Ernst Worrell and Christina Galitsky, Lawrence Berkeley National Laboratory (LBNL), January 2004, p 38.
[83] U.S. Geological Survey, Mineral Commodity Summaries, January 2007, p. 41.
[84] EPA, "Energy Efficiency Improvement Opportunities for Cement Making," LBNL, January 2004, p 39.
[85] U.S. Geological Survey, Mineral Commodity Summaries, January 2007, p. 41.
[86] EPA, "Energy Efficiency Improvement Opportunities for Cement Making," LBNL, January 2004, p. 42.
[87] This section is excerpted from Paustian et al, *Agriculture's Role in Greenhouse Gas Mitigation*, September 2006.
[88] Council for Agricultural Science and Technology (CAST). 2004. Climate Change and Greenhouse Gas Mitigation: Challenges and Opportunities for Agriculture. Ames, IA: p. 120.
[89] CAST, 2004.
[90] Observations on state experience draws from Josh Bushinsky article published in http://www.abanet.org/environ/committees/climatechange/newsletter, May 2007.
[91] Johnson, Linda A. "PSEG exec tells Congress tough greenhouse gas limits needed". *Newsday*. March 29, 2007
[92] See Statement of Policy on Climate Change and GHG Regulation, Adopted unanimously by EPSA's Board of Directors, January 27, 2007, available at: www.epsa.org
[93] Ellerman et al, *Lessons Learned from Emissions Trading Programs*.
[94] See *A Call for Action: US Climate Action Partnership*. http://www.us-cap.org/ClimateReport.pdf
[95] See *An Evangelical Call To Action*, http://www.christiansandclimate.org/statement
[96] *National Security and the Threat of Climate Change*, by The Military Advisory Board, CNA Corporation, April 2007.
[97] Energy *Policy Recommendations to the President and the 110th Congress*, National Commission on Energy Policy, April 2007.
[98] This section draws heavily from chapter 13 "Energy Myth Twelve – Climate policy will bankrupt the US economy" by Eileen Claussen and Janet Peace of the Pew Center, published *in Energy and American Society – Thirteen Myths*, Benjamin Sovacool and Marilyn Brown, eds., Springer Press, 2007.
[99]See "President Announces Clear Skies & Global Climate Change Initiatives," available at http://usgovinfo.about.com/gi/dynamic/offsite.htm?site=http://www.whitehouse.gof/news/releases/2002/02/20020214%2D5.html
[100] See, e.g., Thorning, Margo: 2006, Testimony before the U.S. Senate Committee on Energy and Natural Resources, Climate Change Conference, April 4, 2006.
[101] Stern, Nicholas. 2006. *The Economics of Climate Change: The Stern Review*. Cambridge University Press.
[102] See Weyant *et al.*, 1996 for a more detailed discussion of the types of models that have been used to analyze this issue. See Bernow, Stephen et al, 1998 – A Pragmatic CGE Model for Assessing the Influence of Model Structure and Assumptions in Climate Change Policy Analysis, Office of Atmospheric Programs, US EPA, Tellus Inst. Study #96-190, Boston, MA, for criticisms of CGE climate policy models.
[103] EIA estimated in its Annual Energy Outlook 2003 that U.S. emissions in 1990 were 6172 million metric tons of carbon dioxide equivalent; a 7% reduction implies a target level of emissions at 5740 million metric tons – Figure 1 (EIA, 2003a). EIA, however, assumed this target was somewhat flexible because biological sinks could be included; as such a net reduction target of 3% was often discussed.
[104] Weyant, John. An *Introduction to the Economics of Climate Change Policy*, Pew Center on Global Climate Change, Arlington, Virginia, 2000.
[105] Bailie, Alison et al, *Analysis of the Climate Stewardship Act: A Study for NRDC*, Tellus Inst. Boston MA, 2003. The Tellus results are similar to those of a study – *Scenarios for a Clean Energy Future* – conducted for the U.S. Department of Energy and the Environmental Protection Agency by researchers from five DOE national laboratories. An engineering-economic assessment of technologies and market-based policies, it looked at the benefits and costs of reducing carbon dioxide emissions in 2020 by 30 – 32% compared to a business-as-usual forecast. It concluded that the overall economic benefits of the technologies and policies could result in a benefit (avoided energy cost) equal to or greater than the cost of implementing the policies and investing in the technologies (Brown et al., 2001).
[106] A greenhouse gas offset is an emission reduction or atmospheric carbon removal made voluntarily by one entity and is assumed transferable for use by another.
[107] The Clean Development Mechanism (CDM) is one of the three market mechanisms established by the Kyoto Protocol. The CDM is designed to promote sustainable development in developing countries and assist Annex I Parties in meeting their greenhouse gas emissions reduction commitments. It enables industrialized countries to invest in emission reduction projects in developing countries and receive tradeable credits for reductions achieved.
[108] Non-CO_2 gases refer to other greenhouse gases—including methane, nitrous oxide, and a number of manmade, industrial-process gases such as hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride.

[109] Reilly, John et al. *Multi-Gas Contributors to Global Climate Change: Climate Impacts and Mitigation Costs of Non-CO2 gases.* Pew Center on Global Climate Change, Arlington, VA. 2003.

[110] Arroyo, Vicki and Benjamin Preston, "Change in the marketplace: business leadership and communication," *Creating a Climate for Change*, Moser and Dilling, eds. Cambridge University Press 2007.

[111] Ellerman et al. 2003.

[112] *Informing Regulatory Decisions: 2003 Report to Congress*, OMB, 2003.

[113] The full report, "International Climate Efforts Beyond 2012: Report of the Climate Dialogue at Pocantico," November 2005, is available at http://pewclimate.org/docUploads/PEW_Pocantico_Report05.pdf. The language contained here in Section 8.1 is taken from pages 1 to 3 of the report.

[114] See www.us-cap.org.

[115] Washington Post-ABC poll, April 21, 2007. http://www.washingtonpost.com/wp-srv/nation/polls/postpoll_environment_0 >42007.html.