Climate-friendly Energy Policy: Options for the Near Term

The majority of U.S. greenhouse gas (GHG) emissions—84 percent—are in the form of carbon dioxide (CO_2), resulting almost entirely from the combustion of fossil fuels. As a result, energy policies that reduce fossil fuel use will reduce GHG emissions. Fossil fuel use can be reduced by: (1) deploying technologies that increase energy efficiency (e.g., more efficient power plants, cars, and appliances) and (2) employing non-fossil fueled energy sources (e.g., solar, wind, geothermal, biomass, hydroelectric, nuclear energy, or renewables-based hydrogen). CO_2 emissions also can be reduced by shifting from high-carbon to lower-carbon fuels (e.g., shifting from coal to natural gas in the electricity sector), and by employing carbon capture and sequestration technologies.

A "climate-friendly" energy policy can advance climate objectives while serving energy policy goals. However, a climate-friendly energy policy is not a substitute for climate policy. More significant GHG emissions reductions would be necessary in order to address climate change than can be justified solely on the basis of traditional energy policy objectives. The energy policy options outlined in this brief represent sensible and important first steps in U.S. efforts to reduce GHG emissions.

Energy use and climate change are inextricably linked. The majority of U.S. greenhouse gas (GHG) emissions—84 percent—are in the form of carbon dioxide (CO_2), resulting almost entirely from the combustion of fossil fuels.[1] Choices made today in the current national energy policy debate will directly impact U.S. greenhouse gas emissions far into the future. Decision-makers face the challenge of crafting policies that allow the United States to meet its energy needs while acting responsibly to reduce GHG emissions.

Often, these objectives are thought of as competing goals—that energy policy and energy security issues are in conflict with environmental objectives and vice versa. In reality, there is a substantial convergence between the goals of energy policy and climate policy, and many feasible and beneficial policies from supply and security perspectives can also reduce future U.S. greenhouse gas emissions. This brief considers near-term energy policies that can be adopted in the context of the energy policy debate, short of adopting a GHG reduction program now, to best position the United States to reduce GHG emissions and to implement future climate change policies. These options make up a "climate-friendly energy policy." This brief is drawn from a Pew Center report: *Designing a Climate-friendly Energy Policy: Options for the Near Term*.[2]

It is important to note that a climate-friendly energy policy is not a substitute for a mandatory climate policy. More significant GHG emissions reductions would be necessary in order to address climate change than can be justified solely on the basis of traditional energy policy objectives. A previous Pew Center policy brief outlines potential programs aimed specifically at GHG abatement,[3] and Pew Center reports discuss options for designing a mandatory U.S. GHG reduction program[4] and reducing GHG emissions from U.S. transportation.[5]

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The Link Between Energy and Climate

Because the vast majority of GHG emissions are in the form of CO_2 resulting from fossil fuel combustion, energy policies that reduce fossil fuel use will reduce GHG emissions.[6] Fossil fuel use can be reduced by: (1) deploying technologies that increase energy efficiency (e.g., more efficient power plants, cars, and appliances) and (2) employing non-fossil fueled energy sources (e.g., solar, wind, geothermal, biomass,[7] hydroelectric, nuclear energy, or renewables-based hydrogen). CO_2 emissions also can be reduced by shifting from high-carbon to lower-carbon fuels (e.g., shifting from coal to natural gas in the electricity production sector), and by employing carbon capture and sequestration technologies. Conversely, energy policies that increase fossil fuel consumption, discourage or miss opportunities for efficiency improvements, and expand reliance on high-carbon fuels will increase CO_2 emissions and thereby exacerbate climate change.

Given this close relationship between energy use and GHG emissions, near-term energy policy choices have significant future implications for climate change. Climate-friendly energy policies fall into one of three general categories—policies that:

(1) Reduce GHG emissions now;

(2) Promote technology advancement or infrastructure development that will reduce the costs of achieving GHG emissions reductions in the future; and

(3) Minimize the amount of new capital investment in assets that would be substantially devalued (or "stranded") if a GHG program were implemented.

Energy Policy Context

A discrete and unified U.S. energy policy does not exist. Rather, policies affecting energy production and use in the United States have many sources and take a multitude of forms. For example, while this brief focuses primarily on federal energy policies, state and local governments also play a key role in regulating energy-related activities. In addition, while there are federal policies aimed directly at achieving energy objectives, there are also federal policies aimed at achieving other objectives—ranging from environmental protection to easing traffic congestion—that have indirect but nevertheless substantial impacts on energy production and use. Finally, even those policies aimed squarely at achieving energy-related objectives are shaped by other policy concerns, such as labor and foreign policy issues. Energy policy, in short, operates in multiple dimensions.

Historically, most major shifts in U.S. energy policy have been triggered by interruptions, and subsequent price increases, in crude oil supply. Such events occurred in 1973 (Arab oil embargo), 1979–80 (triggered by the Iranian revolution), and 1990 (associated with the Persian Gulf War). The policy prescriptions for reducing supply vulnerability have included increasing U.S. production of conventional and alternative fuels, emphasizing market forces, reducing demand through efficiency measures, establishing and maintaining the strategic petroleum reserve (SPR),[8] and maintaining international arrangements under the International Energy Program (IEP) to coordinate petroleum stock drawdowns. Over the years, the United States has reduced its vulnerability to a physical interruption of crude oil supplies but economic vulnerability remains. U.S. oil imports continue to grow, and the OPEC countries continue to be the source of significant oil imports, leaving the transportation sector in particular—and the economy in general—exposed to supply and price risk.

Because the vast majority of GHG emissions are in the form of CO_2 resulting from fossil fuel combustion, energy policies that reduce fossil fuel use will reduce GHG emissions.

Today's energy policy debate confronts a mixture of old and new issues. The United States remains vulnerable to concerted action by oil-producing nations to curtail production and increase prices. Conflicts in Central Asia and the Middle East have brought fuel supply concerns again to the fore. Moreover, the events of September 11, 2001, have given rise to a new energy policy priority: Securing domestic energy facilities from terrorist attack. In addition, sharply increased rates of U.S. economic growth in the late 1990s exposed energy supply shortages, as well as transportation and transmission bottlenecks. The deregulation of the electric power industry in some states has created regulatory idiosyncrasies that have sharply increased prices of electricity in some regions.[9] Furthermore, current U.S. energy policy is much more market-oriented, less focused on cost-based price regulation, and more focused on environmental regulation than it was in the 1970s.

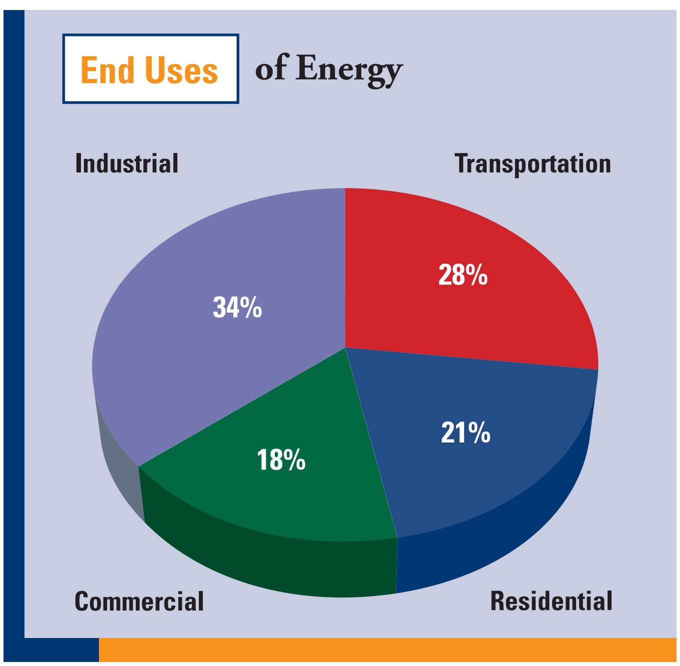
Current U.S. Energy Picture

The United States supplies about three-quarters of its energy needs from domestic sources. The nation has ample sources of coal and, indeed, is a modest coal exporter. The United States also supplies about 84 percent of its own natural gas; imports, mostly from Canada, account for about 16 percent of U.S. natural gas consumption.[10] Oil presents a very different picture, however. The United States imported about 55 percent of the petroleum it consumed in 2001, and imports are projected to increase.[11]

The United States consumes a tremendous amount of energy each year, at considerable expense. In 2001, it consumed about 97 quadrillion British Thermal Units (or "quads") of energy, at a cost of nearly $700 billion.[12] Figure 1 indicates end uses of energy by sector, with the primary energy[13] used for electricity generation allocated to each sector in proportion to its electricity consumption.

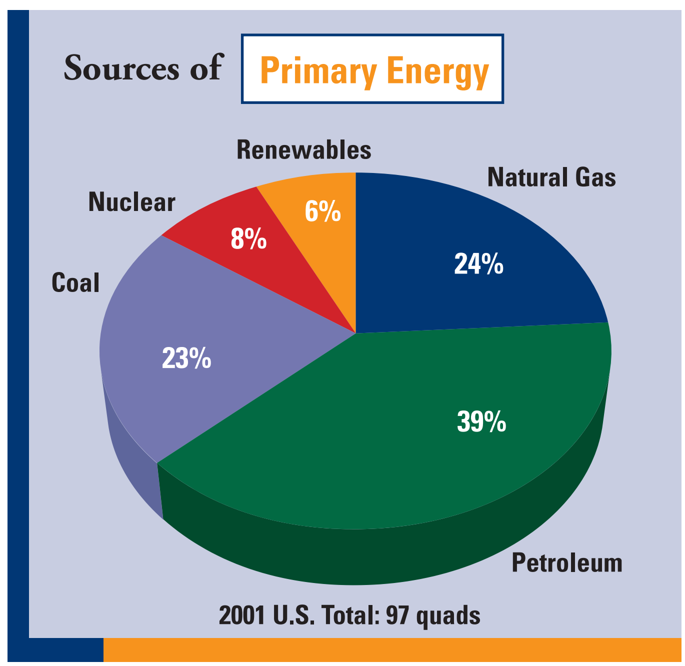
The bulk of U.S. primary energy comes from fossil fuels. Fossil fuels provided 86 percent of U.S. primary energy in 2001.[14] (See Figure 2.) Non-fossil sources provided the remaining 14 percent, of which nuclear energy represented approximately 8 percent and renewable energy resources accounted for approximately 6 percent (about 40 percent of the renewable energy is hydropower). The amount of energy provided by nuclear sources is expected to increase slightly over the next few decades, but DOE does not anticipate any new nuclear facilities being built in the United States during that period.[15] Hydropower output is expected to be static. Other renewable sources

Figure 1



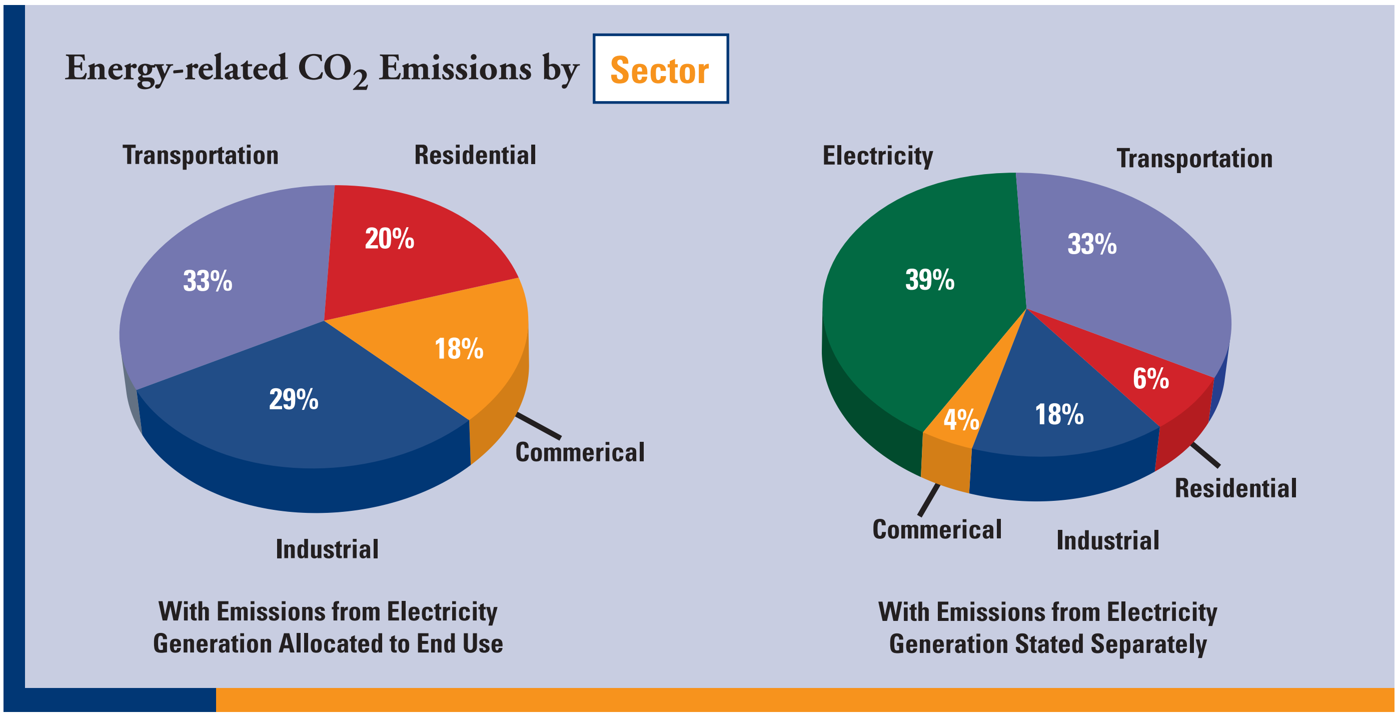
Source: U.S. DOE, EIA. Annual Energy Review 2001, Figure 2.1a.

Figure 2



Source: U.S. DOE, EIA. Annual Energy Review 2001, Table 1.3.

Figure 3



Source: U.S. DOE, EIA. Emissions of Greenhouse Gases in the United States 2001, DOE/EIA-0573 (2002).

(biomass, wood, municipal solid waste, ethanol, geothermal, wind, and solar) now supply only 3.4 percent of total U.S. energy consumption and only 2.1 percent of total U.S. electricity generation.[16] DOE projects slow growth for non-hydro renewables because of the relatively lower costs of fossil fuels for electricity generation, and because less capital-intensive natural gas technologies have an advantage in competitive electricity markets over coal and baseload renewables for new capacity.[17]

Current Greenhouse Gas Emissions Picture

Greenhouse gas emissions from U.S. energy use and production are primarily CO_2 emissions from the combustion of fossil fuels in the electricity generation, buildings, industrial processes, and transportation sectors.[18] (See Figure 3.) CO_2 from fossil fuel combustion accounts for 82 percent of total U.S. GHG emissions.[19] Figure 4 shows U.S. CO_2 emissions broken down by fuel source.

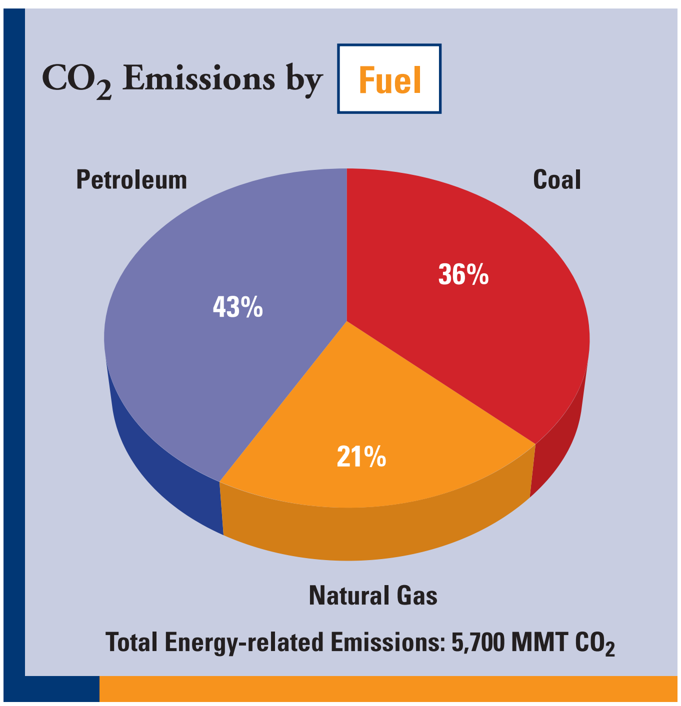
One way to view the broad relationship between energy use and CO_2 emissions is to examine shifts in two indices: energy intensity (measured by energy used per dollar of gross domestic product (GDP) created) and carbon intensity (measured by CO_2 emissions per dollar of GDP created).

The first value indicates the economy's overall energy efficiency, while the second is a function of the fuel mix and generation technologies used to meet the nation's energy needs. With regard to fuel mix, it is important to understand that different types of fossil fuels have different levels of carbon content. (See Figure 5.) Both energy intensity and carbon intensity are influenced by energy policy choices.

As the U.S. economy has grown, CO_2 emissions have increased, although at a slower rate than conventional measures of economic output. During the 1990s, the divergence between CO_2 and GDP growth was primarily a result of lower energy intensity. From 1990 to 2001, GDP grew by about 2.9 percent per year, while CO_2 from energy grew by about 1.3 percent per year, i.e., CO_2 grew at about half the rate of GDP. Energy use per dollar of GDP fell by 1.7 percent per year, while CO_2 emissions per unit of energy consumed have remained at roughly the 1990 level.[20] This decrease in the U.S. economy's energy intensity since the early 1990s has resulted in large part from an increase in non-energy-intensive economic sectors (e.g., computer equipment and semiconductor manufacturing) relative to traditional energy-intensive manufacturing industries (e.g., steel-making), as well as from energy efficiency improvements.[21]

The primary CO_2 growth components during the 1990s were electricity generation and transportation. CO_2 emissions from the electric power sector grew by 24 percent between 1990 and 2001, and CO_2 emissions from transportation increased 19 percent during this period.

Figure 4



Source: U.S. DOE, EIA. Emissions of Greenhouse Gases in the United States 2001, DOE/EIA-0573 (2002).

Note: Excludes emissions from land use, bunker fuels, and U.S. territories.

The primary CO_2 growth components during the 1990s were electricity generation and transportation. CO_2 emissions from the electric power sector grew by 24 percent between 1990 and 2001, and CO_2 emissions from transportation increased 19 percent during this period.[22] The demand for electricity has grown with the U.S. economy and with substantial increases in the market penetration of electricity-consuming electronic equipment, consumer appliances, and manufacturing technologies. In the transportation sector, an increasing proportion of vehicles on the road (e.g., minivans, sport utility vehicles, and light trucks) are not subject to the passenger car Corporate Average Fuel Economy (CAFE) standards, but instead are subject to the significantly less stringent "light-duty truck" CAFE standards. CAFE standards established in 1975 required new passenger car fuel economy to reach 27.5 mpg in 1985, where the standard remains today. Less was required of light trucks; standards set by the U.S. Department of Transportation increased to 20.5 mpg in 1987 and stand at 20.7 mpg today.[23] The actual fuel economy of new passenger cars and light trucks has closely followed the standards, and has not increased since 1988; indeed, today's combined fleet of passenger cars and light trucks gets fewer mpg than the vehicles sold fifteen years ago because of the growth in the proportion of light trucks in the fleet.[24] Finally, all vehicles are being driven more miles as a result of relatively low gasoline prices and land-use patterns characterized by sprawl.

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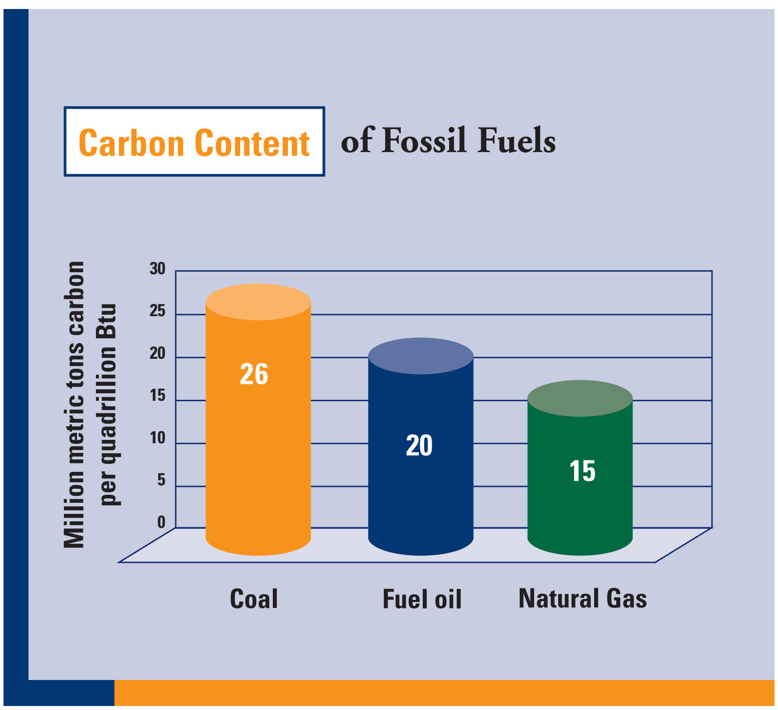
Figure 5



Source: U.S. DOE, EIA. Emissions of Greenhouse Gases in the United States 2001, DOE/EIA-0573 (2002), Appendix B.

Economic Analysis of Energy Policy

The body of economic work on energy and climate change contains several important themes to be considered in any effort that aims to identify "climate friendly" energy policies. These key themes include:

- Energy use in the U.S. economy is largely a function of the current equipment (or "capital stock") used to extract, produce, convert, and use energy (e.g., machinery used in longwall coal mining, technology used to explore for and produce oil and natural gas, boilers and turbines used to convert fossil fuel to electric power, and automobiles and trucks used to transport people and goods).
- New energy technologies usually take time to develop, mature, and find broad acceptance in the market.
- The market penetration of improved equipment reflects economic behavior, not just technological potential.
- Energy or fuel prices can play a substantial role in energy use and emissions outcomes, apart from long-run technology choices.
- To the extent that policy actions alter the market supply or demand of specific fuels or energy types, such policies can change energy prices. As a consequence, future energy use decisions would be based on a new set of prices, which may affect the expected level and cost of eventual emissions reductions.
- Expectations regarding future prices, technologies, and policies can play a large role in shaping current investment decisions. Thus, the form and direction of policy enacted in the near term can encourage market participants to alter longer-term decisions even before regulatory compliance deadlines or other milestones occur.
- It is critical to assess the impact of today's energy policy choices in terms of the future cost of pursuing future GHG reduction policies.

Policy Objectives

While U.S. energy policy has many sources, forms, and influences, it is nevertheless possible to identify four traditional objectives on which U.S. energy policy has focused:

(1) a secure, plentiful, and diverse primary energy supply;

(2) a robust, reliable infrastructure for energy conversion and delivery;

(3) affordable and stable energy prices; and

(4) environmentally sustainable energy production and use.

The policy options considered in this brief serve one or more of these objectives.

Climate-friendly energy policies fall into one of three general categories—policies that:

(1) reduce GHG emissions now;

(2) promote technology advancement or infrastructure development that will reduce the costs of achieving GHG emissions reductions in the future; and

(3) minimize the amount of new capital investment in assets that would be substantially devalued (or "stranded") if a GHG program were implemented.

Climate-Friendly Energy Policy Choices

Using the criteria outlined above, the following elements of a climate-friendly energy policy have been identified:

Fossil Fuels

Expand natural gas transportation infrastructure. Encouraging expansion of the natural gas transportation system in North America through, for example, rate incentives, streamlined permitting for pipeline and liquefied natural gas (LNG) facilities, and expedited approvals needed for construction of an Alaska natural gas pipeline, will increase the delivery capability for natural gas and lower the price of the delivered product. This will facilitate the use of gas as a substitute for coal in electricity production and thus reduce GHG emissions.

Increase natural gas production. Encouraging increased production of natural gas in North America through, for example, tax incentives, royalty relief, and access to public land for resource development will lower the price and increase the availability of natural gas. This will, in turn, permit the use of gas as a substitute for coal in electricity production and thus reduce GHG emissions.

Electricity

Encourage deployment of efficient electricity production technologies. Encouraging developers of new generation capacity to employ very efficient generation technologies—with tools such as tax incentives for combined heat and power and high-efficiency distributed generation—can significantly increase the amount of useful energy gleaned from fuels, and thus reduce both energy costs and emissions. Moreover, support for repowering existing plants with technology that improves the efficiency of electricity generation can reduce electricity prices and reduce fuel consumption per kilowatt-hour (kWh), with corresponding GHG reduction benefits. Conversely, policies that discourage such investments in improved efficiency, and instead result only in energy-consuming pollution control retrofits (e.g., scrubbers to reduce conventional air pollutants), may be counterproductive from a climate perspective. Incentives for investment in advanced technologies such as carbon capture and sequestration would allow future use of coal resources without net GHG emissions.

Maintain role for nuclear and hydroelectric power. Policies that allow the safe continued use of nuclear power plants—such as granting license extensions, approving plant upratings where warranted, and finding new solutions to the nuclear waste problem—preserve diversity of energy supply, may reduce electricity prices, and avoid very substantial coal consumption for electricity generation. Likewise, maintaining or expanding hydroelectric capacity in a way that protects natural resources provides low-cost electricity without GHG emissions.

> *In the long run, we can only curb climate change by weaning ourselves of our reliance on fossil fuels. The energy policy options outlined in this brief represent sensible and important first steps in U.S. efforts to reduce GHG emissions.*

Encourage development of renewable energy resources. Policies that encourage the development of renewable energy resources—such as production tax credits, a renewable portfolio standard, electricity transmission policies that do not discriminate against intermittent renewable resources such as solar and wind, and net metering for small distributed renewable resources—can help diversify our energy portfolio and are environmentally attractive. Wind, solar, geothermal, and hydropower generation produce no GHG emissions, and use of biomass produces no net GHG emissions.

Buildings End-Use Efficiency

Promote use of efficient technologies and green design in buildings. Policies that require increased efficiency of energy end-use (such as building codes or appliance efficiency standards), and policies that encourage use of highly efficient equipment and technologies (such as tax incentives, product efficiency labeling, and Energy Star™ programs) can significantly reduce energy consumption, consumer operating costs over a product's or building's lifecycle, the need for investment in new power plants, and emissions related to energy use.

Industrial End-Use Efficiency

Promote the use of more efficient processes and technologies in industry. Policies that provide incentives for investment in efficient processes and combined heat and power technologies, expand coverage of efficiency standards to standard-design industrial equipment, and provide more information on efficient technologies to industrial consumers can lead to further emissions reductions in the industrial sector.

Transportation

Enhance end-use efficiency of automobiles and light trucks. Regulatory and tax policies—such as more stringent CAFE standards, reforms to the "gas guzzler" tax, efficiency standards for tires, and tax or other incentives for the purchase of highly efficient hybrid vehicles—can significantly reduce fuel consumption per mile, thus reducing oil consumption and mitigating reliance on oil imports. Very significant energy and climate policy benefits can be gained in this area. According to a recent National Research Council study, if lead times are long enough, automakers can produce substantially more fuel-efficient vehicles without increasing net consumer costs or compromising safety.[25] Moreover, fundamental redesigns such as hybrid vehicles (already commercially available in some Honda and Toyota vehicles) and fuel-cell vehicles offer important additional benefits.

Research and Development

Promote research and development on efficient electricity production technologies. Federal funding or tax incentives for R&D on improving the efficiency of the electricity generation process, regardless of fuel source, can provide options to reduce future energy prices and reduce future fuel consumption per kWh, with corresponding GHG benefits.

Promote research and development on efficient end-use technologies. Federal funding or tax incentives for R&D on improving transportation, building, and industrial end-use efficiency can provide options to reduce future energy costs to consumers and to reduce future energy consumption, with corresponding GHG benefits. Support for R&D is particularly important in areas where fundamental changes are possible, such as the widespread use of hydrogen in fuel cells to power vehicles.

Promote research and development on non-fossil fuels and carbon sequestration. Federal funding or tax incentives for R&D on alternatives to fossil fuels, such as biofuels and hydrogen, can provide future viable alternatives to oil. Development of economical carbon sequestration technologies could enable continued reliance on coal consistent with a GHG regulatory regime.

Conclusions

A "climate-friendly" energy policy can advance climate objectives while serving energy policy goals. However, a climate-friendly energy policy is not a substitute for climate policy. More significant GHG emissions reductions would be necessary in order to address climate change than can be justified solely on the basis of traditional energy policy objectives. In the long run, we can only curb climate change by weaning ourselves of our reliance on fossil fuels. The energy policy options outlined in this brief represent sensible and important first steps in U.S. efforts to reduce GHG emissions.

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[1] CO_2 from fossil fuel combustion represents 82% of U.S. GHG emissions. Only 2% of U.S. GHG emissions are CO_2 released from other activities. Although most methane emissions (the second-largest GHG emissions source) come from landfills and agricultual sources, about one-third are attributable to production of natural gas or coal, or to transportation of natural gas. See U.S. DOE, EIA. 2003. *Emissions of Greenhouse Gases in the United States 2001*. Available at http://www.eia.doe.gov/oiaf/ggrpt.

[2] Smith, Douglas W., Robert R. Nordhaus, Thomas C. Roberts, Marc Chupka, Shelley Fidler, Janet Anderson, Kyle Danish, and Richard Agnew. *Designing a Climate-friendly Energy Policy: Options for the Near Term*. Pew Center on Global Climate Change. Arlington, VA. July 2002.

[3] *The U.S. Domestic Response to Climate Change: Key Elements of a Prospective Program.* In Brief, Number 1. Pew Center on Global Climate Change. Arlington, VA.

[4] Nordhaus, Robert R. and Kyle W. Danish. *Designing a Mandatory Greenhouse Gas Reduction Program for the U.S*. Pew Center on Global Climate Change. Arlington, VA. May 2003. This report identifies issues that must be addressed in the design of a mandatory U.S. GHG reduction program. Three options are specifically evaluated: (1) cap-and-trade programs, (2) GHG taxes, and (3) a "sectoral hybrid" program that combines efficiency standards for automobiles and consumer products with a cap-and-trade program applicable to large sources of greenhouse gases.

[5] Greene, David L. and Andreas Schafer. *Reducing Greenhouse Gas Emissions from U.S. Transportation*. Pew Center on Global Climate Change. Arlington, VA. May 2003.

[6] CO_2 makes up the lion's share of U.S. GHG emissions, but other gases also play a role in enhancing the greenhouse effect. Non-CO_2 greenhouse gases account for roughly 18% of the global warming potential of U.S. GHG emissions. Some of them have a very weak effect; options to control GHG emissions have focused on the five with the strongest impact. Methane (CH_4) and nitrous oxide (N_2O) are created through decomposition, chemical processes, fossil fuel production and combustion, and many smaller sources. Sulfur hexafluoride (SF_6) is used as an insulating gas in large-scale electrical equipment. The remaining two are hydrofluorocarbons (HFCs) used as refrigerants and perfluorocarbons (PFCs) released during aluminum smelting and used in the manufacture of semiconductors. When compared using 100-year global warming potentials, their weighted emissions are as follows: CH_4, 9%; N_2O, 5%; HFC/PFC/SF_6, 2%. For further discussion of non-CO_2 greenhouse gases, see Reilly, John M., Henry D. Jacoby, and Ronald G. Prinn. *Multi-gas Contributors to Global Climate Change.* Pew Center on Global Climate Change. Arlington, VA. February 2003.

[7] CO_2 emissions from the combustion of biomass are offset by CO_2 removed from the atmosphere by the plants.

[8] Crude oil in the SPR plus private company stocks would cover approximately 150 days without imports.

[9] For more information about deregulation in the electric power sector, see U.S. DOE, EIA. *Electric Power Industry Restructuring Fact Sheet*. Available at http://www.eia.doe.gov/cneaf/electricity/page/fact_sheets/restructuring.html.

[10] U.S. DOE, EIA. 2002. *Annual Energy Review 2001*. Available at http://www.eia.doe.gov/aer/contents.html.

[11] U.S. DOE, EIA. 2003. *Annual Energy Outlook 2003,* p. 83. Available at http://www.eia.doe.gov/oiaf/aeo. This number reflects net imports.

[12] *Ibid.*, Tables A2 and A3.

[13] "Primary energy" consists of the sum of "site energy" (the energy directly consumed by end users) and the energy consumed in the production and delivery of energy products to end users. See http://www.eia.doe.gov/emeu/consumptionbriefs/cbecs/cbecs_trends/primary_site.html.

[14] U.S. DOE, EIA. 2002. *Annual Energy Review 2001*, Table 1.3.

[15] U.S. DOE, EIA. 2003. *Annual Energy Outlook 2003*, pp. 5-6.

[16] U.S. DOE, EIA. 2002. *Annual Energy Review 2001*, Tables 1.3 and 8.2a.

[17] U.S. DOE, EIA. 2003. *Annual Energy Outlook 2003*, p. 6.

[18] In addition to CO_2 emissions, energy production and use contributes two other greenhouse gases: CH_4, primarily from natural gas systems and coal mining, and N_2O from fuel combustion.

[19] See Endnote 1.

[20] See U.S. DOE, EIA. 2003. *Emissions of Greenhouse Gases in the United States 2001*, p. 26.

[21] *Ibid*.

[22] *Ibid.*, pp. 24 and 21 (respectively).

[23] A rulemaking by the Department of Transportation, in progress at time of writing, calls for the light truck standard to be raised to 22.2 mpg by 2008.

[24] Greene and Schafer.

[25] National Research Council. 2002. *Effectiveness and Impact of Corporate Average Fuel Economy (CAFE) Standards.* Available at http://www.nap.edu/books/0309076013/html/.

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Pew Center on Global Climate Change
2101 Wilson Blvd., Suite 550
Arlington, VA 22201
Phone: 703/ 516.4146
Fax: 703/ 841.1422
www.pewclimate.org