CHAPTER 3

Energy and the Environment

Although fossil fuels will continue to compose a large share of the U.S. energy portfolio for some time, the Federal Government has taken major steps to increase and diversify the Nation's energy supply and improve the environment. Since 2001, the Government has made significant investments to develop cleaner and more reliable energy sources. Several regulatory changes are expected to deliver dramatic improvements in air quality nationwide. The President has signed two major pieces of energy legislation, the Energy Policy Act (EPACT) of 2005 and the Energy Independence and Security Act of 2007 (EISA). EISA was enacted in response to the President's "Twenty in Ten" goal, issued in the 2007 State of the Union Address, of reducing U.S. gasoline usage by 20 percent in the next 10 years by improving fuel economy and increasing the production of alternative fuels. EISA also includes numerous energy efficiency mandates that are projected to result in substantial reductions in greenhouse gas (GHG) emissions. In addition, the Nation is on track to meet—and currently projected to exceed—the President's 2002 goal of reducing U.S. GHG intensity (emissions per unit of GDP) by 18 percent by 2012. This spring, the President set a new goal of stopping the growth in total U.S. GHG emissions by 2025 and to begin decreasing them thereafter. The Administration has also recently led efforts to encourage wider international action on addressing GHGs, including action in developing countries.

Despite these steps by the Administration to address the problems associated with the country's reliance on fossil fuel–based energy sources, major challenges remain. For public health and environmental reasons, the United States must continue to improve air quality by ensuring that State and local areas come into compliance with Clean Air Act (CAA) requirements. Additional steps should be taken to mitigate the global problem of rising GHG emissions associated with fossil fuel–based energy consumption. Furthermore, diversifying the Nation's portfolio of energy sources and increasing domestic production may reduce vulnerabilities associated with the U.S. dependence on imported fossil fuels.

This chapter discusses policies for addressing the Nation's energy needs in the context of both global climate change and the reduction of local and regional pollution associated with fossil fuel–based energy use. It reviews some of the steps this Administration has taken to advance the transition to new sources of energy with fewer environmental and security concerns, and to find cleaner, more efficient methods of using existing energy sources. It also identifies some of the overarching challenges that lie ahead in developing any comprehensive energy policy.

The key points in this chapter are:

- Because of innovative regulations promulgated under this Administration, there should be substantial improvements in air quality over the next few decades. Two rules that implemented cap-and-trade programs in the electricity sector represent a significant step in using cost-effective, market-oriented policy instruments to dramatically reduce power plants' emissions of sulfur dioxide, nitrogen oxide, and mercury.
- Despite widespread support for increased use of market-based approaches to achieve our environmental and energy policy goals going forward, challenges remain in realizing the full potential of these approaches.
- There is an increasing need to reassess how well existing laws can address the environmental problems associated with fossil fuel use in more cost-effective ways. For example, it may become increasingly costly to make additional reductions in traditional air pollutants, and existing statutes were not meant to regulate global problems such as GHG emissions.
- Substantial reductions in global GHG emissions will require participation by all large emitters (countries and sectors within countries).

U.S. Energy Use and Policy Goals

Fossil fuels continue to satisfy the majority of the Nation's demand for energy. Petroleum accounts for about 40 percent of total energy consumption; 70 percent of this petroleum is used for transportation. Coal and natural gas are the next most commonly used fuel types, representing 22 percent and 23 percent of consumption, respectively. Coal is used almost exclusively for electricity production; approximately a third of natural gas consumption is also used in electricity production, with the remaining two-thirds being used directly by residential, commercial, and industrial sources. Finally, nuclear power and renewable energy sources such as hydropower, biomass, geothermal, wind, and solar power remain a small but growing share of our energy consumption, with nuclear power accounting for approximately 8 percent of U.S. energy consumption in 2007 and renewable energy accounting for approximately 7 percent. (See the 2*008 Economic Report of the President* for more details on U.S. energy sources.)

The Nation's current patterns of energy use pose a number of problems that warrant government involvement in energy markets. One is the concern over the public health and environmental effects of fossil fuel–based energy production and use. In particular, the emission of many common air pollutants that are created by the combustion of fossil fuels increases the risk of premature mortality and numerous acute and chronic health conditions. Additionally, these emissions damage ecosystems, impair visibility, and have a substantial impact on water and soil quality. In this chapter, "common air pollutants" refers to the so-called *criteria pollutants* (particulate matter (PM), ozone, nitrogen oxides (NO_X), sulfur dioxide (SO_2), carbon monoxide (CO), and lead), although much that is written about the criteria pollutants also applies to hazardous air pollutants or air toxics.

As in many other countries, anthropogenic (human-made) U.S. GHG emissions continue to increase. Because of the environmental risks posed by climate change and the national security implications of events like droughts and rising sea levels, many countries have grown more aware of the need to slow and reverse the growth of global emissions of carbon dioxide (CO_2) and other greenhouse gases. In 2007, total U.S. GHG emissions were 7,282 million metric tons of CO_2 equivalent (MMTCO2e), a 3-percent increase over 2000 levels; this increase is mainly attributable to energy use. Energy-related CO_2 emissions account for 98 percent of U.S. CO_2 emissions and more than 80 percent of total U.S. GHG emissions. The United States represented about 17 percent of world GHG emissions in recent years.

For energy security reasons, concerns also remain about the U.S. reliance on imported fossil fuels. Net oil imports to the United States account for a substantial share of national oil consumption, which many argue makes the United States economy more vulnerable to oil price shocks that are the result of supply disruptions in unstable exporting regions. However, as economists have pointed out, it is important to remember that it is primarily U.S. oil dependence, rather than U.S. dependence on imported oil, that exposes the country to turmoil in world oil markets. Given the integrated nature of the oil market, a supply disruption in one region still removes oil from the world market causing the price of oil to rise regardless of where it was produced.

Despite a weak economic outlook for 2009, projections indicate that energy consumption in the United States and around the world will continue to grow in the long run. Thus, we will need to continue to determine how to meet these needs while both addressing energy security concerns and improving environmental protection. It is clear that long-term policies aimed at reducing the Nation's overall reliance on fossil fuels can help to advance both goals. However, taking intermediate steps that help us use fossil fuels in more responsible ways during the transition to alternative sources of energy is still consistent with this long-term objective. For example, this Administration has supported removing regulatory impediments to bringing domestic energy sources, including fossil fuels, to market, to advance energy security objectives. It has also supported finding cleaner ways of using fossil fuels. Some of the Administration's efforts on each of these fronts are covered later in this chapter. Before that, the next section provides a brief overview of policy approaches for addressing these objectives.

The Promise of Market-Oriented Policy Approaches

This section reviews the advantages of market-oriented policies, while noting some of the challenges that must be overcome to use them most effectively in tackling some policy objectives such as climate change. This section also discusses the role for policies supporting research and development and widespread adoption of new technologies that pose fewer environmental or security concerns.

Market-Oriented Environmental Regulation

Regulatory approaches for addressing the policy goals outlined above are often grouped roughly into two categories: conventional, or *command and control* approaches, and market-oriented approaches. Conventional approaches to reducing pollution, for example, tend to involve policy instruments that mandate the amount individual entities can emit or prescribe which abatement behaviors or technologies should be adopted. These types of policies are often called command and control approaches because they offer little flexibility about how a particular environmental goal may be met (although, among command and control approaches, performance-based standards can offer a bit more flexibility in achieving abatement goals than do technology-based standards). Market-oriented approaches, by contrast, encourage behavior through price signals rather than with explicit standards on pollution-control levels or methods. Policy tools such as tradeable permits or taxes, for example, offer firms an incentive to reduce their pollution by placing a price on each ton of pollutant emitted.

The primary advantage of market-oriented policies is that, if they are designed well and properly implemented, they have the potential to achieve environmental goals at a lower cost to society than traditional command and control policies. This is because of the greater flexibility they offer in determining how to reduce emissions. If emitters can choose the method of pollution reduction, they have an incentive to find the lowest-cost way to meet the regulatory requirement. For example, policymakers could require producers and consumers to take into account the environmental and public health effects of a criteria pollutant like sulfur dioxide by imposing a tax on emissions that is equal to the incremental damage caused by a unit of emissions or by establishing a *cap-and-trade* program, under which policymakers set an overall cap on emissions but allow regulated entities to trade rights (called *allowances*) to those limited emissions. Since the cost of reducing emissions may vary across firms and sectors, what may be the least expensive approach for one firm may be a relatively high-cost approach for another firm. Emitters that can reduce emissions most inexpensively will do so and then sell allowances to those who face much higher abatement costs. As a result, the most economically efficient allocation of the pollution-control burden among emitters can be achieved without requiring the policymaker to make assumptions about how compliance costs may vary across firms.

Another significant advantage of market-oriented approaches is that they can provide a greater incentive to develop new ways to reduce pollution than can command and control approaches. Command and control policies often offer incentives to abate only to the level of the standard, whereas a pricing approach encourages emitters to continue to innovate as long as they find it relatively cheap to do so. Well-designed pricing of CO_2 emissions through a tax or cap-and-trade program, for example, would give firms a direct incentive to invest in developing new low- or zero-carbon technologies based on their expectations of the increases in the costs of emissions. It would also encourage competition in making incremental innovations in existing emission reduction options. Of course, it will be important to address hurdles in providing the infrastructure necessary to allow large-scale deployment of new technologies, a point to which we return below.

Both of these advantages have created widespread support among economists for greater use of emission pricing policies to address environmental problems, including those problems associated with fossil fuel–based energy use. However, it is important to emphasize that challenges remain in realizing the full potential of market-oriented policy approaches. This is especially true in the context of climate change. Carbon pricing through a cap-and-trade system or, closely related, by taxing fossil fuels in proportion to their carbon content, will require broad-based participation to be effective in addressing global GHG concentrations. Limited action that does not result in emissions reductions from countries that contribute a significant share of world emissions will not lead to significant progress on climate change goals, since the majority of the future growth in emissions will come from developing nations. Absent action by all major emitting countries, it will be impossible to have a meaningful impact on the problem. Also, without similar policies across these countries, firms in energy-intensive industries that face high regulatory costs in the U.S. could have an incentive to move their operations to unregulated foreign markets. These issues and other challenges in implementing more economically efficient policies are discussed in greater detail below.

The Role for Technology Inducement Policies

Another method policymakers often use to give incentives for taking into account the environmental or security consequences of a particular behavior is to subsidize behavior that poses fewer environmental or security concerns.

For example, similar to the way a business reacts to a price signal such as an emissions tax, a profit-maximizing business will abate pollution or invest in research and development (R&D) in cleaner technologies up to the point where the cost is more than the subsidy or reward earned for doing so. This is not to imply that a tax and subsidy are equivalent policies. A tax generates revenue that can be used to offset other preexisting distortionary taxes (such as payroll taxes) in the economy, whereas a subsidy requires that revenue be raised by increasing existing taxes or requires reducing spending in other areas. Still, many economists maintain that, as a complement to any pricing policy, governments will need to support R&D for alternative energy sources and ensure that any R&D support is managed efficiently and effectively. These policies may be justified on economic grounds primarily because the process of generating and diffusing new energy technologies is characterized by imperfect market outcomes. The most significant of these is the general underinvestment in innovation due to the pure public-good nature of R&D. Because devoting a firm's resources to innovation may yield *knowledge spillovers*—benefits to society that do not translate into profits for the innovating firm—there may be an inefficient, low level of R&D in alternative energy technologies. This problem has long been recognized in all industries, and there are numerous policies in place to help innovators reap the rewards of their innovations (for example, patents, copyright laws, funding for general science research).

In assessing the desirability of public sector support for research and development, one might consider the extent to which private sector incentives for R&D already exist. Private incentives for R&D investment may vary across categories of prospective R&D:

- *Emission control for currently regulated pollutants.* In this case, there are regulatory incentives for the private sector to develop technologies that control emissions, but there will only be incentives to develop technologies that reduce emissions in ways captured by regulation.
- *Energy efficiency, new energy sources, and alternative energy.* Since energy is an expensive input, there are strong private sector incentives to develop new or improved technologies even without any government regulation. Support for public sector R&D in this area would be specifically justified if individual producers and consumers do not account for the broader value of energy security or of positive spillovers to others from the technology that goes with the new alternative.
- *Emissions from pollutants that are not currently regulated.* In this case, the incentive for private sector R&D is very limited, because prospective developers are not only uncertain about whether their new invention will work, but also must consider if or when the pollutant will be regulated, and whether their technology will be acceptable under future regulations.

Technologies to reduce emissions of non-CO_2 greenhouse gases are among those that are not currently regulated, as are technologies that would capture and store such gases to prevent them from entering the atmosphere.

It is important to highlight that domestic R&D support for alternative technologies may also help create incentives for action on climate change by other major emitting countries that are unwilling or unable to adopt GHG-reducing regulations. For example, investment in developing low-cost, low-carbon technologies could lead to inventions that such countries would adopt voluntarily. Additionally, it is often argued that production costs of new, unproven technologies fall as manufacturers gain production experience. If the gains from such "learning by doing" experience can be captured by other producers without compensating the early adopters, then there may be inefficient, low deployment of new technologies.

The difficulty in promoting technology adoption through subsidies and other tools lies in designing policies that are neutral across all alternative technologies. Weighting the size of a subsidy by the degree to which each technology reduces environmental and security concerns would help to ensure that the Government is not in the position of picking winners. In April 2008, the President called for a reform of the existing low-carbon technology deployment tax incentives into a single, expanded incentive with such features. We return to this issue below. Overall, there is less agreement among economists about the justification for these types of policies that target the commercial use of a technology than those that target the R&D stage of the technology innovation process. Many argue that once fundamental research is no longer necessary, the market should decide how widely a new technology is adopted.

Increasing Use of Alternative Energy Sources

There are many alternatives to fossil fuels available for meeting our energy needs in the electricity, transportation, and other sectors. Electricity may be generated using renewable sources (such as wind, solar, geothermal, biomass, and hydropower) or nuclear power. In the transportation sector, solutions range from finding new fuels for traditionally gas-powered vehicles to designing different types of vehicles such as those that run on electricity or hydrogen. Policy tools used under this Administration to promote the transition to some of these alternatives can be grouped into two categories: technology policies that provide incentives to encourage R&D and deployment of new technologies, and mandates that require increases in alternative energy use.

Generating Electricity

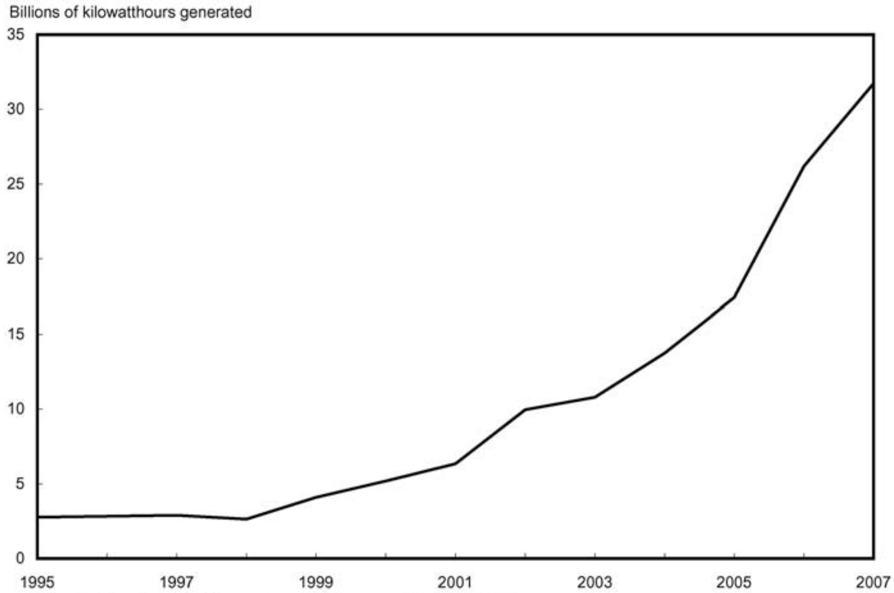
In the electricity sector, the Administration has supported development of alternative energy technologies through a mix of incentives, including both basic research investment and technology deployment policies. Department of Energy funding for electricity-related R&D, for example, totaled $11.5 billion (2007 dollars) from fiscal year 2002 through fiscal year 2007. This section reviews some of the existing incentives for promoting electricity generation from renewable energy sources and nuclear power.

Renewable Energy

Renewable sources of energy such as wind, solar, and geothermal power are desirable for generating electricity because, despite their high initial fixed costs, they are domestic sources of power with no fuel costs or emissions except those involved in building the infrastructure required to generate the power. Biomass-fired electricity, which is derived from sources such as wood, waste, and alcohol fuels, is also a renewable source. While not technically a zero-emission process, biomass energy produces fewer common air pollutants than coal and, depending on the feedstock and firing process, has the potential to create fewer GHG emissions than either conventional coal or natural gas. This Administration has encouraged deployment of renewable energy technologies in electricity generation primarily through tax incentives. For example, the renewable energy production tax credit (PTC) has been important in encouraging the growing market for wind power. Although wind still provides only 1 percent of the United States's electricity, wind generation has grown by about 400 percent since 2001 and, in 2007, made up 10 percent of electricity generation from renewable energy sources (see Chart 3-1). This growth is in part because, in some areas, the PTC makes the cost of wind more competitive with other energy sources such as natural gas. Incentives and requirements for renewable energy use in numerous States are also contributing to the increase. The Federal PTC has been renewed and expanded several times since its original enactment in 1992, including by EPACT 2005 and again in October 2008. It is currently available for a broad range of renewable sources such as solar power; certain geothermal, landfill-gas, and biomass projects; ocean energy; and livestock methane-based power.

Renewable energy deployment is also encouraged through tax credits for investments in renewable energy equipment and property. For example, the Energy Policy Act of 2005 (EPACT) increased the solar investment tax credit (ITC), which offers businesses a tax credit for investments in solar energy equipment and installations. The 21-percent increase in solar powered electricity generation capacity between 2006 and 2007 may indicate that the solar ITC is having some effect. In order to provide clear and consistent incentives for technology investment, policies such as the PTC should be maintained for a

Chart 3-1 **U.S. Wind Power Generation, 1995–2007**
U.S. wind power generation has soared in recent years and capacity grew further in 2008.



Source: Department of Energy (Energy Information Administration).

reasonable length of time but be phased out once they are no longer warranted to address barriers associated with the early commercialization of a technology.

It is worth noting that renewable energy sources, especially wind and solar, face infrastructure obstacles because many large-scale renewable energy installations are most likely to be built in remote areas. Also, neither wind nor solar can currently be relied on as a consistent means to produce energy 24 hours a day. The challenges of bringing these resources to market and finding better ways to store energy are discussed in more detail later in the chapter.

Nuclear Power

In addition to renewable energy sources, the Administration has promoted increased use of nuclear power as a clean, efficient energy source to meet the Nation's growing need for electricity. Nuclear power is not a new technology. Currently, 104 commercial nuclear generating units (reactors) in the United States supply approximately 20 percent of the country's electricity. Nuclear power generation makes no contribution to global CO_2 emissions and produces no notable emissions of SO_2, NO_X, and particulates. In addition, nuclear plants have low operating costs and are able to operate at close to full capacity all the time, thus providing a reliable, constant supply of electricity. Despite these advantages, high construction costs, investment risks, long-term management of spent fuel generated by nuclear plants, and regulatory hurdles have deterred any new commercial reactors from being ordered and approved for construction since 1978. The last new nuclear plant came on line in 1996.

The Administration has taken several steps to address some of the concerns that are barring greater use of nuclear energy. EPACT 2005 provided a new production tax credit to reward investments in the latest developments in advanced nuclear power generation. Since then, the Nuclear Regulatory Commission has received 17 applications for combined construction permit and operating licenses for 26 new nuclear generating units.

As part of EPACT, the President also authorized the creation of loan guarantee programs to encourage commercial use of new or significantly improved energy related technologies, including nuclear power. In 2008, Congress authorized loan guarantees worth over $18 billion to support construction of new plants and enable nuclear plant owners to reduce their interest costs. A loan guarantee is a promise by the Government to take responsibility for a certain portion of a loan in case the debtor defaults. By assuming some of the risk associated with loans for new projects, these guarantees are implicit subsidies for new nuclear energy projects. If priced appropriately, loan guarantees can help to encourage early commercial use of new technologies that had been hampered by informational asymmetries between project developers and lenders. However, such guarantees should be used with caution. If the Government assumes too much of the financial or political risk associated with a new project, investors may attempt to embark on speculative projects that could end up being costly for taxpayers. This same caution applies to loan guarantee programs available to support other energy sources such as renewable and/or energy-efficient systems, cleaner coal-based power, and other technologies.

Alternative Transportation Fuels

Petroleum use in road travel dominates energy consumption in transportation. In recent years, tax incentives have increased the use of some alternatives to petroleum, especially corn-based ethanol, but there has been an increasing emphasis on promoting alternatives that do not rely on food crops and have greater promise for significantly reducing GHG emissions. The Administration's efforts in this area have focused on providing incentives and funding to develop new vehicle technologies and reliable, low-cost alternative fuels to conventional gasoline and on mandating increased use of renewable fuels, including biofuels from non-food sources.

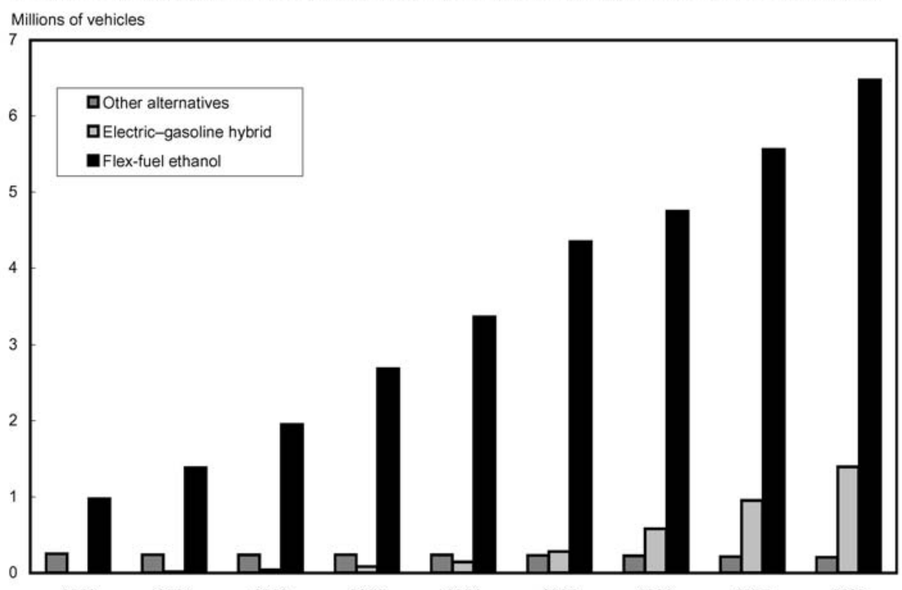
Incentive-Based Promotion of Alternative Fuels

Federal R&D support for alternative fuels has been led by a $1.2 billion investment (over 5 years) in hydrogen-based fuel cell vehicles and about

$1 billion since 2001 in cellulosic ethanol—an ethanol produced from wood, grasses, or the nonedible parts of plants. These fuels face significant cost hurdles which currently prevent them from being commercially viable. The benefits of R&D in hydrogen vehicles will take a long time to be realized because the vehicles still face formidable technological obstacles that may take decades to resolve. The projected cost of cellulosic ethanol, however, has dropped by more than 60 percent since 2001. If these cost reductions continue, cellulosic ethanol may become a viable transportation fuel more quickly than alternatives like hydrogen. Aided by the Corporate Average Fuel Economy (CAFE) credit given to manufacturers for producing "flex-fuel" vehicles that can run on either all gasoline or up to 85 percent ethanol, the number of light-duty vehicles that can accommodate large amounts of ethanol has grown by more than 5 million since 2001 (see Chart 3-2). However, as with other types of biofuels, significant economic, scientific, environmental, and logistical challenges remain with incorporating nationally significant volumes of cellulosic ethanol into the market. Fuel distributors and gas station owners will need to make significant investments in the infrastructure for new fuel distribution and manufacturers will need to make changes to vehicles to accommodate substantially larger biofuel volumes; existing gas station infrastructure and non-flex-fuel vehicles are currently only compatible with gasoline blends consisting of up to 10 percent ethanol.

Chart 3-2 **Alternative Fuel Light-Duty Vehicles in the U.S. Fleet**

Flex-fuel vehicles, capable of burning up to 85% ethanol, have led U.S. growth in alternative-fuel vehicles.



Source: Department of Energy (Energy Information Administration).

Another alternative technology that shows more near-term promise in reducing gasoline consumption is electricity for powering vehicles. The consumer tax credits created under EPACT in 2005 for purchasing electric—gasoline hybrid vehicles have helped to encourage hybrid sales, and there are now more than 1 million hybrid vehicles on the road. The so-called "plug-in hybrid" design takes this technology a step further by using the gas engine only for back-up status and letting the electric motor do most of the work. This is possible because the large battery pack of the plug-in hybrid can be recharged using a standard household outlet. The cost of the battery pack is a major hurdle to widespread commercialization of these vehicles. Between 2001 and 2008, the Department of Energy helped to advance battery technology with about $230 million in funding for energy storage R&D.

Replacing gasoline with electric power helps address energy security concerns by increasing the use of domestic, non-petroleum energy sources to meet our transportation needs. It does not eliminate GHG concerns or emissions of many local pollutants if the electricity is generated using fossil fuels, but it does reduce these concerns as well. Electric vehicles with more efficient alternating current systems would produce fewer CO_2 emissions per mile than most conventional gasoline vehicles if powered by electricity from a coal-fired power plant. CO_2 emissions per mile driven would be significantly lower than with gasoline if the electricity were generated with natural gas. This would also result in fewer emissions than powering a car directly with natural gas, which has shown greater use as an alternative to diesel in heavier trucks or buses. It will still be necessary to modernize and expand the electricity grid to accommodate substantial increases in electric power usage in the transportation sector. The challenge of expanding electricity transmission is discussed in more detail below.

Renewable Fuels Standard

In addition to using incentives to promote alternative fuels, the Administration has also acted to mandate increased use of alternatives to petroleum in transportation. In 2007, the President announced the Twenty in Ten goal to reduce U.S. gasoline use by 20 percent in 10 years. The passage of the Energy Independence and Security Act of 2007 (EISA) represents a major step toward this goal by requiring substantial increases in light-duty vehicle fuel economy standards and an increase in the production of renewable fuels.

The renewable fuels standard (RFS) portion of EISA is an expansion of the first RFS the President signed into law as part of Energy Policy Act of 2005 (EPACT), which required a minimum volume of renewable fuel to be sold or blended with gasoline in the United States. EISA raises the 2008 standard from 5.4 billion gallons to 9 billion gallons and increases the requirement each year thereafter, until reaching 36 billion gallons of renewable fuel by 2022. Beginning in 2009, about 5 percent of the RFS must be met with advanced biofuels—such as cellulosic ethanol made from switchgrass or wood chips or biodiesel made from leftover restaurant grease. By 2022, nearly 60 percent of the RFS-mandated volume must come from advanced biofuels. These advanced biofuels hold greater potential for reducing GHG emissions than current U.S. biofuels and are also less likely to affect future food prices because they are not reliant on food crops as feedstock, although some advanced biofuels may compete for land and other inputs with food crops. However, minimizing the negative environmental impacts (for example, on soil, water quality, forest cover, habitat diversity, and increased GHG emissions from land-use changes) of biofuel production is likely to remain a significant challenge regardless of the type of feedstock. Furthermore, while the RFS will lead to an increase in the use of biofuels, the expected reduction in gasoline consumption (and associated emissions) will likely be dampened due to unintended consequences. For example, gasoline consumption may increase in other countries due to a rebound effect from lower demand in the United States.

The risk of food-price spikes resulting from a binding RFS mandate could be mitigated by establishing a "safety valve" mechanism that would effectively cap the cost of meeting the mandate. With such a mechanism, a refiner or fuel blender would be allowed to purchase credits from the Government to satisfy its RFS requirement if biofuel prices exceeded a predetermined safety-valve price. This would prevent drastic shocks in food prices and also offer more regulatory certainty to refiners, blenders, and biofuel producers. Despite the Administration's support for a safety valve in the RFS mandate, the final version of EISA did not include such a provision.

Harnessing Existing Energy Sources More Responsibly

Given the economy's overwhelming reliance on fossil fuels, it is reasonable to assume that it will take some time to transition to alternative sources of energy. Therefore, in addition to supporting the development of alternatives described above, the Administration has led a parallel effort to promote cleaner, more efficient, and more reliable use of existing sources, including fossil fuels.

Increasing Efficiency

Efforts to use existing energy sources more efficiently have focused on improving efficiency in vehicle fuel use and in electric energy consumption through fuel economy standards on new cars and light trucks and through various lighting and appliance standards.

Vehicle Fuel Economy Standards

The EISA Vehicle Fuel Economy Mandate builds on the Department of Transportation's 2003 and 2006 fuel economy rules for light-duty trucks and requires that the light-duty vehicle fleet (new cars and light trucks) meet a Corporate Average Fuel Economy (CAFE) standard average of 35 miles per gallon (mpg) by 2020. The 2003 rulemaking increased fuel economy standards of new light trucks by 7 percent between 2004 and 2007 model-years, and the 2006 rulemaking required an additional 8 percent increase, bringing fuel economy of new light trucks to 24 mpg by model year 2011. The 2020 requirement represents approximately 40-percent increase in miles per gallon over 2008 standards: 27.5 mpg for passenger cars, and 22.5 mpg for light trucks. Several new credit trading and banking provisions will help reduce the cost to manufacturers of meeting the new standards and are an example of the use of market-based mechanisms. Under EISA, manufacturers whose vehicles exceed minimum CAFE standards can sell credits to other manufacturers below the standards, and companies can transfer credits between their car and light truck fleets. Companies are also permitted to carry credits forward for 5 years (instead of the current 3 years), which should encourage earlier introduction of new technologies and overcompliance in the initial years. In addition, EISA provides $25 billion in loans to the auto industry to assist in meeting the new CAFE standards. In April 2008, the Department of Transportation issued a proposal to raise fuel economy standards more rapidly than required by EISA.

In addressing potential energy security concerns, the advantage of CAFE over some other policies is that it encourages reductions in gasoline consumption, thus reducing not only oil imports but also the economy's overall reliance on oil. However, increased CAFE standards do nothing to reduce externalities related to miles driven (congestion, accidents, noise, local pollution) and will in fact increase these slightly as the per mile cost of driving falls. In addition, since regulations like CAFE standards that differentiate based on a vehicle's age make new vehicles less attractive than existing vehicles, the regulation may delay the turnover of the vehicle fleet and reduce the realized environmental benefits of the tighter standards. For such reasons, many economic analyses suggest that higher fuel taxes may be a more efficient solution to the negative externalities related to fuel consumption. As noted in Chapter 9, congestion pricing may also be a better way than CAFE to address many of the negative externalities associated with driving.

In the absence of other policies, increasing fuel economy standards will help reduce gasoline consumption and greenhouse gas emissions. It is also likely, as recent trends suggest, that higher fuel prices may persuade consumers to buy more fuel-efficient vehicles even before the higher mileage standards take full effect.

In addition to increasing the fuel economy of our vehicles, fuel efficiency may be increased by targeting inefficiencies at other points in the transportation network. For example, municipalities have saved millions of gallons of fuel and abated associated CO_2 emissions by monitoring and retiming their traffic signals and have seen significant returns on their signal-management investments (see Chapter 9).

Electric Energy Efficiency

The final set of mandates included in EISA is aimed at improving energy efficiency in electricity use. The Lighting Efficiency Mandate will essentially phase out the sale of incandescent light bulbs by 2014 and improve lighting efficiency by more than 65 percent by 2020. The Appliance Efficiency Mandate sets over 45 new standards for appliances. The Federal Government Operations Mandate requires Federal agencies to reduce the energy intensity of their facilities by 30 percent from 2003 levels by 2015 (an increase over the 20 percent reduction requirement set by EPACT 2005). EISA also revised the Federal Building Energy Efficiency Performance Standards so that fossil fuel-generated energy use is phased out of new Federal building designs by 2030. While these requirements will undoubtedly deliver efficiency improvements, reductions in fossil fuel use through these and other types of efficiency standards will be dampened by population and economic growth. In fact, the Energy Information Administration projects that net electricity consumption will still increase nearly 30 percent by 2030 even after accounting for the EISA efficiency standards. Furthermore, as in the case of vehicles, it is important to remember that improvements in electric efficiency will reduce energy cost per kilowatthour, resulting in some increased use of lighting, air conditioning, and other electricity-using activities. This rebound effect thus dampens somewhat the overall impact of the EISA mandates.

There are numerous other promising opportunities to make our electricity generation, distribution, and consumption more efficient and reliable. According to the Energy Information Administration, the U.S. electricity-generation system converts only one-third of total energy inputs into usable electricity, and about 9 percent of this electricity is lost during transmission and distribution. One way to increase the efficiency of the system would be through the use of a so-called "smart electricity grid." A smart grid could be able to receive power back from clients. It would thereby allow greater integration of renewable generation resources and facilitate distributed electricity generation from small-scale sources such as home photovoltaic panels and micro-turbines during peak demand times. Using a two-way communications system, a smart grid would also allow consumers in areas where electricity prices rise and fall based on real-time demand to shift energy consumption from high-priced peak demand periods to low-priced off-peak periods. Finally, by enabling near real-time monitoring of electricity use, a smart grid would give utility companies more time to detect faults and take steps to prevent the possibility of a blackout. These steps could include alerting consumers about reducing energy consumption during emergency periods of peak energy usage. Recent estimates suggest that deployment of smart-grid technologies could potentially reduce America's annual electricity usage by up to 4.3 percent by 2030.

The Department of Energy is undertaking many smart-grid planning, implementation, and awareness activities. EISA also authorized up to $100 million per year over the next 5 years for a smart-grid demonstration initiative to demonstrate the potential benefits of advanced grid technologies; to facilitate commercial transition from the current system to advanced technologies; and to improve system performance, power flow control, and reliability.

Cleaner Use of Fossil Fuels

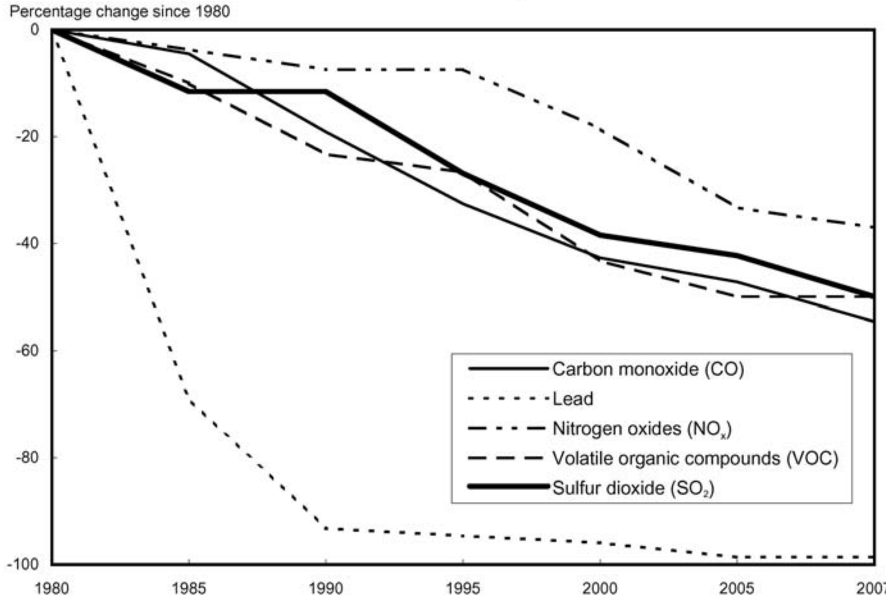
The recent mandates for increased energy efficiency have been further supported by policies promoting cleaner use of fossil fuels, including numerous regulations targeting local and regional air pollution and technology deployment incentives, such as tax incentives for advanced coal technologies.

Regulating Local and Regional Air Pollutants

Regulations directed at local and regional air quality problems are and will continue to be linked to policies to reduce GHG emissions. These policies often provide co-benefits to each other. For example, to the extent that regulations that target common air pollutants in the transportation sector lower fossil fuel use and make fossil energy cleaner, they also contribute to more secure energy with less environmental harm. Similarly, significant air quality benefits can be expected from climate change mitigation policies. (Note that the reverse may not be true, since pollution-control equipment consumes power, which requires greater fossil fuel use (and CO_2 emissions) to generate the same amount of usable energy.) There may be additional savings from reduced investment in local air pollution controls (such as equipment to reduce the amount of nitrous oxide (NO_X) and sulfur dioxide (SO_2) released into the air from coal-burning power plants) under a future GHG emission pricing policy that reduces the use of fossil fuels.

According to a number of indicators, air quality has improved dramatically over the past few decades. As shown in Chart 3-3, emissions of many common air pollutants have decreased, and these trends have continued through this Administration. For example, between 2000 and 2007, NO_X and volatile organic compounds (VOC) emissions (the primary precursors to ground-level ozone) fell by 23 percent and 12 percent, respectively, and SO_2 emissions fell by 19 percent.

Chart 3-3 **Emissions Levels over Time**
Emissions of common air pollutants have declined substantially since 1980.



Source: Environmental Protection Agency.

Over the past decade, the Environmental Protection Agency (EPA) has finalized—and is implementing—a suite of regulations on light- and heavy-duty vehicles and engines and nonroad mobile sources (such as construction, agricultural, industrial equipment, locomotives, and marine engines) that are transforming the diesel engine. The 2004 Clean Air Nonroad Diesel Rule, for example, is expected to reduce emissions from new nonroad diesel equipment (such as tractors and bulldozers) by over 90 percent from 2004 levels by 2014 and to reduce sulfur levels in nonroad diesel fuel by 99 percent from 2004 levels by 2010. The Administration has also strengthened the National Ambient Air Quality Standards (NAAQS) for three out of the six common air pollutants: fine particulate matter (PM2.5), ground-level ozone (the primary component of smog), and lead. Emissions of these pollutants stem from a wide range of sources and State plans for complying with the new standards will vary. Unfortunately, several areas, such as parts of California, remain grossly out of compliance with current NAAQS, and it will be difficult for some of them to reach compliance within the next couple of decades.

The President's 2002 Clear Skies Initiative called for using cost-effective, market-based policy instruments to dramatically reduce power plants' emissions of sulfur dioxide, nitrogen oxide, and mercury. Although Clear Skies legislation did not pass the Congress, in 2005 the EPA took a major step toward a more efficient multipollutant policy in the electricity sector by finalizing two rules, the Clean Air Interstate Rule (CAIR) and the companion Clean Air Mercury Rule (CAMR), which echoed many features of the Clear Skies Initiative.

The Clean Air Interstate Rule (CAIR) received broad support from economists, environmental groups, states, policymakers, and the regulated industry for promoting significant environmental improvements at a lower cost to society than a traditional command and control type of regulation. CAIR was designed to provide states with a solution to the problem of pollution that crosses State boundaries. Covering 28 eastern States and the District of Columbia, the rule requires the steepest emissions cuts from coal-fired power plants required in over a decade implemented in two phases by 2015. When fully implemented, caps on annual NO_X and SO_2 emissions would permanently reduce NO_X and SO_2 from coal-fired power plants in the eastern United States by more than 60 percent and 70 percent, respectively, from 2003 levels. The rule is projected to achieve over $100 billion in net benefits by 2015 (see Table 3-1). In addition to the cost savings from using a more market-based approach, CAIR's cap-and-trade program has other beneficial effects. For example, the cap on NO_X would prevent any increases in aggregate NO_X emissions in the East that might otherwise arise from electricity sector restructuring.

In February 2008, the United States Court of Appeals ruled CAMR to be unlawful because the EPA had not taken the appropriate steps to regulate mercury emissions from power plants under a more flexible portion of the Clean Air Act (CAA) that allows for a cap-and-trade program. Then in July 2008, the Court ruled that the CAIR rule was fundamentally flawed, and it vacated the entire rule. The ruling was based on several issues, including that the cap-and-trade program was too focused on regionwide emission reductions and did not adequately factor in each State's significant contribution to air pollution issues. For example, the Court deemed that CAIR did not provide adequate protection for downwind areas. While both rulings have been appealed through the courts and contested and debated on many fronts, their invalidation would have substantial consequences because the underlying requirements of the Clean Air Act remain in place. For example, all States would have to redo their State Implementation Plans (SIPs) to demonstrate compliance with CAA requirements and would not be able to rely on the cost-effective controls built into CAIR. The thousands of premature deaths avoided annually and other significant health and environmental gains would come at a higher price, if at all, in the absence of a fix for these rules that retains their trading provisions. After receiving petitions from a range of industry groups, States, and the Administration, in December 2008 a Federal appeals court reversed the earlier decision on CAIR, allowing for the

Table 3-1—*Projected Net Benefits from Selected 2001-08 EPA Clean Air Regulations*

Rule Name	Year Enacted	Primary Pollutants Targeted*	Net Benefits in 2020** (billions of 2006 dollars)	
			3% Discounting	7% Discounting
Electricity Sector				
Clean Air Interstate Rule (CAIR)	2005	SO_2, NO_X Cobenefits: Mercury	$119.2	$100.7
Clean Air Mercury Rule (CAMR)	2005; Revised 2006	Mercury Cobenefits: PM	–$0.8 to –$0.7	—
Transportation Sector				
Nonroad Diesel Engines and Fuel	2004	NO_X, PM	$49.2	$48.0
Locomotive and Marine Diesel Engines	2008	NO_X, PM	$3.6 to $8.5	$3.3 to $7.7
Small Spark Ignition Engines and Equipment	2008	Hydrocarbon (HC) + NO_X, CO	$1.0 to $3.9	$0.9 to $3.7
Emission Sources in Multiple Sectors				
Clean Air Visibility Rule (CAVR)	2005	SO_2, NO_X	$2.7 to $14.5	$2.3 to $11.3
National Ambient Air Quality Standards (NAAQS)				
Particulate matter (PM2.5)	2006	PM2.5, SO_2, NOX	$4.2 to $84.7	$2.9 to $71.4
Ozone	2008	NO_X, VOC Cobenefits: PM	–$6.8 to $11	–$7.0 to $9.9
Lead	2008	Lead Cobenefits: PM	$0.9 to $6.8	–$2.6 to $2.4

*Lists pollutants whose reductions are monetized in the benefit calculations. There may be additional cobenefits resulting from reductions in other pollutants that are not quantified in the rulemaking analysis.
** The table shows net benefits expected in 2015 for CAIR and CAVR and 2016 for lead NAAQS.

Note: Consistent with OMB and EPA guidelines, net benefits are calculated using both a 3 percent and 7 percent discount rate for valuing future impacts (although net benefits using the 7 percent discount rate are not available from the revised 2006 CAMR analysis). Note that the assumptions and methods used in each of the Regulatory Impact Analyses (RIAs) are not necessarily consistent across the rules listed.

Source: Environmental Protection Agency (Regulatory Impact Analyses).

reinstatement of the rule until EPA crafts a replacement. This reversal helps to avoid a prolonged period of regulatory uncertainty that may result in the reduction or elimination of pollution-control construction projects.

Developing Cleaner Fossil Fuel Technology

In addition to regulating local and regional air pollutants, the Administration has promoted cleaner ways to use our domestic fossil fuels through the use of tax incentives. For example, EPACT broadened the scope of the investment tax credits (ITCs) for renewable energy production to apply to investments in certain clean coal facilities, such as Integrated Gasification Combined Cycle (IGCC) power plants, which rely on a two-stage process in which pollutants are removed before combustion occurs. Recent research shows that the 20 percent ITC for new IGCC plants potentially could make this technology cost-competitive with new conventional coal plants. Because of their inherently higher operating efficiency, IGCC plants are estimated to produce up to 8 percent fewer CO_2 emissions per megawatt hour (mWh) than conventional coal plants. Furthermore, capturing and store the CO_2 emissions underground (known as carbon capture and sequestration, or CCS) would be less expensive in an IGCC plant than in a conventional power plant. Also, the IGCC process produces very low levels of common air pollutants (NO_X, SO_2, and PM) and volatile mercury, which reduces the cost of compliance with regulations of these emissions. To date, two 260–290 megawatt (mW) IGCC power plants are in operation in the United States and others are in the pipeline. A third, larger facility (with 630 mW capacity) received approval in January 2008.

Removing Regulatory Impediments to Domestic Production

Finally, the Administration has worked to remove regulatory impediments to bringing domestic energy sources, including fossil fuels, to market. In July 2008, the President lifted the Executive restriction on offshore exploration and requested that the Congress also lift its ban. On September 30, 2008, the ban on offshore domestic exploration of natural gas and oil was allowed to expire, a decision that would allow open access to an estimated 14 billion barrels of oil and nearly 55 trillion cubic feet of gas off the Atlantic and Pacific coasts. These previously restricted areas represent a sizable portion of the estimated 101 billion barrels of oil and 480 trillion cubic feet of natural gas untapped on the outer continental shelf. While we strive toward the long-term goal of reducing the economy's overall reliance on oil for environmental and security reasons, expanded domestic oil and gas production in these areas will help reduce the $300 billion Americans spend each year on net petroleum imports.

Overarching Challenges

Despite widespread support for increasing the use of market-oriented approaches to achieve our environmental and energy policy goals going forward, numerous challenges remain in realizing the full potential of these types of policies.

Balancing Local, Regional and Global Goals

First, any future comprehensive national energy policy will need to address potential tradeoffs between environmental and security goals, as well as tradeoffs between competing environmental goals. As noted earlier, policies aimed at mitigating local air pollution can at times reduce GHG and vice versa. For example, the clean diesel programs may provide climate change benefits by reducing black carbon (soot), the climate change effects of which require further study but many argue could be quite substantial. (The clean diesel rules will also likely become more significant if there is an increase in the number of diesel vehicles due to policies aimed at improving fuel economy and reducing GHG emissions from mobile sources.) However, some air quality policies may result in "technology lock-in" that could cause major delays in the implementation of GHG control technologies because of the investment in capital and other resources to meet the air quality control requirements. Policies aimed at GHG mitigation may also at times increase emissions of traditional pollutants. For example, technology standards that require increasing the thermal efficiency of engines may lead designers to achieve the regulatory objective by raising combustion temperatures, a strategy that would tend to increase NO_X emissions unless countered by other control methods. The challenge going forward will be to design comprehensive policies that enhance synergies and reduce the degree to which policies may work at odds with one another.

There are additional conflicts that will continue to arise in achieving long term environmental goals. For example, in the transition to alternative energy sources, where will new facilities and transmission infrastructure for different types of electricity generation be built? This issue is especially contentious when talking about new nuclear facilities, large scale CCS facilities, and renewable sources such as off-shore wind turbines. Renewable energy facilities generally face greater siting hurdles than their conventional counterparts because they can only be located at certain sites. The most highly valued renewable resources are often in pristine, isolated parts of the country (like mountain ridges, open plains, and coastal waters) with significant environmental and aesthetic value. Siting hurdles are compounded by the additional transmission and distribution infrastructure that is needed to bring the electricity from remote generation sites to population centers. States will have to balance renewable energy goals with other environmental concerns in deciding whether to support investment in new transmission infrastructure, such as new regional transmission corridors. Similarly, there are significant challenges that must be faced in expanding or reconfiguring existing fuel distribution systems to accommodate the large volumes of ethanol and other biofuels required by EISA.

Obstacles to increased nuclear power generation extend beyond the hurdles of siting power plants. There is also a concern about the lack of long-term storage for the spent fuel generated by nuclear plants. To reduce the amount of spent fuel that must be properly contained for centuries, efforts may also be made to increase recycling of this fuel within the generation process, but without producing weapons-grade material. The Administration has laid the groundwork for tackling this issue through efforts such as the Global Nuclear Energy Partnership (GNEP) and the Nuclear Power 2010 joint government–industry effort to develop advanced nuclear plant technology and reduce technical, regulatory, and institutional barriers to nuclear deployment.

Efficient R&D Support for Alternative Energy Sources

Technology policies will continue to be an important component of any energy policy portfolio going forward. Many economists maintain that, as a complement to any pricing policy directed at environmental problems, governments will need to support R&D for alternative energy sources. The challenge will be to ensure that any R&D support is managed efficiently and effectively.

As discussed above, an emission pricing policy is a key step in inducing technological change at low cost because the emissions price provides the private sector with a direct incentive to invest in and deploy new environment-friendly innovations. Well-targeted technology policy can reinforce these incentives for private R&D and thus reduce future costs. Basic and applied energy-related research as well as the education of the next generation of researchers will continue to be in particular need of government support, because these areas are the least likely to be undertaken by the private sector. It will also be crucial to expand the use of more flexible research policy instruments that allow the market, rather than government, to pick technology winners. For example, the Government could award prizes for basic research advancements in energy storage, which would help to spur innovation in a wide range of low-carbon technologies. Efforts are already underway to expand the use of prizes in some areas. EISA provided authorization for an L-prize for high-efficiency solid-state lighting products and an H-prize for advancements in hydrogen technology.

Current policies that target the adoption or deployment phase of the technological development process also need reviewing. Many of the existing tax credits have been found to be costly ways of making renewable sources competitive with fossil fuel sources. However, if technology deployment incentives are needed, they should be applied in a way that is neutral across all alternatives. Existing subsidies such as the ethanol blender's tax credit, flex-fuel vehicle credits, and subsidies for alternative electricity generation, in combination with the growing use of existing residential deductions and credits for energy-efficient home improvements, have created a patchwork of incentives that send an inconsistent message about how much the abatement of a ton of carbon is worth. In addition, there are opportunity costs associated with resources devoted to any area of research or deployment support. For example, in the context of renewable fuels, additional support for first-generation biofuels such as corn ethanol reduces the amount of funding available for the development of other alternatives and could make it more difficult for second-generation biofuels (with potentially significantly lower GHG emissions) to become viable.

Going forward, it will be important to reform these subsidies so as to minimize market distortions. One way existing tax incentives could be simplified is to offer a single subsidy in which the payment is weighted by the extent to which petroleum consumption and/or carbon is reduced relative to a baseline technology. In April 2008, the President voiced strong support for such a reform of the current complicated mix of incentives to make the commercialization and use of new, lower emission technologies more competitive. Another policy instrument that could encourage commercial use of new energy-efficient technology at a lower cost to the taxpayer is the reverse auction, in which would-be subsidy recipients (such as a renewable energy project developer) submit proposals for new projects and bid the minimum price they would accept for zero- or low-carbon electricity generation. However, such technology adoption policies may still favor what are currently the least expensive technologies, rather than technologies that may have greater potential to reduce cost and improve environmental performance through learning by doing.

Economically Efficient Regulation Under Existing Statutes

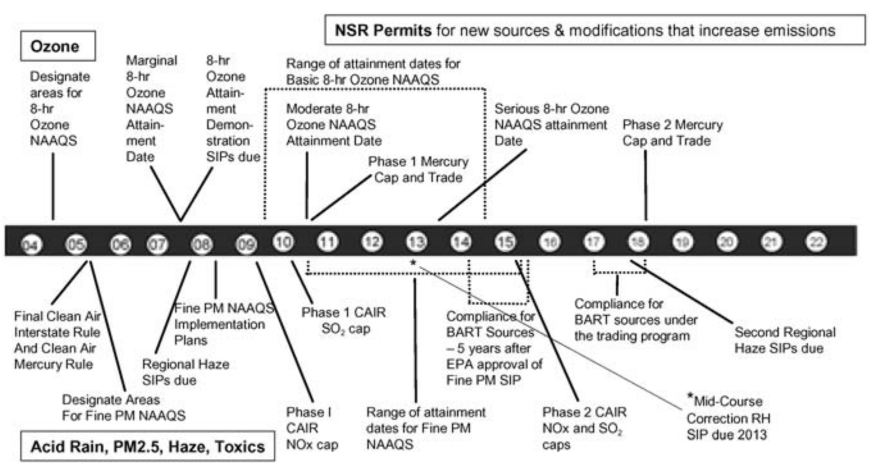
Another significant challenge in realizing the full potential of market-oriented policy approaches is likely to be the ability of existing laws to address old and new environmental problems in more efficient ways.

Local and Regional Air Pollutants

Although there have been great gains in reducing common air pollutants under the Clean Air Act, air pollution will continue to be a problem in the future, and the importance of finding economically efficient ways to further improve air quality will only increase. As seen in the 2008 National Ambient Air Quality Standard (NAAQS) for ozone, stricter standards have moved the private sector up the marginal cost-of-control curve. That is, it is becoming more costly to reduce each additional ton of NO_X and VOC emissions (the precursors to ground-level ozone). Upcoming reviews of the NAAQS for other pollutants will undoubtedly reveal a similar trend. These trends do not shed light on the relative cost of controlling one pollutant over others, due to the sequential nature of the individual NAAQS reviews. However, it is likely to spark debate about the benefits of moving either toward a more integrated multipollutant approach to controlling emissions of pollutants that pose the most significant risks or toward a more goal-oriented standard setting, as there may be no level that adequately protects human health and the environment for some pollutants (for example, lead), and currently costs cannot be considered in setting a NAAQS.

A multipollutant approach can help reduce the costs of meeting standards in regulated industries, such as the electricity sector, in which power plants face an increasingly complex set of requirements under the current Clean Air Act (CAA) (see Chart 3-4). The President's Clear Skies Initiative was an important first step in establishing a multipollutant approach. It is important that the market-oriented aspects of the CAIR and CAMR rules not be lost upon being remanded to the EPA for revision. The Administration has also made efforts to reform the complex requirements for upgrading or building new power plants under the New Source Review provisions of the Clean Air Act. Such age differentiated regulations can create a disincentive to invest in energy efficiency improvements, thus slowing turnover in the capital stock (equipment and facilities) and pollution abatement. The debate over how best to reduce such counterproductive incentives will undoubtedly continue in the future.

Chart 3-4 **Clean Air Act Requirements for New Electric Generating Units, 2004–2022**
Power plants face a complex set of requirements under the current Clean Air Act.



Note: The timeline was developed in May 2005 and reflects EPA assumptions about rulemakings that had not been completed at that time. EPA's rulemakings are conducted through the usual notice-and-comment process, and the conclusions may vary from these assumptions.
Source: Environmental Protection Agency.

Greenhouse Gas Emissions

Existing statutes are not well suited to tackling problems that were not considered when the original laws were written. In the context of climate change, the unique characteristics of GHGs and the ubiquity of GHG emission sources present significant challenges for economically efficient regulatory design under the existing Clean Air Act or other statutes. Unlike most traditional air pollutants, GHG emissions become well mixed throughout the global atmosphere, so a unit of GHG emissions has the same effect on environmental quality regardless of where it comes from, and, once emitted, GHGs can remain in the atmosphere for decades to centuries. Therefore, while policies can control the flow of GHG emissions, the ultimate concern is the stock—the cumulative concentration of GHGs in the atmosphere. These characteristics suggest that GHGs are particularly well suited to market-oriented policies that do not dictate the exact location and timing of emission reductions as opposed to the command and control type of regulation under the CAA that is used for some other pollutants.

There are examples of CAA regulations in which market-oriented approaches have been used for groups of mobile or stationary sources, such as in the Acid Rain Control Program, and even some cases in which multi-sector trading programs have been established. However, economists have demonstrated that taking a more integrated approach to control GHGs, such as through a common cap or price on emissions across sectors, would allow the market to identify a combination of methods to reduce the cost of achieving a given emission reduction. For example, expanding the coverage of such a market-oriented policy to include the industrial, electricity, and transportation sectors has been found to substantially decrease the cost of achieving a given emission reduction compared to one that is limited to the electricity and transportation sectors. However, if a policymaker's goal is to transform technology in a single area to the point where developing countries would voluntarily adopt the new low-carbon technology, then the advantage of a sector-specific approach is that it may help to ensure that technology investment remains within that sector.

It is unclear whether it would be legally possible to implement an economy-wide system for GHGs under the CAA. However, any economy-wide program under one provision of the CAA would likely trigger additional source-specific or sector-based requirements as a result of other CAA provisions, thus resulting in multiple programs affecting a particular sector, source category, or GHG. With multiple market-oriented policies focused on the same problem, the overall emissions reductions may not be achieved in the least costly way because there would not be a common price of pollution across all activities that directly result in GHG emissions. Without such a common price, full trading opportunities to reduce control costs will not be realized. In addition, emissions leakage across sectors and countries can occur when the cost of reducing one ton of emissions differs across them. When faced with a high cost of complying with new environmental regulations, a firm may move its operations to a jurisdiction with less stringent (and less costly) emissions controls. Current requirements under the CAA do not consider the actions (or inaction) of other countries or allow for consideration of unequal treatment of emissions across different types of emitters.

The Clean Air Act is also not designed to implement any carbon-pricing policy so that it operates in an efficient and transparent manner. For example, economists suggest that it would be economically efficient to employ a broad-based emissions tax, using the proceeds to decrease distortionary taxes. A well designed cap-and-trade system can have much in common with a well designed tax, but policy considerations should weigh heavily on how emissions allowances would be distributed under such a program. The economic literature broadly finds that there are significant efficiency advantages to auctioning emissions allowances, particularly if the revenues are used for reducing existing distortionary taxes. Also, cost-containment provisions in a cap-and-trade program, such as a safety valve allowance price, help to prevent caps from resulting in allowance prices that are higher than the social cost of the emissions. However, the CAA does not authorize the EPA to impose taxes or to administer a broad cap-and-trade program with auctioning and cost-containment provisions, making the Act ill suited to address the unique challenges posed by GHG emissions.

The globalized nature of GHG emissions is also likely to create difficulties in other statutes, such as the Endangered Species Act (ESA) and the National Environmental Policy Act (NEPA), which were designed to address local or regional concerns. For example, the ESA requires consultation between Federal agencies when a Federal action is likely to cause effects that pose a threat to a listed species. However, because the effects of GHG emissions have global repercussions, any causal connection between the effects of any particular action and the loss of a listed animal or its habitat is not discernible, or at least not significant or proximate enough to warrant such consultation. Similarly, the types of environmental impacts included in NEPA analyses are local or regional in nature and do not fit into the complexities related to global climate change effects.

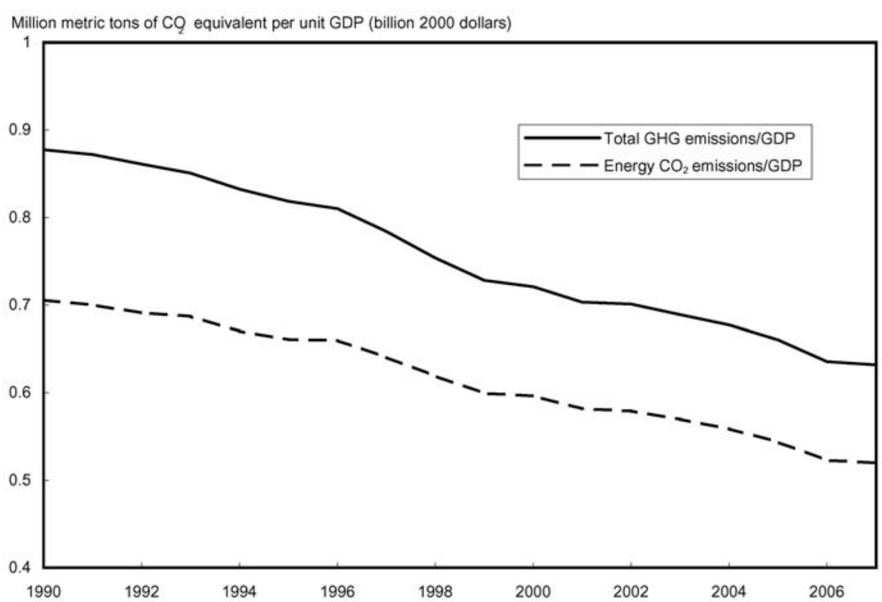
Given the difficulties in applying existing statutes to the unique problems presented by GHGs, policymakers should seek new approaches for enacting comprehensive and market-oriented solutions. The scientific debate over the specific GHG concentrations needed to affect global temperatures and the probability of catastrophic damages will continue for some time, and the policy debate over tough questions such as to how to value future emissions reductions is far from settled. In the face of such uncertainty and discussion of numerous other policy design issues, flexibility and transparency will be vital to the success of any policy designed to address global climate change.

Global Action on Climate Change

Finally, perhaps the most significant challenge in tackling climate change is developing broad-based global action to make meaningful progress in reducing GHG emissions.

As shown in Chart 3-5, U.S. greenhouse gas intensity (as measured by GHG emissions per unit of GDP) has been improving over time. In 2002, the President set a goal of reducing U.S. GHG intensity by 18 percent by 2012, and the Nation is on track to meet and exceed this target. Between 2002 and 2007, both energy-related CO_2 emissions per unit of GDP and total GHG emissions per unit of GDP declined by about 10 percent. In the spring of 2008, the President also set a new goal to stop U.S. growth in total GHG emissions by 2025. Despite U.S. action toward meeting these or future domestic GHG reduction targets, it is important to understand that U.S. action alone will not reverse global emission growth or stabilize global atmospheric GHG concentrations. Many assert that it is the responsibility of developed countries to reduce GHG emissions, since they have a longer historical record of emissions and therefore are responsible for most of the existing atmospheric concentrations. This formulation does not account for the reduction in the

Chart 3-5 **Greenhouse Gas Intensity of U.S. Economy, 1990–2007**
The greenhouse gas intensity of the U.S. economy has improved dramatically over time

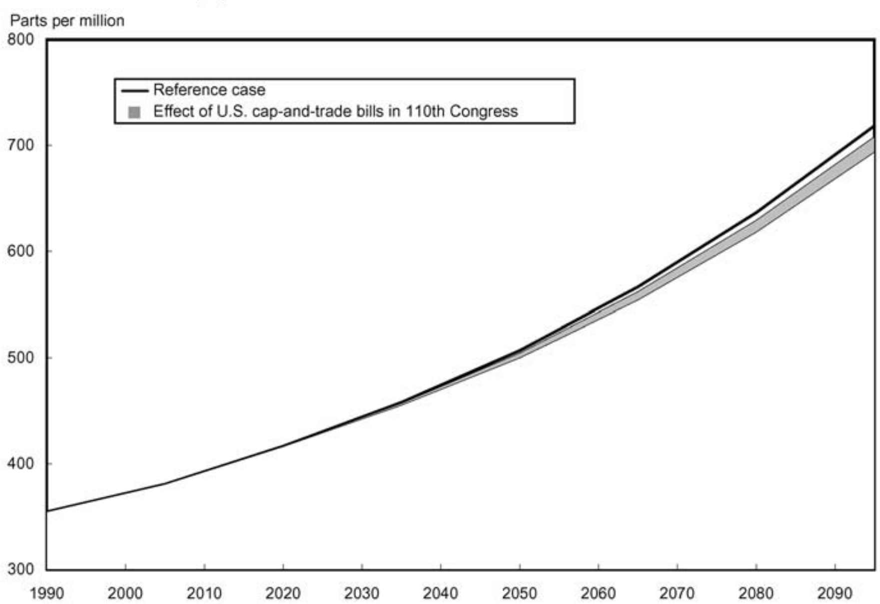


Source: U.S. Department of Energy (Energy Information Administration).

natural absorption of CO_2 (for example, in forests) due to land-use change that has occurred throughout the world. More important, actions by developed countries alone will not stabilize atmospheric concentrations given the recent and projected emissions growth in large rapidly developing economies.

Chart 3-6 provides one example of why it is important for all countries, particularly major economies involved in negotiations, to limit GHG emissions. The chart shows the future path of global CO_2 concentrations if the United States takes action to reduce GHG emissions under various cap-and-trade bills recently debated in Congress. One of the main reasons why future global concentrations do not decrease substantially compared to the reference case (which is a business-as-usual case that includes current international efforts to address climate change) is that major emerging economies represent a large and growing share of global GHG emissions. In addition, international emissions leakage may reduce global mitigation if only a handful of countries take action. Just as sector-based regulation of GHG emissions under the CAA raises worry about potential leakage of emissions across source categories, there are concerns about potential shifts in GHG emissions to countries where GHGs face no regulations. Energy-intensive industries in which domestic firms would face significantly higher costs due to regulation may move operations to unregulated foreign markets where costs are lower. International sectoral agreements in energy-intensive industries can help alleviate some of these competitiveness concerns.

Chart 3-6 **Global CO_2 Concentrations**
Carbon emissions are projected to rise over the next several decades.



Source: Environmental Protection Agency.

It is clear from the projections above, as well as other recent analyses of climate mitigation scenarios, that climate change requires a global solution, with participation by all major economies. The Administration has recently taken several steps to encourage wider international action to address GHGs, including promoting consensus toward commitments in developing countries. In 2007, the Administration launched the Major Economies Meeting (MEM) process, involving those of the world's major economies that use the most energy and emit the most GHGs, to help promote international action to slow, stop, and eventually reverse the growth of GHGs. This process is intended to support the United Nations Framework Convention on Climate Change (UNFCCC) negotiations by elaborating on areas of shared understanding among the major GHG emitters. At the July 2008 MEM meeting in Japan, leaders issued a Leaders Declaration that emphasizes "ambitious, realistic, and achievable" steps toward achieving these goals and agreement to take near-term actions. Leaders agreed to continue to work together to promote the success of the negotiations under the UNFCCC.

In addition to achieving commitments by all major economies, accelerating the deployment of clean energy technology in emerging economies is critical to mitigating climate change. To this end, the United States has taken several steps to form international partnerships to support national climate change efforts. In 2007, the Administration led efforts to produce an international agreement to accelerate the phase-out of the hydrochlorofluorocarbon (HCFC) refrigerants—a potent GHG—under the Montreal Protocol on Substances that Deplete the Ozone Layer. Under this agreement, both developed and developing countries explicitly agreed to accept binding and enforceable commitments that have climate change benefits. In 2008, the President launched the Clean Technology Fund to help bridge the gap between current technology and cleaner, more efficient ways of fueling the world's growth. The President has asked Congress for an initial U.S. commitment of $2 billion, and many other nations have pledge support. Altogether, the United States, the United Kingdom, Japan, France, Germany, Sweden, Australia, and Spain have pledged over $5 billion to the Fund, which will be housed at and overseen by the World Bank.

To be eligible for funding, a project must be consistent with the recipient country's national low-carbon growth strategy and must help move the relevant industry or sector toward a clean-energy path. Competition is intended to be technology-neutral, with projects competing for financing based on lifetime GHG reductions compared to the baseline technology and relative to the Fund's investment. The recipient country would contribute public and/or private capital to meet the project's baseline costs. The Clean Technology Fund would help finance the cost difference between the clean energy technology and the standard baseline, higher-emissions technology.

In partnership with the European Union, the United States also proposed the Environmental Goods and Services Agreement in the World Trade Organization (WTO) to eliminate tariff and non-tariff barriers to environmental technologies and services. This proposal included an agreement in the WTO to eliminate tariffs worldwide on 43 climate-friendly technologies identified by the World Bank. It also included a higher level of commitment from developed and most advanced developing countries to eliminate trade barriers across a broader range of goods and services. Global trade in the environmental goods covered by the proposal totaled approximately $613 billion in 2006, and global exports of these goods have grown annually by an average of 15 percent since 2000. The World Bank suggests that by removing trade barriers on key technologies, trade could increase by an additional 7 to 14 percent annually.

Other international partnerships to pursue development and diffusion of clean energy include the 21-member Global Nuclear Energy Partnership (GNEP) and the 7-country Asia-Pacific Partnership on Clean Development and Climate (APP). These are primarily sectoral efforts to support national climate change efforts. The GNEP, announced by the President in 2006, focuses on promoting technology breakthroughs to support the long-term expansion of clean, safe, proliferation-resistant nuclear power here and abroad. As mentioned earlier, safer ways to deal with storage of nuclear waste are crucial to this effort. The APP has a somewhat broader mission. It aims to promote coordination among different sectors to create new investment opportunities, build local capacity, and remove barriers to the introduction of a wide range of cleaner, more efficient technologies.

Conclusion

Energy policy will continue to be one of the major challenges facing the United States for many years to come. As the Federal Government moves toward a more integrated approach in confronting energy security, climate change, and other environmental challenges, we will need to ensure that we consider the economic efficiency of future laws and regulations. In addition to advancing clean and renewable energy technologies, a key challenge going forward will be leading all countries to work cooperatively to achieve global climate goals with meaningful participation by all major economies.