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MEETING ENERGY DEMAND IN THE 21ST CENTURY

Many Challenges and Key Questions

Statement of Jim Wells, Director
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March 16, 2005

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Highlights

Highlights of GAO-05-414T, a testimony to Darrell Issa, Chairman, Energy and Resources Subcommittee, Committee on Government Reform, House of Representatives

Why GAO Did This Study

Plentiful, relatively inexpensive energy has been the backbone of much of modern America's economic prosperity and the activities that essentially define our way of life. The energy systems that have made this possible, however, are showing increasing signs of strain and instability, and the consequences of our energy choices on the natural environment are becoming more apparent. The reliable energy mainstay of the 20th century seems less guaranteed in the 21st century.

As a nation, we have witnessed profound growth in the use of energy over the past 50 years—nearly tripling our energy use in that time. Although the United States accounts for only 5 percent of the world's population, we now consume about 25 percent of the energy used each year worldwide. Looking into the future, the Energy Information Administration (EIA) estimates that U.S. energy demand could increase by about another 30 percent over the next 20 years.

To aid the subcommittee as it evaluates U.S. energy policies, GAO agreed to provide its views on energy supplies and energy demand as well as observations that have emerged from its energy work.

This testimony is based on GAO's published work in this area, conducted in accordance with generally accepted government auditing standards, and on EIA's Annual Energy Review, 2003 and its Annual Energy Outlook, 2005.

What GAO Found

America's demand for energy has, in recent decades, outpaced its ability to supply energy. As a result, the country has witnessed rapid price increases and volatility in some markets, such as gasoline, and reliability problems in others, such as electricity, where the blackout in 2003 left millions in the dark. Given these recent and sometimes persistent problems, as well as concerns about the impacts of energy consumption on air, water, and other natural resources, there is a growing sense that action is needed.

Today, fossil fuels (coal, oil, and natural gas) provide about 86 percent of our total energy consumption, with the rest coming from nonfossil sources such as nuclear (8 percent) and renewables, such as hydroelectric energy and wind power (6 percent). Overall, the majority of the nation's energy consumption is met by domestic production. However, imports of some fuels have risen. For example, over the past 20 years, imports—primarily oil and natural gas—have doubled, and in 2003 these imports comprised about one-third of total domestic energy consumption. Imports are expected to increase still further in order to meet future domestic consumption. In light of the current and expected levels of imports, the United States is, and will increasingly be, subject to global market conditions, with the transportation sector especially affected. Global markets may face future difficulties in meeting the growing energy demands of developed nations while also meeting the demands of the developing world, particularly considering the explosive growth in some economies, such as China's and India's. If world supplies for some fuels do not keep pace with world demand, energy prices could rise sharply.

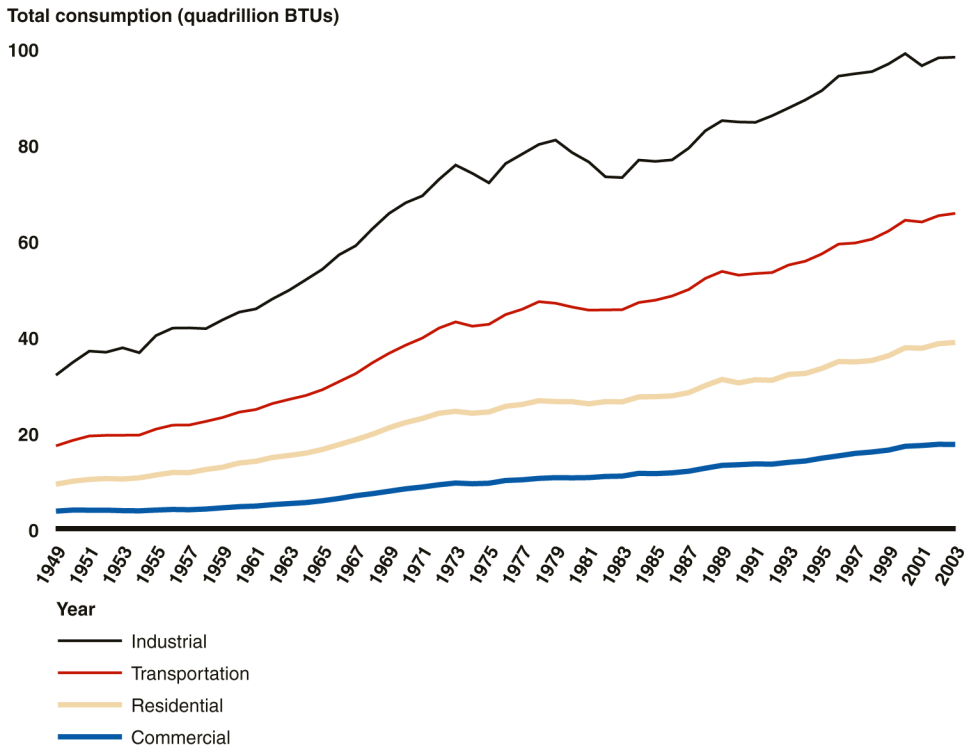
GAO believes that a fundamental reexamination of the nation's energy base and related policies is needed and that federal leadership will be important in this effort. To help frame such a reexamination, we offer three broad crosscutting observations. First, regarding demand, the amount of energy that needs to be supplied is not fate, but our choice. Consumers, whether businesses or individuals, choose to use energy because they want the services that energy provides, such as automated manufacturing and advanced computer technologies. Accordingly, consumers can play an important role in using energy wisely, if encouraged to adjust their usage in response to changes in prices or other factors. Second, all of the major fuel sources—traditional and renewable—face environmental, economic, or other constraints or trade-offs in meeting projected demand. Consequently, all energy sources will be important in meeting expected consumer demand in the next 20 years and beyond. Third, whatever federal policies are chosen, providing clear and consistent signals to energy markets, including consumers, suppliers, and the investment community, will help them succeed. Such signals help consumers to make reasoned choices about energy purchases and give energy suppliers and the investment community confidence that policies will be sustained, reducing investment risk.

Mr. Chairman and Members of the Subcommittee:

I am pleased to participate in the Subcommittee's hearing on the future direction of our nation's energy policies. Plentiful, reliable, inexpensive energy—in its various forms, including gasoline, natural gas, and electricity—has been the backbone of much of modern American economic prosperity and the activities that essentially define the American lifestyle. The United States accounts for only 5 percent of the world's population but consumes about 25 percent of the energy used each year worldwide. U.S. energy demand has increased over 25 percent since 1980, and in 2003 amounted to the equivalent of about 790 billion gallons of gasoline, or roughly 2,800 gallons for every man, woman, and child in the country.

As shown in figure 1, energy consumption in the United States has grown. While energy demand across residential, commercial, and the industrial sectors includes demand for all types of energy sources, such as oil, coal, and natural gas, demand in the transportation sector is almost completely oil dependent.

Figure 1: Energy Consumption by Sector, 1949-2003



Source: GAO analysis of data from the Energy Information Administration.

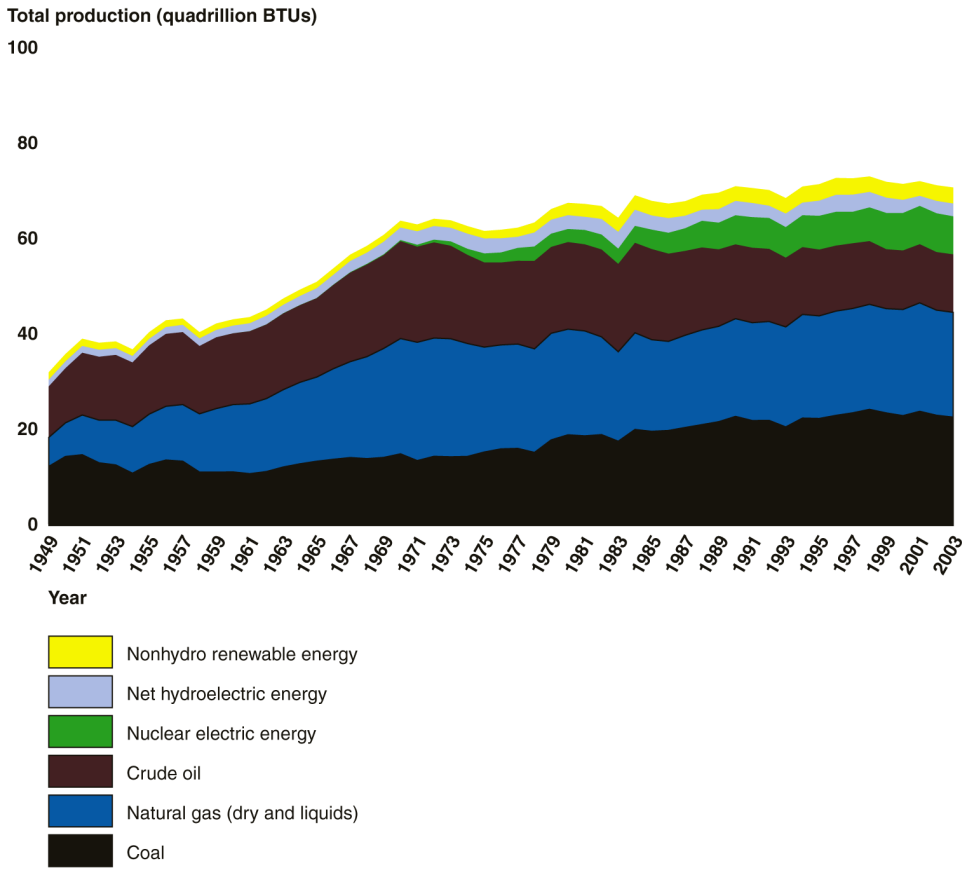
Note: BTU stands for British thermal units and is a standard unit used to measure energy consumption. In 2001, the average household in the United States consumes about 92 million BTUs per year.

Increasing demand across our economy has, at times, strained our energy system. For example, in recent years, natural gas prices have nearly tripled and crude oil prices have more than doubled, and gasoline prices now exceed $2.00 per gallon in Washington, D.C., San Francisco, and other major cities. In addition, our energy supplies have also witnessed problems, most notably in 2003 when the largest blackout in U.S. history left as many as 50 million people in the dark. Further, there have been indications that our energy infrastructure has not kept up with changes in our demand for energy as illustrated by (1) the nation's refinery capacity not keeping pace with the increasing demand for gasoline, leading to increased imports of gasoline, and (2) the electricity sector's transmission constraints periodically limiting the flow of electricity in parts of the country. Lastly, our energy dependence on other countries has increased,

raising greater concern about international turmoil in the Middle East, Russia, Venezuela, and elsewhere.

As shown in figure 2, the United States has increased production (generally through the extraction and use of oil, coal, and other fuels from the land) of a wide range of fuels over the past 50 years to help meet consumer demand. Today, fossil fuels account for about 80 percent of our total domestic energy production, with the rest coming from nonfossil sources such as nuclear electric energy, hydroelectric energy, and nonhydroelectric renewable energy sources, such as wind power. Despite the fact that the United States produces most of its energy, imports of some fuels are rising to meet growing U.S. consumption.

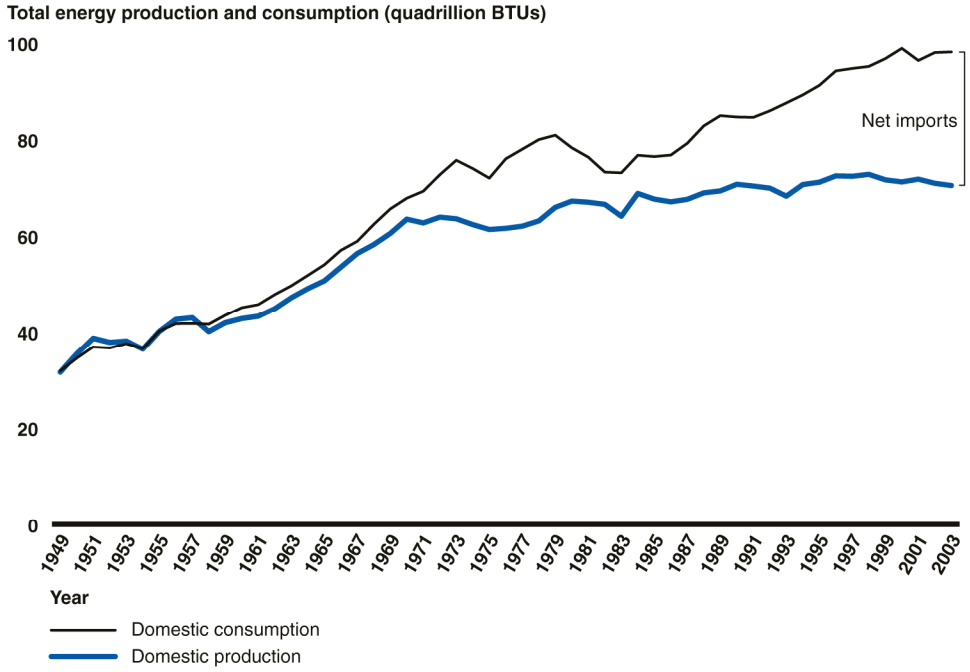
Figure 2: U.S. Energy Production, 1949-2003



Source: GAO analysis of data from the Energy Information Administration.

As shown in figure 3, over the past 50 years net imports of energy have increased. This increase has been most dramatic over the past 20 years, during which time energy net imports more than doubled, reaching 32 percent of our total consumption in 2003. The vast bulk of these imports are oil and natural gas.

Figure 3: Domestic Production and Net Imports Needed to Meet Consumption, 1949-2003



Source: GAO analysis of data from the Energy Information Administration.

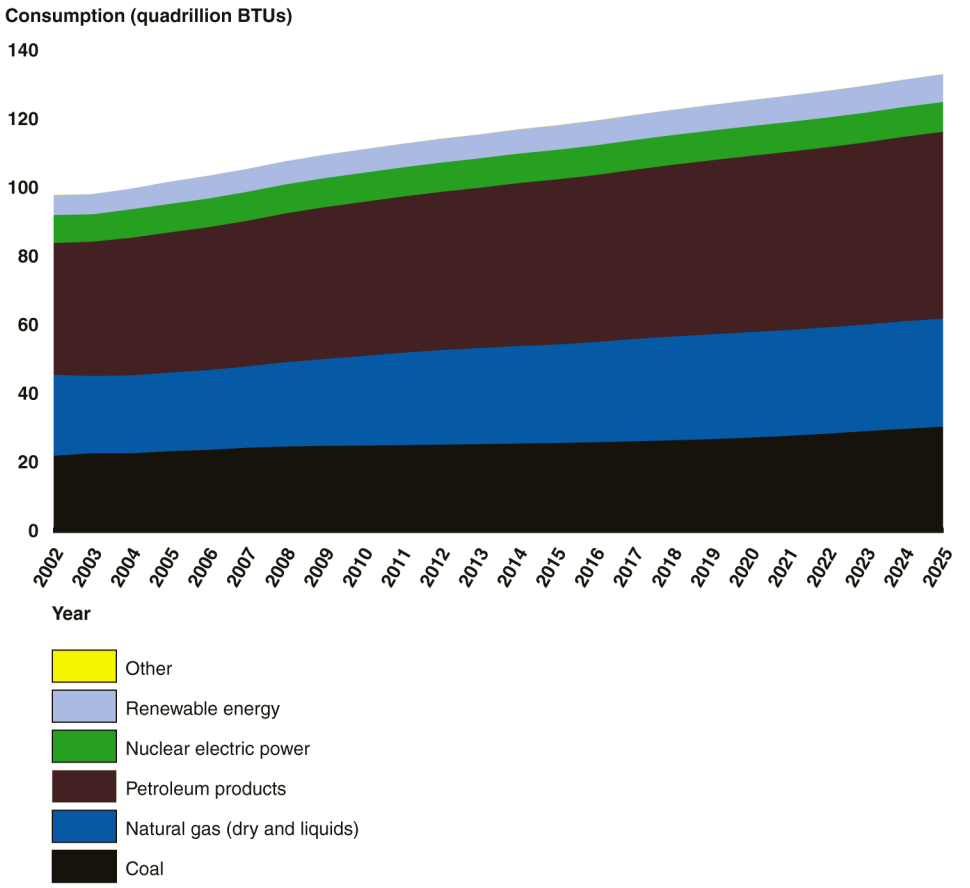
Nearly all energy is supplied by private companies that also own the energy supply infrastructure. Some of these companies are multinational corporations with worldwide shareholders, while others operate only locally. Further, most of the fuels used in the energy sector—including oil, coal, natural gas, and nuclear fuel—are sold at prices determined by competitive markets and, in some cases (such as crude oil), international markets.

Over the years, the federal government has intervened in energy markets, providing tax credits and other benefits to suppliers and consumers of traditional and renewable energy. For example, the federal government has granted tax incentives, direct subsidies, and other support to the petroleum industry, as well as tax and other benefits to the ethanol

industry, in an effort to increase U.S. energy supplies. Similarly, the federal government has also provided tax credits for the production of energy using renewable energy resources, such as wind turbines. While these tax incentives generally work to increase the production of energy, they also generally decrease revenues accruing to the U.S. Treasury.

Looking into the future, daunting challenges lie ahead. As shown in figure 4, the Energy Information Administration (EIA), within the Department of Energy (DOE), estimates that U.S. energy demand could increase by about another 30 percent over the next 20 years, if current trends hold. Meeting these projected increases could be more challenging in the natural gas and petroleum industries, because consumption of these fuels is forecast to increase by 37 percent and 33 percent, respectively, during that period. In addition, forecast imports for these two fuels are expected to rise by over 140 percent and 60 percent, respectively.

Figure 4: Forecast Energy Consumption, 2002-2025



Source: GAO analysis of data from the Energy Information Administration.

Unless changes are made, meeting the forecast increase in energy demand could further stress an already strained system. From a domestic perspective, the nation already faces energy supply constraints and higher prices for some important fuels, as well as environmental problems such as persistent air pollution in some cities. In addition, from an international perspective, the United States is increasingly subject to global markets for key energy sources, such as crude oil and, increasingly, for natural gas. Global markets may face difficulties in continuing to meet the growing energy demands of developed nations such as the United States, while also meeting the demands of the developing world, particularly in light of the explosive growth in some economies, such as China's and India's. If world supplies do not keep pace with world demand, energy prices could rise sharply.

Just last month, as part of our 21st Century Challenges report,[1] we identified two broad questions focused on reexamining the nation's energy base and related policies:

- To what extent are federal energy policies and incentive structures adequately preparing the nation to satisfy its energy needs over the long term?

- What is the appropriate balance between efforts to promote enhanced production of fossil fuels, alternative renewable energy sources, and the promotion of energy conservation?

Given the importance of energy to our nation's economy and current lifestyle choices, it is generally recognized that a secure, affordable, reliable, and environmentally sound energy supply is needed. However, the reliable energy mainstay of the 20th century seems less guaranteed in the 21st century. In the context of developing our nation's energy policies, we are providing our views on energy supply and demand based on our published work in this area, conducted in accordance with generally accepted government auditing standards. In addition, we are providing information on forthcoming work, as GAO continues to report on a range of energy activities and policies of the federal government.
In summary, based on past work and considering recent EIA forecasts, three broad crosscutting observations emerge that could help frame congressional efforts to develop the nation's energy policies:

- First, regarding demand, the amount of energy that needs to be supplied is not fate, but our choice. Consumers, whether businesses or individuals, choose to use energy because they want the services that energy provides, such as automated manufacturing, advanced computer technologies, and many high-technology household amenities. However, consumers can play an important role in using energy wisely by, among other things, choosing technologies that deliver the same services but that use less energy or reducing their energy usage when it is valuable to them to do so. For example, in electricity markets some utilities and system operators have created a variety of electricity pricing and other programs that encourage customers to adjust their usage in response to changes in prices or other factors. These "demand response" programs offer substantial benefits to participants and improve the functioning of these markets because they

[1]GAO, *21st Century Challenges: Reexamining the Base of the Federal Government*, GAO-05-325SP (Washington, D.C.: February 2005).

provide more accurate price signals to consumers and encourage more careful energy use while providing better incentives for conservation and/or energy efficiency.

- Second, all of the major fuel sources—traditional and renewable—face environmental, economic, or other constraints or trade-offs in meeting projected increases in demand. Consequently, all energy sources will be important in meeting expected consumer demand in the next 20 years and beyond. Meeting future demand will be particularly challenging for the transportation sector, where the United States is almost completely dependent on oil—more than half of which is imported. With just 5 percent of world population, the United States consumes roughly 45 percent of world gasoline. Further, the same international markets that supply U.S. needs will also need to supply countries in the developing world, such as China and India, which are experiencing increases in demand that far exceed even our own increasing thirst for oil.

- Third, whatever federal policies are chosen, providing clear and consistent signals to energy markets, including consumers, suppliers, and the investment community, will help them succeed. Energy consumers need clear and consistent signals so that they can make reasoned choices with regard to purchases of energy-consuming equipment that help to determine their long-term energy demand. Energy suppliers require clear signals regarding national policies and confidence that those policies will be sustained over time in order to undertake the substantial investment needed to support expected increases in consumption. The investment community also needs these clearly articulated policies to determine how much to invest in current and future infrastructure, new products, and new technologies.

Specifically, our testimony presents an overall energy picture, discussing each of the major energy sources used in the United States, along with consumer demand. We end each fuel discussion with examples of key questions facing the Congress, the executive branch, states, industry, and consumers.

Oil: Our Largest Energy Source, but Mostly Imported

Oil is the largest single energy source used in the United States and remains perhaps the most visible energy source to most consumers. Oil, and the gasoline refined from it, provided the critical energy for the automobile that mobilized America. Oil remains at the center of the transportation sector and at the center of our national energy policy debate.

In 2003, oil accounted for about 40 percent of the total U.S. energy consumption and the United States consumed about 7.3 billion barrels of crude oil—about 20 million barrels per day. Most oil is used in the transportation sector as gasoline, diesel, and jet fuel, with oil-based products accounting for over 98 percent of the U.S. transportation sector's fuel consumption. In addition, oil is also used as a raw material in the manufacturing and industrial sectors; for heating in the residential and commercial sectors; and, in small amounts, for generating electric power. Although the United States accounts for about 5 percent of the world population, we consume about 25 percent of total world oil demand. Although today the United States and its industrialized counterparts currently account for the bulk of the world oil demand, demand is growing rapidly in the developing nations, especially those in Asia, such as China and India.

The United States relies on imported oil for more than half of its supply and appears likely to increase its reliance in the future. Historically, the United States produced most of the oil it consumed. However, U.S. oil production began to decline in 1970 and has dropped by about 40 percent since then. Since 1970, imports of crude oil and other products have increased 255 percent, and imports now comprise nearly 56 percent of the U.S. oil supply. Part of the reason for the rising imports is cost; it has been less costly to purchase oil produced in other countries than it has been to produce it in the United States.

Rising U.S. imports have increasingly been supplied by countries belonging to the Organization of Petroleum Exporting Countries (OPEC), which collectively provided about 42 percent of our total imports during 2003. Since about 20 percent of our imports came from the Persian Gulf region and 14 percent came from Saudi Arabia, our reliance on these imports has made the United States subject to the political instability of the Middle East witnessed in recent years. We also import a large amount of oil from our neighbors in North America; about 30 percent of our imported oil came from Canada and Mexico. Going forward, the United States will increasingly rely on imported oil because although the United States is currently the world's third largest oil producer, U.S. proven oil reserves account for only about 2 percent of total world reserves. In contrast, OPEC holds about 68 percent of total world oil reserves.

The prices of crude oil and refined petroleum products, such as gasoline and home heating oil, have been volatile over the years. Since the 1970s, the crude oil market has, at times, been heavily influenced by the OPEC cartel. Because the member countries control a large share of world

production and total reserves, these countries have been able to influence crude oil prices by limiting supply through the use of country-by-country production quotas. These quotas have, at times, served to maintain a tight balance between world supply and world demand. However, because of the relative political instability in the Middle East and some of the other OPEC countries (such as Nigeria and Venezuela), occasional oil supply disruptions and price shocks have been a fact of life for about the past 30 years and may remain an issue for the foreseeable future. Although crude oil prices play a large role in determining the prices for gasoline and other refined petroleum products, other factors also influence the volatility of gasoline prices, including limited refinery capacity, low inventory levels relative to demand, supply disruptions, and regulatory factors—such as various gasoline formulations that are used to meet federal and state environmental laws. Federal and state taxes on gasoline and other products serve to raise the level of prices, but these taxes do not fluctuate often and so do not contribute to price volatility.

Demand has pressed the limits of the production and delivery infrastructure in the oil industry in recent years. While U.S. crude oil production has fallen, rapidly rising imports have required more ocean tankers of crude oil to be off-loaded each year—forcing expansions of ocean crude oil terminals and coastal refineries. Because some refineries have closed, and no new ones have been built since 1976, there are fewer refineries available to convert crude oil into gasoline and other products. Although increases in overall output have been achieved through expanding capacity at the remaining refineries and operating those refineries at very high production levels, the nation's domestic refining capacity has lagged overall demand growth for petroleum products. Further, the network of pipelines that delivers refined petroleum products also operates at high levels of capacity, sometimes limiting the amount of fuel that can be shipped. Finally, the capacity of gasoline terminals that distribute fuel to local gas stations is also limited in some parts of the country.

Over the past 30 years, the federal government has undertaken many efforts designed to influence petroleum markets and demand for petroleum based fuels. For example, in the mid-1970s, the federal government developed the Strategic Petroleum Reserve, part of an international reserve effort designed to mitigate the economic impacts on world economies of any large, sustained disruption to the oil supply. In addition, the federal government has supported a number of research and development and regulatory efforts designed to reduce demand for petroleum fuels in transportation. For example, the federal government

supported the Partnership for a New Generation of Vehicles in order to aid U.S. automobile manufacturers in developing gas-electric hybrid vehicles. In addition, the federal government has encouraged the development and deployment of technologies focused on identifying alternatives to petroleum-based fuels, such as the recent FreedomCAR initiative—a program to help develop fuel-cell technologies for vehicles.

GAO has issued numerous reports on aspects of the petroleum sector, including gasoline markets and government efforts to reduce consumption of gasoline in vehicles among other areas. We also have reported on government efforts to improve gasoline vehicle efficiency through the use of gasoline-electric hybrid technologies and to shift vehicle fuel use to alternatives such as compressed natural gas or hydrogen-powered fuel cells. GAO has also noted that low gasoline prices do not reflect external costs associated with gasoline use, such as health and environmental impacts of air pollution or the economic cost that may result from the nation's vulnerability to oil price shocks. Consequently, low gasoline prices work to discourage energy efficiency and the use of alternative fuels. Most recently we reported on the effects of mergers and market concentration in the U.S. petroleum industry, noting that mergers and increased market concentration that occurred in the mid-to-late 1990s contributed to higher wholesale gasoline prices—averaging about 1 to 2 cents per gallon. Other factors such as changes in gasoline formulations and supply disruptions may have also contributed to higher gasoline prices during this period. Later this year, GAO will release a primer on how gasoline is made and distributed, what factors influence the price of gasoline, and why gasoline prices change, among other things. In forthcoming work requested by the Congress, GAO will report on the presence of multiple fuel formulation requirements in some parts of the country and how the expansion of these fuels have affected prices.

Key Questions:

- What are the potential implications for the United States of increased world reliance on oil supplies from politically unstable sources, such as OPEC countries?
- To what extent can the United States increase refining capacity and other delivery infrastructure to meet growing demand for petroleum products?
- What are the implications if there are further consolidations in the U.S. petroleum industry?

- Are there ways to better reflect the full societal cost of using gasoline in gasoline prices, and what are the trade-offs of doing so?

Coal: Balancing the Use of an Abundant Domestic Resource with Its Environmental Consequences

Coal has been a key energy resource in the United States for over 100 years. Over this time, the use of coal has provided low-cost electricity but has brought with it environmental consequences, such as air pollution. Choices regarding the use of coal revolve around balancing these consequences, in the light of new technologies to reduce them, with the energy benefits of using this plentiful domestic resource.

In 2003, coal accounted for about 23 percent of total U.S. energy consumption. Nearly all of the coal consumed in the United States, 92 percent, was used in the production of electricity, with almost all the remaining 8 percent used directly by industries such as steel manufacturing. Coal-fired power plants provided about half of total electricity generation in the United States in 2003, with larger shares in some parts of the country such as the mountainous West and the Midwest. Coal is expected to remain a vital element in the country's energy supply; EIA's most recent forecast indicates that coal would continue to provide about 20 percent of the country's energy needs in 2025.

The United States has substantial domestic coal resources, leading some to refer to the United States as "the Saudi Arabia of coal." Nearly all of the coal used in the country is produced domestically. In 2003, using EIA data, estimates of recoverable U.S. coal reserves could last over 250 years, based on current usage. Coal is generally extracted from either surface, or underground mines, however underground coal also contains combustible gas, called coal bed methane, that can be removed using wells and burned to produce usable energy similar to conventional natural gas. Coal reserves are located across the country, with large reserves in the West, the Midwest, and the Appalachian Mountains, but consumption of coal from the West has increased sharply in recent years. A large portion of the coal reserves are located on federal lands and are subject to direct federal controls, such as payment of royalties, limits on the amount of federal land an individual company may mine, and requirements that surface land be restored to conditions similar to natural conditions when mining ends. Partly owing to the abundance of coal and technological improvements in the mining industry, coal prices have been declining in real terms since the mid-1970s.

The production and use of coal have a variety of environmental consequences, including those related to mining and those related to the

pollution that is emitted when coal is burned. Surface mining has the most significant impacts on land resources, in some cases substantially altering the terrain. Both surface and underground mines can significantly affect water resources by introducing pollution or silt into groundwater or waterways. Regarding air quality, combustion of coal in power plants emits pollutants and contributors to pollutants such as nitrogen oxides (NOx), sulfur oxides (SOx), particulate matter (PM), and toxic chemicals, such as mercury. Although some older power plants emit high levels of these substances, significant advancements have been made in the development of new power plants, utilizing new technologies that substantially reduce emissions. In addition to these pollutants, coal plants release a substantial amount of carbon dioxide, a gas that is common in nature but has been linked with the "greenhouse effect," a greater-than-normal rise in the planet's temperature. Although some countries have agreed to attempt to reduce emissions of carbon dioxide and other "greenhouse" gases, the United States does not currently regulate the emissions of such gases. However, DOE has supported research focused on developing a zero-emission coal-fired power plant that would not emit any pollutants or carbon dioxide into the air. In 2005, according to an industry policy group, 100 or more power plants featuring advanced technologies that substantially reduce emissions of pollutants are being considered for development in the United States.

We have issued reports and testified on two primary coal related issues: technologies supported under DOE's Clean Coal Technology program and the environmental consequences of using coal in power plants. Over the past several years, we have reported on the Clean Coal Technology program, noting that while DOE has reported successes in deploying new technologies, there have been management problems with the program and that there may be important lessons that should be considered in future similar efforts, such as the value of cost-sharing agreements and federal cost-sharing limits. We have also reported (1) that coal-fired power plants that have not been required to install modern pollution reducing equipment emit higher levels of pollutants such as NOx and SOx than plants where this equipment is present, and (2) that increased electricity generation in order to meet expected growth in demand may increase emissions of certain pollutants. In forthcoming work requested by the Congress, GAO will report on the effectiveness and cost of technologies to reduce mercury emissions, a toxic element present in coal that is emitted when coal is burned.

Key Questions:

- How can the federal government balance the use of this abundant domestic energy source with its regulated and unregulated environmental consequences?
- Where will additional coal be mined, where will new power plants be located, and are additional infrastructure improvements needed?
- What is the potential role for coal bed methane, what are the trade-offs of extracting it, and what, if anything, should the federal government do to influence its development and production?
- What changes in controls, if any, should the federal government make to how coal can be mined on federal land and elsewhere?
- What role, if any, should the federal government play in providing incentives for using coal in ways that are safer for the environment?

Natural Gas: A Widely Used and Versatile Fossil Fuel

Natural gas, the fuel of choice recently, is one of the most versatile and widely used fuels—significant amounts are used as a raw material in the fertilizer, chemical, and other industries; for space heating in the industrial, commercial, and residential sectors; and for electricity generation. Until recently, prices have been low and use of natural gas for space heating and for electricity generation has expanded rapidly. Meeting the projected future growth of natural gas demand through delivering additional supply poses challenges.

Natural gas plays a vital role in meeting the country's national energy demand, accounting for about 23 percent of the total energy consumed in the United States. Use of natural gas has been growing rapidly since the mid-1980s, with consumption increasing by about 35 percent from 1986 through 2003. Natural gas demand has been the greatest in the industrial sector, accounting for about 37 percent of total demand in 2003; followed by the residential sector and electric power, each accounting for about 22 percent; then the commercial sector, at about 14 percent. The rest, about 3 percent, is used in the transportation sector, mostly as fuel for pipelines. A significant share of the increased demand in recent years has resulted from increased use of natural gas to generate electricity. This use has increased by 79 percent since the repeal of the Powerplant and Industrial Fuel Use Act in 1987, which had restricted construction of power plants using oil or natural gas as a primary fuel; natural gas is now the primary

fuel in new power plants. EIA estimates that total natural gas demand could increase 50 percent in the next 25 years.

Although natural gas prices remained low for many years, in recent years they have increased dramatically. From 1995 to 2004, average wellhead prices for natural gas increased nearly three-fold; rising from $1.55 per thousand cubic feet to $5.49 per thousand cubic feet. These higher prices for natural gas may have contributed to industrial companies reducing or ceasing U.S. operations. EIA data indicate that demand has fallen rapidly in the industrial sector, where consumption decreased by 16 percent from 1997 through 2003.

Historically, almost all the natural gas used in the United States has been produced here, but a small and growing share is imported. Most natural gas production involves extracting gas from wells drilled into underground gas reservoirs, although some natural gas is generated as a by-product of oil production. In 2003, domestic sources provided about 85 percent of total consumption. Historically, most of the country's natural gas came from Texas, Oklahoma, and Louisiana. However, the Rocky Mountain region, Alaska, and areas beneath the deeper waters of the Gulf of Mexico are becoming increasingly important in supplying natural gas. Overall, from 1994 through 2003, domestic annual production held steady at about 19 trillion cubic feet. In 2003, the United States imported about 15 percent of the total natural gas consumed, with nearly all of it coming from Canada via pipeline. However, a small share is shipped on special ocean tankers as liquefied natural gas (LNG) from countries such as Trinidad and Tobago, Nigeria, and others. Looking ahead, the Energy Information Administration estimates that U.S. consumption could increase to about 31 trillion cubic feet (TCF) by 2025, expanding the gap relative to U.S. production and requiring increasing imports to meet U.S. needs.

The United States still has substantial undeveloped natural gas resources, but some of these resources are located under federal lands, and access to some of these resources is restricted. For example, about 40 percent of the natural gas resources on federal land in the Rocky Mountain region are not available for development. Additional natural gas reserves are located in federally controlled offshore areas or other areas and are not available for development at this time. Extensive drilling for natural gas can substantially modify the surrounding landscape, and in some cases can adversely affect wildlife and its habitat, degrade air and water quality, and decrease the availability of groundwater to ranches and houses that may depend upon it. The federal government is required to consider these environmental consequences when determining if, and how, natural gas

will be extracted from federal lands. In response, the natural gas industry has and continues to use more advanced drilling methods and processes to mitigate future adverse impacts.

Meeting the sharp increases forecast for natural gas demand could also require substantial increases in infrastructure, such as new pipelines and LNG terminals. In particular, increasing natural gas supplies may require greater pipeline capacity and new pipelines. For example, over the past 20 years the federal government has considered a variety of issues with financing and building a new pipeline across federal and state lands to deliver natural gas from Alaska. The federal government is involved in the regulation and permitting of natural gas pipelines, particularly those that must traverse federal lands. To meet the need for sharply higher imports of natural gas, some experts believe that the United States may need to build more LNG terminals. To date, however, such facilities have not been built due to economic, safety, and security concerns. Consequently, it is not clear whether the United States can effectively compete with other countries for these supplies.

Over the last several years, we have issued a number of reports on natural gas, including reports on the natural gas markets and their oversight, various approaches for compensating the federal government when natural gas is removed from federal land, and the impacts of higher natural gas prices on certain industries. In 2002 and 2003, for example, we issued reports analyzing natural gas markets and their oversight. We noted that (1) prices generally increase because limited supplies have not been able to react quickly enough to changes in demand; (2) the federal government (e.g., the Federal Energy Regulatory Commission and EIA) faces significant challenges in overseeing natural gas markets and ensuring that prices are determined in a competitive and informed marketplace, minimizing unnecessary price volatility; and (3) buyers of natural gas have options to reduce their exposure to volatile prices through the use of long-term contracts and financial hedging instruments. In forthcoming work requested by the Congress, GAO will report on federal efforts to understand and manage risks associated with potential terrorist attacks on LNG shipments and other tankers.

Key Questions:

- Should the federal government encourage further development of domestic natural gas on federal lands, and can it ensure that environmental impacts are adequately mitigated?

- What are the infrastructure needs of the natural gas industry, including natural gas pipelines generally and in Alaska in particular, and what role, if any, should the government play in facilitating the development of this infrastructure?

- What are the implications for consumers (residential, commercial, industrial, and electric power) of the increasing reliance on natural gas to generate electricity?

- What are the economic and other barriers and/or trade-offs to developing an infrastructure to support increases in LNG shipments, and what role, if any, should the federal government play?

- To what extent is the federal government positioned to ensure that natural gas prices are determined competitively?

Nuclear Energy: Emission-Free Energy Source, but with Waste Storage Problems and Safety/Security Concerns

Nuclear energy was once heralded as the single answer to all of the country's energy woes, with predictions that electricity would soon be "too cheap to meter." While these enormous expectations have not been met, nuclear energy has become an important part of the country's current energy picture and may remain that way for years to come. Whether we can continue to rely on, or expand our use of, nuclear energy in the future at existing plants or at new plants based on new designs, hinges on solving the long-term waste storage problem as well as resolving concerns over safety and security.

Nuclear energy currently accounts for about 8 percent of U.S. national energy consumption. Nearly all nuclear energy is used to generate electricity, and nuclear plants are important contributors to total U.S. electricity production, providing about 20 percent in 2003. The first commercial nuclear power plant came on line in 1957, and the country witnessed a flurry of construction from the late 1960s through the 1980s. Many nuclear plants operating today were initially licensed for 40 years, and many are now approaching the end of their licenses. Since an accident at the Three Mile Island nuclear plant in 1979 raised concerns regarding the safety of nuclear plants, no new plants have been ordered in the United States, and none has been brought on line since 1996. In addition, many of the plants that were completed witnessed multibillion dollar cost overruns.

Over the past several years, a number of nuclear generating units have been retired, but because the remaining 104 units have increased their

productivity, the output actually increased by about 13 percent from 1998 through 2003. This increase in productivity has been impressive; the average annual capacity factor[2] has increased from 71 percent in 1997 to 90 percent in 2004. These increases in productivity and other improvements have led some plant operators to seek to operate some plants at somewhat higher capacity.

There appears to be renewed interest in extending the licenses of some existing plants and even building new plants. Interest in nuclear power plants has increased, in part, because they do not emit regulated air pollutants such as nitrogen oxides, sulfur dioxides, and particulate matter that can be costly to control, or carbon dioxide, a greenhouse gas, that many in the electricity industry believe might be regulated in the future. Given the improved performance, limited air emissions, and production cost advantages of nuclear power plants, some companies operating existing nuclear plants have already had them relicensed through the Nuclear Regulatory Commission (NRC) to operate for up to another 20 years, and others have started similar efforts. In addition, there have been trade industry reports that a number of utilities and other energy companies are actively considering submitting applications to build new plants. Over the past 20 years, plants have continued to be built overseas. New designs have emerged and foreign manufacturers have gained significant experience building them. Nuclear energy plays a large role in supplying energy in France, Germany, Canada, Japan, and other developed nations. Although nuclear plants remain very costly to build compared to some other plant types, they have lower fuel and other operating costs and can produce electricity at a lower cost than new plants that use fuels such as coal or natural gas—the primary energy source used in new U.S. power plants. In this country, NRC has approved new reactor designs and NRC and the Department of Energy are working to reduce the approval and construction lead times for potential new plants.

Although the United States has a large domestic supply of uranium, the nation increasingly relies on international markets to obtain the nuclear fuel used here. Historically, the fuel used at U.S. reactors has been produced here. However, several factors have combined to reduce the competitiveness and capacity to domestically supply reactor fuel, including falling prices for reactor fuel on international markets and

[2]Capacity factor is the ratio of electricity generated to the amount of energy that could have been generated if the plant ran every hour of every day in the year.

factors surrounding the 1998 privatization of the United States Enrichment Corporation (USEC). In response to the changes in the market, USEC closed the Portsmouth, Ohio, fuel plant leaving only the facility at Paducah, Kentucky, as the domestic source. Both France and Japan have advanced facilities that produce nuclear plant fuel, and these provide a large and growing share of international supplies, including those used in the United States.

Although nuclear plants do not emit pollutants, they produce radioactive waste, including the highly radioactive waste that must be stored in isolation for thousands of years. The federal government committed to develop a permanent storage facility that would receive this waste by 1998, but delays have pushed the potential opening of the facility to the 2012 to 2015 time frame. Efforts to develop the facility have focused on storing the waste deep under Yucca Mountain in the desert north of Las Vegas, Nevada. In 2002, NRC reported that about 45,000 tons of spent fuel from nuclear plants was stored in the United States. Because the permanent repository has not been completed, the highly radioactive waste remains stored at power plants and other facilities and has been the subject of several lawsuits.

Nuclear power plants have been operated safely, largely without incident. Nuclear power plants contain radioactive materials that if released could pose catastrophic risks to human health over an expansive area, but are designed and operated to avoid such an event and incorporate measures to protect the plant from attack. The Nuclear Regulatory Commission, among other things, oversees these plants, conducting periodic inspections of the plant equipment and evaluating security. However, since the terrorist attacks of September 11, 2001, nuclear plants have emerged as a key security concern and attention on these plants has increased. Industry expects that new plant designs will further reduce safety and security risks, incorporating features that, among other things, automatically cool the nuclear reaction.

We have issued a number of reports dealing with aspects of nuclear energy covering three key areas: NRC's oversight of safety issues at the existing nuclear plants; the development of a permanent storage facility for the highly radioactive waste produced by nuclear plants; and the potential vulnerability of these plants in light of the terrorist attacks of September 11. In May 2004, we issued a report on the discovery that corrosion had eaten a pineapple-sized hole in the nuclear reactor vessel head at the Davis-Besse power plant in Ohio that did not result in a radioactive release but highlighted problems with NRC's inspections and oversight. We have

issued a series of reports, spanning more than 20 years, that focus on various aspects of developing of a permanent nuclear waste storage facility. In 2002, we reported (1) that it would be premature for DOE to recommend the facility at Yucca Mountain to the President as a suitable repository for nuclear waste; (2) that DOE was unlikely to achieve its goal of opening a permanent storage repository at Yucca Mountain by 2010; and (3) that DOE did not have a reliable estimate of when, and at what cost, such a repository could be opened. We have also issued reports concerning the vulnerability of nuclear power plants to terrorist attacks. In September 2004, we testified that NRC was generally approving plants' new security plans on the basis of limited details in the plans and without visiting the plants. In forthcoming work requested by the Congress, GAO will undertake a comprehensive review of NRC's reactor oversight process and how NRC ensures that plants operate safely. GAO will continue to examine homeland security issues related to protecting commercial nuclear power plants from terrorist attacks.

Key Questions:

- What role should nuclear energy continue to play in providing the nation's energy needs in view of the aging of existing plants?
- Should new nuclear power plants be built in the United States, and can their design and construction make sense from a business standpoint while providing the safety and security assurances important to surrounding communities?
- How can existing and future nuclear waste generated by power plants be managed in an appropriate and timely manner?
- Are changes needed in how the industry and NRC ensure that plants are operated safely and securely, and is enough being done to protect nuclear plants from terrorist attacks?

Electricity: In the Midst of Change

Electricity has emerged as one of the essential elements in modern life. Today, electricity lights our homes, enables our businesses to be more productive through the use of computers, and creates the basis for our modern quality of life, providing power for everything from our morning coffee to our nightly television news. Unlike the other types of energy that we have discussed—so-called primary sources of energy—electricity is generated through the use of the other energy sources (such as when natural gas is burned in power plants to generate electricity). Encouraged

by the federal government, the electricity industry is in the midst of historic changes. Assessing that transition and determining whether the federal government can improve how electricity markets function remains a focus for federal policy.

Electricity use has grown steadily in recent years. From 1980 through 2003, the quantity of electricity sold increased by 75 percent, with the largest increases coming in the residential and commercial sectors. Electricity is used in these sectors for space heating and for cooling, lighting, and operating small appliances, such as computers and refrigerators. Industrial consumption declined slightly over this period, reflecting the contraction of manufacturing, including some large industrial users of electricity such as the aluminum and steel industries.

In 2003, over 70 percent of electricity was generated using fossil fuels, with over 50 percent coming from coal-fired power plants, about 16 percent from natural gas, and small amounts from petroleum and other fossil fuels. In recent years, new power plants have predominantly relied on natural gas. Nuclear energy provides about 20 percent of electricity generation, hydroelectric energy provides about 7 percent, and a variety of renewable resources, such as wind turbines, provide the remainder.

The federal government has a direct role in supplying electricity, through the federally controlled Power Marketing Administrations, which market electricity produced by federally owned dams and other power plants and which own an extensive transmission network to deliver that electricity. These entities initially aided in the federal mission to bring electricity to rural areas; however, most now serve major metropolitan areas, in addition to some rural customers.

Historically, electricity has been produced and delivered by local monopoly utilities within a specific area, but this has been changing. The electricity sector is restructuring to foster more competition and provide an increased role for open markets. Competition is already under way for the wholesale markets that the federal government regulates. To facilitate fair wholesale competition, the federal government has also pressed for change in what entities control transmission lines—by approving the creation of independent transmission operators to take the place of utilities in performing this function. Some states, such as California and Pennsylvania, had also moved to introduce competition to state-regulated retail markets, where most consumers obtain their electricity. Although the electricity industry is restructuring to include a greater role for competition, the federal government still oversees wholesale electricity

markets through the Federal Energy Regulatory Commission (FERC). Because federal actions have restructured wholesale markets nationwide and states have variously chosen to restructure the markets that they oversee, the national electricity market is currently a hybrid, somewhere between competitive and regulated.

Unlike the other forms of energy, the amount of electricity supplied by power plants must be balanced, on a second-to-second basis, with the amount of electricity consumed in homes and businesses. To do this, utilities or independent entities direct the production of electricity and its movement over transmission lines to avoid blackouts. In some cases, such as in California in 2000 and 2001 and more recently in the Northeast in 2003, the balance between supply and demand was disrupted and blackouts occur.

Electricity demand is projected to increase by at least 36 percent by 2025, and the industry may require significant investment in power plants and transmission lines to reach those levels. The National Energy Policy Development report estimated that the United States may need to add as many as 1,900 power plants to meet forecasted demand growth. In addition, because the existing network of power lines frequently experiences congestion, the capacity of many key transmission lines may need to be increased to move electricity from these new plants and improve the reliability of the existing system.

We have reported on the development of competition in the electricity industry and evaluated the oversight of electricity markets. For example, in one report we found that the way the market was structured in California enabled some electricity sellers to manipulate prices. We also reported on the ability to add new power plants in three states, concluding that the success of restructured markets hinged on private investment in power plants and that this investment was reduced by higher levels of perceived risk in some markets, such as in California. Further, we recently reported on the potential value of empowering consumers to manage their own electricity energy demand in order to save money and improve the functioning of these markets. Allowing consumers to see electricity prices enables them to reduce their usage when prices are high—reducing their energy bills and improving the functioning of the markets. Following the 2003 blackout, we issued a report that highlighted challenges and opportunities in the electricity industry, including whether reliability standards should be made mandatory and whether control systems critical to the electricity industry have adequate security. Regarding oversight of electricity markets, we reported that while the Federal Energy Regulatory

Commission has made progress in revising its oversight strategy, it still faced challenges in better regulating these markets. In forthcoming work requested by the Congress, GAO will assess progress in reporting electricity market transactions for use in developing market indexes and the adequacy of controls over this reporting.

Key Questions:

- To what extent does the division of regulatory authority between the federal government and the states limit the electricity industry's ability to achieve the benefits expected from the introduction of competition in electricity markets?
- What changes are necessary to federal and state monitoring and oversight of electricity markets to ensure that they are adequately overseen?
- Will FERC's actions to promote reliability be sufficient, or will additional actions be needed to improve compliance with reliability rules?
- How does continued uncertainty about how the future of electricity restructuring and electricity markets affect electricity companies, investment in new plants and transmission lines, and consumer prices?
- What role should the federal Power Marketing Administrations play in restructured electricity markets?
- To what extent are homeland security principles being integrated into new electricity infrastructure and business processes?

Renewable and Alternative Energy Sources: What Role Will They Play in the Future?

Renewable energy sources, such as hydroelectric dams, ethanol, wind turbines, and geothermal and solar applications, currently comprise a small percentage of the total energy resources consumed in the United States. Several alternative sources, such as hydrogen and fusion power, may offer potential long-term promise, but research remains at an early stage. While these renewable and alternative energy sources have a nearly unlimited domestic supply, are perceived as relatively clean, and help diversify the U.S. energy supply, technical problems and high costs relative to other options have limited their use.

According to EIA, in 2003 renewable and alternative energy sources accounted for slightly more than 6 percent of the total U.S. energy consumption. Hydropower is the largest single source in this category and

makes up over 45 percent of all renewable and alternative energy consumed. Hydropower generation, which varies due to weather conditions, has fluctuated at about the same level since the 1970s. Wood accounts for about 34 percent of total renewable energy, although its use has declined since 1989. Waste and other byproducts, such as municipal solid waste, landfill gas, and biomass, account for about 9 percent and their use has been relatively flat since the mid-1990s. Geothermal energy use has decreased slightly since it peaked in 1993 and now accounts for about 5 percent of the total. Alcohol fuels, such as ethanol, make up about 4 percent of the total, but their use has increased rapidly in recent years, almost doubling from 1999 through 2003. Wind energy accounted for about 2 percent of the total renewable energy consumed in 2003 but has witnessed substantial and persistent growth in recent years, more than tripling from 1998 through 2003. Solar energy accounts for about 1 percent of all renewable and alternative energy consumed, and its use has declined slightly but steadily since 1997, although use of some specific solar technologies such as photovoltaic solar cells that convert sunlight directly into electricity has grown in recent years.

Renewable energy technologies are increasingly becoming part of global markets and are, in some cases, owned by large multinational energy companies such as oil companies. Solar and wind energy have grown substantially in these markets, but remain at relatively low levels in the United States. Growth in wind power has benefited from improvements in wind turbine technology and the availability of government tax credits here and overseas, both of which have improved the competitiveness of wind power technologies with more traditional forms of energy. EIA estimates, however, that if the federal government removes the tax credit, the U.S. growth in the generation of wind power will almost stop. However, EIA estimates that if the government maintains the tax credit, wind power generation in the United States is expected to grow nearly seven-fold over the next 20 years. Solar technologies, especially solar cell technologies that produce electricity, have supplanted traditional technologies, such as generators for some remote applications, and sales of solar cells have expanded rapidly worldwide, albeit from a small base.

Several alternative sources may offer long-term promise, although they are not ready for widespread application. Technologies such as hydrogen power and fusion are currently being developed as new sources of energy. While these technologies have the potential to deliver large amounts of energy with fewer environmental impacts than traditional energy sources, they cannot be counted upon to deliver significant amounts of energy in the near future due to significantly higher costs and technical challenges.

To date, use of hydrogen fuel cells still requires the extraction of hydrogen from another fuel source, such as natural gas, and currently this extraction is too costly to compete with other sources of energy. In addition, the infrastructure to support hydrogen power has not been built. While fusion also may have the ability to provide an abundant and clean energy source, research on this technology remains at a very early stage.

We have issued several reports describing the viability and technical progress of several renewable and alternative energy sources supported by the federal government. A continuing theme of these reports has been that when the government invests money into research and development initiatives, it is important to keep one eye on the technical goals and one eye on the marketplace. We have noted that the success of the investment should be measured by its contribution to increasing the use and feasibility of an energy source, rather than reaching specific technical research and development goals. In forthcoming work requested by the Congress, GAO will report on the impact of wind turbines on birds and other aspects of the environment, as well as geothermal energy development in the United States.

Key Questions:

- Should the federal government establish clear and measurable goals for the development and use of renewable and alternative energy sources, and, if so, how should progress toward these goals be measured?
- What should the federal government's role be in researching and developing existing and future sources of renewable and alternative energy sources?
- What are the costs and benefits of increasing our use of renewable and alternative energy sources?
- What are the implications of renewable energy mandates for deploying renewable energy technologies and for electricity markets?

Reducing Energy Demand through Efficiency and Consumer Choice: the Often-Overlooked Energy Option

Experts have long contended that energy strategies that reduce demand can cost less, be brought on line faster, and provide greater environmental benefits compared to strategies that increase the amount of energy supplied—particularly if demand reductions decrease fossil fuel consumption and related pollution. Such strategies include improving the efficiency of energy we already use and allowing consumers to choose when it makes the most sense to conserve energy. Despite their advantages, however, opportunities to improve efficiency and consumer choice are often overlooked.

Overall, energy demand in the United States has trended steadily upward for the last 50 years. While demand has increased, the amount of energy the country uses relative to its economic output has fallen. The amount of energy used for each dollar of gross domestic product has dropped by about half from 1970 through 2003. The reduction has been even more striking when examining the industrial sector, where energy used per dollar of GDP has fallen by over 60 percent since 1970. It is not clear whether this reduction reflects a decrease in energy intensive industries, such as aluminum and steel manufacturing, improvements in energy efficiency, or some combination of the two.

The federal government has, periodically, made efforts to reduce demand, encourage energy efficiency, or both. To reduce demand, the federal government has, among other things, encouraged consumers to voluntarily limit excessive heating and cooling of homes and to reduce the number of miles that they drive. To encourage energy efficiency, the federal government has established energy efficiency standards for such things as home appliances, air conditioners, and furnaces, as well as provided incentives for purchasing energy-efficient equipment. In the transportation sector, the federal government has required automakers to meet overall efficiency standards—known as Corporate Average Fuel Economy (CAFÉ) standards—for the vehicles they sell. The federal government has also made investments to improve energy efficiency and save money on energy at its own buildings through the Federal Energy Management Program and utilizing energy savings performance contracts.

Federal efforts have met with some success. According to the American Council for an Energy Efficient Economy and the Alliance to Save Energy, energy efficiency investments made from 1973 through 2003 saved the equivalent of 40 to 50 quadrillion BTUs of energy in 2003, equal to about 40 to 50 percent of total energy consumption and more than any single fuel provided. Several organizations, including a panel of several national

laboratories, estimate that many opportunities for additional improvements in energy efficiency remain untapped.

At times, however, federal efforts to reduce energy demand and improve energy efficiency have had to compete with efforts to keep energy prices low. For example, residential and commercial sectors of the economy have until recently been somewhat protected from price volatility by regulated prices for electricity and natural gas and thus have been less likely to reduce their consumption of these sources. Moreover, inflation-adjusted energy prices have generally declined, until recently. Reducing demand when prices are falling has been difficult for several reasons. For example, because energy-consuming equipment, such as air conditioners, furnaces, and lighting systems, is generally costly to purchase and lasts many years, consumers do not want to replace it unnecessarily. In addition, consumers are often not aware of the energy inefficiency of their homes and businesses. Falling energy prices have also made it more difficult to demonstrate the cost-effectiveness of spending money to replace aging and inefficient equipment, particularly for residential and commercial customers. In contrast, when consumers face prolonged period of higher energy prices, they are more likely to identify and adopt cost-effective strategies for reducing their energy demand. For example, following prolonged supply disruptions and price increases for gasoline in the 1970s, consumers in the 1980s chose to purchase more fuel-efficient vehicles, pushing up overall fuel efficiency averages nationwide. In the late 1990s the opposite has been true; relatively low prices for gasoline have encouraged consumers to choose to purchase larger and less fuel-efficient vehicles.

GAO has examined policies designed to reduce demand in electricity markets, as well as efforts to develop more fuel-efficient automobiles. In August 2004, we issued a report finding that electricity demand programs that better link the electricity prices consumers pay with the actual cost of generating electricity offer significant financial benefits to consumers, improve the functioning of electricity markets, and benefit the federal government by lowering its utility bills. In March 2000, we reported on the Partnership for a New Generation of Vehicles (which sought to develop a family sedan that could drive about 80 miles on a gallon of fuel) and found that the vehicle being developed did not match consumer vehicle preferences and that automakers would not be manufacturing such a vehicle for U.S. markets. In forthcoming work requested by the Congress, GAO will evaluate the Department of Energy's program for setting energy efficiency standards for appliances.

Key Questions:

- What are the benefits and costs of potential federal efforts to reduce energy demand?
- Are there economic, regulatory, or other barriers preventing the adoption of cost-effective, energy-efficient technologies that could meet consumer needs?
- Are there promising energy-saving technologies that are nearly cost-effective that the federal government should consider encouraging through the use of consumer incentives?
- Are there emerging energy-efficiency technologies that are past basic research but that could benefit from federal and industry collaboration?
- Which technologies offer the greatest long-term potential for reducing demand, and should they be considered for intensive federal research?
- To what extent are retail price structures impeding the deployment of cost-effective and energy-efficiency technologies?

Conclusions

Given the increasing signs of strain on our energy systems and our growing awareness of how our energy choices impact our environment, there is a growing sense that federal leadership could provide the first step in a fundamental reexamination of our nation's energy policies. As the Congress, executive agencies, states and regions, industry, and consumers weigh such a reexamination, we believe that it makes sense to consider all energy sources together, along with options to encourage more efficient energy use and consumer choices to save energy. While a balanced energy portfolio is needed, striking that balance is difficult because of sometimes competing energy, environmental, economic, and national security needs.

Clearly none of the nation's energy options are without problems or trade-offs. Current U.S. energy supplies remain highly dependent on fossil energy sources that are either costly, imported, potentially harmful to the environment, or some combination of these three, while many renewable energy options still remain more costly than traditional options. On the other hand, past efforts to reduce energy demand appear to have lost some of their effectiveness in recent years. Striking a balance between efforts to boost supplies from these various energy sources and those focused on reducing demand presents challenges as well as opportunities.

In the end, the nation's energy policies come down to choices. Just as they did some 30 years ago in the aftermath of the major energy crises of the 1970s, congressional choices will strongly influence the direction that this country takes regarding energy issues—affecting consumer, supplier, and investor choices for years to come. Consumer choices made from today forward will determine to a great extent how much energy will be needed in the future. In the same way, energy suppliers have choices about how much of each type of energy to provide, based increasingly on their interaction with competitive domestic and sometimes global markets for energy. Choices made by consumers and suppliers will be influenced by state and local entities, along with regional stakeholders in some areas of the country, which have authority over key decisions that affect such things as the siting of generation and transmission facilities as well as access to their lands. Similarly, investors have choices regarding where to invest their money, whether in new power plants, refineries, research and development for new technologies, or outside the energy sector all together. Yet, many of these choices may be significantly influenced, or even overshadowed, by broader forces that are beyond our control, such as expected energy demand growth in the developing world.

In closing, providing the American consumer with secure, affordable, reliable, and environmentally sound energy choices will be a challenge. I would like to note that more than 30 years ago, during the first energy crisis, our nation faced many of the same choices that we are confronting today. How far have we come? Have we charted a course that can be sustained in the 21st century? In 30 years, will we again come full circle and ask ourselves these same questions about our energy future? The answer to this final question lies in our collective ability to develop and sustain a strategic plan, with supporting incentives, along with a means to measure our progress and periodically adjust our path to meet future energy challenges.

I would be pleased to respond to any questions that you, or other Members of the Subcommittee, may have at this time.

Contact and Acknowledgments

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