DOE/PO-0062

POWERING THE NEW ECONOMY

Energy Accomplishments, Investments, Challenges

September 27, 2000
United States Department of Energy
Washington, DC 20585

In 1999, the Department of Energy and the White House Millennium Council launched a young artists exhibit to ring in the new century and celebrate the wonder of energy technology in the past, present and future. The young artists used the theme "honor the past, imagine the future" to depict their vision of energy technology and what it means to our lives. On the cover is "Vision of Energy" by Desiree Escobedo of Hawthorne Elementary School in San Antonio, Texas. Desiree's teacher is Diane Sosa. An online exhibit featuring 100 illustrations chosen from among 4,000 submissions can be viewed at www.energy.gov/kidz/zone/kidztoc.html.

This document is available on the web at www.policy.energy.gov.

DOE/PO-0062

POWERING THE NEW ECONOMY

Energy Accomplishments, Investments, Challenges

September 27, 2000
United States Department of Energy
Washington, DC 20585

This page intentionally blank.

A Message from the Secretary

This report—*Powering the New Economy*—updates and expands on the 1998 *Comprehensive National Energy Strategy*. The report highlights the Administration's energy accomplishments and investments, and examines the energy challenges facing the nation as we enter the 21st century.

The economic policies of the Clinton/Gore Administration have helped to clearly and cleanly move us from the Industrial Age to the Information Age—giving the nation more jobs at higher wages, low unemployment, real increases in personal and corporate income, low inflation, more expendable income, and greater consumer choices.

At the same time, however, this economic success—and the energy requirements of the Information Age—has dramatically increased demand for energy supply and energy reliability, straining the nation's energy infrastructure.

How do we meet the challenges posed by economic growth and the increased energy demand it brings? We need, for example:

- Additional incentives to ensure we have adequate supplies of oil and gas to meet our near- to mid-term power and fuel needs;
- Expanded policies, programs and investments in energy efficiency, renewable energy, and clean fuels;
- Federal electricity restructuring legislation;
- Added investments in policies and technologies to enable the interconnected gas/electricity grids—the intergrid—to operate at higher levels of efficiency and reliability;
- Increased international cooperation and development of clean energy resources; and
- Additional investments in clean, distributed power technologies, and ways to eliminate the barriers to their use.

All of this work needs to be done in the context of a continuously improved understanding of how energy demands of the 21st century challenge the energy infrastructures of the 20th century, of how the New Economy is affecting the competition for the capital needed to improve and upgrade our energy infrastructures, and of how the government's incentive structure and statutory frameworks should evolve to meet emerging energy needs.

We are proud of our energy accomplishments and look forward to working with industry, consumers, workers, environmentalists, the Congress, and state and local governments to meet the energy challenges of the new century.

Bill Richardson

This page intentionally blank.

POWERING THE NEW ECONOMY

Energy Accomplishments, Investments, Challenges

List of Figures

List of Boxes

This page intentionally blank.

POWERING THE NEW ECONOMY

Energy Accomplishments, Investments, Challenges

EXECUTIVE SUMMARY

A strategically focused national energy policy, integrated with economic, environmental, security, and technology policies, is critical to the well-being of Americans, our economy, and our way of life. To fuel the unprecedented economic growth seen during the Clinton/Gore Administration, the nation's energy resources have expanded to meet ever-growing demand. At the same time, we have met the environmental imperatives associated with increased energy production and use. This progress has been achieved through a sustained, bipartisan commitment to core principles:

- *Reliance on competitive markets as the "first principle" of energy policy,*
- *Support for energy science and technology,*
- *Promotion of government/industry/consumer partnerships,*
- *Use of targeted incentives and regulations, and*
- *Facilitation of international cooperation.*

Within this framework, the Administration has achieved many significant energy accomplishments and advanced a number of energy investments to:

- ✔ Promote energy efficient vehicles to reduce our reliance on imported oil;
- ✔ Promote efficient energy use in homes and buildings to reduce the nation's energy bills;
- ✔ Increase the competitiveness of U.S. industry by reducing its energy costs;
- ✔ Lower the costs of domestic oil and gas exploration through technology advances;
- ✔ Increase production and develop new sources of oil and gas supply through technology advances;
- ✔ Promote changes in government policies to increase oil and gas supply and encourage greater public/private partnerships to develop oil and gas resources;
- ✔ Encourage international cooperation on oil and gas issues and investments in oil and gas infrastructures and production at home and abroad;
- ✔ Increase the size and security of our "national oil insurance policy," the Strategic Petroleum Reserve;
- ✔ Improve the environmental performance of coal;
- ✔ Develop clean and innovative uses for coal to take advantage of its low cost and abundant supply;
- ✔ Develop next-generation options for nuclear power plants to promote safer, more affordable, and more environmentally-benign nuclear power for the future;
- ✔ Safely extend the life of existing nuclear power plants to meet current and growing electricity demand;
- ✔ Develop nuclear fusion as a clean, potentially limitless power source for the future;
- ✔ Safely dispose of commercial nuclear spent fuel to protect the public health and the environment in a responsible, safe, scientifically-sound manner;
- ✔ Economically generate more power from renewable energy sources to provide clean, abundant fuel for the future and reduce our reliance on imported and diminishing fossil fuel resources; and
- ✔ Cleanly power the nation's vehicles with renewable energy to improve the environment and increase our national energy security.

The economic success of the last several years, including the rapid growth of the Digital Economy, has also strained energy production and infrastructures, as demand for energy products and services has grown. This presents several preeminent energy challenges for the first decade of the 21st century, challenges largely identified in the Administration's *Comprehensive National Energy Strategy*, published in the spring of 1998.

Challenge #1: Enhancing America's Energy Security

Our transportation sector is 97 percent reliant on liquid fuels, and economic growth has left world oil capacity only a few percentage points greater than world oil demand. Our national response includes both supply initiatives and demand-side technology development to lower oil requirements and increase production. To meet this challenge the Administration is developing ways to:

- ✔ Reduce overall demand for oil in transportation, industry, buildings and power generation, especially through increased efficiency in use;
- ✔ Increase domestic oil production through tax incentives and technology investments;
- ✔ Promote international investment in developing the world's oil resources;
- ✔ Reduce volatility in world oil markets through international cooperation and better oil market data;
- ✔ Meet the need for increased refining and production capacity; and
- ✔ Protect consumers against price spikes and possible shortages by exploring options for continued filling of the Strategic Petroleum Reserve, through a new Home Heating Oil Reserve, use of Low Income Home Energy Assistance Program funds, and loans to small businesses.

Challenge #2: Increasing the Competitiveness and Reliability of U.S. Energy Systems

Electricity is increasingly the energy form of choice for myriad applications at home and at work. At the same time, the network of generation, transmission, and distribution facilities of electricity and the natural gas transportation system we use to fuel it, are strained by the increased demand for electricity and electricity services.

In addition, the digital New Economy is placing extreme demands on the infrastructure for increased power reliability and power quality. Increasingly the electricity, natural gas, and telecommunications infrastructures are linked, promoting opportunities for increased consumer services, at the same time these linkages add complexities to the system and the rules needed to govern it. To address these growing challenges, the Administration has:

- ✔ Proposed comprehensive federal electricity restructuring legislation;
- ✔ Proposed a significant energy infrastructure initiative to meet the technology needs of the 21st century electricity/natural gas intergrid;
- ✔ Hosted eleven regional electricity reliability summits to find ways to improve the reliability of our electric power supply;
- ✔ Created an Office of Energy Emergencies to anticipate, mitigate, and respond to the range of energy emergencies needs including electricity, natural gas and heating oil problems;
- ✔ Established an Interagency Task Force on Natural Gas to review and implement certain recommendations of the National Petroleum Council on natural gas supply and infrastructure needs;
- ✔ Proposed ways to eliminate key barriers to distributed generation, paving the way for the entry of these new technologies and systems into electricity markets.

Challenge #3: Mitigating the Environmental Impacts of Energy Production and Use

Americans place high value on environmental stewardship, and expanding energy use challenges our ability to protect the environment. The Administration has consistently advanced environmental goals through technology development, incentives, and regulation. Many of the accomplishments and investments discussed earlier, such as those dealing with end-use efficiency in the transportation, industrial and building sectors, directly provide environmental benefits. Other specific actions aimed at 21st century environmental challenges include:

- ✔ Mitigating global climate change through domestic and international cooperation;
- ✔ Addressing global climate change through research and development;
- ✔ Promoting environmental protection through tax incentives and investments in energy efficiency, renewable energy;
- ✔ Promoting cleaner fuels;
- ✔ Supporting a vigorous program for solar, wind, and other renewable energy sources focused on R&D, pilot projects, and other initiatives;
- ✔ Advancing clean energy through a new International Clean Energy Initiative;
- ✔ Creating DOE's 15th national laboratory, the National Energy Technology Laboratory, to focus on technologies to meet the Nation's energy needs for fossil fuel use in environmentally sound ways;
- ✔ Enhancing carbon capture and sequestration programs.

Challenge #4: Providing Diverse Energy Technologies for the Future

Today's technology investments are essential to meet tomorrow's energy needs. The pace of energy research and development needs to increase in line with the Administration's proposals submitted to the Congress over the last several years. The cumulative effect of lower appropriations levels will be felt in the years ahead. The Department of Energy has developed a comprehensive energy R&D portfolio analysis process, working with the private sector and the academic and scientific communities, to ensure that:

- ✔ Our energy investments reflect the Administration's strategic energy goals;
- ✔ DOE's energy research and development portfolio addresses emerging energy challenges; and
- ✔ DOE's energy R&D budget requests reflect energy priorities and the investment levels necessary to meet our future energy needs.

Conclusion

The economic policies of this Administration have helped ensure the nation's successful transition from the 20th to the 21st century—from the Industrial to the Information Age. We also have significant challenges ahead of us and look forward to working with industry, consumers, workers, environmentalists, the Congress, and state and local governments to meet the energy challenges of the new century.

This page intentionally blank.

POWERING THE NEW ECONOMY

Energy Accomplishments, Investments, Challenges

Prosperity and Security are Energy-Dependent

A strategically focused national energy policy, integrated with economic, environmental, security and technology policies, is central to the well-being of Americans, our economy, and our way of life. The Department of Energy has the lead responsibility for developing Administration energy policy and implementing the associated programs, but many other agencies have significant stakes in and play important roles in the process and the outcomes. This brief review of those outcomes is focused principally on Department of Energy policies and programs.

Balancing energy issues at the national policy level requires a continued recognition of the vital role of market forces; an understanding of energy's international strategic importance; and support for a linked set of common-good incentives, regulations, and research investments that must continuously evolve to meet current and future needs— to produce more energy, to use it more efficiently, to reduce its impacts on the environment, and to find additional and alternative sources of energy supplies.

Federal energy policies and research investments have paid big dividends over the last 20 years. We have the largest strategic petroleum stockpile in the world. Policy changes and technological advances have spurred oil and gas production on the Outer Continental Shelf and extended production on Alaska's North Slope. Technology investments have enabled oil and gas producers to dramatically reduce the size of the environmental footprint left by energy production to one tenth the size it was twenty years ago. We have also dramatically diversified our suppliers of imported oil to ensure that we are not overly reliant on one region of the world for our oil supplies.

In addition, the rapid development of energy efficient technologies and practices and the restructuring of our industrial sector have enabled the United States to decrease its energy use per dollar of Gross Domestic Product by around 40 percent since 1973, representing an annual energy savings of over $400 billion. The average fuel efficiency of automobiles has gone from 13.4 miles per gallon in the 1970s to 21.4 today, saving over two million barrels of oil a day. New combined-cycle gas turbines for electric power generation can now achieve 60 percent efficiency, compared to less than 35 percent for most existing power plants. Nuclear power plants reached an unprecedented 85 percent capacity factor in 1999. In 1998-99, U.S. wind capacity grew from 1.5 to 2.5 gigawatts and increased worldwide by 4 gigawatts. Wind energy is providing cost-competitive power generation today; other renewables show tremendous promise for cost-competitive power generation in the relatively near term. Many urban and regional environmental and public health impacts of energy use have been mitigated through the technologies and policies that have addressed air emissions.

This progress has been achieved through a sustained, bipartisan commitment to core energy policy principles that spans many Administrations. These core principles reflect and represent the expertise and input of countless government, industry and public interest organizations. Despite this track record however, the potential for a more competitive and productive U.S. energy sector, and a more energy efficient U.S. economy remains enormous—and, in order to meet the ever-growing demand for energy while protecting the environment and improving our quality of life, achieving it remains essential.

The Clinton/Gore Administration has significantly advanced the nation's energy agenda during the 1990s. Despite some significant

limitations imposed by appropriations levels and opportunities missed through legislative inaction, the Administration has developed a robust set of policies, investments, and proposals that provide a solid foundation for meeting the nation's energy challenges of the 21st century.

The Results: A Strong Economy, Cleaner Environment, More Efficient Energy Use

Energy is a significant driver of economic progress and environmental challenges, inevitably tying measures of energy policy success to advances in those areas. The American public embraces low inflation, a balanced budget, good jobs at good wages, and decreases in air and water pollution, for example, as qualitative measures of economic and environmental success—and indeed they are. But these key indicators serve as important measures of successful energy policies as well.

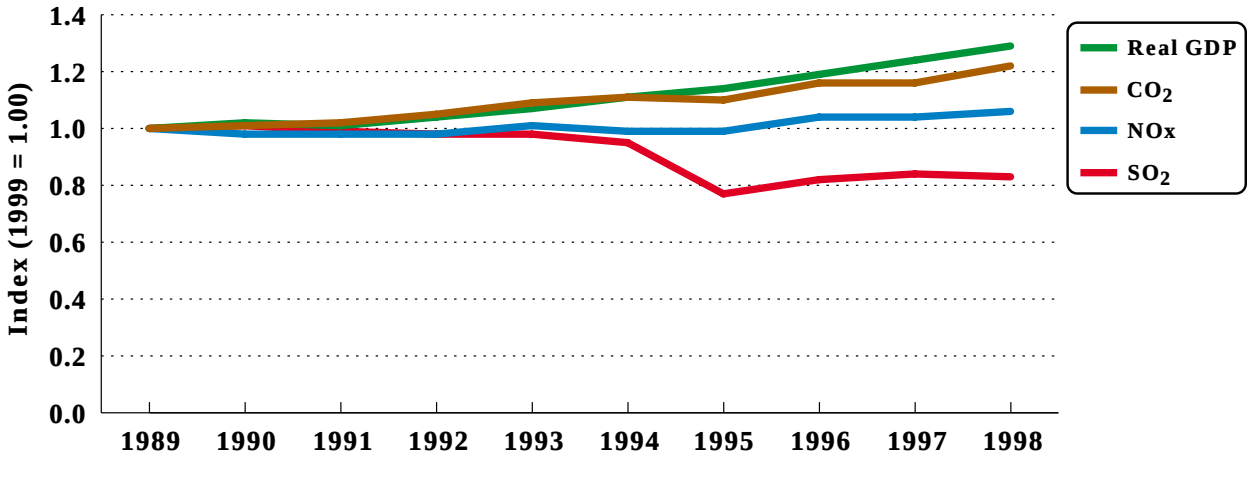
Also, the perceived success of an energy policy often depends on where you sit—whether you are from an energy producing or energy consuming region . . . reside in a relatively smog-free environment or in a Clean Air Act non-attainment area . . . drive an SUV or take public transportation to work . . . run an energy intensive business or have a dotcom enterprise . . . work in a local services industry or compete directly in the global marketplace. These tensions require a significant balancing of stakeholder equities, public and private interests and outcomes, and add to the complexity of developing and implementing sound energy policy.

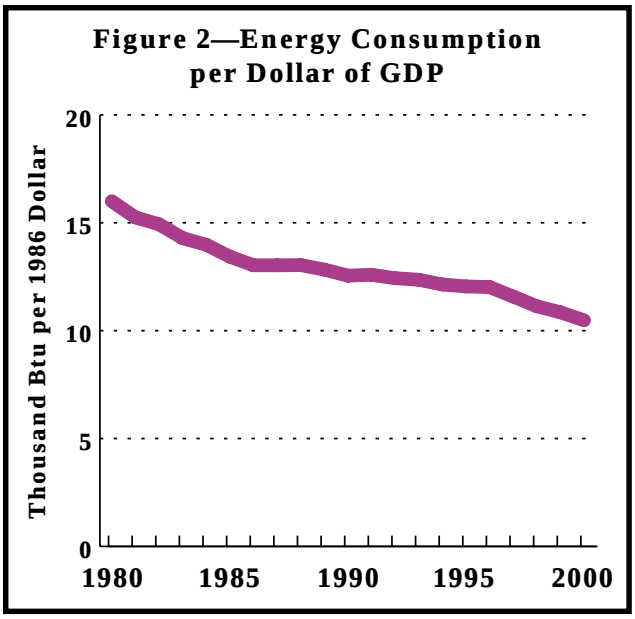
The Administration's careful balancing of these interests throughout the 1990s has enabled energy supplies to keep pace with demand and has given us these results for the economy, for the environment, for energy efficiency, and for consumers:

- From 1990 to 1999, the economy has grown by 32 percent after inflation and real disposable income has grown by 28 percent.
- Electricity generation has increased 22 percent, while sulfur dioxide (SO_2) emissions have actually declined by more than 15 percent, and nitrogen oxide (NOx) emissions have increased by only a few percent (*Figure 1—Economic Growth and Emissions from Electricity Generation*);
- Total energy consumption increased 14 percent from 81.2 quadrillion btus to 92.7 quadrillion btus while the economy's energy intensity has declined by 12 percent since 1992. (*Figure 2—Energy Consumption per Dollar of GDP*.)

To fuel the economic growth of the last decade, domestic production and generation of natural

Figure 1—Economic Growth and Emissions from Electricity Generation



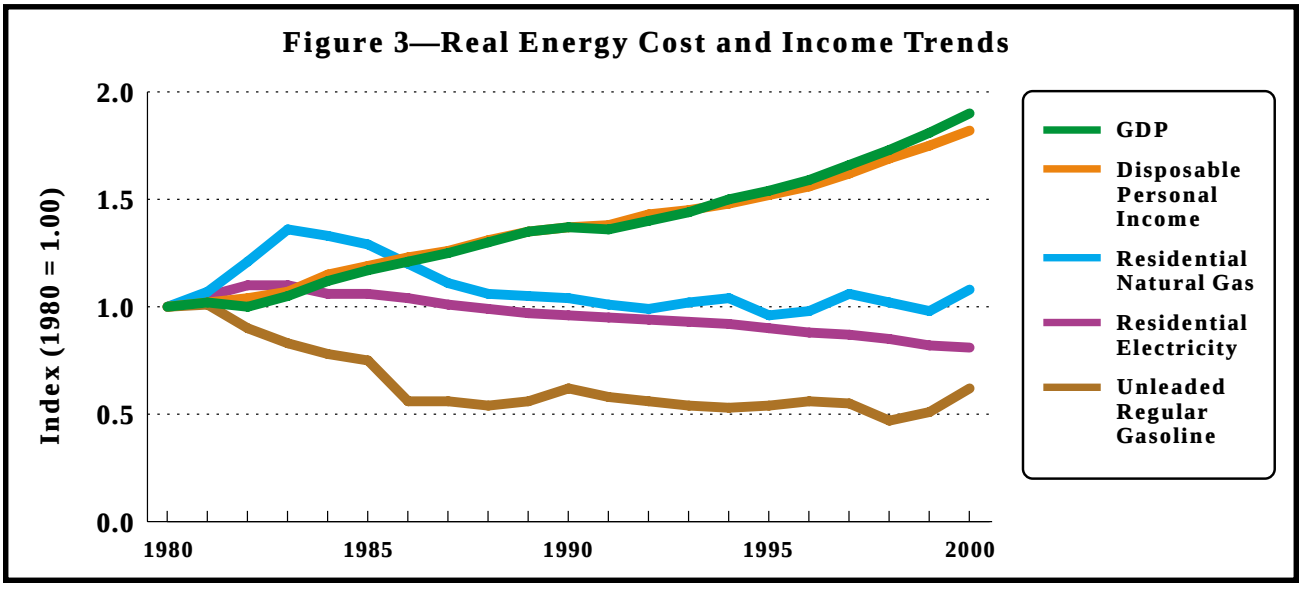


gas, coal, nuclear, renewables and hydroelectric power has increased. Oil production is the only exception, although domestic production declines are expected to flatten out by 2005, ending many decades of decline. Also, over the last several years, the *rate of decline* in domestic oil production has been reduced significantly.

In addition, world oil production has increased substantially over the last decade and we have diversified our sources of oil imports to the point where we are currently supplied by over forty oil-producing nations (including the U.S.) The Western Hemisphere now supplies 27 percent of our oil in contrast to 14 percent in 1980. If we include domestic oil production, three quarters of our oil is supplied from the Americas.

There has been substantial volatility in oil, gasoline, natural gas and electricity prices in the last eight months but over the years, while the demand for energy has grown, real energy prices have come down, even when price spikes are taken into account. In real terms, residential prices for electricity have declined by 25 percent from their peak in 1983. In constant dollars, Americans paid close to 50 percent less for a gallon of gasoline in 1999 than they did in 1980. Even with price increases in 2000, consumers are still paying about 40 percent less for gasoline in inflation-adjusted terms than in 1980. Oil and natural gas prices have spiked sharply this year but in inflation-adjusted dollars still remain below peak prices of the 1970s and 1980s. And today's lower energy costs in real dollars are being paid at the same time the earning power of Americans has increased sharply (*Figure 3 —Real Energy Cost and Income Trends.*)

These are substantive and tangible results. While recent price volatility imposes hardships on many citizens and businesses and thus presents an important challenge, Administration policies overall have helped generate unprecedented economic growth . . . met increased demand for energy from all sources . . . diversified our sources of energy supply . . . decreased energy intensity . . . and, even with increased energy use, held steady or significantly reduced the release of major air pollutants.



The Administration's Energy Policy Framework

The broad energy policy framework that has sustained this success over the last decade, and has been previously put forward in the Clinton/Gore Administration's "*Sustainable Energy Strategy*" (July 1995) and "*Comprehensive National Energy Strategy*" (CNES) (April 1998), is based on a few core principles that have been embraced by several Administrations:

- Reliance on, and stimulation of, competitive markets as the "first principle" of energy policy;
- Support for science and technology as the enablers for energy supply, efficient end use, environmental protection, and meeting future needs;
- Promotion of government/industry/consumer partnerships to accelerate demonstration and deployment of advanced technologies;
- Introduction of targeted incentives and regulations to advance the common good; and
- Facilitation of international cooperation to address security, environmental, and technology deployment goals.

Elaboration on several of these principles is found in two scientific reviews of energy-related technologies conducted by the President's Committee of Advisors on Science and Technology: *Federal Energy Research and Development for the Challenges of the 21st Century* in 1997, and, more recently, *Powerful Partnerships* in 1999. These two documents analyze the broad range of Federal energy technology investments and make recommendations on how to best utilize these technologies both domestically and internationally.

Finally, the Department of Energy, over the last several years, has engaged in numerous roadmapping exercises with industry, government and academic stakeholders, and has carried out two extensive energy portfolio analysis exercises, in which it charted its energy R&D investments against the high level strategic goals of the *Comprehensive National Energy Strategy*. This process has identified specific energy challenges and opportunities ripe for new strategic investments in energy technologies.

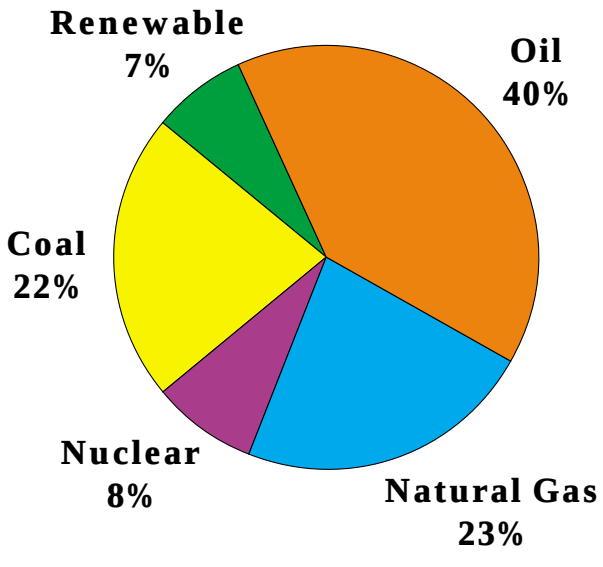
Today's Accomplishments, Tomorrow's Investments

The principles outlined in the CNES and other strategic energy analyses, have been translated into specific actions taken by the Administration to address the full range of energy resources needed to power our economy. Before discussing these actions, the Administration's energy accomplishments and investments must first be viewed in the context of overall energy supply and demand.

The nation's energy options currently include oil, gas, coal, hydroelectric and non-hydroelectric renewables, fission, and energy efficiency *(Figure 4—Energy Sources, 1999.)*

The Energy Information Administration (EIA) reference projection for 2020 anticipates a 25 percent increase in total energy consumption. This implies increased use of all fossil fuels, with an especially rapid increase of 1.8 percent per year in natural gas use, even as renewables

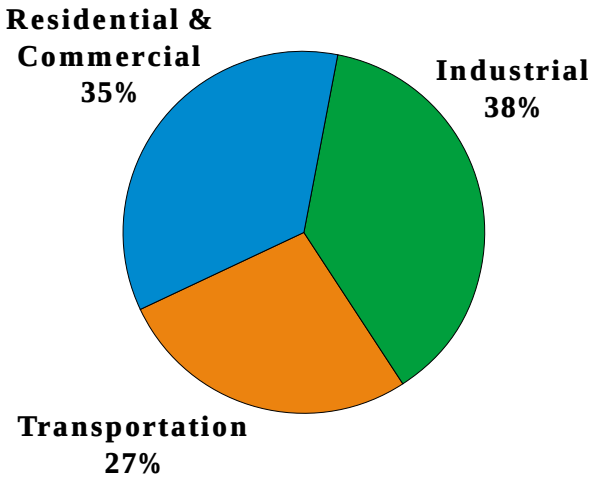
Figure 4—Energy Sources, 1999 (percent of total)



increase their contribution. It should be noted that the EIA reference projection assumes no significant new policy initiatives or technology breakthroughs in the intervening period.

Currently, energy demand in the United States is dominated by three key areas: transportation (27 percent); residential and commercial (35 percent); and industrial (38 percent) *(Figure 5—Energy Sector Demand, 1999.)* This demand is met by oil (40 percent); gas (23 percent); coal (22 percent); nuclear (8 percent); and hydro and non-hydro renewables (7 percent.)

Figure 5—Energy Sector Demand, 1999 (percent of total)



The energy challenges we face today can be quite different for different sectors. For example, the transportation sector today is almost totally dependent on oil, while electricity generation draws significantly upon coal, natural gas, nuclear, and hydropower. Non-hydroelectric renewable resources will ultimately make significant contributions to both sectors.

The diverse and abundant energy sources reflect both the extent of the American natural resource base and the success of American energy policy. The projections, tied to expectations of continued robust economic growth as experienced in recent years, highlight the importance of the foundation laid by the Clinton/Gore energy policies, programs, regulations and initiatives. The following examples—while not a complete list—illustrate the Administration's energy accomplishments and investments. Many of these investments have already produced results, others that have met major milestones, and still others that offer the potential for significant breakthroughs in the decades ahead. The Appendix provides a more detailed description of these and other accomplishments and investments.

Energy Efficiency

Eighty-five percent of our energy comes from the combustion of fossil fuels, the largest contributors of greenhouse gases, sulfur oxide (SOx), NOx and particulate matter emissions. The more efficient use of energy in general, and of fossil fuels specifically, has provided us with substantial energy savings and environmental improvement over the last two decades, and will remain the single most important, near-term means of reducing energy costs, preserving our domestic energy resources, protecting the environment, and making U.S. technology competitive.

In the last two decades, the United States has increased industrial output by 50 percent, but total energy use by the industrial sector has increased by only 13 percent (from 1980-1999) over the same time period. From 1979 to 1995, the energy required for each square foot of commercial buildings was reduced by 20 percent. Over twenty years, efficiency improvements supported by Department of Energy funding in five building technologies (design software, electronic fluorescent lamp ballasts, low emissivity windows, advanced oil burners, and efficient refrigerator compressors) have resulted in present value savings of nearly $33 billion and have kept carbon emissions 60 million metric tons lower than they would have been without these improvements.

To build on these advances and realize even greater efficiency gains, the Administration has developed and advanced policies to enhance and increase energy efficiency, and has made significant new investments in the technologies needed to make the most efficient use of our fossil energy resources.

♦ ***Accomplishments and Investments in Energy Efficiency. . .***

. . . . to promote energy efficient vehicles to reduce our reliance on imported oil

✔ Partnership for New Generation Vehicles (PNGV): The PNGV program is designed to develop an 80 miles per gallon (mpg) automobile by 2004, while maintaining or improving safety, performance, emissions, durability, comfort and affordability. Advances in light weight materials, aerodynamic resistance and hybrid propulsion are expected to help achieve the goal. The program is on-track and has met its year 2000 milestones, demonstrating the technical feasibility of 80 mpg family sedans. This year, Ford, General Motors, and Daimler-Chrysler displayed their concept vehicles which achieved 70-80 mpg. Numerous advanced technologies developed or enhanced through the PNGV program are already contributing to enhanced efficiency of vehicles in current production. (www.uscar.org/pngv/futurecongress2.htm)

✔ Lightweight Materials for Automobiles: DOE's efforts to develop lightweight materials for manufacturing auto parts have saved more than six billion gallons of motor fuel and reduced carbon emissions by over 15 million metric tons. Fiber reinforced composite materials, developed by DOE in concert with industry, will be used in the truck bed for the Chevy Silverado in 2001. The Ford Prodigy unveiled at the 2000 Detroit Auto Show reduced the vehicle weight by 30 percent using lightweight materials. (www.ms.ornl.gov/ott/MCMaterials.htm)

✔ High Efficiency Trucks: DOE, in cooperation with industry partners, has developed diesel engine technologies that are both cleaner and more energy efficient, saving approximately 16 billion gallons of motor fuel and reducing carbon emissions by about 38 million metric tons. DOE's goal is to increase big diesel engine efficiency by 50 percent and reduce emissions by 50 percent more than current mandates. NOx catalysts have produced a greater than 50 percent reduction of NOx while plasma-assisted devices have exceeded 70 percent reductions on a small scale. Recent developments include multi-cylinder heavy-duty diesel engines that run interchangeably on M85 and diesel fuel, and models of NOx production during diesel combustion that are helping manufacturers improve the design of diesel engines. Improvements in engine control systems (using advanced sensors) have been a big factor in improving fuel economy. Turbocharger systems have also contributed to the fuel economy gains. (www.ott.doe.gov**)**

✔ Clean Cities Program: This voluntary, locally-based government/industry partnership is designed to accelerate the deployment of alternatively-fueled vehicles in both Federal and local fleets, including natural gas vehicles, with a goal of reducing the use of gasoline. Between 1993 and 1998, 139,000 alternatively-fueled vehicles were deployed, reducing gasoline and diesel fuel use by an estimated 380 million gallons through 1998 and reducing carbon emissions by an estimated 400,000 metric tons. Since then additional vehicles have been deployed. (www.ccities.doe.gov)

. . . . to meet dramatically increased electricity demand in low-cost, environmentally sound ways

✔ Utility-Scale Gas Turbines: The Advanced Turbine System Program began in 1992 to develop and test utility-scale turbines to convert gas or other fuels to electric power. These systems are ultra-efficient,

Partnership for a New Generation of Vehicles (PNGV)

The Challenge. The U.S. transportation sector is dependent on petroleum for nearly 97 percent of its energy, which translates into 12.3 million barrels per day (MBPD) of petroleum products to run our highway and passenger vehicles. Currently, over half of the petroleum used in the United States is imported. Annually, the cost of oil imports is one of the largest contributors to the U.S. balance of trade deficit—accounting for over 19 percent our merchandise trade deficit in 1998.

If we continue on with business as usual, by 2020, demand for energy to power our vehicles will increase by 45 percent— to 17.9 MBPD. The Department of Energy is working to reduce our dependency on petroleum, our reliance on imports, and our trade deficit by developing vehicles with substantially higher fuel economy.

Meeting the Challenge: Partnership for a New Generation of Vehicles. Since 1993, the Clinton/Gore Administration, through the joint DOE/Commerce/DOT/EPA Partnership for A New Generation Vehicles (PNGV) program, has been working to develop a prototype vehicle designed to triple the efficiency of passenger vehicles—an 80 mpg automobile that is clean, affordable, and has the performance features the American consumer expects .

The year 2000 marks a major milestone in the PNGV program—the unveiling by the big three auto makers of the PNGV proof-of-concept vehicles at auto shows in Detroit and Washington, D.C. All three vehicles—the Ford Prodigy, the General Motors Precept, and the DaimlerChrysler ESX3—featured advanced hybrid propulsion systems, high efficiency diesel engines, and extensive use of lightweight materials. Each vehicle is a significant technological achievement and the auto makers, who have spent over a billion dollars of their own funds on these models—applauded this historic partnership between the Federal government and the auto industry.

The auto manufacturers met a major partnership milestone by introducing their concept vehicles in early 2000. GM Precept (80 mpg), Ford Prodigy (72 mpg), and DaimlerChrysler ESX3 (72 mpg.)

We have made progress but much work remains to be done. PNGV-related technologies include advanced propulsion systems such as fuel cells, energy storage, and lightweight materials, but we also need to further develop automotive integrated power modules, high power energy storage devices, pollution control devices, fuel cells, advanced clean fuels, and compression ignition direct injection engines to make these fuel-efficient cars a commercial reality.

In addition, PNGV technologies, which are targeted to the family-size car, are moving into larger and smaller vehicles designs. The automakers have announced that they will put hybrid SUVs in the marketplace beginning in 2003 and use these and other technologies to improve SUV fuel economy up to 25 percent.

Finally, to provide the training and expertise to support the PNGV program, DOE developed the Cooperative Automotive Research for Advanced Technology (CARAT) and the Graduate Automotive Technology Education (GATE) programs. CARAT's role is to develop advanced automotive technologies to overcome production barriers for ultra-high fuel efficiency vehicle. GATE is designed to train a new generation of automotive engineers in critical multi-disciplinary technologies.

affordable and have low emissions. The program goals of 60 percent efficiency in the combined cycle mode, a 10 percent reduction in cost of electricity, and less than 10 ppm NOx emissions, have all been met. The ATS program has moved to the demonstration phase. Siemens-Westinghouse is testing components of its ATS technology in Florida, and the General Electric 7H-ATS is ready for demonstration in New York. (www.ott.doe.gov/hev/gas_turbine.html)

✔ Stationary Fuel Cells: Fuel cells use a chemical reaction, much like a car battery, to produce electricity directly. There are four types of fuel cells being researched: Molten Carbonate (MC); Solid Oxide (SO); Proton Exchange Membrane (PEM); and Phosphoric Acid (PA). Present day fuel cell electrical generating efficiencies range from 36 percent to 40 percent. When use is made of the recoverable heat generated in the process, net fuel efficiencies in the 80 to 85 percent range can be achieved. Environmentally-friendly fuel cells generate virtually no pollution and easily pass even the most stringent of today's emissions standards—such as those set by the State of California. (www.ott.doe.gov/oaat/fuelcell.html)

✔ Combined Heat and Power (CHP): These systems capture waste heat and use it to heat and cool buildings or to provide steam for use in industrial processes resulting in total system efficiencies of 70 to 90 percent compared to the 33 percent average efficiency of conventional central power plants. Recent successes include the permitting of a CHP system for Malden Mills Industries, a textile plant employing 2,300 workers in Lawrence, MA, designed to provide steam and electricity, replacing older, inefficient steam boilers and reducing the need for electricity purchases, cutting pollutant emission over half. The system also includes a new ceramic liner technology designed to reduce NOx emission rates to within the state's guidelines. A natural gas microturbine installed by Walgreens drugstore in 1999 provides 33 percent of the building's electric, heating, air conditioning and hot water needs at more than 75 percent efficiency. The system includes an absorption chiller and desiccant dehumidification system powered by exhaust heat from the microturbine. (www.eren.doe.gov/der/chp/index.html)

✔ Distributed Energy Resources: Distributed energy refers to the production of electricity at or near the point of distribution or use, rather than at central power stations. DOE's distributed energy generation initiative goal is to develop the cooperation and technology necessary to enable these interdependent systems to provide at least 20 percent of the nation's new power by the end of the decade. Moving energy supplies closer to the point of end use through, for example, rooftop photovoltaic systems or microturbines, promises important economic, environmental, and reliability advantages. The direct economic benefits of such systems include efficient and cost-effective power resources, power in locations where there are no utility services (e.g. rural Alaska), and the sale of surplus power to meet electricity demand or provide peaking power. Distributed systems include combustion turbines, biomass-based generators, concentrating solar power and photovoltaic systems, fuel cells, wind turbines, microturbines, engines/ generator sets, and storage and control technologies. (www.eren.doe.gov/der/index.html)

Vision 21—Not Your Father's Power Plant

The Vision 21 plant depicted here is extremely compact and efficient. With near-zero emissions, the plant will have no stack, and in some cases be sited near urban and industrial centers, thereby relieving the need for additional transmission lines.

Tomorrow's power plants may scarcely resemble those of today. There may be no smokestack, for instance, because the futuristic power generators will emit no smoke. In fact, technological advances now being developed may make such plants virtually emission-free, instead turning pollutants into valuable commercial products such as chemicals and fertilizers. Advanced technology will permit carbon dioxide, the most important greenhouse gas, to be captured, and ultimately eliminated when viable sequestration approaches emerge in the next one-two decades.

Tomorrow's energy plants may also produce much more than just electricity. The Energy Department's *Vision 21* concept, for example, envisions a new fleet of plants that would generate liquid fuels and chemicals, hydrogen, and industrial-grade heat in addition to electric power. This multi-product approach will squeeze every useable amount of energy out of a fuel source, achieving efficiencies that could approach 60 to 80 percent, well above the typical 33 to 35 percent efficiencies of today's conventional coal-fired power plants.

A *Vision 21* plant would also have remarkable fuel flexibility. It could be fed by coal, or natural gas, or biomass, or municipal waste, or perhaps a combination of these fuels. Made up of modules that could be interchanged to meet different fuel and product needs, *Vision 21* plants could be tailored for a variety of geographic regions and different energy markets.

In awarding a group of new *Vision 21* projects, Secretary of Energy Bill Richardson said: "We are building the foundation for a new generation of energy facilities capable of efficiently using our most abundant traditional fuels while virtually eliminating environmental concerns. *Vision 21* represents the future of clean energy."

. . . to promote energy efficient use in homes to reduce the nation's energy bills

✔ Weatherization: DOE and its partner agencies retrofitted 167,000 low income homes in 1998 alone, which will save 108 trillion btu and save occupants $550 million in utility bills over the 20 year life of the installed energy-conservation measures. Over the life of the program, DOE has weatherized 4.7 million homes, saving $1.80 in energy costs for every dollar invested and improving the quality of life for the residents. (www.eren.doe.gov/buildings/weatherization_assistance/)

✔ Federal Energy Management Program (FEMP): The FEMP program reduces energy costs to the Federal government—the largest power user in the country—by advancing energy efficiency and water conservation, promoting the use of renewable energy, and managing utility costs of Federal agencies. Between 1985 and 1999, the government achieved a 21.1 percent reduction in site-based energy intensity and the Federal energy bill was almost $2.2 billion real dollars less than in 1985. Most recently, President Clinton signed Executive Order 13123 setting new energy goals for Federal facilities to reduce energy consumption in buildings by 35 percent, and energy consumption in Federal labs and industrial facilities by 25 percent, diminish greenhouse gas emissions by 30 percent, improve water efficiency, and increase use of renewable energy technology by 2010. (www.eren.doe.gov/femp/)

✔ Energy Savings Performance Contracting (ESPC): At no capital costs to the government, Energy Savings Performance Contracting (ESPC) offers a means of achieving energy reductions through alternative financing, in which private industry would bear the upfront costs of efficiency upgrades in exchange for a portion of the savings realized from those upgrades. Since June, 1998, a total of 34 delivery orders have been awarded, which are valued at approximately $80 million. Ten Federal agencies have awarded at least one delivery order. The largest delivery order awarded so far has an investment value of approximately $20 million to provide comprehensive energy retrofits at NASA's Johnson Space Center in Houston. (www.eren.doe.gov/femp/financealt.html)

✔ Appliance Codes and Standards: To save energy and reduce both emissions and consumer utility bills, DOE sets national minimum energy-efficiency standards for commercial and residential equipment and appliances, such as lighting, heating and cooling equipment, water heaters, refrigerators, clothes washers and dryers. The residential appliance standards in place in 1999 are saving annually about 0.65 Quadrillion btu (primary), equivalent to the annual energy consumption of over 3 million households and annual energy savings of approximately $4 billion. To date, approximately 65-70 percent of U.S. households have purchased one or more of the more efficient products covered by these standards. From 1990 to 2010, enacted standards will avoid cumulative emissions of 227 million metric tons of carbon equivalent and saved consumers $49 billion. DOE has just issued new standards for fluorescent lamp ballasts, and in 2000 and 2001 DOE expects to publish standards for clothes washers, water heaters and central air conditioners. These residential standards, and the recently enacted standards for refrigerators, are expected to avoid greenhouse gas emissions of 13.5 million metric tons in 2010. (www.eren.doe.gov/EE/buildings_appliances.html)

- ✔ Geothermal Heat Pumps (GHPs): GHPs discharge waste heat to the ground during the cooling season and extract heat from the ground during the heating season to more efficiently meet residential and commercial heating, cooling and hot water needs and help electric utilities meet peak demand. A typical system can reduce energy consumption by 23 to 44 percent and pay for itself in three to ten years. About 340,000 GHPs are being used for heating and cooling of residential, commercial, and institutional buildings throughout the United States today. Assuming average unit annual savings of $300 to $400, annual savings due to displacement of air-source heat pumps and other conventional equipment by GHPs is between $100 million and $140 million per year. Savings from GHP units installed between 1995 and 1998 are estimated to be $29-$39 million. This program has been successfully completed.

- ✔ Building America: This program utilizes a "whole building" approach to saving energy in new houses. Several hundred homes built in different regions of the U.S. to date demonstrate the opportunity to design homes in ways that save 30 to 50 percent of the energy used in a typical new home, often with little or no increase in first costs. In the "whole building" approach, thousands of additional homes based on these demonstrations are planned by Building America partners.

. . . . to increase the competitiveness of U.S. industry by reducing its energy costs

- ✔ Industrial-Scale Gas Turbines: The Advanced Turbine Systems (ATS) Program was initiated in 1992 to produce 21st century gas turbine systems that are more efficient, cleaner and less expensive to operate than today's turbines. The goals of the program for industrial class gas turbines include: 1) single digit emissions; 2) 15 percent improvement in efficiency; 3) 10 percent reduction in cost of electricity, and; 4) reliability and durability equivalent to today's engine fleet. Solar Turbines is leading a consortium to develop a 4.3 megawatt recuperated industrial gas turbine, which is being marketed as the Mercury 50. Several engines are undergoing testing: one at Solar Turbine's Harbor Drive Facility, one at Rochelle Municipal Utilities, and one at Western Mines in Australia. This program has been successfully completed.

- ✔ Reciprocating Engines: The new Advanced Reciprocating Engine System Program focuses on the development of an advanced engine with an efficiency over 50 percent and single digit emissions (current engines have efficiencies in the low 40 percent and emissions greater than 50 ppm) for the distributed generation market. Reciprocating engines are used in a variety of applications including gas, electric and water utilities, standby power generation, hospitals, manufacturing of all types and educational services and office buildings. Running on natural gas, these engines will produce at least 20-30 percent lower carbon dioxide emissions compared to oil- or coal-fired technologies. When heat is recovered from the system, the overall system efficiency often exceeds 85-90 percent. (www.oit.doe.gov/power/recipro.html)

- ✔ Advanced Industrial Materials: Materials limitations are a frequent barrier to increased energy efficiency—advanced materials technologies reduce energy use by as much as 25 percent per unit of output for some industries. Examples of advanced materials research include corrosion prevention on existing alloys, which could save more than 15 percent of the cost, and new membrane materials for high temperature chemical separations,

which could save at least half of the energy currently used for today's energy-intensive separation processes. DOE, its materials labs, and university and industry consortia are addressing many of these high risk pre-competitive challenges that individual companies do not address. We have been successful at this undertaking with over 100 industrial partners using our advanced labs, the development of over a dozen commercialized advanced industrial materials, and another two dozen currently underway. (www.oit.doe.gov/materials/)

✔ Industrial Assessment Centers: Working through 30 universities, these centers have provided over 9,000 energy and industrial process audits to small and mid-size manufacturing firms, generating recommendations that are saving participating firms $200 million a year in energy costs and an additional $170 million in annual non-energy benefits. (www.oit.doe.gov/iac/)

✔ Oxyfuel Firing for Glass Furnaces: This industrial process to melt glass, developed with DOE assistance, is in commercial use in over 50 percent of glass furnaces and reduces a glass manufacturer's fuel use by 15-45 percent, NOx emissions by 80 percent, and particulates by 60 percent. The process also increases productivity by 25 percent. (www.oit.doe.gov/glass/refractories.htm)

Oil and Gas Supply

Oil and gas provide 62 percent of the nation's energy. The United States remains heavily dependent on petroleum, which powers 97 percent of our vehicles and heats 11 percent of our homes. We are also relying increasingly on natural gas as the preferred source for cleaner, more efficient power generation.

The United States is a mature oil producing region and exploration and production costs are high relative to other oil producing regions in the world. On the natural gas side, we have abundant resources, and production and reserves are expected to increase over the next twenty years. Expanding gas consumption and associated production needs have been obscured somewhat in recent years because of warm winter weather and unusually high hydro and nuclear power output. Nevertheless, domestic drilling rigs directed toward gas prospects reached 800 in September, 2000, the highest level in over a decade, and gas well completions this year are on track to be the highest in fifteen years.

Complementing investments in oil and gas demand side and end use technologies, the Administration's policies and investments in oil and gas supply are designed to address the relatively high cost of oil production in the U.S., our continuing reliance on oil as a transportation fuel, and the projected increases in demand for natural gas for power generation, transportation, cooling and combined heat and power.

♦ ***Accomplishments and investments to enhance our oil, natural gas and product supplies . . .***

. . . by lowering the costs of domestic exploration and production through advances in technology

✔ Reservoir Class Field Program: An estimated two-thirds of all U.S. oil remains in the ground after primary or conventional recovery. The Reservoir Class Field Program is designed to increase this recovery. The program includes 32 projects. One project alone has already produced an additional 2.4 million barrels from a small field, and is expected to produce an additional 31 million barrels of oil and $160 million in Federal revenue. Another project demonstrated advanced reservoir characterization and process design technologies in a previously idle lease in giant Midway-Sunset oil field, California. The demonstration has found 2 million barrels of recoverable reserves in the previously abandoned 40-acre lease.

An additional 2.5 million barrels of reserves have been found in another formation that had never produced in the lease. This program is expected to add 500 million barrels of cumulative production and reserves. (www.fe.doe.gov)

✔ Drilling Technologies: The Department continues to successfully develop advanced oil, gas and geothermal drilling technologies. Horizontal well reservoir-flow models recently developed by DOE have significantly improved coiled-tubing drilling efficiency and reliability. These systems now have a 50 percent smaller footprint (land affected by operations) than conventional drilling systems and can reduce drilling costs by almost 40 percent. Advanced drilling technologies have helped cut oil finding costs from $20 per barrel to $5 per barrel in the last 20 years. In addition, the Department is working with industry on improved polycrystalline-diamond compact (PDC) drill bits for various applications that will significantly extend drill bit lifetime and lower opportunity costs. Prior DOE research led to the development of the current PDC bit, which is today's industry standard. (www.fe.doe.gov)

✔ Public Lands Technology Partnership: DOE funds numerous projects with the Bureau of Land Management to develop solutions to those technical, regulatory and environmental issues preventing access to oil and gas resources on Federal lands. The Partnership has helped streamline land use regulations and processes, and ensure that sound science and technology advancements are incorporated in Federal land use planning, NEPA reviews, and policy planning. (www.blm.gov)

. . . through advances in technologies to increase production, or develop new or alternative sources of supply

✔ 3D & 4D Seismic: The deployment of 3D seismic technology has had a major impact on oil and gas exploration success. For example, one company has achieved a success rate of nearly 50 percent for its 3D exploration activities, versus 13 percent without 3D. Advances for fracture imaging and advanced drilling technologies, developed by DOE and the Gas Research Institute, led to record-breaking natural gas production in a horizontal well in the Greater Green River Basin in southwestern Wyoming. The project has stimulated additional industry drilling in this previously uncommercial reservoir. Meanwhile, 4D seismic imaging developed by DOE in 1994, has already been applied with outstanding commercial success in 21 Gulf of Mexico fields. (www.fe.doe.gov)

✔ Gas to Liquids Technology (GTL): The North Slope of Alaska natural gas resource in developed fields totals over 30 trillion cubic feet, and undiscovered resources are estimated at about 70 Trillion cubic feet. DOE is spearheading efforts to evaluate the technical and economic feasibility of converting this gas to a liquid suitable for transport in the existing Trans Alaska Pipeline System. Included is support for a novel gas to liquids technology that uses a ceramic membrane to separate oxygen from air, which is then reacted in a single step with natural gas to form a syngas that can be converted to a clean liquid fuel. Successful development of this technology could result in a 25-30 percent reduction in liquid production costs compared to existing technologies. (www.fe.doe.gov)

✔ Methane Hydrates: USGS scientists estimate that there are as much as 300,000 trillion cubic feet of natural gas in the form of natural gas hydrates in the United States, offshore and arctic—15,000 times the 1999 gas consumption of the United States. DOE, in collaboration with USGS,

MMS, NRL, NSF and NOAA, has begun a multi-year program of research, development and demonstration to determine if these resources can be economically produced in a safe and environmentally responsible manner. (www.hydrate.org)

. . . by promoting changes in government policies to increase supply and encourage greater public/private partnerships to develop oil and gas resources

✔ Enhancing Domestic Production via Royalty-Related Measures: The Administration has sought to bolster domestic production through measures related to royalties that are collected from production on Federal lands:

- In 1995, the Administration and Congress jointly supported deepwater royalty relief to advance the development of new deepwater projects in the Gulf of Mexico. This program has proved to be very successful, and the Department of the Interior is considering some form of royalty relief measures as industry moves into ever deeper water. (www.gomr.mms.gov)
- Small oil producers operating on public lands during periods of extremely low oil prices were allowed to suspend operations up to two years without losing their leases or plugging their wells. (www.blm.gov)
- The Administration supported reform of the royalty program for oil and gas production from on- and off-shore Federal lands. Reforms included reduction of record-keeping and reporting requirements for Federal royalty owners. (www.rmp.mms.gov)

✔ Petroleum Technology Transfer Councils (PTTC): Oil exploration and production is a technology-intensive business. At the same time, a significant amount of oil production is from small, independent producers who cannot afford to invest in advanced exploration and production technologies. In 1994, the Department of Energy established the PTTC, which transfer technologies to small producers through 10 technology centers located across the country. These centers conduct more than 100 technology workshops each year. In addition, the PTTC websites average over 77,000 user sessions per month, and the ten regional technology centers have thousands of industry contacts each year. (www.pttc.org)

✔ Elk Hills Sale: On February 5, 1998, the Department of Energy, through the sale of the Elk Hills Petroleum Reserve, concluded the largest divestiture of Federal property in the history of the U.S. government. This $3.6 billion sale completed a privatization process that began in 1995 when the Clinton Administration proposed selling Elk Hills as part of its efforts to reduce the size of government, return inherently non-Federal functions to the private sector, and prolong the useful life of the field. (www.fe.doe.gov)

✔ Naval Petroleum and Oil Shale Reserve Number 2 (NOSR 2): The Administration submitted legislation this year to transfer NOSR 2 in Utah to the Northern Ute Indian tribe. The transfer of 84,000 acres will be the largest voluntary return of land to Native Americans in the lower 48 states in more than a century and will enable the Utes to produce natural gas on the Reserve, volumes of which, according to preliminary estimates by USGS, could be as high as 0.6 trillion cubic feet. Under the plan, 9 percent of any royalties from future energy resource production on the lands would help fund clean-up and disposal of uranium mill tailings at a site near Moab, Utah. (www.fe.doe.gov)

Deepwater Recovery

The deepwater of the Gulf of Mexico (GOM) is characterized by many experts as the next Alaska "North Slope" and holds enormous potential to help meet the United States growing demand for natural gas and oil. This is in sharp contrast to the view just two decades ago that the Gulf of Mexico was a mature region with limited potential for further discovery and development.

Deepwater drill ships such as Global Marine's Glomar Explorer help industry meet the challenge of recovering oil and gas from vast Federally-owned resources underlaying water depths from 7,000 to 10,000 feet.

These statistics tell the story of great potential—between 1985 and 1996, onshore domestic production of oil decreased by 30 percent but offshore production increased almost 8 percent. This turnaround, which has occurred primarily in the deepwater GOM, can be attributed, in large part, to government/industry investments in new technologies and to government incentives to develop the deepwater gulf. Oil and gas production in the deepwater GOM has grown dramatically in the last eight years. Gas production from deepwater increased ten-fold between 1992 and 1999, reaching 2.6 billion cubic feet per day. Oil production increased six-fold to 675 thousand barrels per day during the same period. Also, President Clinton signed the Deep Water Royalty Relief Act in 1995. Since then, deepwater GOM bids have gone from 10 percent of total leases to over 50 percent. The Administration is considering new incentives to encourage industry to move into even deeper waters.

Technology advances in reservoir detection and drilling have reduced the cost of finding offshore oil and gas from $15 per barrel of oil equivalent to $4 in the ten years from 1986 to 1996. However, offshore wells are still expensive to drill. For example, the total investment for establishing new production in the deepwater GOM, expressed on a per barrel basis, is several times higher than that for competing resources in most other parts of the world. Clearly we need to focus our efforts on technologies to change this equation and attract additional investment for more aggressive development of deepwater GOM resources.

The deepwater technology challenges are formidable— deeper wells encounter extreme temperatures and pressures and increased potential for intensively corrosive environments. The magnitude of these challenges may be doubled or tripled for ultra-deepwater wells. These conditions require high-strength materials and advanced drilling methods. To fully develop the potential in the deepwater GOM we will need innovative design, fabrication, installation, and automation and robotics techniques. We are now hard at work with oil and gas producers, service companies, National Labs, and Federal and non-governmental groups to develop a "roadmap" for addressing major technology needs, environmental and safety challenges, government/industry roles, and opportunities for collaboration and investment.

✔ National Petroleum Reserve - Alaska (NPR-A): On May 5, 1999, BLM held a lease sale which resulted in the granting of 133 leases for the northeastern portion of the NPR-A. Careful consideration was given during the pre-leasing process as to whether technology was available to allow those resources to be recovered with minimal adverse environmental impact. The NPR-A is estimated to contain between two and five billion barrels of technically recoverable oil, with approximately two billion barrels being economically recoverable at today's oil prices. (www.aurora.ak.blm.gov/npra)

. . . by encouraging international cooperation on oil and gas issues, and investments in oil and gas infrastructure and production at home and abroad

✔ Oil and Gas Loan Guarantee Program: On August 17, 1999, President Clinton signed into law the "Emergency Oil and Gas Loan Program Act," Public Law No. 106-51. The Act provides $500 million in loan authority for oil and gas producers who suffered severe economic hardships in the 1998-1999 oil downturn. Eligible companies must have experienced losses and/or had to lay off employees during this period. The board established to run the program has received applications for loans totaling over $71 million. DOE has worked closely with the SBA, USDA and the Emergency Oil and Gas Loan Guarantee Board to assist the small, independent domestic oil and gas producers meet the capital access challenges of the energy marketplace—over the past year the DOE has conducted 10 Federal loan guarantee workshops around the country and is currently working with the Emergency Oil and Gas Loan Guarantee Board to revise its current loan guarantee program to ensure that it reflects the needs of independent producers. (www.fe.doe.gov)

✔ Asian Pacific Economic Cooperation (APEC) Natural Gas Initiative: This initiative seeks to accelerate investment in natural gas supplies, infrastructure and trading networks throughout the APEC region, and has been developed in close collaboration with the business sector. The initiative aims to reduce investor risk in APEC nations by: encouraging private ownership of natural gas facilities; ensuring sanctity of contracts; establishing autonomous regulators; promoting non-discriminatory treatment of foreign and domestic companies; fostering competition among all sources of energy, and; supporting the free flow of exports and imports of natural gas and natural gas-related products and services across borders.

✔ Caspian Pipelines to Western Markets: In the Caspian region, bilateral policy dialogue with Turkey, Azerbaijan, Georgia and Turkmenistan has fostered an investment climate to develop oil and gas resources and the pipelines needed to transport these products to Western markets. This was highlighted when President Clinton witnessed the signing of intergovernmental agreements among Turkey, Azerbaijan and Georgia for the development of a critical pipeline system from the Caspian region to western markets.

✔ Import Diversification: To ensure that we are not overly reliant on oil imports from a single region of the world, the Administration has continued efforts to encourage oil production in diverse regions and nations of the world. Although our oil imports have increased, our sources of supply have changed significantly over the last two decades. Our imports now come from over 40 nations of the world. In 1999, we imported 4.95 million barrels per day from OPEC nations, down 20 percent from 6.19 million barrels per day in 1977.

. . . by increasing the size and security of the Strategic Petroleum Reserve, our "national oil insurance policy"

✔ Strategic Petroleum Reserve Royalty-in-Kind Program: The Administration implemented a unique initiative to add 28 million barrels of oil to the SPR using Federal royalty oil owed the Treasury by private industry for oil production on Federal lands. This program, when completed, will give us a Reserve of approximately 590 million barrels, the largest oil reserve in the world. (www.fe.doe.gov)

✔ Strategic Petroleum Reserve (SPR) Life Extension: The completion of the life extension program marked a major milestone for the SPR. Most SPR facilities were constructed in the late 1970s and early 1980s and were nearing the end of their 20-year design life. Under the life extension program, DOE redesigned and replaced critical systems and equipment that had deteriorated and aged, to maintain reliability and availability and to assure the Reserve could be drawn down within 15 days of a Presidential determination. As a result, the useful life of the SPR's facilities and drawdown systems has been extended through 2025, and operating costs will be reduced by $12-$15 million per year. (www.fe.doe.gov)

Coal

The Administration supports coal as a key source of energy for domestic power generation and recognizes its importance to world economic growth. Coal use for power generation has increased by 17 percent over the last 10 years and currently supplies 55 percent of our electricity. We have more than 240 years of domestic supply at current rates of use. The Administration has focused its coal policy on enabling its continued use as a valuable resource by working to dramatically mitigate its environmental impacts. Coal-fired power plants generate the majority of our sulfur dioxide emissions and a significant share of nitrogen oxides, the two pollutants most closely linked to acid rain. In addition, coal-fired utilities generate significant volumes of solid combustion wastes, over 107 million short tons in 1998, along with significant greenhouse gas emissions.

Coal is also an abundant and relatively inexpensive energy source worldwide. China and India, for example, use coal for a significant portion of their power generation, as do many of the nations in Eastern Europe, further adding to concerns about the global impacts of carbon emissions and other environmental impacts of coal combustion and waste.

To encourage the continued economical and environmental viability of coal as a key fuel for power generation both domestically and abroad, the Administration has continued or enhanced a variety of clean coal initiatives and launched a major new initiative—carbon sequestration—with a goal of eliminating carbon emissions from coal and other fossil fuel combustion. In addition, the Administration acknowledges the key role coal could play in providing alternative fuels and has invested in advancing technologies to expand innovative future uses for coal.

♦ ***Accomplishments and investments in coal combustion . . .***

. . . to improve the environmental performance of coal in order to maintain its desirability as a key energy source for domestic power production

✔ Clean Coal Technology (CCT) Program: The CCT program, jointly funded by government and industry, demonstrates full-scale technology to reduce environmental impacts and increase the efficiency of coal-fired electric generators. Based on the performance demonstrated in the CCT Program. (www.fe.doe.gov)

- About three-fourths of the U.S. coal-fired generating capacity has installed low-NOx burners;
- Reduced capital and operating cost have been demonstrated for a variety of innovative flue gas desulfurization systems, which coupled with advancements from the R&D program, have been a major factor in reducing the cost of sulfur removal from coal plants by 50 percent over the past 20 years. Advanced scrubbers can produce dry disposable wastes or valuable byproducts, and are capable of capturing multiple air pollutants; and
- Advanced power generation projects are providing the basis for increased efficiency resulting in reduced greenhouse gases and very low pollutant emissions.

✔ Advanced Coal Gasification and Combustion Systems: DOE is supporting development of high efficiency coal-fired power technologies, including advanced fluidized combustion and integrated gasification combined-cycle. These systems are expected to convert coal into electricity with efficiencies of at least 55 percent (current industry average is under 35 percent) at a cost 10 percent lower than today's technology. Emissions of air pollutants will be 90 percent lower than Federal pollution standards. Their high efficiency will also reduce emissions of carbon dioxide. These technologies are expected to be an integral part of the development of Vision 21 coal-fired power plants.

✔ Innovations to Existing Plants: A major goal of this program is to reduce the high cost of environmental compliance at existing coal fired power plants. The aggregate cost of compliance was $1.9 billion in the United States in 1997, and environmental compliance costs will increase by seven-fold to over $13 billion per year by 2010. Research is being conducted in the areas of control of fine particulate matter, mercury/air toxics, nitrogen and sulfur oxides, and utilization of coal combustion byproduct. The program is pursuing a 50 percent reduction in overall environmental compliance costs through the development of advanced technologies and integrated systems, which would reduce environmental compliance costs by over $6.5 billion per year by 2010. (www.fe.doe.gov)

✔ Carbon Sequestration: Carbon sequestration is increasingly seen as an essential carbon mitigation tool for long term stabilization of atmospheric concentrations of greenhouse gases. Based on the roadmap described in DOE's "Carbon Sequestration Research and Development," DOE is pursuing innovative approaches for separating, capturing, and storing (or reusing) greenhouse gas emissions, with the goal of beginning to deploy technologies by 2015 that can help offset U.S. emissions. Storage options include geologic formations, oceans, soils, and vegetation. (www.fe.doe.gov)

. . . . to develop clean and innovative uses for coal to take advantage of its low cost and abundant supplies

✔ Coal-derived Fuels Program: Improved solid fuels and economically competitive transportation fuels from our Nation's vast coal resource base are expected near-term products of this program. A key emphasis in transportation-fuels development is the production of economic, high-quality, clean-burning diesel fuels from coal. The solid fuels program is focusing on precombustion control of potentially hazardous air pollutants from coal; converting one billion tons of impounded "waste" coal to clean fuel by 2005; and facilitating 8 gigawatts of coal/biomass cofiring by 2010. (www.fe.doe.gov)

Nuclear

Nuclear energy's continued role in electricity production is important for our economic and energy security and may be an important component of the nation's global climate change response. Nuclear power plants generate approximately 20 percent of all U.S. generated electricity without emitting carbon dioxide, or the sulfur and nitrogen oxide pollutants associated with fossil fuel combustion. Between 1973 and 1998, the use of nuclear energy avoided 87.3 million metric tons of SO_2, more than 40 million metric tons of NOx, and more than two billion metric tons of carbon dioxide (CO_2.) The radioactive waste from nuclear power is carefully packaged, and currently stored safely at the power plant sites.

The U.S. is at a critical juncture in the continued operation of its nuclear power plants. Competitive pressures from electricity deregulation may well result in the shut down of poor performing plants sooner rather than later. Nevertheless, with the exception of a very few plants, nuclear power is competitive with other existing generators, and there has been an active market for purchase of nuclear plants with consolidation under fewer operators of multiple plants. There is also a regulatory hurdle in the path of continuing operation. All of our nation's nuclear power plants were licensed for 40 years of operation and licenses for operating plants will begin to expire in 2010. However, nuclear power plants can be granted an additional operating term of up to 20 years under Nuclear Regulatory Commission (NRC) regulations.

Although careful stewardship of existing assets will likely keep them running well into the first half of this century, there have been no new nuclear power plants ordered in the United States since the 1970s. This is likely to remain the case unless plant economics, and permanent spent fuel disposal are successfully addressed.

Advancing future nuclear power plant designs, the safety and life-extension of existing reactors, and the safe long-term storage of spent nuclear fuel are the focus of Administration investments in the nuclear power arena. To implement these policies, the Administration has launched three specific initiatives—the Nuclear Energy Research Initiative, the Nuclear Energy Plant Optimization Initiative, and the Generation IV Initiative.

♦ ***Accomplishments and investments in nuclear power . . .***

. . . . to develop next generation options for nuclear power plants to promote safer, more affordable, and more environmentally benign nuclear power for the future

✔ Advanced Light Water Reactor (ALWR) Program: The ALWR program was designed to ensure the viability of nuclear energy and to advance energy security and diversity. The plant designs developed by DOE and industry include the General Electric Advanced Boiling-Water Reactor (ABWR), the ABB-Combustion Engineering System 80+, and the Westinghouse AP600. Each of these NRC approved designs can be built and operated under a single license, significantly reducing the uncertainty regarding the cost and schedule of building the plants. Just after completion of the ALWR program, Taiwan elected to build two new ABWR plants. These plants are currently under construction.

✔ Nuclear Energy Research Initiative (NERI): NERI, initiated in 1999, will promote and advance concepts and breakthroughs in nuclear fission and reactor technology to address scientific and technical barriers to the long-term use of nuclear energy; advance the state of nuclear technology to maintain a competitive position in the domestic and overseas markets; and promote and maintain a nuclear science and engineering infrastruc-

ture. In FY 1999, the 46 NERI research awards went to 45 universities, laboratories, and industrial organizations. International collaborators in these awards included 4 universities, 5 industrial companies, and one government research and development organization. (neri.ne.doe.gov)

✔ Generation IV Nuclear Power Systems: The goal of this program is to develop the next generation of nuclear power reactors that are more economic, enhance proliferation-resistance, produce less waste, and have improved safety features. This new program, which started in 2000, is developing plans for collaborative research with other interested governments. An international workshop, in May, 2000, identified the characteristics and attributes of the next-generation reactors and drew input from industry, universities, and public interest groups. In FY 2001 a reactor technology roadmap will be developed to further define and focus the research efforts.

. . . . to safely extend the life of existing nuclear power plants to meet electricity demand

✔ Nuclear Energy Plant Optimization Program (NEPO): The goal of the NEPO program, started in 2000, is to invest in the research needed to ensure that current nuclear plants can continue to deliver adequate and affordable energy supplies up to and beyond their initial 40 year license period by resolving open issues related to plant aging, and by applying new technologies to improve plant reliability, availability and productivity. (nepo.ne.doe.gov)

✔ Plant Relicensing: Three years ago, with state-by-state electricity restructuring well under way and uncertainty about nuclear plant relicensing, it was predicted that existing nuclear plants would shut down prematurely at an alarming rate and few, if any, nuclear plants would receive a renewed license for 20 years of additional operation. To date, NRC has renewed licenses for five reactors of two utilities, for a total service life of 60 years of operations—Calvert Cliffs, Units 1 and 2, and Oconee, Units 1, 2, and 3, have been granted 20 additional years of operations. Three additional utilities have submitted license renewal applications and several other utilities have announced their intention to seek license extensions.

. . . to safely dispose of commercial spent fuel to protect the public health and the environment in a responsible, safe, scientifically-sound manner

✔ Spent Fuel Disposal: Decisions made many decades ago to develop nuclear energy for civilian use and to pursue a nuclear weapons program, committed the nation to perpetual custody of a large and growing inventory of radioactive materials. Spent nuclear fuel from commercial power plants constitutes the largest portion of this inventory. The Nuclear Waste Policy Act of 1982 created the Office of Civilian Radioactive Waste Management to develop a permanent, safe geologic repository for disposal of spent nuclear fuel and high-level radioactive waste. After the Department of Energy identified three potential sites, the Congress amended the Nuclear Waste Policy Act in 1987 and directed DOE to consider only Yucca Mountain, Nevada as a potential repository.

DOE is currently evaluating Yucca Mountain as a possible location for a geologic repository. The evaluation is based on rigorous scientific studies of the site and extensive development of engineered barriers. The completion of a repository will assure the permanent disposal of

spent nuclear fuel from the nation's nuclear power reactors. A repository is central to Administration policy not only because of its implications for the future availability of nuclear energy, but also because it is a prerequisite to the cleanup of DOE's nuclear weapons complex and the disposal of its weapons-grade materials. A repository will also further U.S. international nuclear nonproliferation objectives.

The Administration has so far maintained the repository program on schedule despite budget shortfalls. Key accomplishments include:

- Issuing a Program Plan after a comprehensive reassessment of the Program designed to strengthen confidence in having an operational repository in 2010;
- Issuing a viability assessment in December, 1998 that assessed the status of scientific work at Yucca Mountain and identified the work remaining to complete the repository; and
- Issuing a Draft Yucca Mountain Repository Environmental Impact Statement.

DOE is positioned to complete a Site Recommendation Consideration Report by the end of 2000 that will describe the technical information germane to the Secretary's consideration of whether to recommend the site to the President.

. . . to develop nuclear fusion as a clean, potentially limitless source of power for the future

✔ Advances in Nuclear Fusion: In contrast to the nuclear fission process that underlies today's nuclear power plants, nuclear fusion seeks to replicate the energy-releasing processes of the sun on earth. Commercial electricity production is decades away, with many scientific and engineering challenges to be met, but the benefits can be very substantial. During the last decade, Department of Energy fusion facilities used by the national plasma science and engineering community have increased fusion energy nearly a thousand-fold, have identified advanced operating regimes for fusion devices, and have developed significant simulation tools. A new facility, the National Spherical Torus Experiment (NSTX) at Princeton, began operation in FY 1999 and has already, well ahead of schedule, demonstrated a new technique for establishing plasma current and reached one million amperes. Such work simultaneously advances basic research in plasma science and engineering, supports increasingly important industrial applications of plasmas from chip processing to pasteurization, and represents the kind of long term energy investment strategy that must be supported in the Federal energy R&D portfolio.

Renewable Energy

Renewable energy resources—wind, solar, geothermal, biomass, hydrogen and hydroelectric—are abundant. These alternatives are mainly used for power generation (biomass can be used for transportation fuel, and biomass, solar and geothermal for heating), and they produce virtually no emissions or solid wastes. Their primary challenges are the cost of producing power (except hydroelectric) compared with conventional sources, and in some cases, the need to modify infrastructures to deliver renewable power to markets.

The nation's diverse portfolio of renewable energy technologies offers increasingly affordable solutions for providing clean, reliable energy for the 21st Century and will be a key component of the nation's long-term energy future and economic role in global energy markets. Research and development efforts have continued to reduce the cost of renewable energy

and focus areas include applications for distributed power and the development of advanced, domestically produced transportation fuels. In the relatively short period of Federal R&D on renewables, there has been significant progress. For example, the cost of producing photovoltaics has decreased 50 percent since 1980, making it cost-competitive in certain applications; and the real cost of wind power has decreased 85 percent over the same time period.

Renewable energy technologies have many other benefits. For instance, biomass energy crops planted on otherwise unproductive land (or the use of waste products from existing crops) offer exciting new revenue options for farmers. Likewise, many farmers and ranchers can lease small tracts of farm or grazing land to wind power developers in exchange for substantial annual payments—as much as $2000 to $3000 per year per wind turbine installed. Nationally, liquid fuels derived from biomass not only help reduce environmental emissions, but also decrease our consumption of gasoline. Biomass material can also replace oil as the source for important chemical precursors for plastics, pharmaceuticals, and other high value products.

Finally, in addition to their clear domestic benefits—less reliance on energy imports, virtually limitless resources, and clean power generation—renewables have benefits internationally. Because most of the world today still does not have adequate electric power service—or any electricity at all— the international market opportunities for advanced renewable energy and power delivery technologies are tremendous. These international opportunities mean potentially billions of dollars in export sales of U.S.- produced renewable energy and power delivery technologies, which translates into thousands of high-paying domestic jobs and a much-improved balance of trade, and reduced economic pressure on carbon based fuels. (www.eren.doe.gov/power/)

- ***Accomplishments and investments in a renewable energy future . . .***

. . . . to economically generate power from renewable energy sources to provide clean, abundant fuel for the future and reduce our reliance on imported and diminishing fossil fuel resources

✔ Wind Energy Systems: In the 1990s, wind was the fastest growing source of electricity generation in the world. The Department's Wind Energy Program continues to support wind turbine manufacturers in their efforts to reduce costs. DOE is currently sponsoring a $50 million program to push the technology envelope further and develop the next generation of wind turbines, with 30 percent of these funds coming from private industry. Along with R&D investments, DOE also began funding the *Wind Powering America Initiative* in 1999, which is committed to increasing the use of wind energy in the United States from 2,500 megawatts to 10,000 megawatts within the decade. (www.eren.doe.gov/wind/)

✔ Photovoltaic (PV) Systems: The PV Program's goals are to reduce the cost of electricity generated by PV from 12-20 cents per kilowatthour today to less than six cents per kilowatthour by: making devices more efficient; making PV systems less expensive; and validating the technology through measurements, tests, and prototypes. Researchers in the National Center for Photovoltaics (NCPV) recently took a significant step in reducing cost through efficiency gains by setting a world record in efficiency for a thin-film solar cell. (www.eren.doe.gov/pv/)

✔ Geothermal Power: Currently in the United States, the installed capacity for geothermal energy is about 2,800 megawatts, providing enough electricity for

over one million people. The cost of producing this power ranges from 5–8 cents per kilowatt hour. DOE sponsors research aimed at developing the science and technology to tap geothermal resources reducing the levelized cost of geo power to 3-5 cents per kilowatt hour by 2007. In addition, the Department announced the *Geopowering the West Initiative* in January, 2000, to increase the use of geothermal energy in the West, where geothermal resources are abundant. (www.eren.doe.gov/geothermal/)

✔ Transpired Solar Collectors: Most industrial and commercial buildings require large quantities of ventilation air to maintain a healthful work environment. Transpired solar collectors, developed during the last decade, use 60 to 75 percent of the solar heat reaching a building to preheat incoming fresh air supplies. By raising the incoming air temperature, building heating systems use less energy to maintain comfortable indoor air temperatures. These reliable and low cost systems have a 30-year lifetime and typically pay back their initial purchase cost in 3 to 5 years through reduced energy bills. Over their lifetimes, the currently installed systems will displace 2.2 trillion btus of energy. (www.eren.doe.gov/solarbuildings/space.html)

✔ Million Solar Roofs: The goal of the Million Solar Roofs Initiative is to install one million solar energy systems on U.S. buildings by 2010. DOE, working through State and Community Partnerships, has obtained commitments for more than one million solar energy systems and nearly 100,000 systems have already been installed. (www.eren.doe.gov/millionroofs/)

✔ "Fish-friendly" Turbines**:** About ten percent of the nation's electricity is generated by hydro power. The DOE Hydropower Program aims to develop advanced technology to allow the maximum use of hydropower resources, while minimizing adverse environmental impacts. Our focus is on developing "fish friendly" turbines to minimize fish mortality to two percent compared to the current 5-30 percent rates. Under a DOE-industry partnership, conceptual designs are now complete and we plan to complete full scale testing of prototype turbines in this decade to pave the way for market entry. (www.inel.gov/national/hydropower/)

. . . . to cleanly power the nation's vehicles with renewable energy to improve the environment and increase our national energy security

✔ National Biomass Ethanol Program: DOE has been developing alternative fuels technologies in partnership with the industry for more than 20 years. Fuels and vehicles to use these fuels are at many different stages of development. In the case of ethanol, E85 (15 percent gasoline and 85 percent ethanol) vehicles have been available for purchase by the general public since 1982. DOE is currently sponsoring work to demonstrate the capability of an E85 vehicle to meet ultra-low-emission vehicle (ULEV) standards. The DOE biofuels production program is developing new technologies to lower the cost of ethanol by approximately 50 percent, while using renewable resources to minimize net emissions of carbon dioxide. (www.ott.doe.gov/biofuels/)

✔ Biomass Feedstock Production: Agriculturally-derived fuels have the potential to reduce the United States' dependence on imported petroleum and at the same time alleviate some environmental concerns. The Clinton/Gore Administration has set a goal of tripling U.S. use of biobased products and bioenergy by 2010, which would generate as much as $20 billion a year in new income for farmers and rural

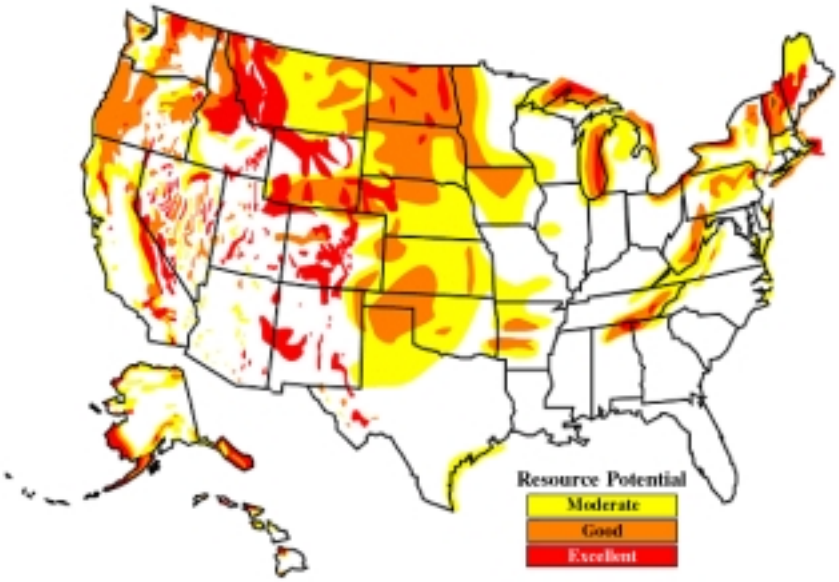
Wind is Powering Up

Wind was the 1990s fastest growing source of electric power generation. Indeed, the "wind is at our backs" in the expansion of world wind energy resources. In 1999, new worldwide wind-generating capacity grew by 3,600 megawatts, a 36 percent increase that brought worldwide wind-generating capacity to 13,400 megawatts. In the United States, this increase was even greater at 41 percent, bringing our 1999 total wind-generating capacity to 2,500 megawatts.

Wind: An All American Resource

Rank	State
1	North Dakota
2	Texas
3	Kansas
4	South Dakota
5	Montana
6	Nebraska
7	Wyoming
8	Oklahoma
9	Minnesota
10	Iowa
11	Colorado
12	New Mexico
13	Idaho
14	Michigan
15	New York
16	Illinois
17	California

Source: AWEA



World Class Wind Potential
Germany's Potential: 100 gigawatts
North Dakota's Potential: 250 gigawatts

Working with private sector partners, DOE, through its Wind Energy Systems Program, is developing advanced wind turbine technologies capable of reducing the cost of wind energy generation to 2.5 cents per kilowatthour—making wind energy competitive with other power generation and putting us on track to meet our goal of 10,000 megawatts of installed wind-powered generating capacity in the U.S. by 2010. DOE also estimates that the Wind Energy Systems Program could displace as much as 10 million metric tons of carbon equivalent in 2010 if the program goals are met. Large wind projects can now achieve costs of around 4 to 5 cents per kilowatthour.

We need to look only as far as Lake Benton, Minnesota to see solid achievements from our investments in wind energy. The 107-megawatt wind power plant located near Lake Benton was the world's largest wind-generation facility at the time of its completion in 1998. Electricity generated by this facility will power 43,000 homes and displace greenhouse gas emissions equivalent to removing 50,000 new cars and light trucks from the road. The technical assistance, testing capabilities, and utility operating experience made possible by the Department's Wind Program were critical to the successful development of the wind turbines used in the Minnesota project.

Not only does wind energy have potential to add to the nation's power supplies and reduce harmful emissions, it has tremendous potential for serving remote rural areas that do not have access to the conventional power grid. DOE supported the design and installation of a 660 Kilowatt wind energy project for the Kotzebue Electric Association in Kotzebue, Alaska. Kotzebue's wind turbines are producing electricity for approximately 13 cents per kilowatthour, compared to the 20 cent cost of the diesel generation they replaced. The Kotzebue project is a model for other Alaskan and remote communities seeking to relieve their dependence on diesel power systems.

Finally, we are working to establish new sources of income for American farmers, Native Americans, and other rural landowners—and meet the growing demand for clean sources of electricity—through DOE's *Wind Powering America Initiative*. More than 500 megawatts of new wind generating capacity have been installed on farmlands in the Great Plains region of the United States, providing a substantial economic boost directly to farmers, landowners, and local communities while satisfying the growing demand for clean electricity. Wind farms create construction and service jobs in rural regions, as well substantial tax revenues for local municipalities.

communities, while reducing greenhouse gas emissions by as much as 100 million tons a year—the equivalent of taking more than 70 million cars off the road. The U.S. Department of Energy's Bioenergy Feedstock Development Program (BFDP) has screened more than 125 tree and nonwoody species and selected a limited number of model species for development as energy crops. (www.bioenergy.ornl.gov/papers/bioam2000/ppt/index.htm)

- *Ethanol Production*: The approximately 1.5 billion gallons of ethanol produced each year is derived mostly from corn. The Department is concentrating its efforts on developing an alternative, low-cost feedstock–cellulosic biomass. Ethanol can be produced from plentiful, domestic, cellulosic biomass feedstocks such as bioenergy crops (herbaceous and woody plants), agricultural wastes (corn stover, bagasse, etc.), forestry residues, and municipal solid waste. DOE anticipates that within the next few years, the first commercial biomass ethanol plants will begin operation in the United States.

✔ Automotive Fuel Cells: The goal of the DOE Fuel Cell Program is to develop highly efficient, low or zero emission automotive fuel cell propulsion systems. This government/industry alliance includes domestic automakers, component suppliers, fuel cell developers, national laboratories, universities, and the fuels industry. Pre-competitive fuel cell R&D managed by DOE is attempting to resolve fundamental problems and issues associated with fuel cells and ancillary components that apply to a number of different fuel cell propulsion systems. (www.ott.doe.gov/hev/fuelcells.html)

✔ Hydrogen R&D: DOE's Hydrogen Program is a part of an integrated partnership with private industry, universities, and government laboratories to accelerate the introduction of cost-competitive hydrogen production methods and end-use technologies into the marketplace. The Program focuses on research and validation of various hydrogen production processes and appliances in order to provide clean, sustainable energy sources for buildings, vehicles and industrial uses. In addition to researching a variety of means for producing hydrogen with renewable energy, DOE is investing in R&D to create innovative technologies for purifying, storing, sensing, and using hydrogen. The long term transition to a hydrogen-based economy, in which renewable-produced hydrogen joins electricity as a major carrier of energy, would provide substantially greater flexibility in meeting energy needs throughout the economy. (www.eren.doe.gov/power/hydrogen.html)

The Administration's accomplishments will continue to enhance and improve the nation's energy security. Our investments will help meet tomorrow's energy challenges.

Energy Trends in Focus/Energy Challenges in Context

The unparalleled energy infrastructure that enables us to effortlessly flick on a light switch or turn an ignition key leaves most Americans unaware of the requirements to maintain and improve its performance, and is testament to the success of ongoing energy policies and technology investments.

Recent events however, with gasoline and heating oil prices and electric reliability and electricity prices, have once again brought energy issues to the forefront of the public dialogue. To a significant degree, the current volatility in energy prices and increasing concerns over power generation are symptoms of success—the very economic power and growth we have seen in the last decade has dramatically increased demand for energy. This increased

demand is, in turn, straining our existing energy infrastructure and domestic energy resource base.

The energy trends through 2020 that are identified in the Energy Information Administration's Annual Energy Outlook/2000 help to focus our efforts on future energy challenges. These are long-term forecasts that are adjusted on annual basis. While forecasts of this nature are rarely accurate predictors of the future, they serve as useful tools in developing general directions for public policy and R&D investments. It should be noted that these forecasts generally represent "business as usual" and do not take into account substantial policy implementations or technological breakthroughs. Indeed, sound policy and sustained technology investments can significantly modify the scenarios so as to enhance our economy and environment relative to the reference case.

The EIA reference case suggest that by 2020:

On energy demand –

- Primary energy use in the U.S. is expected to grow from 97 quadrillion btus to 121 quadrillion (*Figure 6—Primary Energy Use by Fuel*.)
- The average American home is expected to be 2 percent larger and to rely more heavily on electricity-based technologies. Highway travel is expected to increase by 21 percent and air travel by 97 percent.
- Industrial energy use is expected to grow by 20 percent.
- Despite this growth in demand for energy services, maintaining the pace of energy efficiency gains will keep per capita energy intensity from rising.

On electricity –

- A thousand new power plants (with as many as 900 of these gas-fired) averaging 300 megawatts will likely be needed to meet growing demand for electricity.
- Retirements of nuclear power plants starting in 2010 could lead to higher fossil fuel use for power generation.

On energy technology –

- Municipal solid waste (MSW) and biomass will lead to growth in renewable fuel use for electricity (*Figure 7—Nonhydroelectric Renewable Electricity Generation by Energy Source*.)
- Advanced technologies could reduce residential energy use by 20 percent.
- Automobiles are expected to average 31.6 mpg through technology improvements.

Figure 6—Primary Energy Use by Fuel

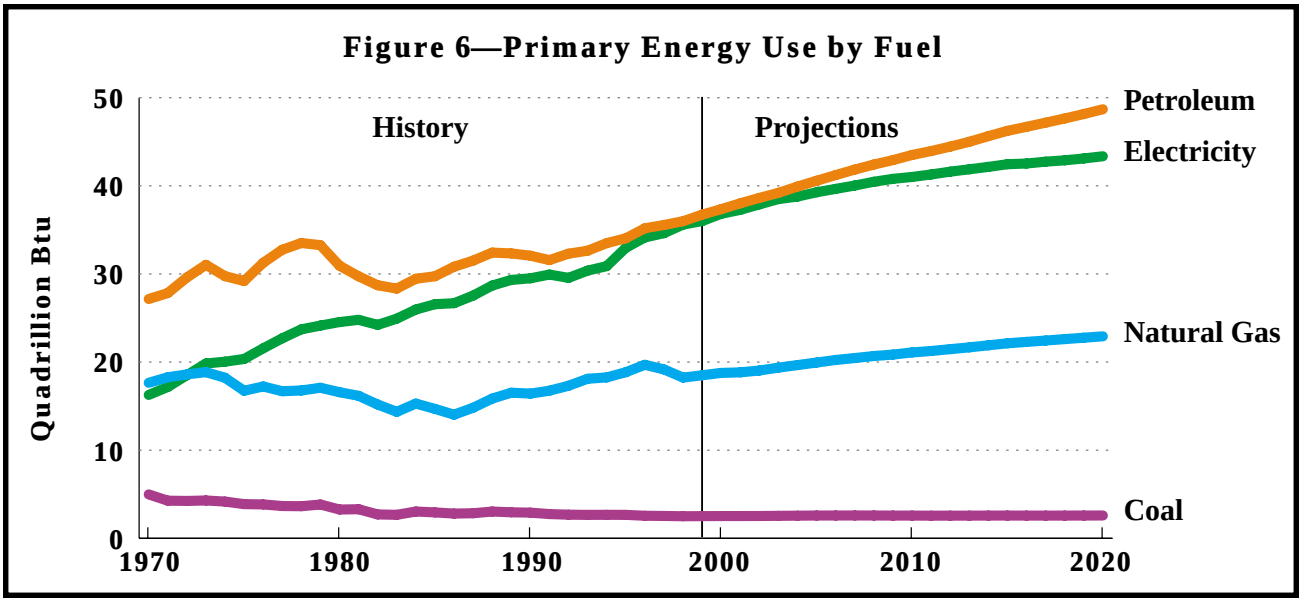
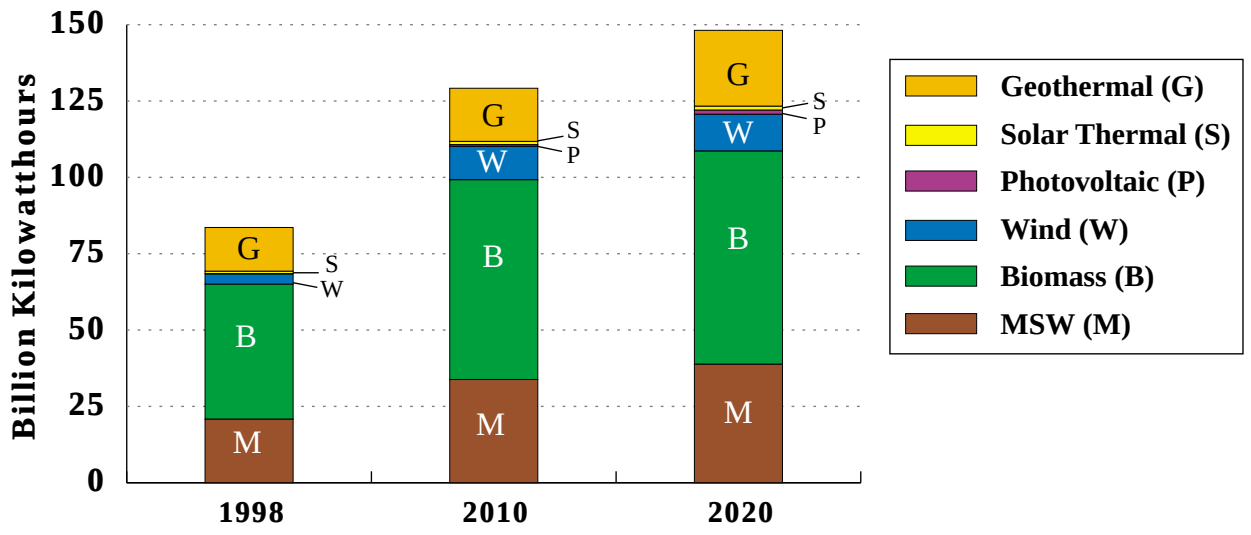


Figure 7—Nonhydroelectric Renewable Electricity Generation by Energy Source



- Advances in recovery technologies will increase gas production (gas prices are especially sensitive to technology.)
- Technology advances could increase offshore and Alaska oil and gas production.

On energy prices –

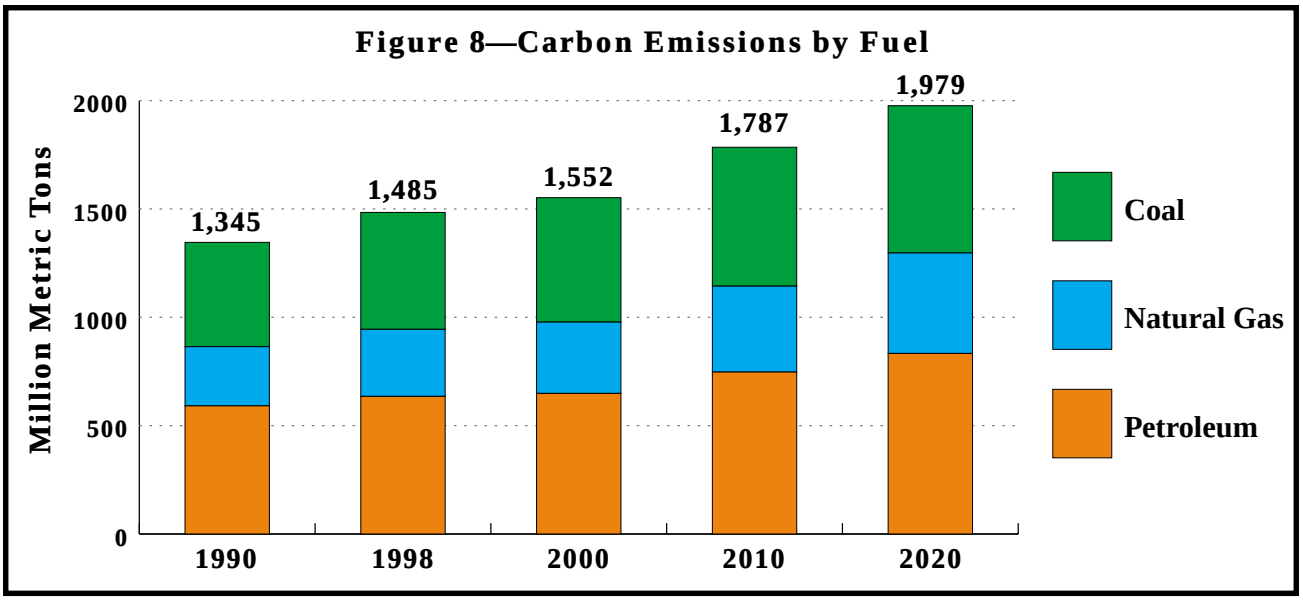
- Oil prices are expected to remain above 20 dollars per barrel (in real 1998 dollars.)
- Competition is expected to decrease electricity generation costs and provide new consumer services.
- Rising demand for natural gas will mean higher natural gas prices which will, in turn, encourage natural gas production.
- Processing costs for gasoline and jet fuel are expected to rise.
- Competitive markets will keep residential natural gas prices reasonable.
- Higher oil and gas prices will maintain coal-fired power generation and domestic coal demand will rise.
- Minemouth coal costs will continue to fall.

On energy production and infrastructure –

- Domestic oil production will decline until 2005 and remain flat after that.
- There will be high levels of gas reserve additions.
- Significant new gas finds are likely to continue increases in gas production.
- We will need significant new natural gas pipeline capacity to meet growing demand for natural gas, mostly for power generation.
- New U.S. refining capacity will likely come from existing refineries.
- Ethanol use as a gasoline additive will increase.

On the environment –

- High energy consumption will increase carbon emissions.
- Scrubber retrofits will be needed to meet sulfur caps.
- There will be a significant drop in NOx emissions, driven by legislation and regulation.



- Emissions caps will lead to the use of more Western low-sulfur coal.
- Carbon emissions from transportation will grow rapidly (*Figure 8—Carbon Emissions by Fuel*.)

The Nation's Emerging Energy Challenges

The trends identified in the Annual Energy Outlook 2000 reference case scenarios demonstrate the complexity of the linkages among many of the issues, which require a significant amount of strategic planning, investments in R&D, and policy and regulatory support. Current conditions in energy markets also enable us to draw many conclusions about future energy needs. Finally, the 1998 *Comprehensive National Energy Strategy* identified several preeminent energy challenges, which have been refined or updated to reflect new or additional market conditions and needs.

These challenges are not necessarily energy-source specific and more often than not identify extremely complex interrelationships between energy sources and their end uses, as well as the complicated cross-cutting nature of the actions needed to address them. The Administration has taken a variety of actions to meet these challenges, and has proposed others to Congress that will require statutory changes or additional appropriations.

♦ *Challenge #1: Enhancing America's Energy Security*

Mobility is key to our economic productivity and central to our quality of life. The U.S. transportation sector is 97 percent reliant on liquid fuels. There have been relatively low average oil prices over the last 15 years and abundant world supply. Past and very recent history, however, suggests that there are highly credible scenarios in which oil represents an energy security concern. EIA forecasts that by 2020:

- U.S. net petroleum imports, already over 50 percent of the 19 million barrels per day consumed, will increase to 64 percent of the projected 25 million barrels per day consumed. This is a continuing trend that has persisted since 1970. Domestic production declines will level out by 2005 but imports will still increase to meet increases in demand;
- World oil dependence will continue at nearly 40 percent of the energy consumed. Total petroleum imports by all countries will increase by 75 percent; and
- Increased oil demand will be met by OPEC nations and other oil-producing nations, some of which are in potentially unstable parts of the world.

There are also fuels-related environmental concerns. Vehicles currently account for a large portion of urban air pollution, including 77 percent of carbon monoxide, 49 percent of nitrogen oxides and 37 percent of volatile organic compounds. The transportation sector also produces over one-third of U.S. carbon dioxide emissions. In coming decades cleaner fuels could help address public health and environmental concerns.

Rapidly increasing worldwide demand for oil has dramatically reduced world excess oil productive capacity, leading to volatility in oil prices. This, together with high domestic demand and other factors, has led to tight and volatile U.S. product markets.

Oil, in contrast to other energy sources, is truly a global commodity, traded and sold in world markets. Reducing levels of oil imports is a goal of the Administration but absent extreme measures such as import quotas—which would have to be established by Congress and which would likely dramatically increase costs to U.S. businesses and consumers and adversely impact the economy—levels of oil imports will continue to be determined by supply and demand, and levels of capital investment will be determined by the cost of exploration and production.

In addition to the concerns about growth in oil demand and oil's impacts on the environment, the Administration's response to the important role of oil in our energy security recognizes the following:

Tools of the Energy Policy Trade

The Administration relies on the best available data, combined with state-of-the-art economic, energy and environmental modeling and forecasting tools to develop its energy policies, measure their impacts, and assess the levels and types of Federal investment required to meet energy policy goals.

A wide range of analytical tools are needed to address the incredible variety of energy policy issues that face the nation—tools that make use of recent advances such as those in economics, operations research, and decision theory. These tools are increasingly dependent on modern computational techniques, making use of ever larger data sets and depicting complex inter-relationships. For example, the Policy Office at the Department of Energy maintains a complex model of the electricity system, allowing analysis of various policy alternatives for enhancing competition in the electricity sector. Oak Ridge National Laboratory maintains a sophisticated model of refinery operations that can be used to explore the supply and cost implications of new fuel specifications for gasoline and diesel fuel.

The Energy Information Administration (EIA) develops and maintains the National Energy Modeling System (NEMS)—an energy-economic modeling system of U.S. energy markets. NEMS projects the production, imports, conversion, consumption and prices of energy, subject to assumptions on macroeconomic and financial factors, world energy markets, resource availability and costs, behavioral and technological choice criteria, cost and performance of energy technologies and demographics.

Increasingly, the models used in the energy sector incorporate the situations faced by other countries, as markets become more global in nature. One tool used in analyzing the potential impacts of efforts to reduce emissions of greenhouse gases in developing and developed countries is the MARKAL energy model, which has modules for a number of countries, including fast growing countries such as China and developed countries such as the United States. Keeping these tools up-to-date and available for use on relatively short notice is a resource-intensive activity. However, because the foundation for good policy is good analysis, investments in these areas clearly have payoffs that exceed the overall costs.

Energy models are also used to analyze:

- The effect of appliance and equipment efficiency standards on manufacturing costs, product price, and environmental quality;
- The impact of financial incentives on the level and type of private investment in more energy efficient technologies;
- The degree to which policies to limit greenhouse gas emissions affect the demand, supply and price of energy, economic growth, and environmental quality; and
- The impact of more stringent fuel quality regulations on energy suppliers and consumers.

EIA data products on energy are frequently cited as the best in the world and have become industry standards. These include:

- The Annual Energy Outlook
- The International Energy Outlook
- Weekly Petroleum Report
- Short-Term Energy Outlook
- Natural Gas Weekly
- Summer and Winter Fuels Conferences

- The cost of oil production in the U.S. is high relative to other producing nations;
- The price of oil is a world price. High or low prices worldwide will mean high or low prices domestically;
- Reducing volatility in world oil markets will most likely spur investment in oil exploration, production, refining, and distribution;
- Global production and refining capacity is very tight, contributing to market volatility;
- Increasing net imports are not only an indicator of flat or declining domestic production but also of increased domestic consumption; and
- Development and deployment of advanced demand-side technology and energy diversity is critical to long term success.

The Administration has taken or proposed significant actions to address the challenges presented by our ongoing and almost exclusive reliance on oil for our transportation needs and its implications for energy and national security.

☆ *Reduction in U.S. Oil Demand*

As almost 67 percent of U.S. oil consumption is for transportation, vehicle efficiency is a ripe target for reducing the consumption side of the net oil import equation. Increasing the average fuel economy for cars and light duty vehicles by just three miles per gallon would save the United States almost one million barrels of oil per day. The importance of lowering oil demand without impacting the economy or quality of life is clear. Success depends on the development and deployment of advanced technology. The Administration will continue to invest in:

- Developing an 80 mile-per-gallon prototype sedan by 2004 through our Partnership for New Generation Vehicles Program;
- Improving light truck fuel efficiency by 35 percent while meeting newly-issued EPA tier 2 emissions standards by 2004;
- Developing technologies to increase fuel economy of the largest heavy trucks from 7 to 10 mpg (nearly 50 percent) by 2004;
- Increasing domestic ethanol production to 2.2 billion gallons per day by 2010;
- Tax credits for biofuels;
- Developing production prototype vehicles that will double the fuel-efficiency of tractor trailer trucks and triple the efficiency of heavy-duty pick-ups; and
- Tax credits for hybrid vehicles.

☆ *Expensing of Geological and Geophysical, and Delay Rental Costs*

To spur domestic oil and gas production and lower the costs of doing business—without imposing restrictions on imports that would raise costs to consumers—the President has proposed tax incentives for 100 percent expensing of geological and geophysical costs (G&G) and allowing the expensing of delay rental payments. G&G expensing will encourage exploration and production and delay rental expensing will lower the costs of doing business on public lands.

☆ *Continuation of the Oil and Gas Exploration and Production Program*

DOE is continuing its Oil and Gas Exploration and Production Program to enhance the efficiency and environmental quality of domestic oil and gas production and utilization, helping ensure the

availability of competitively-priced oil and natural gas supplies to support a strong U.S. economy. Even though remaining recoverable oil and gas in the U.S. is substantial, exploration and production is becoming increasingly expensive due to the maturity of this resource. Historically, technology advances have improved well success rates and cut oil and gas finding costs. However, continued technology advancement is necessary for cost effective recovery from geologically complex reservoirs and deeper water offshore fields compatible with environmental regulations. The program focus is on areas such as diagnostics and imaging, drilling, reservoir life extension, and environmental protection. (www.fe.doe.gov)

☆ *Offshore Technology Roadmap*

The ultradeep waters of the Gulf of Mexico can significantly expand domestic natural gas supply. The National Petroleum Council in its December 1999 report on natural gas projected that deepwater Gulf of Mexico natural gas production would increase from 0.8 trillion cubic feet in 1998 to over 4.5 trillion cubic feet in 2010. Achieving this production, however, will present major technology challenges. Working with industry, the Department of Energy is developing a technology roadmap that will shape a research and development program to reduce ultradeep offshore drilling costs by 40 percent. (www.fe.doe.gov)

☆ *Promotion of International Investment in Developing World Oil Resources*

The Department of Energy has organized three international energy summits involving Energy Ministers from the Western Hemisphere, Africa, and the Asian-Pacific Economic Cooperation (APEC) community to promote regional integration, to open markets and to plot a course for global energy development. In addition, Secretary Richardson visited OPEC and non-OPEC producing nations to encourage increased oil production by emphasizing up-to-date information about world supply, demand, and inventories. Since last year at this time, there are 4.0 million more barrels of oil per day on world markets. The Administration has invested a significant amount of diplomatic effort in developing oil resources in the Caspian Basin and the means to deliver this oil to Western markets. Just recently a significant find was made in the Caspian and potential reserves are thought to equal or surpass those of the North Sea. In 1998, the Department initiated an International Oil and Gas Industry Forum with the Chinese Government, which was based on a similar, highly successful initiative in Latin America. At meetings in Beijing and Houston, representatives of the two countries and senior executives of U.S. and Chinese Petroleum companies committed to working together to develop the policies, laws, regulations, and market operating systems needed to create an open market in oil and gas technology.

☆ *Reducing Volatility in World Oil Markets*

To address volatility in world oil markets, the Administration has strengthened its ties with the world's oil producing nations, worked closely with oil consuming nations through organizations such as the International Energy Agency, and launched a campaign to improve the collection, dissemination, and understanding of world oil supply and demand data. Last January, the Department of Energy organized a forum of leading industry analysts and data experts to discuss how the quality, timeliness and availability of oil data might be affecting volatility in oil markets. This forum was followed by a recent international conference on the same subject, organized by DOE and attended by 23 consuming and

On the International Front: Promoting U.S. Energy Business, Clean Energy Development, and Infrastructure Investments

Over the next twenty years, China expects to add up to 170 million cars to its roads, almost all of which will be powered with petroleum-based fuels. Major population centers—India, Mexico, South Africa, Brazil, Chile, Argentina, Southeast Asia—need electricity and petroleum to develop their economies. At the same time, demand for energy and energy services in the industrialized world continues to grow—the United States is in the lead, with projected energy demand growth of over 20 percent by 2020.

Competition for energy resources and the capital to develop them will be intense. World energy demand is expected to double by 2030 and quadruple by the end of this century—much of this increased demand will be in the developing world. Total world energy consumption is projected to reach 560 quadrillion btus in 2015, an increase of 200 quadrillion btus over 1995. As energy demand and use grows, so do environmental problems. World carbon emissions are projected to increase by 3.5 billion metric tons by 2015, along with other harmful emissions and particulates.

At the same time, the global market for energy supply equipment is $300 billion annually. This will grow proportionately as world energy demand doubles in the next several decades. If we include the value of products whose marketability depends on energy performance—such as cars or appliances—the value of the global energy market reaches into the trillions of dollars. China serves as an example of this potential, recently announcing that it needs $14.5 billion to develop its natural gas resources over the next five years, and that "there will be no limits on the equity foreign partners can hold, and no restrictions on the forms of cooperation."

The Clinton/Gore Administration wants U.S. companies to get a substantial share of the world's energy business—we are aggressively promoting our business interests overseas, for both clean energy technologies, and energy production and infrastructure development. DOE activities in the international arena range from promoting distributed generation in countries that lack central power grid infrastructures . . . to encouraging power sector reform to increase foreign investment, energy production and energy efficiency . . . to opening the doors of foreign governments to U.S. company investments in upstream oil and gas exploration and production.

Promoting Clean Energy

In addition to launching the International Clean Energy Initiative, DOE has signed cooperative Clean Energy Statements with a number of countries to build support for market-based emissions trading mechanisms and new technology to reduce greenhouse gas emissions. We have also teamed up with U.S. businesses, and engaged energy ministers from the Western Hemisphere, Africa, and the Asia-Pacific Economic Cooperation (APEC) region, the International Energy Agency and the European Union to speed the export of U.S. clean energy technologies.

In October 1999, DOE signed a Joint Statement on Cooperation in Energy and Related Environmental Aspects with the Government of India. This set the stage for President Clinton's visit to India, which included the signing of an Energy and Environment agreement and a major U.S./South Asia Regional Initiative on clean energy development. In March 2000, a Joint Statement on Clean Energy and Climate Change was signed with the Government of the Philippines, facilitating international negotiations on climate change. DOE has also signed Clean Energy Statements with the Governments of Russia, Estonia, Latvia, Lithuania and the Kyrgyz Republic. These statements emphasize the role of the energy sector in joint efforts to protect and enhance the environment, and advance the international negotiating process on climate change. In the Western Hemisphere, DOE has initiated clean energy programs with Bolivia, Costa Rica and Mexico. In Mexico, the focus is on clean and affordable fossil technology development and deployment. Bolivia recently agreed to develop a greenhouse gas emission target.

Promoting Investment in International Energy Production and Infrastructure

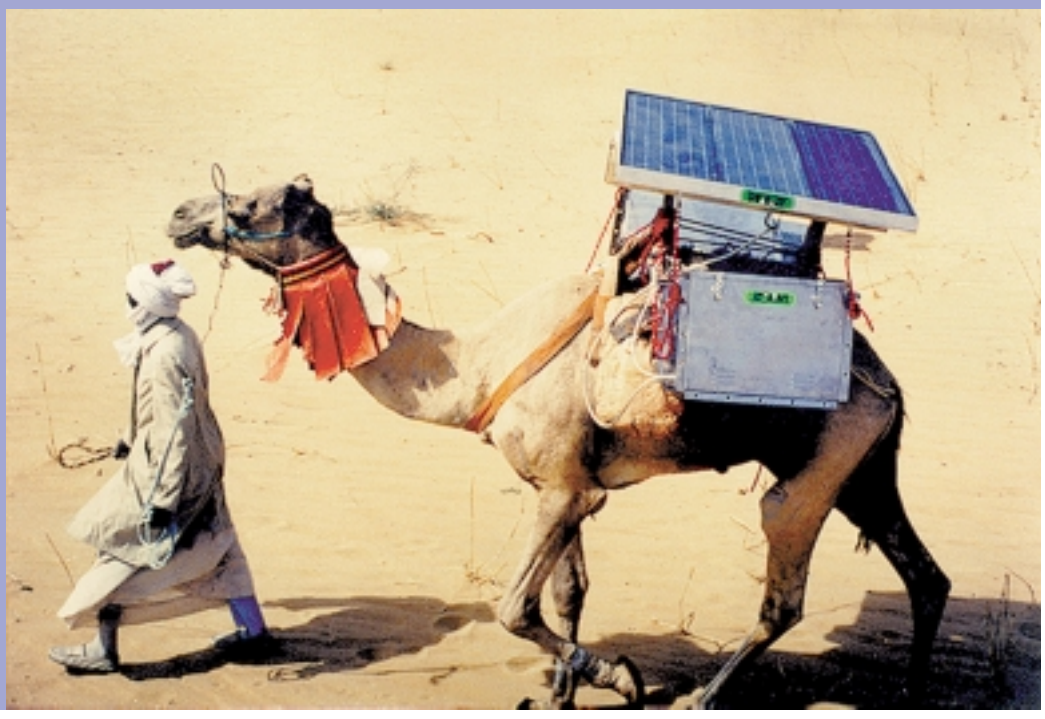
DOE cooperative programs helped advance passage of Russian Production Sharing Laws to encourage investment in the oil and gas sector. The first oil flowed from Sakhalin Island in 1999, a project developed jointly by Marathon Oil and Russian companies. In the Caspian region, bilateral policy dialogue with Turkey, Azerbaijan, Georgia, and Turkmenistan has fostered an investment climate to develop oil and gas resources and the pipelines needed to transport these products to Western markets. This was highlighted when President Clinton witnessed the signing of intergovernmental agreements among Turkey, Azerbaijan and Georgia for the development of a critical pipeline system from the Caspian region to western markets. The Department has also established a regional oil spill response system with the countries bordering the Black Sea, through a website and technical workshops in the region.

The Administration is also promoting energy efficiency and renewable energy in Russia through a host of measures including: regional energy efficiency laws; renovation of district heating systems; energy-savings codes and standards; advances in energy-efficient window technologies; and the construction of wind-diesel hybrid power stations at remote sites in the Northern Territories and a new geothermal power plant in Kamchatka.

DOE has launched an $850,000 initiative in Ukraine to finance energy efficiency projects, to conduct energy audits of five industrial firms, and facilitate a $30 million World Bank loan to retrofit municipal buildings in Kiev. We actively participate in the U.S.-China Forum on Environment and Development, and together with the U.S. Export-Import Bank, have established a $100 million credit facility to finance energy efficient, clean energy systems. U.S. and Chinese government officials and petroleum industry leaders, working through the China Oil and Gas Industry Forum, have contributed to a major strategic decision by China to develop its natural gas resources, import liquefied natural gas, and permit foreign ownership of natural gas production and transportation infrastructure.

Good Policy/Good Business

The cooperative development of the world's energy resources and infrastructure is good public policy and good for business all around—we are helping spur economic development, creating new markets, encouraging stability, and promoting environmental responsibility.



A solar powered vaccine refrigeration unit developed for the World Health Organization (WHO.) This is part of an innoculation program conducted by WHO for the Bedouin tribes of the Sudan, East Africa.

producing nations. The International Energy Agency is expected to organize a follow-on conference later this year.

☆ *U.S. Petroleum Refining Industry: Meeting Energy and Environmental Needs*

In June, 2000, the National Petroleum Council—an advisory body to the Secretary of Energy that includes representatives of the oil and gas industry, consumer and environmental groups, the financial community, and states—delivered a report to the Secretary on the U.S. petroleum refining industry which urged the government to continue to develop ways to mitigate the costs of environmental requirements on the U.S. refining industry. Consistent with these findings, DOE and the Environmental Protection Agency (EPA) are working together to develop regulations and technologies that meet our environmental needs and energy goals. For example, EPA promulgated final regulations to reduce the sulfur content of gasoline. DOE worked with EPA on these regulations in order to minimize the price impacts on producers and consumers while achieving clean air goals. Similarly, DOE is working with EPA on regulations that would reduce the sulfur content of diesel fuel to allow the use of advanced pollution control devices for diesel-powered vehicles that may optimize fuel efficiency and thus reduce oil demand. In addition, industry is working with DOE on the Ultra-Clean Fuels Program, designed to meet future fuels requirements in the context of the existing refining infrastructure. (www.npc.org)

☆ *Home Heating Oil Reserve*

On July 10, 2000, President Clinton directed Secretary of Energy Bill Richardson to establish a home heating oil reserve in the Northeast to reduce the risks presented by extreme price spikes and possible shortages similar to those that occurred in winter of 1999-2000. DOE has completed the process of obtaining 2 million barrels of home heating oil to store at interim facilities in the Northeast through exchange of crude oil from the Strategic Petroleum Reserve. The Administration will continue to seek authorization from Congress for a permanent heating oil reserve in the Northeast and an appropriate trigger for using it. (www.fe.doe.gov)

♦ *Challenge #2: Increasing the Competitiveness and Reliability of U.S. Energy Systems*

Over 40 percent of the nation's energy bill goes for electricity. With over $200 billion in annual sales, a reliable supply of electricity is vital to our economy and to the health and safety of all Americans. Electricity is increasingly the energy form of choice for myriad applications at home and at work. The network of power sources, transmission and distribution has served the nation exceptionally well but is confronting significant new challenges.

Rapidly increasing demand requires new generating plant and transmission capacity, with most of the new supply powered by natural gas. The digital New Economy is placing stringent demands for increased reliability and power quality on top of those requirements for the broad consumer base. Also, the linkage of the electricity grid with gas and telecommunications networks—the intergrid—presents new opportunities for customer service.

This growing relationship between natural gas and electric power generation suggests the need for greater coordination of policies, regulations and energy R&D investments. Realizing the new benefits and services that will result from this interrelationship will require new regulatory and government structures to encourage market competition and entrepreneurial opportunity. It will also require greater coordination of the entire electricity supply chain—from production, to transmission, to distribution. This increased need for policy and industry coordination is

occurring at precisely the time states and the Federal government are restructuring the industry to stimulate competition.

Addressing these issues involves electricity industry restructuring "rules of the road," developing cleaner, more efficient fossil fuel power technologies, advancing renewable energy sources, enabling the benefits of distributed generation, and enhancing grid technologies to meet increased reliability requirements. The Clinton/Gore Administration is seeking to extend the role of markets and competition in the electricity sector and improve the reliability of our electricity grid.

Twenty-five states have now adopted electricity restructuring proposals that allow for competition at the retail level. Almost every other state has the matter under active consideration. The Administration believes that the full range of benefits from restructuring can only be realized within an appropriate Federal statutory framework. Electricity markets are becoming increasingly regional and multi-regional—actions in one state can and do affect consumers in others. States alone cannot ensure that regional power and transmission markets are efficient and competitive, nor can they provide for the continued reliability of the interstate bulk power grid.

The Administration has taken or proposed significant actions to address the challenges presented by our growing need for electricity, the environmental problems associated with this growth in demand, the need for greater reliability, the demand for significantly expanded natural gas supply, and the need to address these issues at the Federal level in order to provide for a smooth transition to competitive electricity markets.

☆ *Comprehensive Electricity Restructuring Proposal*

In 1998 and 1999, the Clinton/Gore Administration presented the Congress with a comprehensive legislative blueprint of changes needed for updating the Federal statutory framework to support the advent of competition in electricity markets and to avoid some of the problems associated with the state-by-state, piecemeal restructuring we are witnessing today. This bill was a featured element of the Comprehensive National Energy Strategy the Administration sent to the Congress in 1998.

☆ *Energy Infrastructure Reliability Initiative*

To ensure the reliability of the electricity and natural gas infrastructures, which will be increasingly linked in the future, the Administration has proposed a new Energy Infrastructure Reliability Initiative that would address three components:

- Electric reliability by focusing on regional grid control, distributed resources and microgrids, information system analysis, possible offsetting of peak summertime electric load with distributed generation and natural gas cooling technologies for example, and high capacity transmission;
- Natural gas infrastructure reliability to include storage, pipeline and distribution R&D; and
- Critical infrastructure protection, secure energy infrastructures, vulnerability assessments, risk analysis, and the development of protection and mitigation technologies.

☆ *Reliability Summits*

Secretary Richardson hosted 11 regional electric reliability summits with Federal, state and local government officials, regulators, utilities and consumers during the spring and summer of 2000 to discuss ways to improve delivery of electricity to the American consumer, promote cooperative solutions to reliability problems, and improve the power grid of the 21st century.

Electricity Restructuring—The Need for Federal Action

Would American consumers say "no" to a $20 billion reduction in their annual electricity bill, an entirely new range of services, new business opportunities, and a cleaner environment? The Clinton/Gore Administration doesn't think so. This list of benefits represents the promise of true competition in the nation's electric power industry—a promise we can deliver on through the enactment of comprehensive Federal electricity restructuring legislation.

Why do we need Federal restructuring? Already, twenty-five states have adopted state-specific restructuring programs and there are clear benefits—over the next two or three years, millions of additional consumers will have choices in electric power providers and, after a transition period, should realize the lower costs and better services that come with competition. According to regulators in Pennsylvania, for example, consumers have already saved $2.8 billion.

But these state-by-state patchwork efforts underscore the need for comprehensive Federal legislation. The absence of overarching Federal direction has created significant uncertainty in electricity markets—energy markets are becoming increasingly regionalized, but market requirements that change at each state border are discouraging the investments we need to modernize and expand the nation's power grid. This is showing up in regional electricity price volatility and needs to be addressed promptly.

Also, today's electricity infrastructure is being asked to operate in ways for which it was not designed, with ever growing demands for improved service and increased load. In addition, the digital New Economy is placing unprecedented reliability and power quality demands on the system. Power outages already cost the U.S. more than $50 billion annually, and in the growing competitive environment of state-by-state restructuring, owners and operators of transmission lines are increasingly focused on the bottom line—with far fewer incentives to comply with voluntary reliability standards or invest in system upgrades. Unfortunately, the consequences are now being seen in some regions of the country.

These uncertainties and the inability of the infrastructure to keep pace with demand, have translated into new, real, and growing problems. Generating capacity reserve margins have diminished. The construction of new major transmission facilities has virtually stopped. During this and recent summers, some regions of the country experienced major problems—as the heat rose, demand for electricity increased and the lights went out. In others, elected officials and utility executives had to make urgent public appeals for conservation to avoid the major blackouts that could result from stressed and inadequate facilities.

Without Federal action, state restructuring programs cannot reach their full potential—and in the end it will be electricity consumers that lose out. This is why the Clinton/Gore Administration has had comprehensive legislation before Congress since 1998, which would:

- Clarify key authorities for Federal and State agencies with respect to governance of the new electricity industry;
- Establish clear Federal policy support for retail and wholesale competition;
- Maximize consumer benefits through mechanisms and authorities to ensure true competition, including clear labeling for informed choices;
- Support for public benefits such as low income assistance, energy efficiency, renewable energy;
- Stimulate the use of advanced technologies and innovative services that reduce emissions and encourage efficiency and the use of green power;

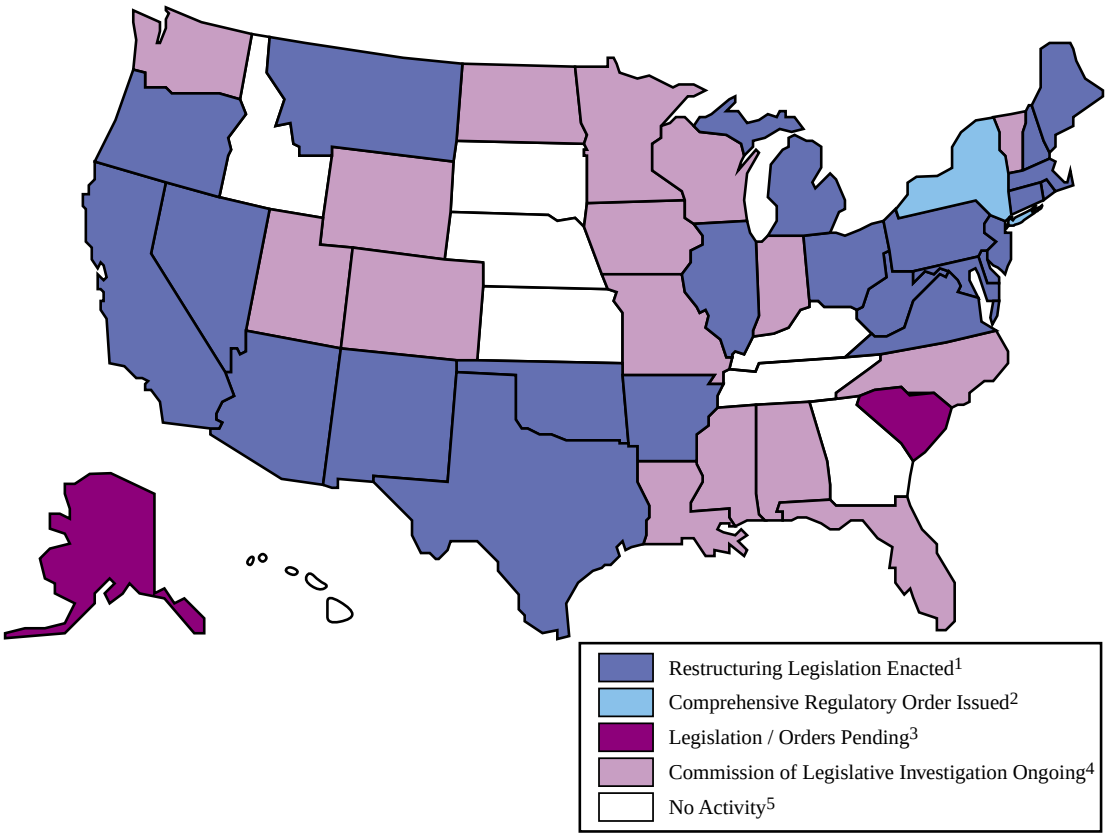
- Provide incentives for distributed generation; and
- Strengthen system reliability while relying on traditions of industry self-regulation.

The electricity industry in the United States currently delivers over $200 billion worth of electric services every year, and has a book value of over $700 billion—we cannot neglect the engine that powers our economy. Electricity markets are crying out for the certainty needed to make essential investments in generation, transmission and distribution infrastructure.

The Federal government needs to send out the right signals—to establish the "rules of the road" and develop a comprehensive roadmap so that consumers, businesses and the environment will all benefit from the promise of electricity competition.

It is important that we act . . . we act wisely . . . and we act soon. The Clinton/Gore Administration stands ready—and has been over the last three sessions of Congress—to work with Congressional lawmakers to deliver on the promise of competition by passing comprehensive Federal electricity legislation.

Status of State Electric Industry Restructuring Activity as of August 2000



[1]Arizona, Arkansas, California, Connecticut, Delaware, District of Columbia, Illinois, Maine, Maryland, Massachusetts, Michigan, Montana, Nevada, New Hampshire, New Jersey, New Mexico, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, Texas, Virginia, and West Virginia.
[2]New York.
[3]Alaska and South Carolina.
[4]Alabama, Colorado, Florida, Indiana, Iowa, Louisiana, Minnesota, Mississippi, Missouri, North Carolina, North Dakota, Utah, Vermont, Washington, Wisconsin, and Wyoming.
[5]Georgia, Hawaii, Idaho, Kansas, Kentucky, Nebraska, South Dakota, and Tennessee
Source: Energy Information Administration.

☆ *Office of Energy Emergencies*

In spring, 2000, Secretary Richardson announced the creation of the Office of Energy Emergencies (OEE.) The Office will work within the Department and with Federal and state agencies and industry to anticipate, mitigate, and improve the coordination of the Federal response to a wide range of energy emergencies, such as summer electricity outages, or fall heating oil shortages. The OEE has had three emergency power outage exercises and plans a more comprehensive electricity/natural gas/ heating oil exercise this fall.

☆ *Power Outage Study Team (POST)*

The Power Outage Study Team was established in July, 1999 by Secretary Richardson in response to power outages across the nation. After visiting with utilities and other stakeholders in New York, Chicago, the Mid-Atlantic, South-Central States, and New England, the Team held three workshops to solicit industry and stakeholder comments, and published a final report in March, 2000, which contained recommendations to enhance electric reliability. (www.policy.energy.gov/)

☆ *Barriers to Distributed Generation*

Government has a significant role to play in addressing barriers necessary to increased distributed generation. There are regulatory and institutional barriers that interfere with market development, e.g., the existing regulatory framework for energy generation, delivery, and use favors incumbent suppliers; environmental siting and permitting requirements are different from state-to-state. Output-based emissions standards and pre-certification of certain types of systems are being considered but further analysis is needed. Siting difficulties along with a lack of uniform interconnection standards across utility service territories often leads to costly delays in project schedules. Effectively addressing these technology, policy, and market barriers requires a comprehensive program strategy. (www.eren.doe.gov/power)

☆ *National Petroleum Council Natural Gas Study/ Interagency Task Force on Natural Gas*

Recognizing the growing demand for natural gas in the United States, particularly for power generation, the National Petroleum Council was asked to undertake a comprehensive study of the capability of industry to meet potentially significant increases in future natural gas demand. The resulting December 1999 study, "*Natural Gas, Meeting The Challenges of The Nation's Growing Natural Gas Demand*," listed seven major recommendations. Acting on these recommendations, the Administration has established an interagency working group to work with industry and other stakeholders to develop a path forward to meet the nation's natural gas supply, distribution, and safety needs. (www.npc.org)

♦ *Challenge #3: Mitigating the Environmental Impacts of Energy Production and Use*

Americans place a high value on environmental stewardship—to protect natural resources for future generations, to preserve the air and water quality that is essential to our health and quality of life. Efforts to improve the quality of our environment resulted in reductions in energy related pollution and environmental damage without substantial increases in energy prices. This achievement is due, in part, to the constructive role played by the Department of Energy in the development of environment-friendly technologies and the support of science-based regulatory policies that have enabled the energy industry to minimize costs and avoid supply disruptions.

Addressing the environmental impacts associated with increased demand and energy use will require ongoing technological innovation and policies that stimulate use of these technologies. In addition to further reducing the environmental impacts of energy use in the transportation and power sectors, we need to ensure that continued access of the energy industry to resource areas happens in a manner that protects our national heritage, and we need to ensure that regulation of the energy sector is based on sound science.

Internationally, responding to the threat of climate change is the greatest environmental challenge facing the energy sector. There is a strong scientific consensus that the greenhouse gas emissions have already raised average global temperatures and that a "business-as-usual" energy scenario will, within a century, lead to further warming, associated climate change, and possibly major societal dislocations.

A shared commitment between the Administration, the Congress, and the private sector would allow us to meet the greenhouse gas challenge while growing the economy, just as we have with other emissions, as shown in Figure 1. Because of the long time over which greenhouse gases reside in the atmosphere, prudence demands that we address now the more efficient use of fossil fuels and the aggressive development of renewable energy sources. It should be emphasized that such policies simultaneously advance our economic, security, and broad environmental goals. The record on SOx and NOx and energy use strongly suggests that reductions in carbon emissions could be achieved in an effective and economical manner.

Domestically, support for the development of technologies to reduce the environmental impacts of energy use remains a key element of the Administration's energy policy to:

- Produce cleaner fuels;
- Increase the efficient use of conventional energy sources, primarily fossil fuels; and
- Develop alternative sources of energy.

In addition to the accomplishments and investments previously highlighted, the Administration has also taken more recent and specific actions to reduce the future impacts of energy use on the domestic and global environment.

☆ *Mitigating Global Climate Change through International Cooperation*

The Administration will continue to work with other countries to elaborate rules and guidelines for the flexibility mechanisms identified in the Kyoto Protocol-emissions trading, the Clean Development Mechanism, and Joint Implementation. The full use of market-based emissions trading and related mechanisms is critical for substantially lowering or halting the growth in global greenhouse emissions without imposing significant costs on the United States. These mechanisms should lower costs and spur U.S. technology exports. The anticipated use of these mechanisms should also provide the economic incentive for developing countries to make meaningful commitments to greenhouse gas emissions reductions. In addition, carbon sinks achieved through forest and agricultural management practices can make a very significant contribution.

☆ *Addressing Global Climate Change through Research and Development*

To provide the technologies needed to reduce greenhouse gas emissions and to preserve U.S. competitiveness and economic growth, the Administration has proposed an aggressive $4.1 billion climate change package for fiscal year 2001. The package includes: the International Clean Energy Initiative; Clean Air Partnership Fund; Climate Change Technology Initiative; Biofuels and Bio Products Initiative; the Global Change Research Program; and other programs such as Carbon Sequestration. The program simultaneously achieves other key economic, security, and environmental goals.

The Science of Climate Change: Why Research is Critical

Three years ago, the National Climatic Data Center reported that 1997 was the warmest year of the century. This record was quickly broken when 1998 drew to a close.

Data show that our climate is warming faster than at any other time in the 100 to 200 year history of widespread temperature measurement (including proxy data.) The top six warmest years of the century have all been in the 1990s. The current scientific consensus is that global average temperatures, in the "business-as-usual" scenario, will increase from two to six degrees Fahrenheit in the next hundred years, with a corresponding rise in sea level of six to 37 inches.

Half of the U.S. population and more than two-thirds of the global population currently live in coastal areas—future rises in sea level, altered storm patterns, and higher storm surges could have devastating effects. These changes will also have significant impacts on the environment, human health, the economy and society in general, affecting everything from energy use. . .to transportation. . .to water resource management. . .to international trade and development. . . to agriculture. . .to natural ecosystems.

A few years of warm weather and extreme weather events do not by themselves indicate global warming and climate change. However, the basic science of atmospheric greenhouse warming of the earth is indisputable. Indeed, it has been recognized for over a century that naturally occurring greenhouse gases in the atmosphere, such as water vapor and carbon dioxide, provide an essential blanket that sustains life on earth.

The challenge lies in the significant increase in greenhouse gas concentration, particularly carbon dioxide, since the beginning of the Industrial Age and especially in the last few decades. The Intergovernmental Panel on Climate Change (IPCC) has concluded that the balance of evidence suggest a discernible human influence on global climate. The energy sector is by far the dominant anthropogenic source of greenhouse gas emissions, and projected worldwide economic and energy demand growth point to further dramatic increases of greenhouse gas concentrations unless energy efficiency, production and use patterns are altered appropriately. Because of the long residence time of carbon in the atmosphere—about a century—the time to act is now.

Climate Research at DOE

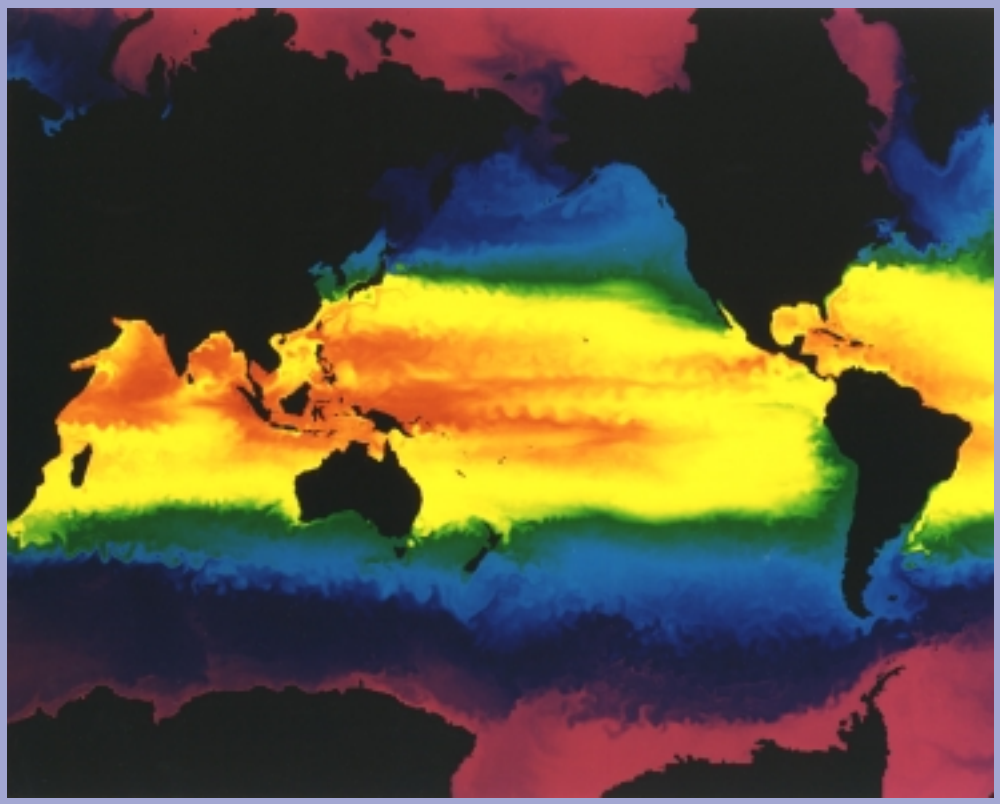
With the stakes so high, it is imperative that our decisions reflect the best available scientific information, and that we act on this information to develop and deploy clean energy technologies. At DOE, our research is directed at understanding the basic chemical, physical, and biological processes of the Earth's atmosphere, land, and oceans, and how these processes may be affected by energy production and use, primarily the emission of carbon dioxide from fossil fuel combustion. Highlights of our research program include:

- **Carbon cycle**: We will continue a range of experiments that advance our basic understanding of the global carbon cycle and assess the potential consequences of increased atmospheric carbon dioxide on vegetative growth and ecological systems. This will be coordinated with numerous international research efforts. These scientific efforts provide the foundation for the Department's applied energy research programs for developing carbon sequestration technologies.
- **Atmospheric Radiation Measurement Program**: Through adjustments to this existing monitoring system, sites in climatically significant regions are being thoroughly instrumented to provide data critical to improving General Circulation

Models so that these important computational tools can be used to provide reliable climate predictions under various scenarios of human activity.

- **Computer Hardware, Advanced Mathematics and Model Physics Program (CHAMMP)**: This program is at the center of the Department's advanced climate prediction research. Advances in computing technology, computational science, experimental data, and theoretical developments contribute to state-of-the-science General Circulation Models, producing more accurate and reliable climate predictions.
- **Climate Models**: The development of a new generation of climate models that run on massively parallel high-performance scientific supercomputers is a major objective of the DOE Global Change and High Performance Computing and Communications programs. The increased computational power of parallel scientific supercomputers will make it possible for future models to simulate climate processes at higher resolutions, thereby enabling decade and longer-term climate predictions to be more accurate and realistic. In particular, increased resolution will allow much better incorporation of important phenomena such as cloud formation and ocean vortices.

These programs contribute to the U.S. Global Change Research Program that was codified by the Congress in the Global Change Research Act of 1990. DOE continues to work closely with the USGCRP and its supporting agencies to develop and implement a comprehensive U.S. climate change research program. More information can be found at www.usgcrp.gov.



Shown here are the surface temperatures of the ocean as simulated with a 3 dimensional global ocean model developed at Los Alamos National Laboratory for Massively Parallel Connection Machine (CM-5) computer. Warm temperatures are shown in red and coolest in blue. Continents and islands are black. The computational grid employed represents the highest resolution used in any global ocean simulation performance to date, resulting in great detail visible in the eddies of various ocean currents. From the High resolution Global Ocean Circulation Model: "Parallel Ocean Program."

☆ *Expanding Alternative Energy Programs*

In its 1997 review of the national energy R&D portfolio, the President's Committee of Advisors on Science and Technology (PCAST) recommended expanding a number of national energy R&D programs—renewable energy programs being among the highest priorities for increased funding. Renewable energy technologies provide multiple benefits, including air emission reductions and reduced dependence on imported oil. To respond to this recommendation, DOE is seeking a 32 percent funding increase (for FY 2001) for renewable energy programs. Included are programs on: alternative transportation fuels; solar buildings; photovoltaics; concentrating solar power; biomass; wind energy; geothermal; hydroelectric power systems; hydrogen; energy storage; high temperature superconductivity; programs to address the power needs of remote and Native American lands; power system reliability; distributed power; and electricity restructuring.

☆ *Producing Cleaner Fuels*

In addition to the President's *Bioenergy and Biobased Products Initiative*, DOE has also proposed a new initiative this year, the *Ultra-Clean Fuels Initiative*, to address the need for cleaner fuels within the context of the existing refining infrastructure. The initiative will mobilize industry and DOE's national laboratories to develop and demonstrate new technologies for making large volumes of clean fuels from our diverse fossil energy resource base. The initiative will also be integrated with our PNGV and truck programs to ensure that we have the clean fuels needed to power the next generation of more efficient vehicles. (www.fe.doe.gov)

☆ *International Clean Energy Initiative*

In the next two decades, over half of global energy growth will be in the developing and transitional economies as those nations improve their standard of living. Developing country energy use will overtake that of industrial countries by 2020, accounting for three-fourths of the increase in global energy use over that time. This represents a challenge to oil supply, global environmental concern, and business opportunity. Between now and 2050, investments in energy technologies in developing nations will approach $15 to $25 trillion dollars, and ninety percent of the markets for coal, nuclear and renewable energy technologies are expected to be outside the United States in coming decades.

This represents a significant global challenge with economic, energy security and environmental ramifications. This initiative, following the recommendations of the President's Committee of Advisors on Science and Technology, will give U.S. companies access to innovative ideas and open doors to global markets; provide new technology for transportation and nuclear power generation to reduce risks associated with oil supply disruption and nuclear proliferation; and provide incentives for clean energy commercialization in the context of strengthened markets, vigorous economic development and expanded international trade.

☆ *Creation of the National Energy Technology Laboratory*

On December 10, 1999, Secretary Richardson, designated the National Energy Technology Laboratory (NETL) as the Department's 15th national laboratory. The primary mission of the new laboratory is improving the environmental performance of fossil fuels through technology advances. The laboratory's work will be dedicated to the goal of

developing innovative, clean and efficient fossil energy technologies to meet the Nation's growing energy needs in environmentally sound ways. The new laboratory will have several key focus areas including carbon sequestration, combustion simulation, and ultra-clean petroleum fuels. In addition, the Secretary established a Strategic Center for Natural Gas Studies at NETL. This center will provide both a research and policy focus for natural gas from production and supply, to transportation and storage, to end use. (www.netl.gov)

♦ *Challenge #4: Providing Diverse Energy Technologies for the Future*

Today's investments will meet tomorrow's challenges—Vision 21 technologies for virtually emission free coal utilization; carbon sequestration; Partnership for a New Generation of Vehicles and associated programs dealing with light and heavy trucks; alternative clean fuels, both fossil fuel based and biofuels; distributed hybrid energy systems, involving renewables, fuel cells and other modular technologies; smart buildings; and many more described in the Appendix.

Energy is a technology driven business. Over the long term, technology development and deployment uniquely provide the foundation for resolving our energy challenges. The Federal government has a significant public interest in ensuring that we have adequate R&D dollars to invest in the nation's energy future, especially when new technology can help address national policy concerns not reflected in the marketplace.

The private sector under-invests in R&D for breakthrough technologies for a variety of reasons. The industry is very fragmented in areas such as buildings or small scale oil/gas production. There is significant business risk associated with large scale investments in research and development. Also private investment in pre-competitive research is inhibited by the long time frames needed to achieve results and the inability to capture exclusive access to those results.

One consequence of restrictions in the various energy industries has been a corresponding decline in private sector investment in pre-competitive research and development. For example, the sectoral research organizations for electricity and natural gas—EPRI and GRI—have experienced 30-50 percent declines in research budgets. These declines are occurring precisely when we need new technologies to meet growing energy demand and further mitigate the impacts of energy production and use on the environment.

As noted, energy is a technology driven business—technology is, in turn, science-driven. The Department of Energy is the nation's principal funder of basic and applied research in the physical sciences and also builds and operates large cutting-edge facilities that are used by more than 15,000 of the nation's scientists from universities, laboratories, and industry. As one example, the Department supports wide ranging research in advanced materials, providing a scientific foundation for a broad spectrum of energy technology applications. Facilities such as the Advanced Photon Source at the Argonne Laboratory or the Spallation Neutron Source under construction at Oak Ridge Laboratory allow scientists to understand and develop such advanced materials. High temperature superconductors are examples of new materials that are beginning to affect the power sector and are likely to have profound impact in the next two decades.

The Department of Energy is also the lead Federal agency for energy research and development. Much of the Department's energy research and development work is carried out in partnership with the private sector, a formula that has, over the years, provided significant dividends across all areas of energy supply and use. Many examples of the impact of DOE-sponsored technology development have been discussed earlier in this report.

Nevertheless, the Department's R&D efforts need ongoing reevaluation in the context of evolving energy drivers and new scientific opportunity. Evaluation criteria, noted in the 1997 report of the President's Committee of Advisors on Science and Technology, include:

- Strategic criteria: The overall portfolio should address the principal energy-related economic, environmental, and security challenges facing the nation.
- Diversity criteria: The portfolio of R&D projects should have a balance across technologies, time scale for results, and degrees of technical risk.
- Public-private interface criteria: The portfolio should have potential societal payoffs that merit public investment and should be shaped to great extent in partnership with the private sector

In response to this need, the Department has developed a formal Energy Resources R&D Portfolio analysis process, engaging participants from the DOE national laboratories, universities, and the energy industry, to ensure that:

☆ *Energy Investments Reflect the Administration's Strategic Energy Goals*

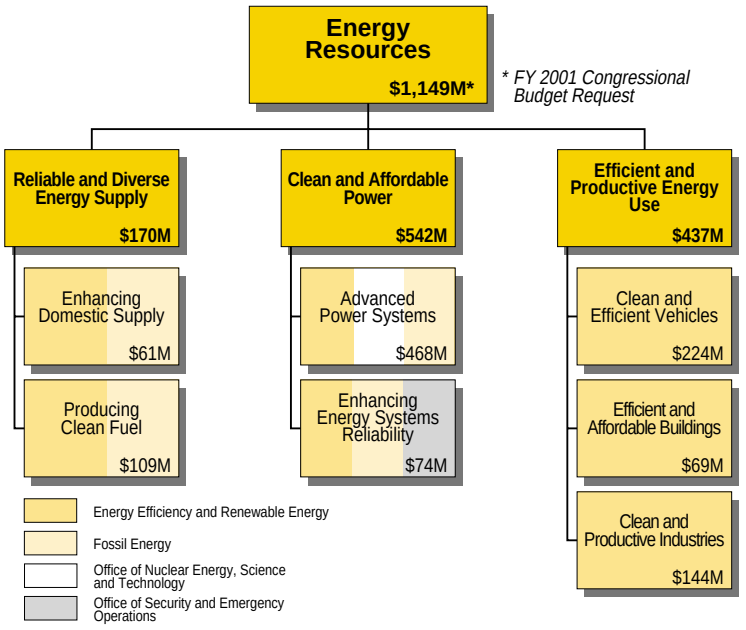
DOE's energy R&D portfolio, as shown in *Figure 9—DOE Research and Development Portfolio, Energy Resources*, is organized in three broad strategic areas, with their FY 2001 request:

- Reliable and Diverse Energy Supply ($170 million);
- Clean and Affordable Power ($542 million); and
- Efficient and Productive Energy Use ($437 million.)

A full description of DOE's energy portfolio can be found at www.osti.gov/portfolio.

In addition, the Department supports a basic science portfolio that supplies the foundation for much of the Department's applied research. The basic science programs are deeply engaged in developing crucial enabling knowledge and tools, such as large-scale scientific simulation, robotics and intelligent machines, advanced materials, nanoscience, plasma fusion science, and many others.

Figure 9—DOE Research and Development Portfolio, Energy Resources



☆ *The Energy R&D Portfolio Addresses Emerging Energy Challenges*

The Administration has, through PCAST and through the Secretary of Energy's Advisory Board, conducted several reviews of the adequacy and focus of our energy R&D investments. While the energy R&D portfolio lays out the programs according to strategic goals, the portfolio analysis evaluates the portfolio against the likelihood of significant progress against these goals. This process identified a number of gaps, opportunities, and program management needs in DOE's energy R&D portfolio, including:

- Energy infrastructure reliability;
- Carbon sequestration R&D;
- Bioenergy R&D;
- Methane hydrates R&D;
- Clean fuels R&D;
- Integration of fuel cells R&D efforts;
- Crosscutting management of distributed generation;
- Hydrogen R&D; and
- An international clean energy research, developmentr and deployment effort.

This portfolio analysis process can help guide the Administration and Congress to work together to direct R&D investments towards shared goals and emerging energy challenges. This activity is an important part of an integrated strategic national energy policy. It provides a dynamic element that keeps our energy investments aligned with marketplace realities and public needs.

☆ *DOE's Energy R&D Budget Request Reflects Energy Priorities and Investment Levels to Meet Energy Needs*

This process has had tangible results in shaping the Administration's budget request, to address gaps and opportunities in the R&D portfolio earning strong support from the private sector. Some specific FY 2001 energy R&D budget requests that represent new thrusts in response to the portfolio analysis process include:

- <u>The Energy Infrastructure Reliability Initiative</u>

  In the transition from regulated to restructured electricity and natural gas markets, and in light of the increasing interdependence of the electricity, gas and telecommunication infrastructures, reliability and security of energy delivery systems is a clear priority. This initiative will advance technology areas such as power storage, real-time sensors and controls, distributed power architectures, integrated system simulation and management, and distributed intelligent systems.

- <u>Enhanced Carbon Sequestration Program</u>

  Carbon sequestration science and technology is a portfolio element with a long time horizon and potentially major implications for fossil energy utilization in a greenhouse gas constrained world. A significant expansion of this research program will include: better understanding of natural carbon sequestration processes in terrestrial and ocean systems; microbe sequencing for carbon sequestration or for methane/hydrogen production; and applied science and technology development for se-

questration in geologic structures, oceans, and useful product forms.

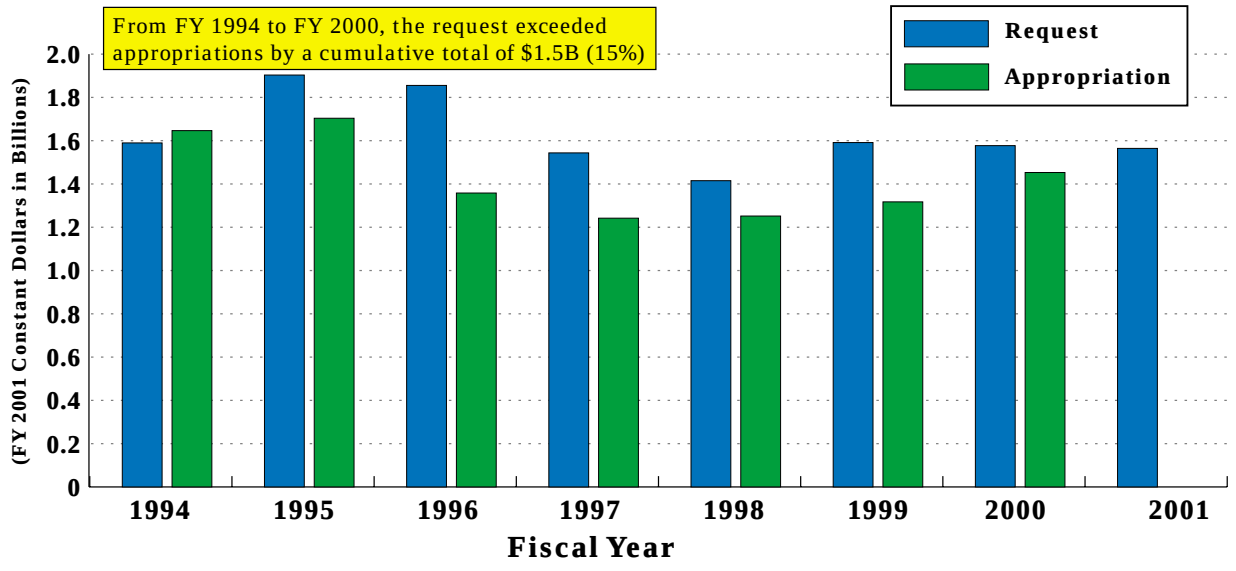
- Combustion Science and Engineering

  Better understanding of the complex molecular processes and of the complicated and turbulent flows that take place in fossil fuel combustion will lead to much more efficient combustion devices and to concomitant economic and environmental benefits. The new generation of supercomputers will, for the first time, allow scientists to simulate these processes all the way from the molecular scale to the engineered device scale. Such work will be expanded very significantly, in concert with greatly enhanced experimental capabilities at Sandia National Laboratories, at the National Energy Technology Laboratory, and elsewhere. For example, the DOE's Combustion Research Facility, upgraded in 1999, performed novel experiments investigating the interplay of chemistry and turbulence that are leading to changes in current models of basic combustion processes.

Other initiatives described earlier which are a direct outcome of this process include the International Clean Energy Initiative, enhanced bioenergy R&D, and the Ultra-Clean Fuels Initiative.

It is essential that we pick up the pace of these R&D investments. This message was put forward forcefully and convincingly by the President's Committee of Advisors on Science and Technology in their 1997 report. As shown in Figure 10, the Administration has proposed significant increases for the energy business line and, particularly, for efficiency improvements and renewables development. The shortfall in R&D investments has been most pronounced in the conservation and renewables areas; together these areas account for 92 percent of the $1.5 billion cumulative shortfall. The cumulative effect of the lower appropriations level will be felt in the years ahead. Significant capital investments are required for energy supply, and the turnover time of energy investments is long—power plants take years to site, license and build; replacing the existing vehicle fleet takes over a decade; developing infrastructures

Figure 10—Fossil, Nuclear, Renewables, and Conservation R&D Appropriation versus Request History



to accommodate distributed power or alternative fuels or greatly expanded natural gas demand will take longer still. These decisions are made every day, locking in diminished economic performance, security, and environmental performance for over a decade if the most advanced technologies are not available in a timely way. Thus, the effects of delaying or forgoing sound energy R&D investments are compounded year by year.

Conclusion: Powering the New Economy

The economic policies of this Administration have helped ensure the Nation's successful transition from the 20th to the 21st century—clearly and cleanly moving us from the Industrial Age to the Information Age—giving the nation more jobs at higher wages, low unemployment, real increases in personal and corporate income, low inflation, more expendable income, and greater consumer choices.

At the same time, however, this economic success—and the energy requirements of the Information Age—has strained the nation's energy infrastructure, dramatically increasing demand for energy supply and energy reliability.

Consider the energy needs of the Silicon Valley for example. The 21st century's version of the steam engine—the computer—places additional and substantial requirements on the system for increased reliability and power quality as well. In many places such as the Silicon valley, backup or off-line power generation is supplanting grid power simply because businesses that rely on computers cannot afford even the occasional power losses associated with the current electricity grid.

This year's problems with heating oil and gasoline also highlight the stresses that economic success, and the attendant demand for energy, are placing on the nation's energy infrastructures. The Administration has invested a significant amount of time in encouraging OPEC and non-OPEC producing nations to increase oil production sufficient to meet increased demand. As noted earlier, due in part to this effort, world oil supplies are about 4.0 million barrels per day higher than this time last year—yet oil prices have continued to climb and we have not seen a significant decline in prices at the gasoline pump. World capacity is now only a few percentage points over world demand.

Not only is oil demand continuing to outpace supply, but U.S. and European refineries are running almost full out. Oil production capacity and refinery capacity are key issues we must confront in the very near future if we are to meet the increased near-term demand for the petroleum-based fuels that power our cars, trucks, and airplanes, and heat many of our homes, schools and businesses. We also need to re-double our investments in reducing the demand side of the oil equation and producing clean alternative fuels.

Finally, the recent natural gas pipeline rupture in New Mexico illustrates the significant issues associated with our future natural gas needs. The pipeline in New Mexico was over forty years old and showed evidence of corrosion. Also, this particular pipeline provides Southern California with a significant portion of the natural gas needed to generate electricity—natural gas and electricity supply are increasingly interrelated. Alternative supplies of natural gas for the region were temporarily met by using stored gas—we not only need more storage but ultimately, more natural gas supply and modern infrastructures.

What do these specific examples say about that nation's future energy challenges? We need:

- **Federal electricity restructuring legislation** if we are to create the investment certainty needed to expand the electric grid and increase its reliability. Congress needs to pass comprehensive electricity restructuring legislation.
- **Investments in the technologies that will enable the inter-grid to operate at higher levels of reliability.** The Administration has expanded its request for

energy reliability R&D and Congress needs to fund our FY 2001 Energy Infrastructure Initiative at requested levels.

- **To ensure the availability of clean, distributed power technologies and eliminate institutional, business and technological barriers to their use.** The Federal government, state governments, industry and consumer groups need to work together to reduce legal and institutional barriers to distributed generation. We need to continue to invest in clean distributed generation technologies and system architectures.
- **Policies and investments that acknowledge and reflect the increasing interdependence of our electricity and natural gas infrastructures**. The convergence of the electricity, natural gas, and telecommunications infrastructures has profound implications for energy reliability and presents significant opportunities for consumers and businesses. Government needs to support an overarching suite of technologies and policies that promote expanded, reliable, safe and secure energy infrastructures, and address the issues associated with converged energy/telecommunications markets.
- **To ensure that we have adequate supplies of oil and natural gas to meet our near- to mid-term power and fuel needs**. The Administration is supporting policies and R&D investments to increase energy supplies but we need to work with industry and Congress to provide additional incentives to meet growing demand for energy, focusing on areas of potential oil and natural gas development in the ultra deep Gulf of Mexico and in areas available to be produced in Alaska.
- **To use energy more efficiently and to provide cleaner alternative sources of power and fuel** if we are to meet our long-term national and energy security and environmental goals and needs. We need to continue and expand our efficiency and renewable research, and develop policies and regulations to help provide environmentally-friendly energy at affordable prices. We seek the cooperation and support of the Congress in addressing the very serious issues of global warming and climate change.

Many of the Administration's accomplishments, investments and responses to energy challenges address these needs but much work remains to be done, starting with a fuller understanding of the implications of stresses the increased energy demand of the 21st century is placing on the energy infrastructures of the 20th century. This understanding should extend to challenges faced specifically by the private sector in building the 21st century infrastructure. For example, developing such infrastructure, whether refining capacity or electricity transmission networks, is capital intensive and must compete with other investments that may have higher returns, such as some in the New Economy. Success will come through government/private sector dialog and partnership. Thus, while adhering to basic market principles, we should continually review our policies, programs, and incentives to sustain energy and environmental progress.

Finally, the United States has enormous stakes in helping to shape energy development at home and abroad. This is perhaps most obvious with respect to oil supply, the most widely traded world commodity and one that has been a core geopolitical issue throughout the twentieth century. But adequate affordable clean energy, particularly in the developing world, affects our interests in other ways too—satisfying economic aspirations and promoting stability, protecting the environment, providing markets for energy technologies, supporting market development for international trade. These considerations rein-

force the importance of our energy policy integrated with economic, environmental, security and technology policies.

The economic policies of this Administration have helped ensure the nation's successful transition from the 20th to the 21st century—from the Industrial to the Information Age. We are proud of our energy accomplishments and look forward to working with industry, consumers, workers, environmentalists, the Congress, and state and local governments to meet the energy challenges of the new century.