

# 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](http://www.energy.gov/kidz/zone/kidztoc.html).

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## 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 21<sup>st</sup> 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 21<sup>st</sup> century challenge the energy infrastructures of the 20<sup>th</sup> 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.

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# 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 21<sup>st</sup> 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 21<sup>st</sup> 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 21<sup>st</sup> 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 15<sup>th</sup> 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 20<sup>th</sup> to the 21<sup>st</sup> 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.

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# 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 21<sup>st</sup> 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.

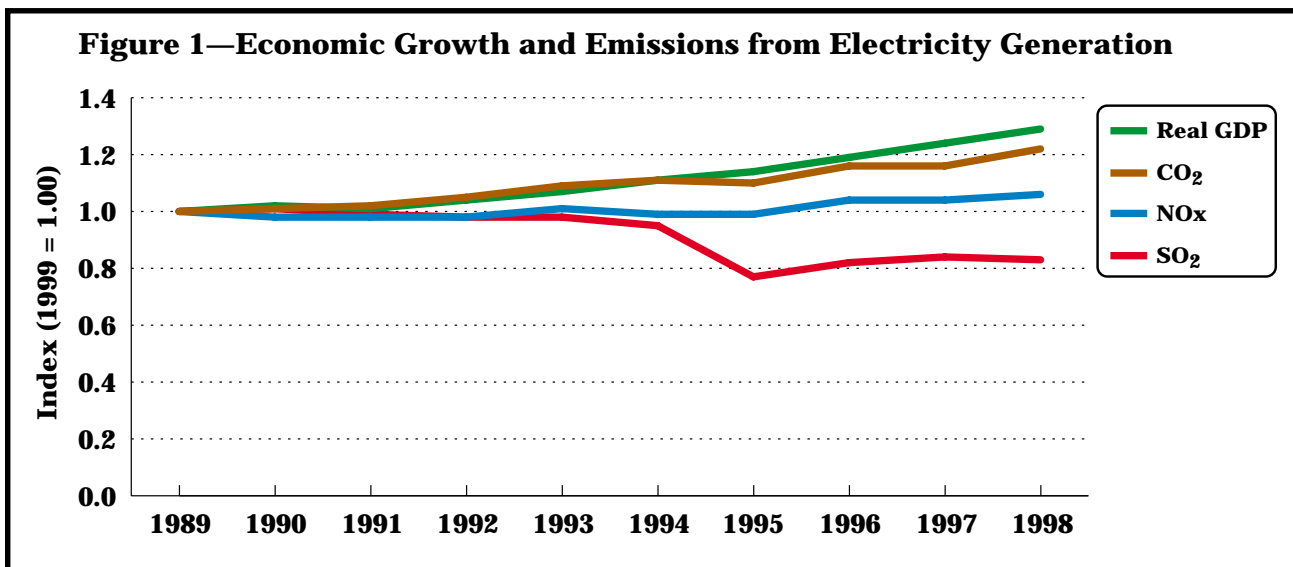
Also, the perceived success of an energy policy often depends on where you sit—whether you are from an energy producing or energy consuming region . . . reside in a relatively smog-free environment or in a Clean Air Act non-attainment area . . . drive an SUV or take public transportation to work . . . 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 stake-

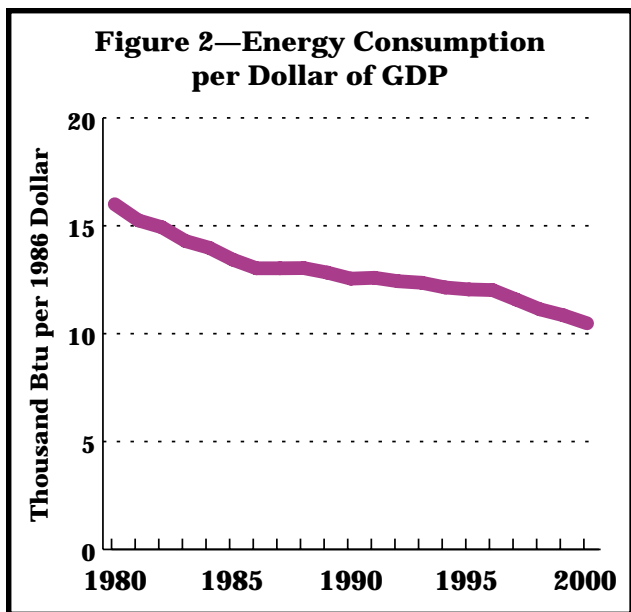
holder equities, public and private interests and outcomes, and add to the complexity of developing and implementing sound energy policy.

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<sub>2</sub>) emissions have actually declined by more than 15 percent, and nitrogen oxide (NO<sub>x</sub>) 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



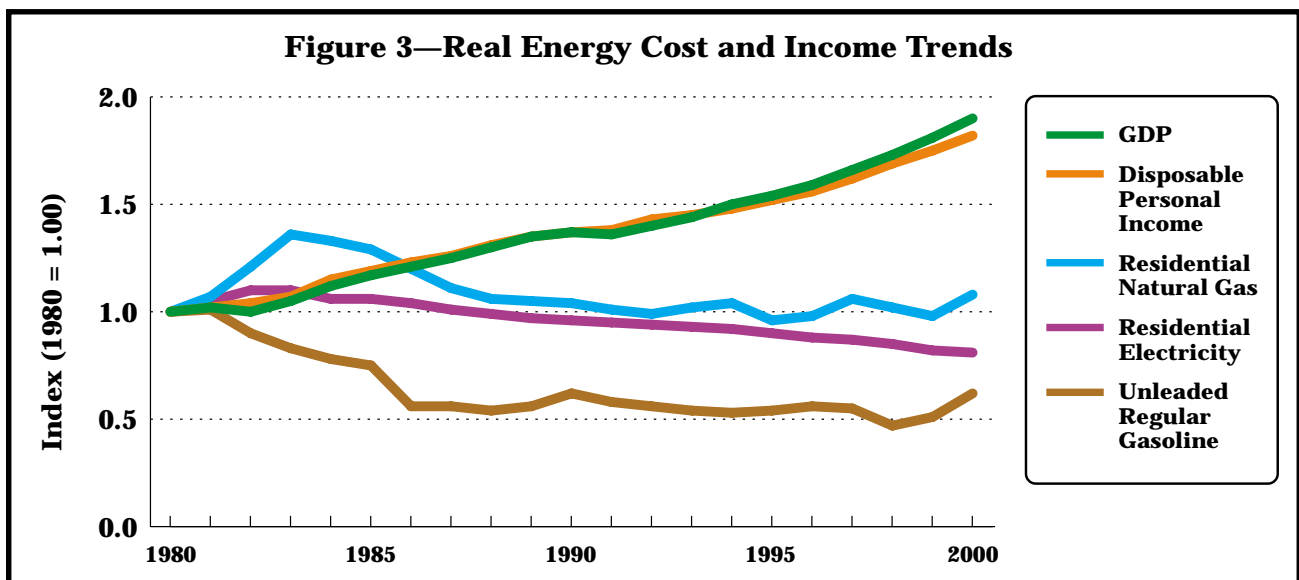


gas, coal, nuclear, renewables and hydroelectric power has increased. Oil production is the only exception, although domestic production declines are expected to flatten out by 2005, ending many decades of decline. Also, over the last several years, the *rate of decline* in domestic oil production has 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 21<sup>st</sup> 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

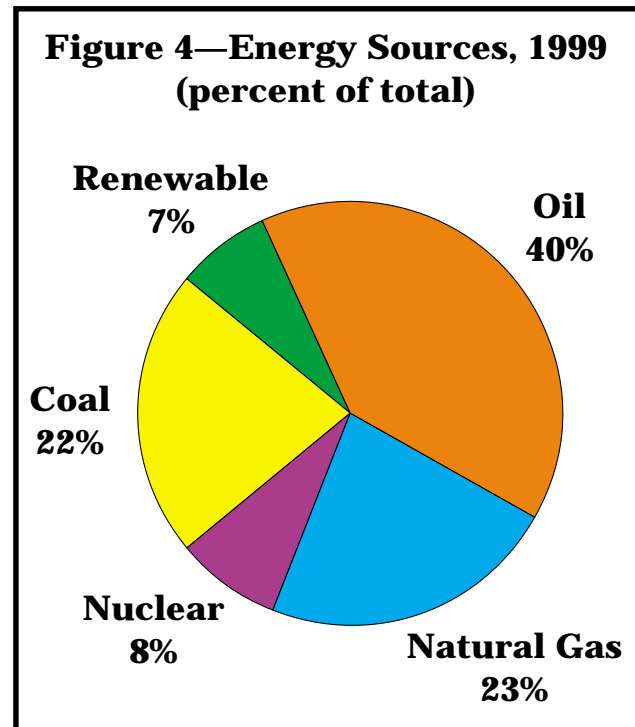
investments against the high level strategic goals of the *Comprehensive National Energy Strategy*. This process has identified specific energy challenges and opportunities ripe for new strategic investments in energy technologies.

## ***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*.)

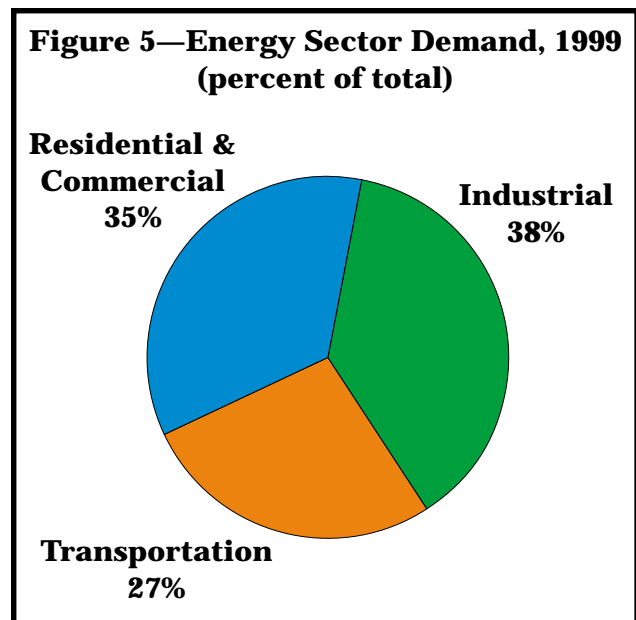
The Energy Information Administration (EIA) reference projection for 2020 anticipates a 25 percent increase in total energy consumption. This implies increased use of all fossil fuels, with an especially rapid increase of 1.8 percent per year in natural gas use, even as renewables





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.)



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 (SO<sub>x</sub>), NO<sub>x</sub> 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](http://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](http://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. Turbo-charger systems have also contributed to the fuel economy gains. ([www.ott.doe.gov](http://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.cities.doe.gov](http://www.cities.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](http://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](http://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](http://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](http://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/](http://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/](http://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](http://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](http://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 21<sup>st</sup> 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](http://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/](http://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/](http://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](http://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](http://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](http://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](http://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](http://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](http://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](http://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](http://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](http://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](http://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](http://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](http://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](http://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



*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 underlying water depths from 7,000 to 10,000 feet.*

the Gulf of Mexico was a mature region with limited potential for further discovery and development.

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](http://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](http://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](http://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](http://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](http://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](http://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](http://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 pre-combustion 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](http://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<sub>2</sub>, more than 40 million metric tons of NO<sub>x</sub>, and more than two billion metric tons of carbon dioxide (CO<sub>2</sub>.) 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](http://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](http://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 21<sup>st</sup> 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/](http://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/](http://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/](http://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 geothermal 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/](http://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](http://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/](http://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/](http://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/](http://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

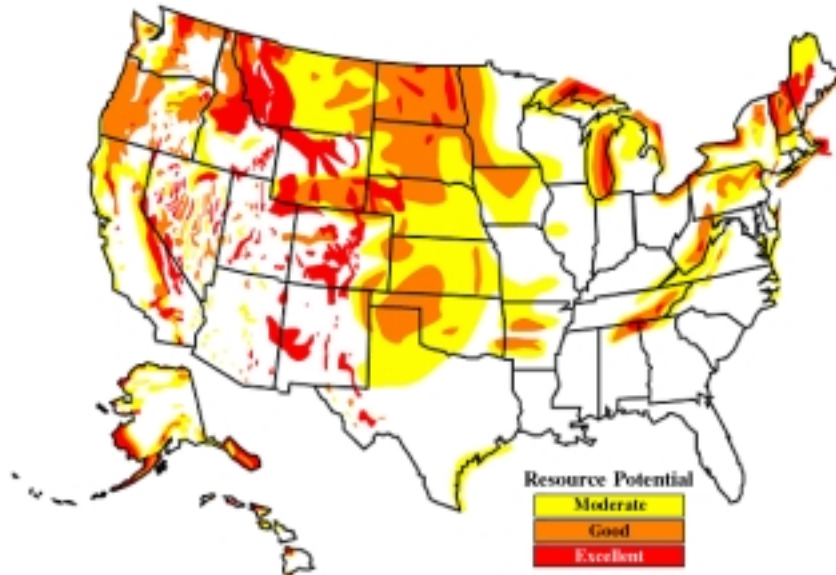
## WIND IS POWERING UP

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



**World Class Wind Potential**

Germany's Potential: 100 gigawatts  
North Dakota's Potential: 250 gigawatts

Source: AWEA

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 kilowatt-hour, 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](http://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](http://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](http://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.

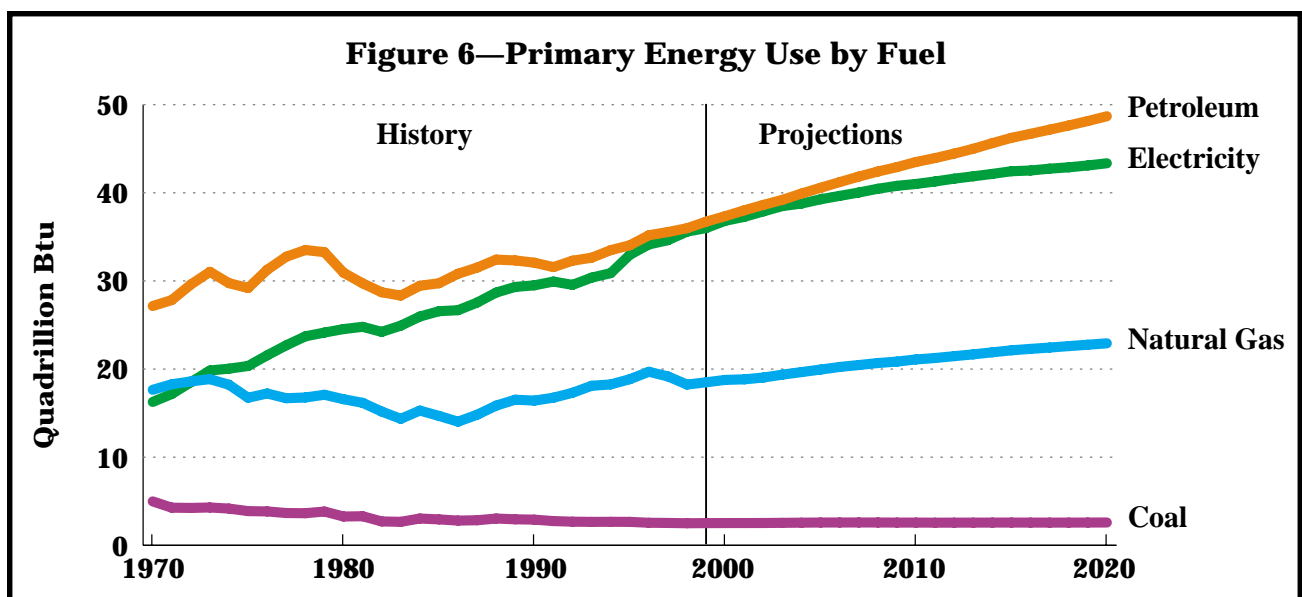
- Industrial energy use is expected to grow by 20 percent.
- Despite this growth in demand for energy services, maintaining the pace of energy efficiency gains will keep per capita energy intensity from rising.

**On electricity –**

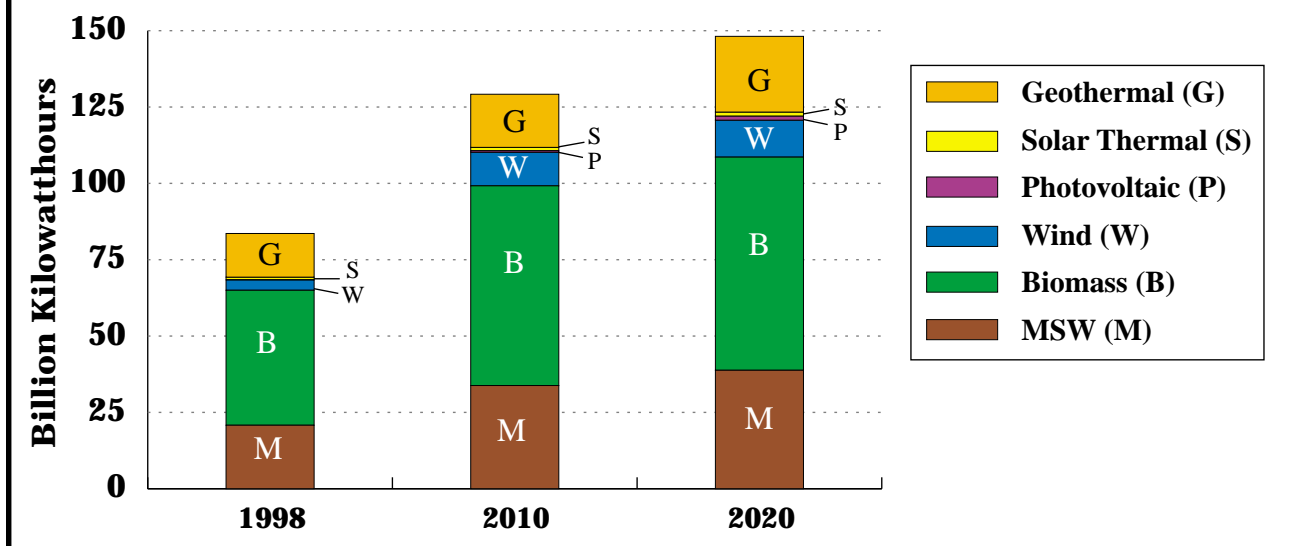
- A thousand new power plants (with as many as 900 of these gas-fired) averaging 300 megawatts will likely be needed to meet growing demand for electricity.
- Retirements of nuclear power plants starting in 2010 could lead to higher fossil fuel use for power generation.

**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 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.

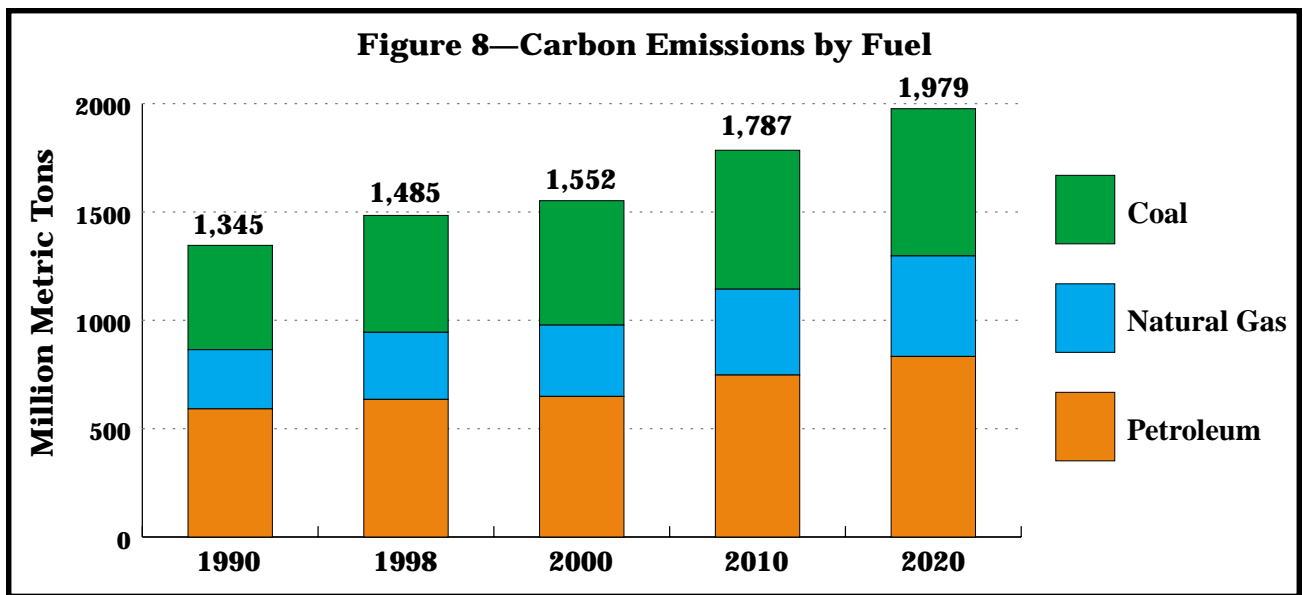
**On energy production and infrastructure –**

- 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.

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

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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.
- 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.

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:

#### ☆ *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](http://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](http://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 inoculation 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](http://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](http://www.fe.doe.gov))

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

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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 21<sup>st</sup> 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;

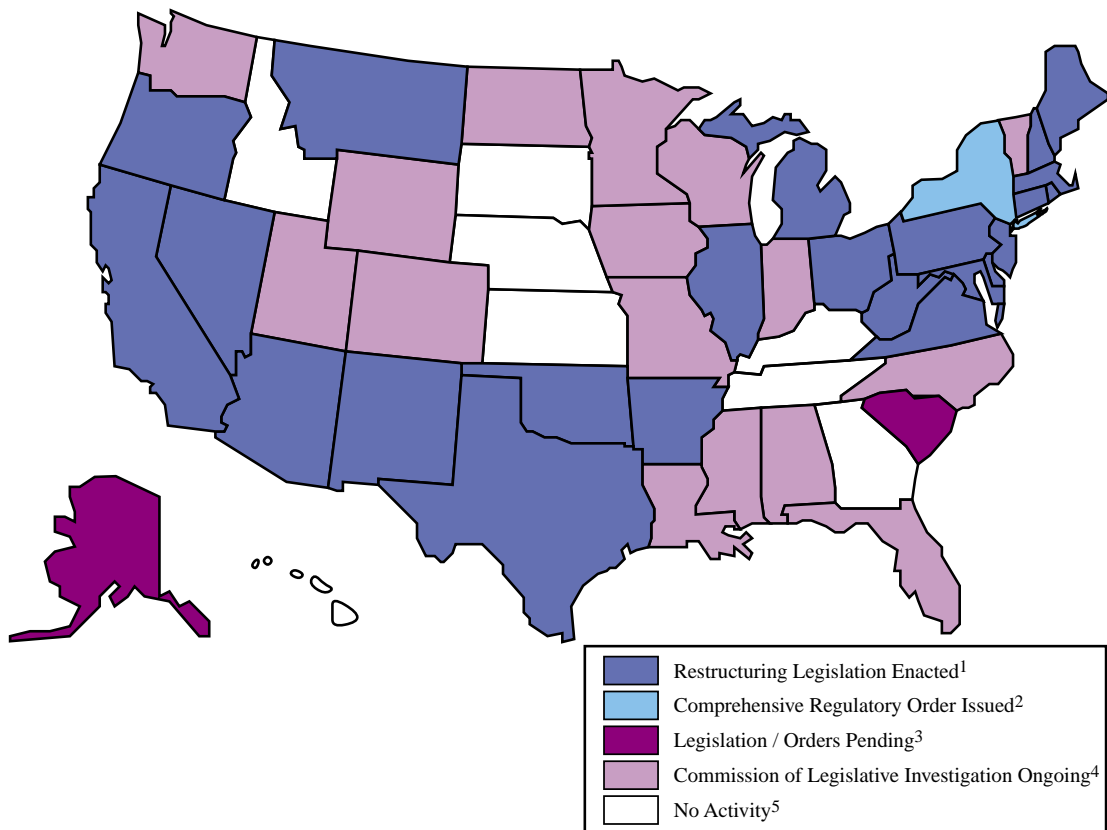
- Provide incentives for distributed generation; and
- Strengthen system reliability while relying on traditions of industry self-regulation.

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



<sup>1</sup>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.

<sup>2</sup>New York.

<sup>3</sup>Alaska and South Carolina.

<sup>4</sup>Alabama, Colorado, Florida, Indiana, Iowa, Louisiana, Minnesota, Mississippi, Missouri, North Carolina, North Dakota, Utah, Vermont, Washington, Wisconsin, and Wyoming.

<sup>5</sup>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/](http://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 stan-

dards 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](http://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](http://www.npc.org))

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

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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 SO<sub>x</sub> and NO<sub>x</sub> 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

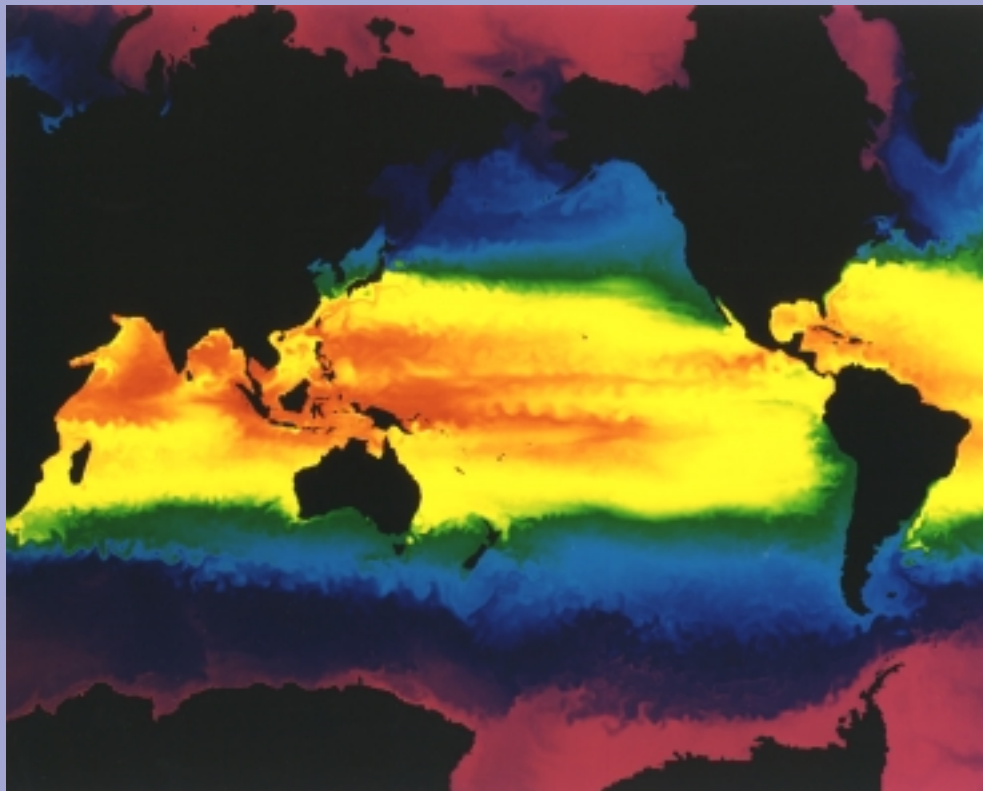
With the stakes so high, it is imperative that our decisions reflect the best available scientific information, and that we act on this information to develop and deploy clean energy technologies. At DOE, our research is directed at understanding the basic chemical, physical, and biological processes 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](http://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](http://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 15<sup>th</sup> 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](http://www.netl.gov))

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

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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*

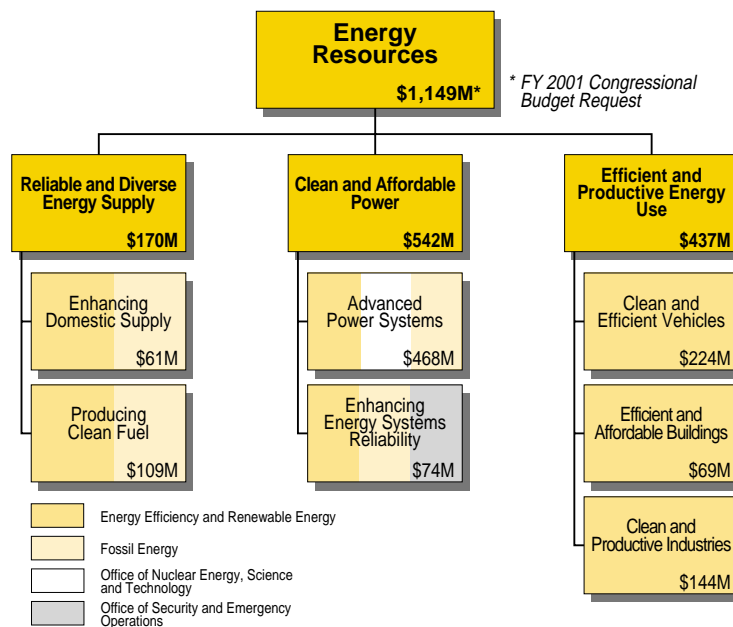
DOE's energy R&D portfolio, as shown in *Figure 9—DOE Research and Development Portfolio, Energy Resources*, is organized in three broad strategic areas, with their FY 2001 request:

- 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](http://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, development 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:

- The Energy Infrastructure Reliability Initiative

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.

- Enhanced Carbon Sequestration Program

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

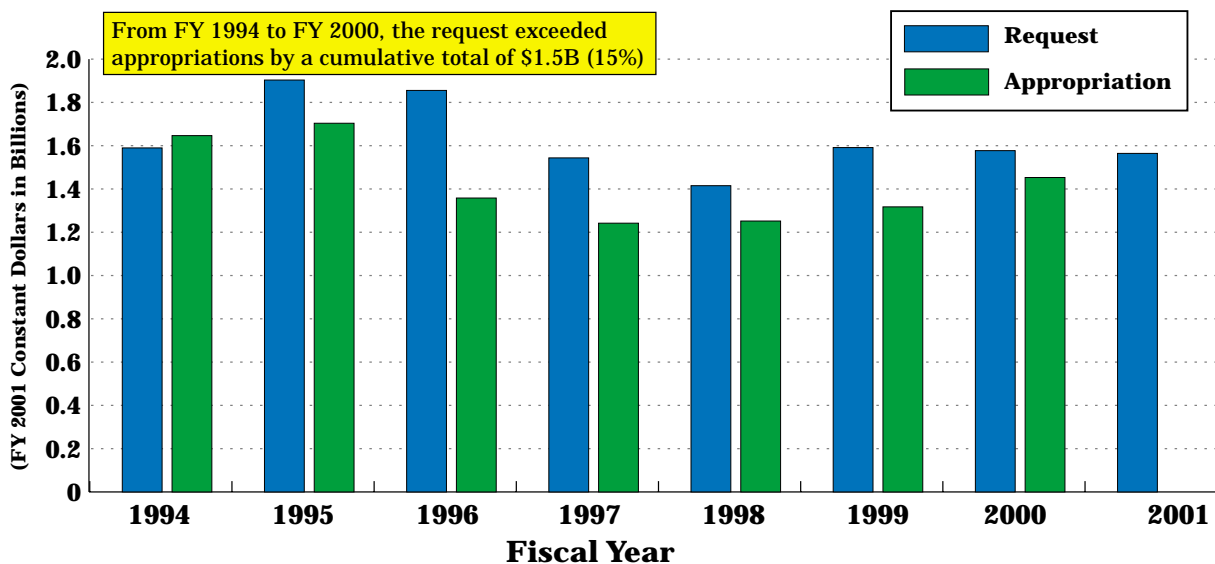
Better understanding of the complex molecular processes and of the complicated and turbulent flows that take place in fossil fuel combustion will lead to much more efficient combustion devices and to concomitant economic and environmental benefits. The new generation of supercomputers will, for the first 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 20<sup>th</sup> to the 21<sup>st</sup> 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 21<sup>st</sup> 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 21<sup>st</sup> century is placing on the energy infrastructures of the 20<sup>th</sup> century. This understanding should extend to challenges faced specifically by the private sector in building the 21<sup>st</sup> 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 20<sup>th</sup> to the 21<sup>st</sup> 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.

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# Appendix: Department of Energy Program Summaries

This Appendix contains additional information about Department of Energy programs, many of which are discussed in the text. While not a comprehensive review of DOE programs and R&D, these summaries provide a clear illustration of the range and depth of energy efficiency, oil and gas, coal, nuclear and cross-cutting programs. The summaries denote which DOE challenge they address, as well as describe the program activity and related accomplishments and benefits. Contact information is also provided for additional information. More complete information about DOE's energy resources R&D portfolio can be found at [www.osti.gov/portfolio](http://www.osti.gov/portfolio).

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# **Energy Efficiency**

## ***Vehicles***



## Partnership for a New Generation of Vehicles (PNGV)

**DOE Challenge:** Enhancing Energy Security, Mitigating Environmental Impacts

**Program Activity:** PNGV is a government-industry, cost-shared program initiated in 1993 to reduce the cost and time of automotive development, improve fuel efficiency and emission performance of conventional vehicles, and develop mid-size vehicles that achieve up to 80 miles per gallon (mpg) while maintaining or improving safety, performance, emissions, durability, comfort, and affordability.

PNGV identified three major milestones for the 10-year program. Prior to 1997, the objective was to rapidly advance specific component technologies for vehicle application. In late 1997, the first major PNGV milestone was to select the most promising of these technologies for integration into concept vehicles. The second PNGV milestone was the display of concept vehicles in the year 2000 that demonstrate the technical feasibility of 80 mpg family sedans. The 2004 milestone is to have advanced vehicle production prototypes that contain enhancements of these technologies.

### Accomplishments:

- The National Academy of Sciences recognized program schedule performance and commended the progress made by the partnership; and
- Met concept vehicle year 2000 milestone demonstrating the technical feasibility of 80 mpg family sedans. Ford, General Motors and DaimlerChrysler displayed their PNGV concept vehicles this year. Each concept showcased unique and innovative approaches to combining advanced technologies in an appealing, functional vehicle that could achieve between 72 and 80 miles per gallon (gasoline equivalent.)

### Benefits:

- By meeting PNGV's goals and objectives, the nation will reduce its dependence on oil and achieve energy savings as well as reduce carbon emissions;
- By 2010, the entry of advanced automotive technologies into the market will displace 1.2 quads of primary oil, increasing to 2.5 quads by 2020;
- Resulting energy cost savings total \$8 billion in 2010 and over \$20 billion by 2020;
- Carbon reductions are estimated at 16.1 and 37.2 million metric tons in 2010 and 2020, respectively; and
- Displaced oil consumption would have a positive impact on the US balance of payments deficit.

**For More Information, Contact:** Ed Wall, Office of Advanced Automotive Technologies, (202-586-0410) or go to: [www.ott.doe.gov/oaat/pngv.html](http://www.ott.doe.gov/oaat/pngv.html)

## Lightweight Vehicles

**DOE Challenge:** Enhancing Energy Security, Mitigating Environmental Impacts

**Program Activity:** The goal of the Lightweight Vehicles program is to reduce national petroleum dependency as well as local pollution and greenhouse gases emissions by developing lighter-weight autos, trucks and buses while maintaining or improving size, comfort, affordability/cost-effectiveness, safety and recyclability.

The DOE Lightweight Vehicles programs began in FY 1992 but have grown, especially for autos, since the advent of the Partnership for a New Generation of Vehicles (PNGV) in FY 1994. In FY 1996, efforts were formally split into two complementary programs, the larger on autos under the PNGV, the smaller on heavy-duty trucks. The majority of efforts to date have been on aluminum casting, aluminum sheet production and forming, and manufacturing of glass-fiber reinforced polymer-matrix composites (PMCs.) As those efforts have matured and have begun to be implemented by U.S. industry, the Lightweight Vehicle programs are focusing on development of carbon-fiber reinforced PMCs, magnesium casting, metal-matrix composites, titanium, crashworthiness and recycling/repair. All efforts are highly coordinated with, and cost-shared by, U.S. auto and truck manufacturers and their suppliers, notably the United States Automotive Materials Partnership. In addition, nine DOE National Laboratories participate.

### Accomplishments:

- Demonstrated that a 40 percent reduction in the weight of the average mid-size family auto is technically feasible (though not yet economically competitive);
- Developed a cost-effective system for casting large, single-piece truck structures at rates required for high-volume production;
- Demonstrated that large, fiber-reinforced PMC components can be produced at typical auto production rates;
- Validated cost-effective technologies for producing dependable, high-quality, cast aluminum structural components at high production rates, and transferred the technology to Tier 1 auto suppliers; and
- Demonstrated technologies necessary to produce low-cost, continuously-cast, aluminum sheet and improved forming technology necessary to produce automotive components.

**Benefits:** Generally, lightweight materials technologies allow a 6 percent increase in fuel efficiency for every 10 percent decrease in vehicle weight, with corresponding decreases in tailpipe emissions. Light-weighting is viewed as the second most effective way of improving fuel efficiency, next to improvements in propulsion/drive train systems.

**For More Information, Contact:** Joseph A. Carpenter, Jr., Office of Advanced Automotive Technologies, (202-586-1022) and/or Sidney Diamond, Office of Fuels Development, (202-586-8032) or go to: [www.ott.doe.gov/oaat/lw\\_materials.html](http://www.ott.doe.gov/oaat/lw_materials.html)

## Advanced Combustion and Emission Control for Diesel Engines

**DOE Challenge:** Enhancing Energy Security, Mitigating Environmental Impacts

**Program Activity:** Addresses the future technology challenges faced by advanced diesel engines which the PNGV program identified as one of the most promising technologies for achieving the fuel economy goal of up to 80 miles per gallon. Today's diesel engines achieve impressive thermal efficiency; however, in order to meet future emissions standards, advancements in clean combustion, emission control technology, and fuels are necessary, including:

- Reducing and controlling unwanted nitrogen oxides (NO<sub>x</sub>) and particulate matter in the exhaust below current-technology diesel engine emissions; and
- Improving the durability and decreasing fuels sensitivity of emission control devices.

The Combustion and Emission Control program is a joint effort between industry and government. The program is focused on improving combustion processes and emission control technologies through basic and applied research in combustion modeling, materials research, and emission control system development.

### Accomplishments:

- Demonstrated the potential of a new catalyst formulation to remove 95 percent of NO<sub>x</sub> emissions over a broad range of temperatures with ultra-low sulfur diesel fuel;
- Initiated programs with Cummins/Engelhard and Detroit Diesel/Johnson Matthey to develop and demonstrate emission control systems for passenger cars (PNGV) and light trucks that will enable compliance with future emissions standards;
- Received 1999 R&D 100 Award (R&D Magazine) for "Clean Diesel Technology"; and
- Tested DOE-sponsored microwave regenerative particulate trap technology successfully.

### Benefits:

- Contribute to achieving 80 miles per gallon PNGV mid-size passenger vehicles, and significantly improved fuel economy for light trucks and sport utility vehicles, while meeting stringent Tier 2 tailpipe emission standards.

**For More Information, Contact:** Ken Howden and/or Kathi Epping, Office of Advanced Automotive Technologies, (202-586-3631) and/or (202-586-7425) or go to: [www.ott.doe.gov/pdfs/Comb\\_ReportNew.pdf](http://www.ott.doe.gov/pdfs/Comb_ReportNew.pdf)

## Alternative Transportation Fuels

**DOE Challenge:** Enhancing Energy Security; Mitigating Environmental Impacts

**Program Activity:** To advance the Energy Policy Act of 1992 (EPACT) objective to increase the use of alternatives to petroleum in the transportation sector. EPACT seeks to achieve this goal via an increase in the use of alternative fuels and alternative fuel vehicles (AFVs) as well as through an expansion of the use of non-petroleum components (replacement fuels) in conventional petroleum-based fuels. EPACT section 502(b)(2) established goals of displacing 10 percent of motor fuel consumption in 2000 and 30 percent of motor fuel consumption in 2010 with alternative and replacement fuels.

### Accomplishments:

- Implemented regulations governing the purchase of alternative fuels by State governments and fuel providers;
- Published an Interim Final Rule governing the availability of alternative fuel vehicle credits through the use of biodiesel fuel;
- Supported Executive Orders resulting in over 40,000 alternative fuel vehicles operating in the Federal Government fleet; and
- Induced a total population of around 160,000 alternative fuel vehicles in the fleets of the Federal Government, State governments, and fuel providers.

### Benefits:

- Displaced around 140 million gallons of petroleum fuels since 1992;
- Helped increase the number of AFV models available from 7 in 1993 to 29 in 2000; and
- Helped increase the number of alternative fuel refueling stations to 6000 in 2000.

**For More Information, Contact:** David Rodgers, Director, Office of Technology Utilization, EE-34, (202-586-9118) or go to: [www.afdc.doe.gov/](http://www.afdc.doe.gov/)



## Clean Cities

**DOE Challenge:** Enhancing Energy Security, Mitigating Environmental Impacts

**Program Activity:** Provides the technical assistance needed to expand the use of alternative fuel vehicles (AFVs) and their supporting infrastructure throughout the nation by building community networks. The Clean Cities program takes a unique, voluntary approach to AFV market development, working with coalitions of local stakeholders to help develop the AFV industry and integrate this development into larger planning processes.

The Clean Cities program thrives on strong local initiatives and a flexible approach to the challenge of building alternative fuels markets, providing participants with options to address problems unique to their cities, and fostering partnerships as the mechanism to overcome these problems. Current and potential members of the Clean Cities network also help each other by sharing local innovations, by addressing and relaying obstacles they encounter in pursuing alternative fuels programs, and by exchanging “do’s” and “don’ts,” based on experiences in these programs.

### Accomplishments:

- Around 170,000 alternative fuel vehicles in service in Clean Cities;
- 80 participating communities; more than 3500 stakeholders;
- Over 4000 alternative fuel refueling stations in service in Clean Cities;
- 10 domestic AFV corridors under development;
- Six national conferences held, the most recent of which attracted almost 1000 attendees;
- Creation and maintenance of Alternative Fuels Data Center and Clean Cities websites, providing wide dissemination of alternative fuels and Clean Cities information; and
- More than \$10 million in grants to States for innovative projects.

### Benefits:

- Over 600 million gallons of petroleum fuel displaced since 1993;
- Over 130,000 metric tons of criteria emissions displaced since 1993; and
- Over 300,000 metric tons of carbon emissions displaced since 1993.

**For More Information, Contact:** Shelley Launey, Office of Technology Utilization, (202-586-1573) or go to: [www.ccities.doe.gov](http://www.ccities.doe.gov)

## International Clean Cities

**DOE Challenge:** Mitigating Environmental Impacts, Enhancing Energy Security, Increasing Competitiveness and Reliability

**Program Activity:** Extending the Clean Cities model of public-private partnerships to enable developing countries to make use of U.S. Alternative Fuel Vehicles technology to mitigate pollution problems and build sustainable transportation. The international projects in the Clean Cities program facilitate international exchange and government/industry partnerships to promote alternative fuel technologies that address shared energy and environmental issues. Technical assistance and expert support:

- Build and maintain partnerships through international information exchange;
- Advance economic opportunities for U.S. and in-country industries; and
- Enhance and maintain the technological and analytical knowledge of the international community.

### **Accomplishments:**

- Enrolled Santiago, Chile, Juarez, Mexico, and Toronto, Canada, into the Clean Cities International program;
- Conducted a reverse trade mission from Chile to the U.S. in February, 1999;
- Co-sponsored a Climate Change Initiative Workshop in San Salvador, El Salvador in March, 2000;
- Conducted a successful trade mission to Monterrey, Mexico in April, 2000; and
- Sponsored a transit workshop in Santiago, Chile in May, 2000.

### **Benefits:**

- Chile has adopted tough new emissions regulations for transit buses and a financial incentive program for purchase of natural gas buses; and
- U.S. industry has developed partnerships in Chile, Mexico, and Canada to promote natural gas and other alternative fuel vehicle products.

**For More Information, Contact:** Marcy Rood, Office of Technology Utilization, (202-586-8161) or go to: [www.hemis-ccities.doe.gov](http://www.hemis-ccities.doe.gov)

## Electric Vehicle Batteries

**DOE Challenge:** Enhancing Energy Security, Mitigating Environmental Impacts

**Program Activity:** Develop advanced energy storage and related systems technologies that simultaneously meet competitive requirements such as high power demand, fast rechargeability, long life, safety, low heat and low cost. Address barriers including high cost, inadequate performance and life, reliability, system safety, and disposal through high-energy battery research. Focuses on advanced energy storage technologies will enable full-range electric vehicles to travel at least 200 miles on a single battery charge. Working closely with U.S. automakers as part of the U.S. Advanced Battery Consortium (USABC), the Electric Vehicle Battery program is developing the next generation of nickel-metal hydride (NiMH), lithium-ion and lithium-polymer battery technologies.

### Accomplishments:

- Completed nickel-metal hydride battery research activities with the delivery of production modules from SAFT America to DaimlerChrysler for use in the EPIC Electric Minivan and from GM Ovonic to General Motors for use in the EV-1 and S-10 electric vehicles;
- Demonstrated life of more than 500 cycles in laboratory tests of a lithium-polymer electrochemical cell cohort group representing an entire EV battery pack; and
- Developed a comprehensive series of tests to characterize the abuse tolerance of advanced batteries developed under the USABC and PNGV programs. These test procedures were published in July 1999 and have been recognized and adopted by the Society of Automotive Engineers (SAE) as the industry standard (J2464.)

### Benefits:

- By 2010, 700,000 electric vehicles on the road replacing inefficient urban vehicles.

**For More Information, Contact:** Dr. Kenneth L. Heitner, Office of Advanced Automotive Technologies, (202-586-2341) or go to: [www.ott.doe.gov/oaat/ev\\_batt.html](http://www.ott.doe.gov/oaat/ev_batt.html)

## Fuel Cell Development for Vehicles

**DOE Challenge:** Enhancing Energy Security, Mitigating Environmental Impacts, Providing Diverse Energy Technologies

**Program Activity:** A fuel cell is an electrochemical device that combines hydrogen and oxygen to produce electricity with zero emissions and high energy efficiency—either as a stationary means of producing electricity or a mobile propulsion system for vehicles. The DOE effort is designed to help industry develop effective, low-cost fuel cells, that move well beyond the costly fuel cells developed for the U.S. space program.

The U.S. Government owns and operates 30 fuel cell co-generation units, the world's largest fleet of fuel cells. Five cabinet-level Departments participate in fuel cell research and demonstration programs, investing more than \$100 million per year. The U.S. Department of Energy spends about \$50 million on research in molten carbonate and solid oxide fuel cells for stationary power and more than \$30 million on transportation applications, primarily utilizing the Proton Exchange Membrane (PEM) technology.

### Accomplishments:

- October, 1997. A government-industry team (Department of Energy, Ford Motor Company and International Fuel Cells) announced that for the first time, a PEM fuel cell system fueled by hydrogen, produced more than 50 kilowatts of electrical power without an air compressor;
- October, 1997. A breakthrough in “on-board” fuel processing demonstrated that ordinary gasoline and clean alternative fuels can be converted to power a fuel cell electric car; and
- January, 2000. PNGV effort produces 80-mpg concept cars by GM, Ford and DaimlerChrysler. One of the GM cars utilizes fuel cell/hybrid propulsion system and promises fuel efficiency of 108 miles per gallon (gasoline equivalent.)

### Benefits:

- Fuel cells can provide major environmental, energy and economic benefits that advance critical national goals: clean air, increased national self-reliance for transportation fuels, and enhanced national security; and
- Continued aggressive development will help retain competitive advantage for U.S. fuel cell suppliers and automakers.

**For More Information, Contact:** Patrick Davis, Program Manager, EE-32, (202-586-8061) or go to: [www.ott.doe.gov/oaat/fuelcell\\_tech.html](http://www.ott.doe.gov/oaat/fuelcell_tech.html)

# **Energy Efficiency**

## ***Electricity Generation***



## Gas Turbines

**DOE Challenge Area:** Mitigating Environmental Impacts; Increasing Competitiveness and Reliability

**Program Activity:** This program focuses on development and testing of advanced turbine systems to convert natural gas and other domestic fuels into electric power. These systems are ultra-efficient, near zero emissions, and affordable in today's power generation marketplace. The program includes research and development in critical research areas with U.S. DOE National Labs, 40 U.S. universities, and industry partners. The ATS program began in the year 1992 with the goals to achieve 60 percent net electrical efficient utility scale power plants, a 10 percent reduction in cost of electricity, and less than 10 ppm NO<sub>x</sub> emissions. The ATS program is a success with the General Electric 7H-ATS ready for demonstration at the Site Energy site near Scriba, NY and the Siemens-Westinghouse ATS currently being tested at Lakeland Municipal Utilities near Orlando, FL.

With environmental and energy security pressures continuing to grow in the U.S., the DOE is planning further development of *next generation turbine systems* for Vision 21 plants. By the year 2010, turbine based power systems developed will include turbine/fuel cell hybrids, flexible turbine systems, and revolutionary concepts such as the Ramgen and Clean Energy Systems concepts. By the year 2015, these systems will be enhanced and integrated into Vision 21 power plants.

### Accomplishments:

- Development and testing of utility scale ATS which are 60 percent efficient, 10 percent lower in cost of electricity, and ultra-low emissions;
- 60 universities have contributed to the development of the ATS under the industry-university consortium; and
- DOE National Laboratories and industry have developed materials and combustion technology to achieve the cost and emissions goals of the ATS program.

**Benefits:** In the 2000 Annual Energy Outlook, the DOE EIA predicts that 300 gigawatts of new generating capacity will be required in the United States by 2020 to meet growing demand and to replace retiring units. Of the new capacity, 90 percent is projected to be combined-cycle or combustion turbine technology. Development of next generation turbine systems will provide the following savings to the U.S.:

- 4900 trillion btu of primary energy;
- \$6,900 million fuel cost savings;
- 490 million metric tons of CO<sub>2</sub>;
- 0.55 million metric tons of SO<sub>x</sub>; and
- 1.1 million metric tons of NO<sub>x</sub>.

In the near term, it is estimated that a **reduction of up to 165 million tons of CO<sub>2</sub> per year** could be achieved in the U.S. alone by displacing older, less efficient, intermediate coal, oil, and NG-fired steam plants with next generation technology.

In the long term, if turbine/fuel cell hybrid systems penetrate the U.S. market, these systems will produce less than 1 ppm NO<sub>x</sub> and virtually no SO<sub>x</sub>. They are at least 70 percent efficient, have a concentrated CO<sub>2</sub> stream, and no particulates even when utilized as electric generation modules for coal-fired power plants. With integration of the next generation technologies into Vision 21 plants,

public benefits will be further increased due to significant long-term emissions reduction and fuel savings to the U.S. economy.

Currently U.S. turbine manufacturers annually export more than \$3 billion worth of power generation systems. Maintaining the U.S. technological lead in gas turbines power generation equipment will provide for increased exports and enhance our industrial competitiveness. The U. S. Department of Commerce estimates that every \$1 billion of exports equates directly to 20,000 jobs. More than 60,000 jobs can be accredited to U.S. turbine manufacturers through the export of power generation systems.

**For More Information, Contact:** Vic Der, Director, Power Systems, Office of Coal and Power Systems, (301-903-2700) or go to: [www.fe.doe.gov/coal\\_power/ats/ats\\_sum.html](http://www.fe.doe.gov/coal_power/ats/ats_sum.html)



## Fuel Cells for Utility Sector

### DOE Challenge Area: Mitigating Environmental Impacts

**Program Activity:** In the near term, the Fuel Cell Program is committed to creating environmentally friendly technology for the expanding distributed generation market that has gained impetus from the deregulating electric industry. The molten carbonate and solid oxide fuel cell technology products should enter the near-term distributed generation market by 2003. In the long term, the Program is committed to realizing the full potential of ultra-high efficiency with zero emissions fuel cell technology and to wider, deeper market applications of the technology. The greatest opportunities in the fuel cell program are expected to be achieved through the Solid State Energy Conversion Alliance (SECA.) SECA comprises government agencies, commercial developers, universities, and national laboratories committed to the development of low cost, high-power density solid state fuel cells for a broad range of stationary and transportation applications. SECA technology will ultimately lead to megawatt-size configurations for commercial/light industrial packages and Vision 21 central power station applications.

### Accomplishments:

- Commercialization of the phosphoric acid fuel cell and deployment of over 200 units worldwide has created the first generation of ultra-clean, highly reliable power plants that produce high quality electricity and thermal energy;
- The next generation molten carbonate and solid oxide fuel cell technology is being demonstrated and scaled-up to 1 megawatt; and
- The world's first fuel cell turbine hybrid is being tested.

### Benefits:

- By 2010, molten carbonate (MCFC) and solid oxide fuel cell (SOFC) developers will produce 5,000-10,000 new jobs, \$400 million/year in potential wages and \$1 billion in tax revenue;
- The SOFC and MCFC developers will capture 10-15 percent of the 10 gigawatt per year European and U.S. distributed generation (DG) market;
- By 2010, the DG market is expected to be 20-40 percent of the total new and replacement market worldwide. The DG market could be potentially 40 gigawatts per year worldwide;
- In terms of CO<sub>2</sub> emissions, with an average efficiency of 50-60 percent (LHV), almost twice that of conventional power plants, CO<sub>2</sub> emissions would be reduced by almost 40 percent on all power plants using fuel cells. This would reduce the growth in new CO<sub>2</sub> emissions by 40 percent. In addition, NO<sub>x</sub> and SO<sub>x</sub> emissions would virtually be eliminated;
- Grid reliability will be enhanced through the ancillary services benefits of fuel cells (including power quality, premium power, voltage control, etc.); and
- Longer term, SECA will produce the first demonstrations of even lower-costs, Vision 21-enabling fuel cell technology concepts, such as solid-state fuels cells, networks, multi-staged designs, etc., to enhance wider and deeper penetration of the mature, competitive distributed generation market. These revolutionary fuel cells systems will target efficien-

cies of over 80 percent at costs below \$400 per kilowatt, while reducing carbon dioxide emissions by over 56 percent. This breakthrough will allow widespread penetration into high volume stationary and transportation markets, ultimately leading to “Vision 21” central station power application of advanced fuel cell technology. The inherently high 60-70 percent conversion efficiencies of these solid state fuel cells will provide significantly reduced CO<sub>2</sub> emissions, in addition to negligible emissions of pollutants when operating using fossil fuels.

**For More Information, Contact:** Vic Der, Director, Power Systems, Office of Coal and Power Systems, (301-903-2700) or go to: [www.fe.doe.gov/coal\\_power/fuel\\_cells/fc\\_sum.html](http://www.fe.doe.gov/coal_power/fuel_cells/fc_sum.html)

## Combined Heat and Power

**DOE Challenge:** Enhancing Energy Security, Mitigating Environmental Impacts, Increasing Competitiveness and Reliability

**Program Activity:** This program is intended to assist industry and state agencies in developing and deploying clean, reliable, and affordable clean energy generation options for the 21<sup>st</sup> century. It focuses on identifying and removing regulatory and institutional barriers for the use of Combined Heat and Power (CHP) systems. DOE efforts provide leveraging mechanisms for accelerating the deployment of research, development and deployment investments in turbines, engines, fuel cells, HVAC, and humidity control equipment.

This is the second year of the CHP program. Activities have focused on launching a national information and education campaign on the energy, economic, and environmental benefits of CHP systems. The primary audience is state energy and environmental policy officials, particularly state public utility commissioners and staff and environmental siting and permitting officials. The Department has formed an alliance with the U.S. EPA to develop new policy actions and to clarify existing air quality regulations for CHP. EPA has joined with the Department in the CHP Challenge Initiative, which was announced in December, 1998 and aims at doubling the amount of CHP capacity in the U.S. by 2010. This means adding approximately 46 gigawatts of new CHP capacity in this timeframe.

To achieve the CHP Challenge Initiative goal, the U.S. Combined Heat and Power Association has started a vision and roadmap process to identify the most productive pathways for achieving the CHP Challenge goal. A series of conferences, workshops, and seminars have been held with CHP developers and state regulatory officials to identify better approaches for the siting, permitting, and interconnection of CHP systems. Financial assistance has been provided to state agencies in California, Washington, New York, Indiana, and Vermont to explore the CHP potential in those states and identify barriers to CHP implementation. Outreach workshops have been held in Maine, New York, and New Mexico. Regional workshops have been held in the Northeast, Midwest, and Pacific Northwest.

There is also a focused effort targeting increased use of CHP in commercial buildings. As part of this effort, the BCHP Initiative, a series of workshops have been held involving the natural gas industry, CHP developers, and building designers to determine R&D needs to tailor the integration of CHP systems for use in buildings for heating, cooling, power, and humidity control needs.

### **Accomplishments:**

- Developed and disseminated information on CHP systems and regulatory and institutional barriers to CHP to hundreds of state officials, which has led to local efforts in New York, New Jersey, Illinois, Michigan, Wisconsin, Washington, New Mexico, and Maine to eliminate the unnecessary barriers to the installation of CHP systems;
- Held national and international conferences on CHP involving senior level policy officials and business executives to raise awareness of CHP benefits. This has led to the DOE-EPA partnership on CHP and a review of air quality regulations and their effects on CHP development. These conferences have also led to international initiatives with the UK, EC, and Canada on CHP development and deployment; and
- Launched the CHP vision and roadmap process led by the U.S. Combined Heat and

Power Association involving hundreds of business executives representing equipment manufacturers, CHP developers, A&E firms, electric and gas utilities, energy services companies, and potential industrial and commercial CHP users.

**Benefits:** Doubling U.S. CHP capacity by 2010 will result in these net benefits:

- Net energy savings of 1276 trillion btus;
- Carbon reductions of 37 million metric tons;
- SO<sub>2</sub> reductions of 0.94 million tons;
- NO<sub>x</sub> reductions of 0.42 million tons; and
- Economic savings of \$5.5 billion.

**For More Information, Contact:** Pat Hoffman, Team Lead, Distributed Energy Resources (202-586-2387) or go to: [www.oit.doe.gov/chpchallenge/](http://www.oit.doe.gov/chpchallenge/)

## Distributed Energy Resources

**DOE Challenge:** Enhancing Energy Security, Increasing Competitiveness and Reliability, Mitigating Environmental Impacts

**Program Activity:** In March 2000 a Distributed Energy Resources Task Force was established in the Office of Energy Efficiency and Renewable Energy (EERE), Office of Power Technologies. The Task Force consolidates the programs and staff from across EERE related to the development and deployment of distributed energy resources. The vision is for the U.S. to have the cleanest and most efficient and reliable energy system in the world through maximizing the use of affordable distributed energy resources. The focus is on technology development and the elimination of regulatory and institutional barriers to the use of distributed energy systems including interconnection to the utility grid and environmental siting and permitting.

The program directs and coordinates a diverse portfolio of research and development. Activities consist of investments in natural gas and renewable technologies including advanced turbines and microturbines, natural gas engines, fuel cells, and cooling, heating and power systems (CHP.) The program also conducts supporting research, development and deployment (RD&D) in enabling technologies such as advanced combustion systems, advanced materials, and sensors and controls. Additional efforts focus on energy generation and delivery systems and architectures for distributed energy resources to strengthen grid reliability in electricity transmission and distribution technologies, energy storage systems, grid interconnection technologies, power parks, mini grids, and district energy.

Outreach and implementation activities are also program priorities. These efforts are addressing infrastructure, institutional and regulatory needs in utility restructuring, environmental siting and permitting, uniform interconnection standards, tax provisions, state initiatives, and international recommendations of the Presidents Committee of Advisors on Advanced Science and Technology (PCAST.)

### Accomplishments:

- Developed advanced turbine systems that achieve emissions (single digit NO<sub>x</sub> emissions), efficiency (40 percent LHV), and cost targets (competitive installation, O&M costs) for use in industry, commercial facilities, and district energy complexes for baseload power, backup power, and combined heat and power applications;
- Initiated RD&D for developing the next generation of microturbine and reciprocating engine systems for electric power and combined heat and power applications;
- Developed advanced engine driven heating, cooling, and humidity control equipment for use in commercial buildings that use natural gas, reduce electric power requirements, and are applicable to building cooling, heating, and power applications;
- Launched a transmission reliability R&D program aimed at understanding the technical requirements of competitive power markets and developing advanced systems for the interconnection of distributed power systems, real time systems control, and outage management;
- Developed advanced energy storage systems for use in utility applications for power quality and reliability; and

- Assisted state agencies in the development of utility restructuring concepts and plans to open electricity and natural gas markets to competitive market forces.

**Benefits:** Reduced air emissions, reduced fuel consumption, lower energy costs, greater power system reliability, better power quality, more customer choice, better customer energy services.

**For More Information, Contact:** Pat Hoffman, Team Lead, Distributed Energy Resources (202-586-6074) or go to: [www.eren.doe.gov/der/](http://www.eren.doe.gov/der/)

## Vision 21

### **DOE Challenge:** Mitigating Environmental Impacts

**Program Activity:** The mission of Vision 21 is to effectively remove environmental concerns associated with the use of fossil fuels for producing electricity and transportation fuels (at competitive cost.) Vision 21 is a long-range (~15 year), industry-driven, research and development program aimed at creating technology that will allow future energy plants to achieve almost double the efficiency of today's power plants while virtually eliminating all harmful emissions. Technology innovation is emphasized. Designs for technology modules (plant subsystems and major components) will be developed along with the systems integration capabilities necessary to configure the modules into Vision 21 energy plants. Other products of the Vision 21 program will be improved computer design and simulation tools, including virtual demonstration, and spin-off technologies, e.g., air separation membranes for producing low-cost oxygen. The approach allows for the inclusion of carbon sequestration at a later time. In a report issued in May, 2000, the National Research Council recommends that over time, Vision 21 become the primary focus of the Office of Fossil Energy's program in coal and power systems. Also, the President's Committee of Advisors on Science and Technology (PCAST), in their November, 1997 report, endorse Vision 21. Vision 21, along with other Fossil Energy programs, plays a prominent role in the Department's Energy Resources R&D portfolio.

### **Accomplishments:**

- Vision 21 solicitation issued September 30, 1999. The solicitation requests proposals in three areas: enabling and supporting technologies, systems integration, and advanced plant design and visualization software. There are four proposal submission periods; selections are made every three months. Minimum cost-sharing is 20 percent; and
- Selection of the first six projects was announced on March 7, 2000 (see DOE Techline.) These projects involve development of hybrid power systems (Fuel Cell Energy), oxygen separation membranes for fuel cell applications (Siemens Westinghouse and Praxair), hydrogen separation membranes (Eltron Research), a novel steam generator design for a high-efficiency power cycle (Clean Energy Systems), systems integration (National Fuel Cell Research Center), and model development for a virtual demonstration (Fluent.)

**Benefits:** A successful Vision 21 program will help ensure that our nation continues to have a plentiful supply of clean, low-cost energy essential to robust economic growth. When coupled with sequestration, Vision 21 technology will remove environmental concerns, including climate change, associated with the use of fossil-based energy. New advances for the manufacture of hydrogen will make gasification an important technology in the transition to a hydrogen economy.

**For More Information, Contact:** Vic Der, Director, Power Systems, Office of Coal and Power Systems, (301-903-2700) or go to: [www.fe.doe.gov/coal\\_power/vision21/vision21\\_sum.html](http://www.fe.doe.gov/coal_power/vision21/vision21_sum.html)

## Innovations to Existing Power Plants

### **DOE Challenge:** Mitigating Environmental Impacts

**Program Activity:** The program is directed at existing power plants and has two major focuses: (1) develop advanced environmental control technology and (2) provide high-quality scientific data and analysis for use in policy and regulatory determinations. The program portfolio includes research and development activities aimed at either preventing the generation of pollutants during fossil fuel conversion or capturing them from effluents before they are released to the environment. Research is being conducted in the areas of control of fine particulate matter; mercury/air toxics, nitrogen and sulfur oxides, and utilization coal combustion byproduct. The program covers the entire “life cycle” of emissions and technology, from source speciation through advanced emissions control technology development and testing. The program has targeted a 50 percent reduction in overall environmental compliance costs through the development of advanced technologies and integrated systems. The achievement of this target is expected to provide over \$6.5 billion per year savings by 2010.

**Accomplishments:** The Innovations for Existing Plants program has a strong history of assisting in the development of useful commercial products. Low-NO<sub>x</sub> burners (LNBs), advanced SO<sub>2</sub> scrubbers, and other products have provided the United States with both billions of dollars of savings and a cleaner environment through lower-cost technology. For example, collaborative research with industry has led to LNB technology capable of achieving 50 percent reductions in NO<sub>x</sub> emissions at an incremental cost of roughly 0.03 cents per kilowatt hour. In another example, advanced scrubbing technology developed under the program is lowering SO<sub>2</sub> emissions at one Pennsylvania utility while saving the company over one-half million dollars in annual operational costs. The program has also provided unbiased, high-quality scientific and technical data to EPA and other federal agencies in response to regulatory actions regarding mercury, CCBs, and TRI.

**Benefits:** The aggregate cost of environmental compliance for coal-fired generators in the United States was \$1.9 billion in 1997. It is projected that the cost of environmental compliance will increase by seven-fold to over \$13 billion per year by 2010. This growth will be driven by calls for more stringent environmental regulations to address mercury, ambient fine particulates, regional haze, acid gases, acidification, eutrophication, air toxics, and their potential impacts on human health and on terrestrial and aquatic ecosystems. This Program will enable major reductions in this \$13 billion annual compliance cost.

In addition, roughly 71 percent of the byproducts of coal combustion (CCBs) continue to be disposed of in landfills, at a cost of roughly \$1 billion per year. New applications for CCBs will be developed to substantially reduce the volume of CCBs landfilled each year.

The program will meet these challenges through continued partnership with industry and other key stakeholders in the development of cost-effective technology and by providing quality scientific data and analyses associated with the environmental performance of coal-fired power plants.

**For More Information, Contact:** Doug Carter, Director, Planning and Environmental Analysis, Office of Coal and Power Systems, (202-586-9684) or go to: [www.fe.doe.gov/coal\\_power/environ/environ\\_sum.html](http://www.fe.doe.gov/coal_power/environ/environ_sum.html)



## Power Plant Environmental Regulatory Analysis

### **DOE Challenge:** Mitigating Environmental Impacts

**Program Activity:** DOE plays a significant role in the development of environmental regulation for the energy sector, particularly for fossil fuel-fired powerplants. Through one of the roles mandated DOE by Congress, to develop improved technologies to address environmental issues, DOE has amassed a large body of information on energy processes, energy conversion, the pollutants associated with such processes, and technologies to mitigate emissions. This knowledge base is provided to EPA, which has the final responsibility for regulations to protect the environment. This information has led to several positive outcomes, including the avoidance of unnecessary regulations, better approaches to address others, and development of altogether new technologies or technologies much less expensive than preceding technologies to reduce emissions.

### **Accomplishments:**

- Development of information related to nitrogen oxides control technology to assist EPA in promulgating regulations for electric utilities. DOE participated in public meetings chaired by EPA, interagency regulatory review meetings chaired by OMB, and summarized information on the state of mitigation technology for the final EPA rule;
- Development of a database on toxic emissions from powerplants. The measured data demonstrated that emissions were much lower than previously estimated using less precise methods, and were used by EPA to avoid adoption of unnecessary regulations for several pollutants;
- Collection and analysis of data related to EPA's Toxic Release Inventory, and participation in interagency meetings influencing the final utility regulation by EPA; and
- Collection and analysis of data related to coal combustion wastes and participating in two cycles of interagency meetings leading to EPA decisions to regulate these wastes under State solid waste regulations, rather than more onerous Federal regulations.

**Benefits:** It is difficult to quantify the benefits of this activity because alternative outcomes are hypothetical. In just one of the rulemakings avoided, EPA cited costs up to one trillion dollars for the electric utility industry. In other rulemakings, development of advanced technologies enabled greater degrees of environmental protection than would otherwise have been possible.

**For More Information, Contact:** Doug Carter, Director, Planning and Environmental Analysis, Office of Coal and Power Systems, (202-586-9684)

## Regulatory Oversight of Natural Gas Imports/Exports and Electricity Exports

### DOE Challenge: Enhancing Energy Security

**Program Activity:** The Office of Fossil Energy (FE) is responsible for authorizing requests to import and export natural gas and electricity exports, as well as authorizing the construction of international electric transmission lines. Originally, the Federal Power Commission (FPC) exercised regulatory authority over cross-border natural gas and electricity trade; however, the Department of Energy Organization Act (1977) transferred this authority to the Secretary of Energy. This regulatory responsibility was given to the Secretary rather than to the Federal Energy Regulatory Commission (FERC), an independent regulatory body, because the DOE Act wanted all regulatory functions affecting international commerce to remain under the direct control of the President.

The principal objective of FE's regulatory oversight responsibilities is to maintain a program that promotes the freest possible international gas and electricity trade, with minimal government intervention. The regulatory program facilitates natural gas and electricity imports and exports which enhance the nation's energy security by minimizing our dependence on less secure supplies of oil; diversifying our energy sources; and reducing our vulnerability to the adverse impacts of supply disruptions. Further, the regulatory oversight promotes a level playing field that facilitates competition.

### Accomplishments:

- Consistent with the Canada-United States Free Trade Agreement and the North American Free Trade Agreement, FE maintains a regulatory program that promotes market-sensitive natural gas and electricity trade, with minimal government interference;
- FE authorizes natural gas and electricity exports in a manner that encourages development of foreign markets for surplus natural gas and electricity supplies;
- FE determines the reliability and environmental impacts associated with installing international transmission lines and exporting electric energy;
- FE has extended the principles of non-discriminatory open access transmission service to international transmission lines; and
- FE monitors North American natural gas and electricity trade. It collects and publishes extensive data on cross-border natural gas trade in the Quarterly Report of Natural Gas Imports and Exports; the data are also used by the Energy Information Administration.

### Benefits:

- DOE's light-handed regulatory policy regarding natural gas and electricity imports and exports has resulted in a more efficient, market-driven, and integrated North American energy market; and
- Natural gas imports have increasingly become a very important incremental source of supply to the growing gas demand in the United States. During 1999, natural gas imports from eight different countries (primarily Canada) supplied almost 16 percent of our country's total gas demand; this compares with 4.2 percent in 1986.

**For More Information, Contacts:** Tony Como, Manager, Electricity Import Regulation, Office of Coal and Power Systems, (202-586-5935) or go to: [www.fe.doe.gov/coal\\_power/elec\\_reg/elec\\_reg.htm](http://www.fe.doe.gov/coal_power/elec_reg/elec_reg.htm)

John Glynn, Manager, Natural Gas Import/Export Regulation, Office of Natural Gas and Petroleum Technology, (202-586-9454) or go to: [www.fe.doe.gov/oil\\_gas/im\\_ex/gasimex.html](http://www.fe.doe.gov/oil_gas/im_ex/gasimex.html)

# **Energy Efficiency**

## ***Homes and Buildings***



## Low Income Weatherization Assistance Program

**DOE Challenge:** Enhancing Energy Security, Mitigating Environmental Impacts

**Program Activity:** DOE's Weatherization Assistance Program has served as the nation's core program for delivering energy conservation services to low-income Americans since it was created by Congress in 1976. Low-income households spend about 14.9 percent of their income for energy needs, as opposed to the 3.5 percent of income spent on energy needs by other households. The Weatherization Program reduces this disproportionate burden. The program's resources are focused particularly on the elderly, persons with disabilities, and families with children.

### Accomplishments:

- Through local agencies, the program has retrofitted over 4.7 million homes since 1976;
- Most local programs now use the National Energy Audit (NEAT), a computer program developed by ORNL for DOE which identifies the most cost-effective energy conservation measures specifically for each house, significantly boosting achieved energy savings;
- Improving program practices resulted in average savings of 33.5 percent of natural gas space heating consumption in 1996, 80 percent higher average savings than in 1989. Assuming that this same level of improvement was achieved in homes heated by other fuels, the annual energy savings for a home weatherized in 1996 is estimated to be 32.2 million btu. Over the 20-year average life of weatherization measures, this represents an energy cost savings of more than \$3000 per house; and
- Over the average 20-year life of weatherization measures, these homes will save 108 trillion btu of energy, their occupants will pay \$550 million less in utility bills, and 1.63 million metric tons of carbon emissions will be averted.

### Benefits:

- Weatherization of low-income homes directly and immediately improves the health and safety of inhabitants by reducing carbon monoxide emissions and eliminating fire hazards, in addition to lightening the financial burdens of those most in need;
- The program's longer-term impacts include community revitalization; and
- The Weatherization Program also creates about 8000 jobs nationwide; 52 jobs grow directly from every million dollars invested in the program.

**For More Information, Contact:** Gail McKinley, Director, Office of Building Technology Assistance, (202-586-4074) or go to: [www.eren.doe.gov/buildings/weatherization\\_assistance/](http://www.eren.doe.gov/buildings/weatherization_assistance/)

## Federal Energy Management Program

**DOE Challenge:** Enhancing Energy Security, Mitigating Environmental Impacts

**Program Activity:** The Federal Energy Management Program (FEMP) reduces the cost to government by advancing energy efficiency and water conservation, promoting the use of renewable energy, and managing utility costs of federal agencies. FEMP accomplishes its mission by leveraging both Federal and private resources to provide technical and financial assistance to other Federal agencies. The agencies make investments in projects that increase energy efficiency and renewable energy use, and reduce water consumption in their buildings, facilities and operations.

The President issued Executive Order 13123, “Greening the Government Through Efficient Energy Management,” on June 3, 1999, providing new emphasis and commitment to improve the efficiency of Federal energy use. The Executive Order establishes new goals of improving efficiency in federal buildings by 35 percent by 2010 from the 1985 baseline, and reducing greenhouse gas emissions attributable to Federal buildings energy use by 30 percent from 1990 levels by 2010. FEMP helps agencies achieve their needs by providing alternative financing tools and guidance to use the tools, technical and design assistance for new construction and retrofit projects, training, technology transfer, procurement guidance, software tools, and reporting and evaluation of all agencies’ programs.

### Accomplishments:

- Between 1985 and 1999, the government achieved a 21.1 percent reduction in site based energy intensity (energy used per square foot of building floor space), meeting the 2000 goal one year early;
- Half of these savings is attributable to the FEMP program;
- FEMP trained over 13,000 Federal energy managers since 1992; and
- FEMP established 44 regional and technology energy savings performance contracts (ESPC.)

### Benefits:

- FEMP helps agencies save energy and money;
- Agencies can potentially achieve an estimated \$2 billion in cumulative investment in their facilities via FEMP Super ESPCs and utility energy service contracts over the 2002-2010 time frame (which averages to \$240 million per year); and
- By the end of 2010, the Federal renewable energy use is estimated to increase by 7.5 percent relative to a 1990 baseline.

**For More Information, Contact:** Beth Shearer, Director, Federal Energy Management (202-586-5772) or go to: [www.eren.doe.gov/femp](http://www.eren.doe.gov/femp)

## Whole Buildings Approach

### DOE Challenge: Mitigating Environmental Impacts

**Program Activity:** We have found that an effective way to optimize energy performance in buildings is to integrate efficiency components, accounting for all interactive effects, including non-energy effects. In addition to improved energy performance, the resulting improvements in indoor environmental quality, comfort, productivity (in workplaces and schools) and affordability will bolster support for improved building energy efficiency at all levels. However, the building industry encompasses literally thousands of different businesses and millions of individual decision makers. The resulting fragmentation separates developers, designers, builders, utilities, engineers, and occupants from one another as they pursue objectives which often are at cross-purposes. Fragmentation also results in lower-than-average profit margins for many firms, often making it difficult for these firms to invest in efficiency strategies that add to up-front construction costs.

The DOE Building America program is the flagship program of the whole building approach. The Building America program brings together architects, engineers, builders, equipment manufacturers, material suppliers, community planners, mortgage lenders, and contractor trades. These teams use a systems engineering approach to identify highly energy efficient building designs with little or no additional net up-front costs. Up-front cost savings can occur, for example, when improved insulation and duct systems allow the size of the heating and cooling systems to be reduced. Currently, there are five teams comprised of more than 50 different companies. Team members agree to evaluate their design, business, and construction practices to identify cost savings and re-invest cost savings in improved energy performance and product quality. Everyone benefits from the improved knowledge of which whole building strategies typically work best.

Concurrent DOE work on building performance design tools also contributes to the whole building approach, by helping builders take full consideration of energy efficiency options and their interactions in their building designs. The whole building approach is being extended to address efficiency improvement in existing homes (where the Weatherization Assistance Program already makes widespread use of similar building design tools), and new and existing commercial buildings. The lessons learned through these innovative research and engineering activities will be transferred to broader markets through state grants, community-based partnerships, and information and outreach efforts that catalyze rapid market adoption of the whole building approach.

### Accomplishments:

- Building America partnerships have produced several hundred homes, and plans are in place to build several thousand more. Dissemination of results continues;
- Since its launching in 1998, Building America has led the energy efficiency efforts of the Presidential Initiative “Partnership for Advancing Technology in Housing”; and
- DOE-developed design tools are used by a wide spectrum of interests, from technology researchers, code developers, local officials, building designers, owners and developers.

### Investments:

- Building America and related programs have averaged \$7 million dollars in appropriated funding for technical assistance since 1996. No DOE funds are used for capital expenditures.

**Benefits:**

- The goal of the Building America program is to produce homes that: use 30 percent to 50 percent less energy; reduce construction time and waste by as much as 50 percent; improve builder productivity, provide new product opportunities to manufacturers and suppliers; and implement innovative energy- and material-saving technologies, all at little or no incremental cost to the builder or the consumer.

**For More Information, Contact:** John Talbott, Office of Buildings Systems, (202-586-9455) or go to: [www.eren.doe.gov/buildings/building\\_america/](http://www.eren.doe.gov/buildings/building_america/)



## Appliance and Equipment Standards

**DOE Challenge:** Enhancing Energy Security, Increasing Competitiveness and Reliability, Mitigating Environmental Impacts

**Program Activity:** During its lifetime, the operating costs of an appliance may exceed its initial purchase price several times over. U.S. homeowners spend \$1,329 per household each year to operate such home appliances as refrigerators, freezers, clothes washers, clothes dryers, water heaters, furnaces, air conditioners, and lights.

Recognizing the great potential for energy savings, many states began prescribing minimum energy efficiencies for appliances during the late 1970s and early 1980s. Anticipating differing state standards, manufacturers supported developing federal standards. These were enacted as the National Appliance Energy Conservation Act (NAECA) of 1987. There are now national efficiency standards for most home appliances and equipment. DOE periodically reviews and updates these efficiency standards for most household appliances. Although efficiency measures may add a small cost to products, the efficiency standards are set at levels where the extra costs are rapidly offset by energy savings.

### Accomplishments:

- Final appliance standards have been issued for small gas furnaces and refrigerator products (1989), clothes washers, dishwashers and clothes dryers (1991), refrigerator products (1997), room air conditioners (1997), electric cooking products (1998), and for electric motors (1999) and plumbing products (1998) used in a range of applications;
- New standards are under development for fluorescent lamp ballasts, water heaters and residential central air conditioners and upgraded standards are under development for clothes washers and certain commercial heating, air conditioning and water heating equipment as contained in the American Society of Heating, Refrigerating and Air-conditioning Engineers, Inc. (ASHRAE) and Illuminating Engineering Society of North American (IES) 90.1-1999; and
- Appliance energy costs have dropped significantly as a result. For example, the new standard for refrigerators which will become effective July 1, 2001 will reduce the energy consumption of the typical top-mount automatic defrost refrigerator-freezer to about 500 kilowatthours of electricity per year. (Similar models in use consume between 700-972 kilowatthours a year.)

### Benefits:

- Since the enactment of the National Appliance Energy Conservation Act of 1987, the Department has issued eight appliance energy efficiency standards final rules. In 2000, these standards, including those set by law, are expected to save consumers \$4.7 billion in reduced energy costs, or an average annual savings of \$44 per U.S. household;
- Based on these forecasts, each federal dollar spent on the appliance standards program will result in consumer savings of about \$1,000; and
- More efficient products are more competitive internationally and have environmental benefits from reduced atmospheric emissions.

**For More Information, Contact:** Ed Pollock, Office of Building Systems, (202-586-5778) or go to: [www.eren.doe.gov/buildings/codes\\_standards/index.htm](http://www.eren.doe.gov/buildings/codes_standards/index.htm)



# Energy Efficiency

## *Industry*



## Industries of the Future

**DOE Challenges:** Economic Security, Competitive Restructuring, Environmental Improvement

**Program Activity:** DOE partners with the most energy intense domestic industries to identify and pursue common technology needs through public-private sector partnerships. The industry visions process enables and encourages industries to work together to: create broad industry wide goals for the future that incorporate the DOE challenges and industry objectives; identify specific needs and their priorities through a system design modeling process called roadmapping and, to form cooperative alliances to help attain those goals cost effectively through diverse technology partnerships; take advantage of departmentally-developed crosscutting technical assistance.

**Accomplishments:**

Vision Title:	Vision Date:	Roadmap Date:	Major Successes:
Forest Products	Nov-94	Mar-99	Launched gasification initiative, selected for funding the first demonstration project. Have funded over 90 research and development projects. DOE has funded over 90 projects supporting the industry vision and roadmap. Partners include 20 universities, 11 national laboratories, 10 suppliers, 2 research institutes and about 30 forest product companies.
Steel	May-95	Aug-97	Twelve commercial successes including furnace sensors, models and controls, and new alloy (nickel aluminide) applications multiplying service life. Six process developments in the waste oxide recovery, recycling, steelmaking, furnace heating and coating. Two important steel technology showcases were held.
Aluminum	Mar-96	May-97	New energy efficient technologies developed include: A filtration system for primary aluminum, a novel grain refining system, a vertical floatation melter and scrap dryer, and vitrification technology to produce glass fiber from spent aluminum potliners. Three inert anode materials and cell designs have been developed and are being tested. Developed, tested and demonstrated improved wettable cathodes that could reduce energy intensity of primary production by 10+ percent.

Vision Title:	Vision Date:	Roadmap Date:	Major Successes:
Metal Casting	Sep-95	Mar-98	<p>Broad partnership with industry involving 250 partners in 32 states. Commercialized a 3-sensor “air gauging system” for maintaining the dimensional accuracy of the advanced lost foam casting process.</p> <p>Commercialized a PC-based modeling program for die casting flow simulation to reduce development lead time and scrap from die try-outs. Developed a clean cast steel technology resulting in significant time and material savings, fewer defects and reduced weld repairs.</p>
Glass	Jan-96	Jan-98	<p>Commercialized oxy-fuel firing technology now in place in over 30 percent of all glass plants. Technology improved productivity, and reduces energy and environmental emissions. Helped to organize the Glass Manufacturing Industry Council (GMIC) representing over 72 percent of U.S. glass production. Commercialized oxygen enriched air-staging which dramatically reduces NOx emissions.</p>
Chemicals	Dec-96	Nov-98	<p>Formed Computational Fluid Dynamics consortium whose tools are now used by chemical companies to shorten energy efficient production process technology development time. Commercialized Super critical CO<sub>2</sub>, Nylon Carpet Recycling process technology, Membrane technology to recover chemicals, and Silicone manufacturing waste recovery process. Developed a total cost assessment tool and sustainability metric methodologies to assess chemical plant impact on the environment.</p>
Mining	Sep-98	Feb-99	<p>Completed two mining roadmaps: crosscutting technologies and processing. Awarded 26 projects. Several technologies are nearing commercialization.</p>

Vision Title:	Vision Date:	Roadmap Date:	Major Successes:
Agriculture	Apr-98	Feb-99	Established industry executive steering group to oversee implementation of vision and roadmap. Issued three solicitations since program inception with 16 project awards. In partnership with Cargill-Dow's joint venture, accelerated commercialization of technology for turning plant-derived matter into industrial chemicals at the first global-scale factory in Blair, Nebraska.
Petroleum	Feb-00	In process	A first round of procurements has been initiated to address key technology areas identified in the vision and roadmap. Vision signed in February, 2000.

**Benefits:**

- Enables industry cooperation and sharing of technology and resources;
- Encourages research, development and deployment (RD&D) that would not otherwise happen;
- The nation, its industries and consumers receive energy, environmental and cost savings years earlier;
- Through cooperative cost-shared RD&D programs industry and government pool resources and share risks; and
- Preserves and improves U.S. industry competitiveness.

**For More Information, Contact:** Douglas Kaempf, Program Manager, (202-586-5264) or go to: [www.oit.doe.gov/industries.html](http://www.oit.doe.gov/industries.html)





# Oil and Gas



## Oil Supply Research and Development

**DOE Challenge:** Enhancing Energy Security

**Program Activity:** The Oil R&D Program focuses on the development of technology needed to sustain domestic oil production in an environmentally responsible manner. The program focuses on high-risk or underutilized technologies that private industry alone will not undertake.

Historical data demonstrate that technology advances are key to keeping energy prices low for consumers and maintaining the profitability and long-term survival of the domestic oil and gas industry.

### Accomplishments:

- Oil Reservoir Class Program includes 32 projects with a total DOE investment of \$118 million and industry co-funding of \$150 million. In one project, reservoir characterization and process analysis of an idle lease in Midway-Sunset field, California found 4.5 million barrels of new recoverable reserves in new and previously abandoned reservoirs on the 40-acre property. The technology has already been transferred to other field areas;
- Petroleum Technology Transfer Council (PTTC), formed in 1994, to provide independent oil operators easy and timely access to new technology, includes 10 regional resource centers, workshops, websites, outreach activities, publications and software;
- Coiled Tubing Horizontal Drilling Systems models developed by the program increase coiled-tubing drilling efficiency and reliability. Coiled tubing drilling systems have a 50 percent smaller footprint and reduce drilling costs by almost 40 percent; and
- Four-Dimensional Seismic, which integrates multiple 3-D seismic surveys, has been commercially applied to 21 Gulf of Mexico fields after it was developed by the program in 1994.

### Benefits

- Oil R&D Program projects are expected to add over 1 million barrels of oil per day in 2010.

**For More Information, Contact:** Edith Allison, Program Manager for Exploration, Office of Natural Gas and Petroleum Technology, (202-586-1023) or go to: [www.fe.doe.gov/programs\\_oilgas.html](http://www.fe.doe.gov/programs_oilgas.html)

## Natural Gas Supply Research and Development

**DOE Challenge:** Mitigating Environmental Impacts, Providing Diverse Energy Technologies

**Program Activity:** Natural Gas Research & Development Program focuses on the development of technology needed to supply the growing demand for natural gas. The program focuses on high-risk or underutilized technologies that private industry alone will not undertake.

Historical data demonstrate that technology advances are key to keeping energy prices low for consumers and maintaining the profitability and long-term survival of the domestic oil and gas industry.

### Accomplishments:

- 3-D Seismic advances for fracture imaging and advanced drilling technologies developed by the Energy Department and the Gas Research Institute, led to record breaking horizontal well in the Greater Green River Basin in southwestern Wyoming. The additional drilling using this technology could generate almost \$10 million in Federal and State royalties; and
- Horizontal Drilling research led to air motors now being used for most new wells drilled in eastern gas formations. Horizontal drilling techniques, that use air in place of mud to drive and cool the downhole bit motor and remove drilling debris, have vastly improved the efficiency of drilling in Appalachian reservoirs, where mud use causes formation swelling and fracture blockage.

**Benefits:** It is estimated that in 2010, almost 2 trillion cubic feet of gas per year will be produced as a result of projects funded within the Gas R&D Program.

**For More Information, Contact:** Edith Allison, Program Manager for Exploration, Office of Natural Gas and Petroleum Technology, (202-586-1023) or go to: [www.fe.doe.gov/programs\\_oilgas.html](http://www.fe.doe.gov/programs_oilgas.html)

## Ultra-Clean Transportation Fuels

**DOE Challenge:** Enhancing Energy Security

**Program Activity:** The Ultra-Clean Transportation Fuels Program is a joint effort of the Office of Energy Efficiency and Renewable Energy and the Office of Fossil Energy. The goal of the Program is to promote, in partnership with all sectors of the refining and transportation industries, the development and deployment of advanced fuels, refinery processes and vehicle technologies. The advanced fuels technology will produce ultra-clean burning, high performance transportation fuels for the 21<sup>st</sup> century from a diversity of resources in addition to conventional petroleum. These will support the introduction of advanced, highly efficient fuel/engine combinations that meet EPA Tier II emission standards and possible future, more stringent standards. Promotion of resource diversity will result in other feedstocks in addition to petroleum (e.g. natural gas, petcoke, biomass, coal, etc.) being used to produce ultra-clean fuels, thereby reducing our dependence on imported petroleum. These ultra-clean liquid fuels will use the nation's existing transportation infrastructure.

### Accomplishments:

- Determined diesel fuel formulation could reduce particulate emissions by up to 50 percent, and NOx emissions by up to 10 percent, without any changes to the engine;
- Demonstrated a light-duty diesel vehicle with prototype emission control devices that met the fleet average Tier 2 emissions for particulates and NOx for limited durability with ultra low sulfur diesel;
- Identified a group of 8 oxygenates that could reduce particulate emissions from diesel fuel and potentially increase its renewable content;
- Identified several new classes of ceramic membrane and seal materials that are necessary to reduce the capital cost of gas to liquids technology by 25-30 percent;
- Awarded several Early Entrance Coproduction Plant feasibility. These plants would co-produce ultra-clean transportation fuels, chemicals and electricity from a variety of feedstocks; and
- Received proposals for projects to be implemented under Ultra Clean Fuels Transportation Solicitation, 1<sup>st</sup> Round.

### Benefits:

- Provides ultra clean fuels needed for advanced engines used to power automobiles (PNGV), light- and heavy-trucks while meeting Tier 2 emission standards.

**For More Information, Contact:** Lowell Miller, Director, Coal Fuels and Industrial Systems, Office of Coal and Power Systems, (301-903-9451), and Stephen Goguen, Team Leader, Office of Transportation Technologies, (202-586-8044) or go to: [www.fe.doe.gov/techline/tl\\_ultrafuel1.html](http://www.fe.doe.gov/techline/tl_ultrafuel1.html)

## Royalty Rates on Federal Lands

**DOE Challenges:** Enhancing Energy Security

**Program Activity:** DOE has worked with the Department of Interior, the Bureau of Land Management (BLM), and the Minerals Management Service (MMS) for the last 10 years to find cost-effective incentive royalty rates to promote development of petroleum resources on Federal lands.

### Accomplishments:

#### BLM

- Worked closely with the BLM to develop royalty relief programs for stripper oil wells and heavy oil wells on onshore (BLM) Federal lands; and
- Provided expertise and modeling support for these initiatives. This work includes supporting the original development of these royalty relief programs in the last 7 years, and also the 5-year reviews of each program.

#### MMS

- Assessed and commented on royalty relief proposals by the Federal offshore (OCS) program. This includes the deepwater royalty relief program that was passed in 1995, and will expire in November, 2000.

### Benefits:

- All of the current royalty relief programs were determined to be cost-effective for the government in terms of not losing (or adding) royalty revenues for the Federal Treasury;
- These programs have also benefitted the industry by supporting marginal operations or promoting new development in high-cost frontier areas; and
- The added supplies of oil and natural gas help supply the nation's demand for these products, and reduce imports.

**For More Information, Contact:** John Pyrdol, Chief Economist, Upstream Natural Gas and Petroleum, Office of Natural Gas and Petroleum Technology (301-903-2773) or go to:  
[www.fe.doe.gov/oil\\_gas/modeling/oilgas\\_modeling.html](http://www.fe.doe.gov/oil_gas/modeling/oilgas_modeling.html)

## Market Access and Emergency Oil and Gas Loan Guarantee Programs

**DOE Challenge:** Enhancing Energy Security

**Program Activity:** The energy marketplace is undergoing profound changes. Small, independent oil and gas producers (the backbone of the domestic oil and gas industry) are finding it harder to obtain the capital needed to maintain and/or enhance production from marginal wells. Deregulation of the gas and electric industries is changing how these products are marketed and is creating numerous opportunities—and challenges—for small and disadvantaged businesses.

The Market Access Program works to provide opportunities for small, disadvantaged businesses, women and minority-owned businesses, small independent oil and gas producers, and oil field service companies, in this new energy marketplace. Begun in 1996, the Program works to remove or circumvent obstacles blocking small business access to oil and gas markets, identifies opportunities for small businesses in this market, and develops procedures to assist small businesses take advantage of these opportunities.

The Market Access Program is currently: working with the Emergency Oil and Gas Loan Guarantee Board to re-shape the Emergency Oil and Gas Loan Guarantee Program in a way that makes federal loan guarantees accessible to small, independent oil and gas producers and oil field service companies; developing workshops on opportunities for minority businesses in the natural gas industry; assisting small and disadvantaged businesses qualify for, purchase, and resell the royalty-in-kind natural gas being sold by the Minerals Management Service; and, identifying federal and state economic development funds for which small, independent oil and gas producers might qualify.

### Accomplishments:

- Created the DOE Natural Market Access Program for Small and Disadvantaged Businesses. The Program, in turn, created a Roundtable that serves to coordinate DOE support to small and disadvantaged businesses competing in the natural gas marketplace;
- Took a credit instrument developed by a small business (the Funds Transfer Agent Agreement) and convinced the Gas Industry Standards Board (GISB) to incorporate this financial instrument in the GISB Base Contract for Short-Term Purchase or Sale of Natural Gas;
- Persuaded the Office of the Comptroller of the Currency to award Community Reinvestment Act (CRA) credit to banks that serve as a Funds Transfer Agent for small and disadvantaged businesses. Several banks are now using this instrument to provide financing to small and disadvantaged businesses marketing natural gas;
- Worked with the General Services Administration, Office of Public Utilities, to qualify small and disadvantaged businesses to market offshore royalty-in-kind natural gas to federal facilities;
- Signed an Memorandum of Understanding with the Small Business Administration under which SBA agreed to work with DOE to assist small, independent oil and gas producers qualify for SBA 7(a) loan guarantees;
- Assisted the Emergency Oil and Gas Loan Guarantee Board to develop Emergency Oil and Gas Loan Guarantee Program implementing regulations. Also, conducted a series of 10 workshops around the country designed to educate stakeholders in the domestic oil and gas industry about SBA and USDA loan guarantee programs and also the Emergency Oil and Gas Loan Guarantee Program; and

- With DOE encouragement, the National Association of Regulatory Utility Commissioners (NARUC) approved a Resolution, *In Support of States Adopting Efforts to Increase Participation of Small and Disadvantaged Business and Women and Minority-Owned Business in the Natural Gas Industry*. NARUC and DOE are collaborating on efforts to encourage state regulated utilities to diversify their supplier base.

**Benefits:**

- Preserve domestic oil and natural gas productive capacity;
- Increase (or slow the decline of) domestically produced oil and natural gas;
- Promote natural gas utilization;
- Increase competition, and thereby reduce prices, for natural gas; and
- Support DOE Diversity Initiative.

**For More Information, Contact:** Peter Lagiovane, Analyst, Planning and Environmental Analysis, Office of Natural Gas and Oil Technology, (202-586-8116) or go to: [www.fe.doe.gov/oil\\_gas/americaoil/loanprog\\_main.html](http://www.fe.doe.gov/oil_gas/americaoil/loanprog_main.html)



## Public Lands Access

### DOE Challenges: Enhancing Energy Security

**Program Activity:** DOE has worked with other agencies since 1994, to increase access to oil and gas resources on public lands for environmentally responsible and protective exploration and production. DOE funds research projects cooperatively with the Bureau of Land Management (BLM) and the Minerals Management Service (MMS) to understand the impacts of oil and gas activities on Federal lands and to improve environmental performance. Other parts of DOE's oil and gas research program improve access by developing technologies and practices that reduce footprint, reduce wastes, and improve environmental protection.

DOE also works with other agencies on regulatory and land management policy, making sure that the energy policy perspective is represented in their decisions, that regulations and processes are streamlined, and that credible data, sound science and technology advancements are incorporated in land use planning, NEPA decisions, and permit reviews.

### Accomplishments:

- Worked closely with BLM on their Oil and Gas Performance Review to streamline and improve their leasing and permitting system;
- Contributed data and expertise to the Federal land access analysis section of the recent National Petroleum Council Natural Gas Study. Broadening that analysis in cooperation with BLM, the Forest Service, and USGS;
- Established an Interagency Work Group on Natural Gas within the White House National Economic Council to respond to the recommendations of the National Petroleum Council Natural Gas Study;
- Performed analysis of air quality modeling issues for assessing the impacts of oil and gas activities on Federal lands on air quality in the Rocky Mountain region;
- Submitted comments to BLM supporting environmentally responsible leasing of the NPR-A. Successful lease sale held in May, 1999. Three wells drilled during the 1999-2000 drilling season;
- Facilitated EPA's accelerated rulemaking for use of synthetic based, environmentally friendly muds for offshore drilling;
- Developed a Safety and Environmental Management Program template, cooperatively with MMS, for independent operators working in the OCS;
- Funding nine projects under the Public Lands Technology Partnership with BLM to improve access;
- Conducted modeling analysis for BLM of the impact of accelerated leasing on oil and gas production and reserve additions;
- Participating in the Federal Leadership Forum, an interagency group that is streamlining the NEPA process for oil and gas development on Federal lands in four western states; and
- Participating in the Wyoming Oil and Gas Assessment, a Federal-State effort to establish agreed-upon resource estimates and future oil and gas development scenarios for Wyoming, as a basis for resource management planning and environmental analysis.

**Benefits:**

- Promotes environmentally-sensitive development of oil and natural gas resources on Federal lands to meet the nation's needs for these products, reduce imports, and improve the environment; and
- The new development also generates additional royalty revenues for the Federal Treasury.

**For More Information, Contact:** Bill Hochheiser, Manager, Oil and Gas Environmental Research, Office of Natural Gas and Petroleum Technology, (202-586-5614)

## Alaska North Slope Oil Exports

### **DOE Challenges:** Enhancing Energy Security

**Program Activity:** In 1995, Congress removed the ban on the exports of oil from the Alaska North Slope (ANS.) Recently, there have been proposals to reinstate the ban because of a concern about high gasoline prices in California.

DOE has assessed the situation, and concluded that allowing the export of ANS oil has benefitted the nation, and has not resulted in higher gasoline (or other product) prices to consumers.

### **Accomplishments:**

- In 1995, DOE provided much of the analysis that supported the legislation to lift the export ban, forecasting benefits for domestic producers;
- In May 2000, DOE assessed the impacts of having the ban removed for the last 5 years; and
- Congressional staff have been advised that DOE has found the removal of the ban to be beneficial to producers, and has not resulted in higher prices for consumers. This conclusion is supported by GAO (in a 1999 study required by the 1995 law), and the Commerce Department.

### **Benefits:**

- ANS producers, as well as California producers of oil with similar qualities, have benefitted from higher crude oil prices (about \$1/bbl.) This will provide them an incentive for further exploration which could result in a more domestic oil and natural gas production to meet the nation's needs. This would also reduce imports;
- ANS producers have benefitted with more options to sell their crude oil;
- Alaska has benefitted with higher tax revenues associated with the higher ANS oil prices; and
- Consumers have benefitted because the prices they pay for petroleum products were not affected by lifting the ban.

**For More Information, Contact:** John Pyrdol, Chief Economist, Upstream Natural Gas and Petroleum, Office of Natural Gas and Petroleum Technology, (301-903-2773)

## Regulatory Streamlining in Oil and Natural Gas Supply

**DOE Challenge:** Enhancing Energy Security

**Program Activity:** The Department of Energy works cooperatively with States and other Federal agencies to streamline regulations and enhance the efficiency and effectiveness of government programs that affect U.S. oil and gas supply. These activities enable other agencies to make use of the Department's unique expertise in oil and gas supply issues and technology. DOE actively participates in advisory committees and interagency work groups to provide a national energy perspective and to promote cost-effective approaches for protecting the environment.

**Accomplishments:** Consistent with recommendations of the National Petroleum Council, an advisory body to the Secretary of Energy, on *Future Issues – A View of U.S. Oil and Natural Gas in 2020* and *Meeting the Challenges of the Nation's Growing Natural Gas Demand*, DOE has worked with other agencies to address policy and regulatory issues related to oil and gas supply ranging from the regulation of consumer fuel choice to achieve national air quality objectives, Clean Water Act permitting, Federal land management, tax policy, royalty relief, conflicts on pipeline siting, safety and environmental management planning, and electronic permitting.

### Highlights include:

- Work by DOE and other Executive Branch agencies on more than 14 priority *Issues for Interagency Consideration* identified by the National Petroleum Council in 1996;
- Efforts undertaken by DOE and other Executive Branch agencies to preserve the production capacity of the domestic oil and gas industry during the low oil price situation of 1998 and 1999 which included initiatives to lower the costs of oil and gas production;
- Grants from DOE that have enabled more than 14 States to adopt improved data management techniques to facilitate risk-based decisions for protecting ground water resources and more cost-effective implementation of oil and gas regulatory programs;
- The successful demonstration of an innovative on-line permitting system by the Railroad Commission of Texas, with support from DOE, that could save Texas oil and gas producers \$3 million to \$6 million per year;
- Efforts by DOE to increase awareness of the *Environmental Benefits of Advanced Oil and Gas Exploration and Production Technology*;
- Participation in the Federal Leadership Forum, an interagency group that is streamlining the NEPA process for oil and gas development on Federal lands in four western states; and
- Collaborative efforts undertaken by DOE and industry, in coordination with the Environmental Protection Agency, to ensure the availability of ultra-clean fuels.

**Benefits:** Potential outcomes of regulatory streamlining and improved government coordination include improved, more cost-effective regulatory and policy decisions, reduced delays, cost savings for industry and government, and related opportunities for more efficient recovery and utilization of our Nation's valuable oil and gas resources, increased Federal and State revenues, jobs and economic activity.

**For More Information, Contact:** Bill Hochheiser, Manager, Oil and Gas Environmental Research, Office of Natural Gas and Petroleum Technology, (202-586-5614) or go to: [www.fe.doe.gov/oil\\_gas/modeling/oilgas\\_modeling.html](http://www.fe.doe.gov/oil_gas/modeling/oilgas_modeling.html)

## Natural Gas Infrastructure Reliability

**DOE Challenge:** Increasing Competitiveness and Reliability, Mitigating Environmental Impacts

**Program Activity:** Natural Gas Infrastructure Reliability program assists industry to ensure the integrity and efficiency of the Nation’s natural gas infrastructure and storage system. The reliability of the natural gas distribution and transmission systems across the United States is essential to ensure the availability of clean, affordable energy for our homes, businesses and industries. The Natural Gas Infrastructure program includes the Gas Storage Technology program initiated in FY 1993, and a new program initiated for FY 2001—Enhancing Infrastructure Reliability. Efforts are being directed to enhance energy system reliability with the Nation’s natural gas pipelines and gas storage facilities.

The goal of the natural gas infrastructure reliability program is to develop and promote, in partnership with the gas storage, transmission, and utility distribution segments of the gas industry, technologies to enhance and expand the gas system infrastructure to meet a 30 Tcf market by 2015.

The gas industry and its suppliers face significant regulatory, technology, and market challenges to reach the 30 Tcf market. Regulatory constraints in the expansion of transportation and distribution pipeline systems and storage facilities could impede industry progress, harm the economy, and weaken the environment. Technology constraints could lead to increased fugitive emission methane leaks from the aging gas transmission and distribution system. Market constraints could lead to higher gas prices for consumers and the power generation sector. Industry mergers and increased competition have reduced private sector incentives for long-term R&D. Many utility managers, in their efforts to reduce shareholder risk, have abandoned long-term resource planning and resisted making capital investments in pipeline operations and gas storage system development. Government funding of “public benefit” R&D has become essential and more critical to ensure the integrity of the gas delivery and storage infrastructures in maintaining system throughput and in meeting future gas demands as R&D funding by private firms and the Gas Research Institute (GRI) declines.

To achieve the DOE challenge, the Department and the National Energy Technology Laboratory (NETL), have started a process to develop a vision and roadmap to enhance infrastructure reliability. NETL held a series of meetings and workshops with business executives representing transmission and utility distribution companies, equipment manufacturers, energy service companies, gas storage operators, national laboratories, and Federal agencies and state government to identify the most productive areas of infrastructure research to ensure the integrity and efficiency of the natural gas delivery system.

### **Accomplishments:**

- Launched natural gas infrastructure reliability program vision and roadmap process, led by NETL, which involved business executives representing transmission and utility distribution companies, equipment manufacturers, energy service companies, gas storage operators, national laboratories, and Federal agencies;
- Initiated advanced high-deliverability gas storage research in non-reservoir rock formations to serve peak power customers in the Northeast. Developed conceptual designs to demonstrate the feasibility and commercialization potential of Lined Rock Cavern Storage; and
- Initiated research on direct energy meters, capable of measuring gas volume flow, gas composition, and energy content.

**Benefits:**

- \$200 million savings to consumers by 2010 from gas storage facilities using ultrasonic and direct energy meters;
- 255 Bcf/year of additional storage deliverability by 2010;
- Advanced storage well revitalization technologies will increase storage well deliverability (projected at 28 percent or 800 MMcf/day by 2010 for applicable sites) and lower utility storage costs;
- Salt cavern storage capacity will be increased (17 Bcf potential by 2010 with 10 percent reduction of minimum working gas pressure) without impact to environment and without increasing pipeline infrastructure;
- Supports use of technologies to detect and mitigate fugitive gas emissions to reduce greenhouse gas concentrations; and
- Supports distributed power systems and natural gas micro turbines and fuel cells.

**For More Information, Contact:** Christopher Freitas, Manager for Natural Gas Storage and Infrastructure, Office of Natural Gas and Petroleum Technology, (202-586-1657) or go to:  
[www.fe.doe.gov/oil\\_gas/gasstorage/gas\\_storage.html](http://www.fe.doe.gov/oil_gas/gasstorage/gas_storage.html)

## International Oil and Gas Forums

**DOE Challenge:** Enhancing Energy Security

**Program Activity:** The Forums, through structured discussions with foreign governments and companies, seek to promote the adoption of open-market principles and level playing field operations. These activities were developed through candid and open discussions between foreign government officials and petroleum companies and U.S. government and petroleum companies. The Forum format has proven successful in developing trust between parties in a low pressure environment that none the less has the benefit of government level assurances.

The program, begun in 1998, has as its focus developing trust between governments and petroleum companies in the development of policies, laws, regulations, and market operating systems that are open to all parties. The first Forum was conducted in 1998 in Beijing, China. Several U.S. government agencies and U.S. petroleum companies cooperated in the Forum which had participation of all the major Chinese government agencies related to petroleum production and all Chinese petroleum companies. A second Forum session was conducted in Houston, Texas in 1999.

Additional Forum sessions are planned for the future as well as ancillary meetings on specific topics such as natural gas regulation in the U.S. Other Forum structures with other governments are under consideration.

### **Accomplishments:**

- Conducted Forums in China and the U.S. Expanded Forum activities to encompass Experts Working Groups of U.S. and Chinese government and industry participants.

### **Benefits:**

- World-wide acceptance of open market principles protected by laws and regulations will facilitate the most efficient development of world petroleum resources, as well as provide opportunities for U.S. companies who are the leaders in petroleum technology development.

**For More Information, Contact:** Don Juckett, Director, Natural Gas and Petroleum Import and Export Activities, Office of Natural Gas and Petroleum Technology, (202-586-8830) or go to: [www.fe.doe.gov/oil\\_gas/china\\_forum/](http://www.fe.doe.gov/oil_gas/china_forum/)

## International Oil Data Transparency

**DOE Challenge:** Enhancing Energy Security

**Program Activity:** Secretary Bill Richardson initiated a series of roundtable discussions regarding worldwide oil data to assess what could be done to provide better information regarding world crude oil supplies. The first roundtable was held on January 26, 2000. The U.S. Department of Energy and the University of Houston's Energy Institute co-hosted the event. The second roundtable was held in Madrid, Spain on July 14-15, 2000. The U.S. Department of Energy and the Government of Spain co-hosted the event.

The objectives were to promote a formal industry and government dialogue on what role, if any, data on international oil markets have played in recent oil price volatility, and whether improvements in data quality and collection will enhance market stability; and also to establish priority follow-up activities, including the need for additional discussion sessions.

### **Accomplishments:**

- Drew audiences and panels from the best and most knowledgeable people in the oil data business, both domestically and internationally;
- Agreed that further discussions will be initiated and that they will have the support of the Secretary's office as well as other offices and organizations within DOE;
- An APEC initiative will begin action on production and consumption in the APEC economies beginning in October, 2000; and
- The International Energy Agency will host a continuation of the Madrid activity in the fourth quarter of 2000 to continue working on process related actions related to transparency in the producing and consuming nations.

### **Benefits:**

- Assembling the best informed parties to discuss an issue that has great importance to large segments of the oil and gas industry is expected to bring about improvement in petroleum data gathering and analysis. This, in turn, will help stabilize the world oil marketplace and increase energy security for the U.S.

**For More Information, Contact:** Don Juckett, Director, Natural Gas and Petroleum Import and Export Activities, Office of Natural Gas and Petroleum Technology, (202-586-8830)



## International Oil Spill Workshops

**DOE Challenge:** Enhancing Energy Security

**Program Activity:** The workshops seek, through interaction with foreign governments and international organizations, using coordination and information sharing workshops, to improve the ability to respond to oil spills world wide. They will allow nations to better respond to oil spills within their borders and in international waters. Many American companies are preeminent in the field of oil spill containment and clean up and thus US industry should benefit from an increased international preparedness for oil spills.

The program, begun in 1999, has as its focus developing the ability of governments to respond to serious environmental threats brought about by oil spills. The first such workshop was conducted in 1999 for the Black Sea region. Many U.S. government and private organizations cooperated in the workshop, which had participation of all the Black Sea littoral states. A follow up workshop is planned for 2000.

Similar workshops are planned for the Caspian Sea, the Gulf of Guinea and Brazil.

### **Accomplishments:**

- Conducted workshop on Black Sea, scheduled workshop for Cameroon, October 17-18, 2000.

### **Benefits:**

- The existence of regional oil spill response organizations will lessen the chance of significant environmental degradation from oil spills. The ability to respond efficiently to oil spills will lessen the concern of environmental groups to development of world petroleum resources and thus provide for additional petroleum supplies available to the U.S. and others.

**For More Information, Contact:** Don Juckett, Director, Natural Gas and Petroleum Import and Export Activities, Office of Natural Gas and Petroleum Technology, (202-586-8830)

## **International Production Sharing Agreement (PSA)**

**DOE Challenge:** Enhancing Energy Security

**Program Activity:** Through interaction with executive and legislative branches of foreign governments, this activity seeks to improve the ability of the foreign government to offer PSAs and other appropriate contractual vehicles for oil and natural gas exploration and production. Such actions will allow those nations to better develop their petroleum resources, facilitate American company's participation in the host country's petroleum industry, and increase the availability of worldwide petroleum supplies.

The program, begun in 1998, has had its major focus in developing the legal system of Ukraine to permit the initiation of PSAs. 1999 saw the passage of the key legislation necessary for initiating PSAs in Ukraine, and in July, 2000, Ukraine legislature passed conforming legislative amendments to complete Ukraine's ability to offer competitive PSAs that conform to world standards. These actions allow US petroleum and other private companies to successfully participate in Ukraine's petroleum industry.

Similar, though less direct, activities will be carried out through the actions within the U.S./China Oil & Gas Industry Forum, through Asian-Pacific Economic Cooperation, and through cooperative activities with emerging economies where AID operates.

### **Accomplishments:**

- Conducted several workshops in Ukraine;
- Provided assistance in Drafting PSA legislation;
- PSA legislation passed by Ukraine legislature;
- Provided assistance in Drafting conforming legislation; and
- Conforming legislation passed by Ukraine legislature.

### **Benefits:**

- Several U.S. companies are participating in the initial activities relating to Ukraine's offering of PSAs for the development of domestic petroleum resources. This will increase the production of petroleum available to Ukraine and the worldwide oil market; and
- An expanded program will draw on the Ukrainian experiences to support better private investment access to emerging oil and natural gas economies.

**For More Information, Contact:** Don Juckett, Director, Natural Gas and Petroleum Import and Export Activities, Office of Natural Gas and Petroleum Technology, (202-586-8830)

## Strategic Petroleum Reserve Fill—Royalty-In Kind

**DOE Challenge:** Enhancing Energy Security

**Program Activity:** On February 11, 1999, Secretary Richardson announced plans to resume fill of the Strategic Petroleum Reserve (SPR) using federal royalty oil from production in the Central Gulf of Mexico. The initiative was designed to replace approximately 28 million barrels of oil sold from the Reserve in FY 1996 and 1997 largely for deficit reduction purposes. The first contracts for the oil transfer were signed on March 31, 2000. Initially the oil was scheduled to arrive in batches continuously through November 2000. Some delivery schedules were renegotiated due to tight supplies and high oil prices, and deliveries initially scheduled from March through June were delayed. The delivery of oil is currently scheduled to continue until December 2001.

**Accomplishments:**

- DOE completed writing contracts for exchange and delivery of the oil to the SPR sites;
- The vast majority of the 28 million barrels have been delivered and are in SPR caverns, and all deliveries should be completed before the end of the year; and
- DOE gained over 600,000 extra barrels of oil as a result of the renegotiated schedules.

**Benefits:**

- Allows the U.S. to pursue long term energy security;
- Helps the United States to reassert international leadership among other energy consuming and stockpiling countries;
- Filling the SPR with royalty oil costs the Treasury revenues but does not require appropriations and allows the Government to retain a valuable asset; and
- Resuming fill of the Reserve increases the days of net import protection provided by the SPR and increases national energy security.

**For More Information, Contact:** John Shages, Director, Finance and Policy, Office of Petroleum Reserves, (202-586-1533) or go to: [www.fe.doe.gov/spr/spr\\_rik.html](http://www.fe.doe.gov/spr/spr_rik.html)

## Strategic Petroleum Reserve Life Extension

**DOE Challenge:** Enhancing Energy Security

**Program Activity:** On April 20, 2000, Secretary Richardson announced the completion of a 7-year, \$328 million refurbishment of the Strategic Petroleum Reserve. The Life Extension Program was initiated in 1994 to upgrade or replace major systems by 2000, and ensure mission readiness through 2025. The program uses new technologies to increase reliability and reduce operating and maintenance costs.

### **Accomplishments:**

- The Life Extension Program was completed ahead of schedule and nearly \$42 million below its original cost estimate;
- Pumps have been upgraded, oil handling equipment streamlined and many of the control systems automated, making maintenance and inventory control more efficient and lower cost; and
- Close to half of the pumps, motors and valves have been eliminated from the physical infrastructure.

### **Benefits:**

- Annual operating costs will be reduced by \$12-\$15 million per year over the next 25 years;
- The expected life of the four storage sites will be 25 years, essentially doubling the original design life and extending it to the year 2025;
- The critical systems reliability during a drawdown is greatly increased; and
- The number of employees has been reduced in compliance with the goals of the National Productivity Review.

**For More Information, Contact:** John Shages, Director, Finance and Policy, Office of Petroleum Reserves, (202-586-1533) or go to: [www.fe.doe.gov/spr/spr.html](http://www.fe.doe.gov/spr/spr.html)

## Home Heating Oil Reserve

**DOE Challenge:** Enhancing Energy Security

**Program Activity:** Last winter heating oil prices spiked to all time record highs. On March 18, 2000, the President proposed the creation of a 2 million barrel home heating oil reserve in the Northeast to supply additional heating oil to the market in the event of a future shortage. On July 10, 2000, the President directed the Secretary to use existing authority to establish an interim home heating oil reserve in the Northeast to help protect Americans from possible fuel shortages this winter. On July 19, 2000, the Defense Energy Support Center, acting as an agent for the Department of Energy, issued a solicitation requesting that companies submit offers to receive Strategic Petroleum Reserve crude oil in exchange for up to two million barrels of heating oil and storage capacity in the New England and New York/New Jersey areas. The Heating Oil Reserve will be in place by October 1, 2000.

Congress must enact legislation to provide specific authority for use of the Home Heating Oil Reserve. The House passed H.R. 2448 which extends the Energy Policy and Conservation Act and creates a heating oil reserve in the Northeast. The Senate amendments include set two conditions under which the President can release oil from the Home Heating Oil Reserve—a severe disruption in supply or an increase in the differential between crude oil and heating oil prices which is over 60 percent above the five year average.

### Accomplishments:

- On July 10, 2000, Plan Amendment No. 6 was transmitted to Congress to establish a permanent Northeast heating oil reserve. The Plan Amendment becomes effective if Congress does not disapprove it in 60 days after submission;
- The FY 2001 Interior and Related Agencies Appropriations Bill included \$4 million for the Home Heating Oil Reserve; and
- The Defense Energy Support Center awarded three contracts for two million barrels of storage—two contracts each for 500,000 barrels in New England (New Haven, Connecticut) and one contract for 1 million barrels in coastal New York Harbor (Woodbridge, New Jersey).

### Benefits:

- A heating oil reserve would serve as an interim source of supplies to the region until other supplies can be transported either from other commercial sources or the Strategic Petroleum Reserve during a winter disruption preventing shortages and excessive prices;
- According to a 1998 DOE study, the expected benefits of a smaller 2 million barrels regional petroleum product reserve located in leased terminals in the Northeast would approximate or exceed its costs, provided that those costs could be reduced by trading Strategic Petroleum Reserve crude oil for distillate fill; and
- The distillate oil stored in the Northeast can be released in conjunction with Strategic Petroleum Reserve crude oil in the event of general oil disruption.

**For More Information, Contact:** John Shages, Director, Finance and Policy, Office of Petroleum Reserves, (202-586-1533) or go to: [www.fe.doe.gov/programs\\_reserves.html](http://www.fe.doe.gov/programs_reserves.html)



# Coal





## Coal-Related Activities

**DOE Challenge:** Mitigating Environmental Impacts

**Program Activity:** DOE/Office of Fossil Energy is the lead Federal agency for conducting research on coal use technologies, such as advanced coal-fired powerplants. This work includes policy and environmental regulatory analysis, as well as pure R&D.

### Accomplishments:

- Coal use for generation of electricity in the U.S. has increased 17 percent over the past 10 years;
- 56 percent of U.S. electric power comes from coal;
- The price of electricity in the U.S. is among the lowest of any market economy, giving U.S. manufacturers a competitive edge in the global economy;
- A continuous stream of advanced technologies, developed through government/private sector partnerships, have enabled electric utilities to meet environmental standards which have become significantly more stringent over time;
- Advanced technologies are under development to provide near-zero emission coal-fired powerplants to meet future electricity needs; and
- Data and expertise have been provided to EPA to provide for more informed environmental regulations.

### Benefits:

- Clean, low-cost power meeting more than one-half of U.S. needs;
- Pollution control technologies which have reduced environmental compliance costs by about one-half—with savings totaling several billion dollars per year; and
- Sound scientific technical data on which to base environmental regulations.

**For More Information, Contact:** Doug Carter, Director, Planning and Environmental Analysis, Office of Coal and Power Systems, (202-586-9684) or go to: [www.fe.doe.gov/programs\\_coalpwr.html](http://www.fe.doe.gov/programs_coalpwr.html)

## Clean Coal Technology Program

### **DOE Challenge:** Mitigating Environmental Impacts

**Program Activity:** The Clean Coal Technology Program (CCT) began in 1985 as a joint effort between government and industry to demonstrate innovative coal-based technologies that addressed environmental and operational concerns in a competitive economic manner. A total of five competitive solicitations were conducted with the final project award occurring in 1996. Technologies demonstrated in the CCT Program include advanced electric power generation systems, environmental control devices, industrial applications, and coal processing for clean fuels. The program has a total of 38 projects and 26 have completed operational testing. Of the remaining 12 projects, five are in design, two are in construction, and five are in operation. Government participation is limited to 50 percent of the total project costs. However, industry has exceeded this requirement by funding over 65 percent of the total project costs for the 38 projects.

### **Accomplishments:**

- Demonstrated a variety of NO<sub>x</sub> control technologies that provide a portfolio of cost-effective compliance options for the full range of boiler types;
- Demonstrated a variety of innovative flue gas desulfurization systems that have reduced capital and operating costs, can produce dry disposable wastes or valuable byproducts, and are capable of capturing multiple air pollutants;
- Provided valuable design and operational data for advanced combustion technologies including fluidized-bed combustion and integrated gasification combined cycle; and
- Reduced emissions and improved economic competitiveness of U.S. industry in energy-intensive applications through new combustion technologies, new fuel forms, and environmental equipment.

**Benefits:** The CCT Program has demonstrated the technology necessary to take advantage of the nation's coal resources while significantly reducing environmental impacts. Based on the performance demonstrated in the CCT Program, nearly one-half of the U.S. coal-fired generating capacity has installed low-NO<sub>x</sub> burners. Many of the flue gas desulfurization systems demonstrated in the CCT Program continue in operation today and hold significant promise for application in emerging markets. The advanced power generation projects are providing the basis for increased efficiency resulting in reduced greenhouse gases and very low pollutant emissions.

**For More Information, Contact:** Gene Kight, Financial and Procurement Director, Office of Coal and Power Systems, (301-903-2624) or go to: [www.fe.doe.gov/coal\\_power/cct/cct\\_ipo/cct\\_ipo00.html](http://www.fe.doe.gov/coal_power/cct/cct_ipo/cct_ipo00.html)

## Sequestration

**DOE Challenge:** Mitigating Environmental Impacts

**Program Activity:** This Program focuses on development of technology to reduce net emissions by sequestering carbon, either through enhancing natural sinks (e.g., forestation) or by capturing the CO<sub>2</sub> emitted from fossil-based energy systems and storing it in geologic formations of the deep ocean or converting it to benign (potentially reusable) form.

The primary goal of this research program is to be able to deploy sequestration technologies after 2015 which could offset all future growth in U.S. GHG emissions under a “business as usual” scenario, which amounts to hundreds of millions of tons of carbon per year by 2030, and increasing amounts thereafter. A secondary goal is to accomplish such reductions for less than \$10 per ton of carbon—90+ percent below today’s commercially available sequestration technologies. At \$10 per ton, carbon reduction would be inexpensive enough that traditional market mechanisms, such as the vendors’ desire to market “green power,” could be sufficient to drive deployment of this technology.

**Accomplishments:** This long-term program is in its infancy, but several small-scale sequestration development projects are underway that were selected in the FY 1998 Novel Concepts solicitation, and feasibility studies have been initiated for projects selected under the Office of Fossil Energy’s August and September 1999 solicitations.

**Benefits:** Sequestration is an essential tool, along with higher energy efficiencies and less carbon intensive energy sources, for long-term stabilization of atmospheric concentrations of GHGs at levels that protect the environment. Benefits include:

- Dramatically lower GHG emissions—potentially over 500 million ton per year carbon (2030);
- Substantially lower costs than other options with comparable reduction potentials; and
- Expanded policy options for managing climate change.

**For More Information, Contact:** Bob Kane, Manager, Climate Change Activities, Office of Coal and Power Systems, (202-586-4753) or go to: [www.fe.doe.gov/coal\\_power/sequestration/index.html](http://www.fe.doe.gov/coal_power/sequestration/index.html)



# Nuclear



## **Advanced Light Water Reactor Program**

**DOE Challenge:** Providing Diverse Energy Technologies for the Future

**Program Activity:** In the 1980s and 1990s the Department funded nuclear research that was cost shared with industry to develop the advanced light water reactors, a program established to ensure the viability of nuclear energy and to advance energy security and diversity in this century. This program was completed in 1997.

**Accomplishments:** Today, three vendors have brought their “evolutionary” designs to commercialization, with the first two boiling water reactors in operation today overseas. For example, the Kashiwazaki Kariwa Nuclear Power Station in Japan—the world’s largest nuclear power station, supplying about 23 percent of Tokyo Electric’s total capacity—is the site of the first operating General Electric Advanced Boiling Water Reactors. This past March, the U.S. Nuclear Regulatory Commission completed and issued the Standard Design Certification for the last of the advanced light water reactors funded under this program—the AP600, a Westinghouse passive-design, Pressurized Water Reactor. With this accomplishment, three designs are now available to be built and operated under a single license, significantly reducing the time needed to license a new plant in the U.S.

**Benefits:** Improved performance and safety of future nuclear power plants.

**For More Information, Contact:** Gail Marcus, Deputy Director of the Office of Nuclear Energy, Science and Technology, (202-586-2240) or go to: [www.nuclear.gov](http://www.nuclear.gov)

## Nuclear Energy Research Initiative (NERI)

**DOE Challenge:** Providing Diverse Energy Technologies for the Future

**Program Activity:** Started in FY 1999 in response to the recommendations of the President's Committee of Advisors on Advanced Science and Technology, the NERI provides for innovative investigator-initiated, peer reviewed research and development at universities, laboratories, and industry to advance nuclear power technology, thus paving the way for expanded use of nuclear energy in the future and rebuilding U.S. leadership in nuclear technology. NERI research focuses on proliferation-resistant reactor and fuel technologies, high performance/efficient reactor technology, advanced nuclear fuels, new technologies for the minimization and management of nuclear waste, and fundamental nuclear science.

**Accomplishments:** In FY 1999, with \$19 million, the initial NERI procurement resulted in the award of 46 one to three-year R&D projects involving research participants from 45 U.S. and 11 foreign universities, laboratories and industrial organizations. NERI is finding considerable success in helping place the U.S. once again in a key leadership role in the international exploration of nuclear technology, prompting interest, support, and collaborations from many other nations. Additionally, NERI has re-energized research in U.S. laboratories, universities and industry, and has begun to show the way towards solving some of the key obstacles to future expansion of nuclear energy.

In FY 2000, with \$22.5 million, the Department will continue the research begun in 1999 and will award 8-10 new R&D projects, and complete 3 of the R&D projects awarded in FY 1999. While the NERI research was initially launched less than a year ago, progress has been made on all 46 projects. Some of the projects showing promise include using advanced ceramic materials in nuclear fuel, developing radiation-resistant alloys, automating future nuclear power plants, developing new proliferation-resistant nuclear fuels, exploring direct energy conversion technologies for nuclear power, and designing a low-cost proliferation-resistant reactor.

**Benefits:** NERI supports our nation's ability to apply nuclear technology to our energy, environmental, and economic goals. The objectives of NERI are to develop revolutionary advanced concepts and scientific breakthroughs in nuclear fission and reactor technology to address scientific and technical barriers to long-term use of nuclear energy; advance the state of nuclear technology to maintain a competitive position in overseas and future domestic markets; and promote and maintain the nuclear science and engineering infrastructure to meet future technical challenges.

**For More Information, Contact:** Shane Johnson, Acting Director, Office of Technology and International Cooperation, Office of Nuclear Energy, Science and Technology, (301-903-3860) or go to: [nepo.ne.doe.gov](http://nepo.ne.doe.gov)



## Generation IV Nuclear Power Systems

**DOE Challenge:** Providing Diverse Energy Technologies for the Future

**Program Activity:** The Gen IV program identifies and coordinates the R&D necessary to support development of next-generation reactors, specifically reactors that may be deployed in the next 20 years. The program began in FY 2000. In its initial stages, the program aims at working with other governments who may be embarked on similar R&D with an eye to eliminating duplicative research, establishing R&D collaborations and, to the extent possible, pooling research results. Countries include Argentina, Brazil, Canada, France, Japan, South Africa, South Korea, and the United Kingdom. Other countries have expressed interest in participating as well. FY 2000 accomplishments and benefits/beneficiaries are noted below. In FY 2001, the program expects to produce a Gen IV Technology Roadmap to define the path forward internationally.

### Accomplishments:

- January 2000 meeting of the nine-country steering group:
  - Determined that the countries involved wanted to continue to pursue discussions of attributes and criteria associated with next generation reactor technologies; and
  - Recommended a subsequent meeting of senior technical experts to discuss opportunities for bilateral and multilateral research.
- April 2000 meeting of senior technical experts:
  - Identified nuclear R&D priorities of each participating country; and
  - Began identifying opportunities for collaborative research; and
- May 2000 International Generation IV Workshop identified characteristics and attributes of the next-generation reactors with respect to economics, safety, proliferation-resistance and waste, drawing on input from industry, universities and public interest groups. A report will be issued late spring 2000.

**Benefits:** The potential beneficiaries are countries that now or may in the future use nuclear power, as a successful Gen IV program will result in better-coordinated and more cost-effective R&D, in reactors that are safe, proliferation-resistant, less waste-producing and more economical than the current generation of plants. In addition, the Gen IV program puts a premium on developing reactors with the customer's concerns in mind, enhancing both their domestic and export value.

**For More Information, Contact:** Gail Marcus, Deputy Director of the Office of Nuclear Energy, Science and Technology, (202-586-2240) or go to: [www.nuclear.gov](http://www.nuclear.gov)

## Nuclear Energy Plant Optimization

**DOE Challenge:** Increasing the Competitiveness and Reliability of U.S. Energy Systems

**Program Activity:** This past year was in many ways a banner year for nuclear power in the U.S., with nuclear plants generating a record amount of electricity and performing at the highest average capacity factor, 85.5 percent, ever achieved.

Recognizing the important role that these plants will continue to serve over the next several decades in meeting demand for electricity in an environmentally sound manner, this fiscal year the Department launched the *Nuclear Energy Plant Optimization Program* (NEPO) as part of the President's Climate Change Technology Initiative in cost-shared cooperation with the Electric Power Research Institute, the research arm of the electric power industry. This program, recommended by PCAST and initially funded at \$5 million, represents a Federal investment in intermediate-term, higher risk research that is needed to increase the pace of innovation for developing new technologies that enhance operation, reliability and safety of the nation's nuclear plants and addressing critical issues associated with aging and extended operation of these plants.

**Accomplishments:** Thus far, the Department and EPRI have established the Joint DOE-EPRI Strategic R&D Plan to Optimize U.S. Nuclear Power Plants. This plan is being used to prioritize the R&D that will be conducted. Additionally, the Department expects to complete the preparation of and sign a Cooperative Agreement with EPRI in May, 2000 that will provide for the solicitation and award of research contracts.

**Benefits:** Contrasting industry's \$85 million annual investment—focused on a short term horizon that funds “just in time” solutions to problems for the existing plants—NEPO's investment leverages Federal dollars with industry's matching funds in order to expedite and conduct intermediate term research needed by all of the nuclear utility industry to address critical aging issues and issues associated with long-term safe, economic and reliable operation of the Nation's nuclear power plants.

**For More Information, Contact:** Shane Johnson, Acting Director, Office of Technology and International Cooperation, Office of Nuclear Energy, Science and Technology, (301-903-3860) or go to: [nepo.ne.doe.gov](http://nepo.ne.doe.gov)

## **Nuclear Power Plant Relicensing**

**DOE Challenge:** Increasing the Competitiveness and Reliability of U.S. Energy Systems

**Program Activity:** Three years ago, with electricity restructuring looming and concerns over regulatory relicensing uncertainty, the prediction was that some existing nuclear plants would be shut down prematurely and few if any nuclear plants would receive a renewed license for 20 years of additional operation. With the Department contributing as appropriate, the nuclear industry and the Nuclear Regulatory Commission took bold steps to resolve outstanding issues and to move the process forward. As a result, the NRC has now issued renewed licenses to two utilities for five reactors. Furthermore, three additional utilities have submitted license renewal applications and several other utilities have announced their intention to seek license extensions.

### **Accomplishments:**

- March 23, 2000. The Nuclear Regulatory Commission approved the renewal of operating licenses for two reactors at the Calvert Cliffs plant. The Baltimore Gas and Electric Company, which owns and operates the Calvert Cliffs plant, was the first utility to seek NRC approval for a 20 year license renewal. During the 22 months that the NRC reviewed the Calvert Cliffs submittal, license renewal applications for another six of the nation's 103 reactors were filed with the agency, and utilities owning another 22 reactors informed the NRC of their plans to apply by the year 2003. (Original nuclear plant licenses are issued for a 40-year operating period); and
- May 23, 2000. The U.S. Nuclear Regulatory Commission (NRC) approved the renewal of operating licenses for Duke Power's three-unit Oconee nuclear power plant in western South Carolina. The approval made Oconee the second nuclear power plant in the country to have its operating licenses renewed.

**Benefits:** Nuclear power is the single greatest source of clean electricity in the U.S. and around the world. Continuing operation of our nation's safe and economic nuclear power plants can contribute significantly to achieving our goals for affordable and environmentally responsible power.

**For More Information, Contact:** Gail Marcus, Deputy Director of the Office of Nuclear Energy, Science and Technology, (202-586-2240) or go to: [www.nuclear.gov](http://www.nuclear.gov)



# Renewable Energy



## Wind Energy Cost Reduction

### DOE Challenge: Mitigating Environmental Impacts

**Program Activity:** Under the rapidly emerging U.S. restructured electricity generation environment, the competitive threshold for new supply technologies has been reduced dramatically in most regions of the country. The Wind Program has helped U.S. industry to significantly reduce the cost of wind energy, enabling wind to become a major new source for clean electricity. Today, wind technology can produce power for as low as 4 cents per kilowatt-hour, and the Program is working to achieve a goal of 2.5 cents per kilowatt-hour commercial technology by the end of the decade. This supports the Department's Comprehensive National Energy Strategy goal of achieving 25,000 megawatts of non-hydroelectric renewable generating capacity by 2010.

The Wind Program focuses on completing the research, testing and field verification needed by U.S. industry to fully develop advanced wind energy technologies, and on coordinating with partners and stakeholders to overcome barriers to wind energy use. Key activities include: Applied Research, which develops cutting edge tools and concepts for wind energy system design efforts, technologies to expand wind energy applications, and strategies to assure cost-effective wind plant operation; Turbine Research, which provides an opportunity for U.S. industry to apply the technology breakthroughs and design tools from Applied Research in developing advanced wind technology wind turbines; and Cooperative Research and Testing, which supports turbine certification and other activities for the domestic and international competitiveness of wind energy equipment and services offered by U.S. firms.

### Accomplishments:

- R&D by the Department's Wind Program has helped lower the cost of wind generated electricity by 80 percent in the last 20 years. Wind electricity costs have dropped from over 30 cents per kilowatt-hour in 1980 to about 4 cents per kilowatt-hour in 2000;
- An example of the type of advancement accomplished by the DOE Wind Program are improved wind turbine airfoils, which have increased efficiency by up to 30 percent and have been adopted in most commercial U.S. wind turbines;
- Next generation wind turbines from U.S. companies are expected to reduce the cost of energy to about 2.5 cents per kilowatt-hour at 15 miles per hour average wind speed sites by 2003; and
- Wind Powering America was launched in 1999 to accelerate domestic use of wind.

### Benefits:

- In 1999 about 5 billion kilowatt-hours of electricity was produced by wind turbines in the United States, enough to meet the needs of over 500,000 average U.S. households;
- In a recent 18 month period, over 900 megawatts of wind capacity was installed in the U.S., bringing the nationwide total to 2,500 megawatts in 2000. About \$1 billion of private sector capital was invested in wind power plants in the U.S. over this period;
- 5,000 megawatts of domestic wind capacity is anticipated by 2005, and 10,000 by 2010; and
- By 2010 wind energy is expected to provide about 0.6 quads of primary energy and reduce carbon emissions by over 10 million metric tons of carbon equivalent.

**For More Information, Contact:** Peter Goldman, Director, Office of Geothermal and Wind Technologies, (202-586-1995) or go to: [www.eren.doe.gov/wind/](http://www.eren.doe.gov/wind/)

## Photovoltaic Cost Reductions

**DOE Challenge:** Mitigating Environmental Impacts; Providing Diverse Energy Technologies

**Program Activity:** The technology revolution in the power generation sector has led to drastic decreases in the price of power from new sources of generation. For example, natural gas-fired combustion turbine technology produces electricity for about \$0.03 per kilowatthour. Given the low domestic market prices of fossil fuels, market penetration of renewable energy technologies is occurring more quickly in remote locations domestically and overseas where the cost of electricity is generally much higher than in the U.S. Recent trends in the growth rate of global PV sales, especially in Japan and Germany, indicate that this rapidly accelerating market will more than double in the next two years.

The program conducts a balanced R&D effort in fundamental and applied research, materials and device development, advanced manufacturing R&D, module reliability, and system testing and evaluation. The strategy is to concentrate on areas of high-risk, high-payoff R&D, an area where private sector companies traditionally under invest, and where a national research program tapping the unique capabilities of our national laboratories can make a significant impact. As a result of efforts to date, the U.S. is the unquestioned world leader in the development of new advanced PV technologies such as thin films and high efficiency devices. The successful transition of these potentially low cost technologies to large-scale manufacturing is the foremost technical challenge for the Program and is critical to the ongoing viability of the domestic PV industry. The Photovoltaics Program, in partnership with the U.S. PV industry, universities and national laboratories, has established aggressive technical goals as measures of success in order to meet this challenge.

### Accomplishments:

- In FY 2000, PV systems are delivering electricity for as low as \$0.12 - \$0.20 per kilowatthour—depending upon the specific technology—making clean, reliable PV systems competitive in many remote and on-grid sites here in the U.S. and around the globe. This compares with a cost of more than \$1.00 per kilowatthour in the early 1980s; and
- R&D in crystalline silicon and thin film cells that have enabled a multi billion dollar industry.

### Benefits:

- Reduces the dependency on fossil fuels;
- Provides increased reliability of energy service;
- Reduces the emission of greenhouse gases; and
- Establishes a \$22.5 billion industry by 2020.

**For More Information, Contact:** Richard King, Office of Photovoltaics and Wind Technology, (202-586-1693) or go to: [www.eren.doe.gov/pv/](http://www.eren.doe.gov/pv/)



## Geothermal Energy Cost Reduction

### DOE Challenge: Mitigating Environmental Impacts

**Program Activity:** The Geothermal Program has worked closely with U.S. industry to reduce the cost of geothermal energy, providing technology that has resulted in the installation of 2800 megawatts of domestic geothermal power. Today, geothermal technology can produce reliable power in the range of 5-8 cents per kilowatt-hour at average geothermal sites, and the Program is working to achieve a goal of 3-5 cents per kilowatt-hour by 2007. Geothermal energy will contribute as much as 6,000 megawatts to the Department's Comprehensive National Energy Strategy goal of achieving 25,000 megawatts of non-hydroelectric renewable generating capacity by 2010.

The Geothermal Program conducts the research, testing and field verification needed by U.S. industry to fully develop advanced geothermal energy technologies. This is accomplished in large part through cost-shared partnerships with industry. Key activities include: Geoscience and Support Research which investigates problems associated with finding and producing geothermal resources; Drilling Research directed at developing advanced drilling technology to reduce the cost of drilling geothermal wells; and Energy Systems Research and Testing which improves the efficiency of converting geothermal energy into electricity and tests new technology with the potential of reducing overall system costs.

### Accomplishments:

- The Department's Geothermal Program has contributed to a 50 percent decline in the cost of geothermal electricity in the past 20 years. Costs at the best geothermal sites have dropped from an average of about 10 cents per kilowatt-hour in 1980 to about 5 cents per kilowatt-hour in 2000;
- An award-winning, advanced direct contact condenser resulted in a 17 percent increase in generation capacity at a geothermal power plant in 1999;
- Development of a high-speed, diagnostics-while-drilling system will reduce well costs by more than 20 percent, resulting in a reduction in geothermal development costs by as much as 10 percent by 2005; and
- In early 2000, the Department announced a new initiative, GeoPowering the West, to encourage the use of geothermal energy in 19 western states.

### Benefits:

- Over 14 billion kilowatt-hours of electricity was generated by geothermal facilities in four states last year, meeting the needs of about 1.4 million homes;
- GeoPowering the West is expected to result in geothermal energy being used by 7 million homes or the equivalent of about 10,000 megawatts;
- Capital investment in geothermal facilities will total \$50 billion over the next 20 years; and
- By 2020, geothermal energy will displace 20 million metric tons of carbon equivalent.

**For More Information, Contact:** Allan Jelacic, Office of Geothermal and Wind Technologies, (202-586-6054) or go to: [www.eren.doe.gov/geothermal/](http://www.eren.doe.gov/geothermal/)

## Biobased Products and Bioenergy Initiative

**DOE Challenge:** Enhancing Energy Security, Mitigating Environmental Impacts,

**Program Activity:** As we move into the 21<sup>st</sup> century, a number of key issues challenge our nation's rural economy, energy security, and environment. Recent scientific advances in bioenergy and biobased products have created enormous potential to develop new economic opportunities for rural America, enhance U.S. energy security, help manage carbon emissions, and protect the environment. "*The Bioenergy Vision: Achieving Integrated Development and Use of Our Nation's Biologically Derived Renewable Resources*" developed by industry, challenges industry and government alike to develop a sustainable energy future founded on science, domestic resources, and the protection of the natural environment.

A 1999 Executive Order on Biobased Products and Bioenergy provides for coordinated Federal efforts to accelerate the development of 21<sup>st</sup> century biobased industries that use trees, crops, agricultural, forest, and aquatic resources to make an array of commercial products including fuels, electricity, chemicals, adhesives, lubricants, and building materials. Legislation in support of the principles established in the Executive Order has been introduced. The Agricultural Risk Protection Act of 2000 has received bipartisan support. The U.S. Department of Agriculture, EPA and others have joined DOE in focusing efforts toward integrated R&D that will support a strong industrial and agricultural participation.

The cornerstone of the initiative is a concept called "the biorefinery," similar to the refineries of the oil industry. These biorefineries will use biomass from today's farms and forests to create an array of products. Additional focus areas include outreach and analysis, combined with the integrated R&D to lead to cost-shared demonstrations. Future efforts will follow the new strategic plan that will be developed under the Executive Order and roadmaps identified under the Bioenergy/Bioproducts Initiative that utilizes biomass to advance both an integrated bioenergy industry, as well as its renewable bioproducts industry sector. It is anticipated that new partnerships will come together for the first time in an integrated fashion, leading to new business opportunities. Innovative approaches will be encouraged through a multi-agency, industry peer review project selection process.

**Accomplishments:** The initiative depends on the integration of the existing programs within DOE, including the EEREs Offices of Transportation Technologies, Power Technologies, and Industrial Technologies. These programs have been developing the core technologies needed to support the goals of the integrated Bioenergy/Bioproducts Initiative.

**Benefits:**

- The initiative goal is a tripling of U.S. use of biobased products and bioenergy by 2010;
- Reduced oil dependence; and
- Increased economic opportunities, especially in rural areas.

**For More Information, Contact:** Richard Moorer, Office of Transportation Technologies, (202-586-5350) or go to: [www.eren.doe.gov/bioenergy\\_initiative/](http://www.eren.doe.gov/bioenergy_initiative/)

## Million Solar Roofs Initiative

### DOE Challenge: Mitigating Environmental Impacts

**Program Activity:** Million Solar Roofs is an initiative to install solar energy systems on one million U.S. buildings by 2010. Announced by President Clinton on June 26, 1997 in his speech before the United Nations Session on Environment and Development, this effort includes two types of solar technology—photovoltaics that produce electricity from sunlight and solar thermal panels that produce heat for domestic hot water, space heating or heating swimming pools.

The U.S. Department of Energy is working with partners in the building industry, other Federal agencies, local and state governments, utilities, the solar energy industry, financial institutions and non-governmental organizations to remove market barriers to solar energy use and develop and strengthen local demand for solar energy products and applications. The Initiative works in a “bottom-up” fashion by attracting partners building by building, community by community, state by state and business by business. It also works in a “top-down” fashion by developing financing, leveraging resources, coordinating Federal agency support and sharing information. Any person or organization who installs the minimum size solar electric or solar thermal energy system on a residential, commercial, institutional or government building is able to register with the Million Solar Roofs Registry. President Clinton has committed the Federal government to install solar electric and solar thermal energy systems on 20,000 federal buildings by 2010. The U.S. Department of Energy’s Federal Energy Management Program will assist Federal agencies to meet that commitment.

### Accomplishments:

- The original Initiative Action Plan was developed with input from members of the solar energy community and was first introduced in April, 1998. Since then, it has been updated annually to set goals and prioritize actions. The 2000-2001 Action Plan will continue to build on that work;
- In April 2000, Secretary Richardson announced that the total number of preliminary pledges made by the Initiative’s Partners has reached over one million solar energy systems. With the addition of seven new State and Local Partnerships this Spring, the total number of Partnerships has grown to 47 and the number of preliminary pledges to install solar energy systems has reached 1,000,440;
- As an example, the City of Chicago and ComEd will install \$4 million worth of solar panels atop Chicago’s nine major museums and Lincoln Park Zoo. Each installation will generate approximately 50,000 kilowatthours of electricity per year from the sun. In total, the solar panels will provide more than 600,000 kilowatthours per year, enough to power 60 average households;
- Photovoltaics were invented approximately 40 years ago at AT&T’s Bell Laboratories and later developed as a means to power satellites and space vehicles. In the past two decades, research and development have improved the efficiency and reliability of photovoltaics and reduced the costs of photovoltaic electricity by a factor of 5; and
- The Federal sector has installed 1,745 solar energy systems as of April, 2000. They are well on their way to install 2,000 systems by the end of calendar year 2000.

### Benefits:

- In 2010, with one million solar energy roofs in place, the Initiative could reduce carbon emissions in an amount equivalent to the annual emissions from 850,000 cars;

- By 2010, approximately 70,000 new jobs could be created as a result of the increased demand for photovoltaic, solar hot water and related solar energy systems;
- By increasing the domestic market for solar energy, increasing domestic production and reducing the unit cost for solar energy systems, the Initiative could enable U.S. companies to retain their competitive edge in the worldwide market; and
- By 2005, the photovoltaic market alone is expected to exceed \$1.5 billion worldwide.

**For More Information, Contact:** Peter Dreyfuss, Energy Efficiency and Renewable Energy, (202-586-8779) or go to: [www.eren.doe.gov/millionroofs/index.html](http://www.eren.doe.gov/millionroofs/index.html)

## Environmentally-Friendly Hydropower Turbines

### **DOE Challenge:** Mitigating Environmental Impacts

**Program Activity:** The Department’s hydropower research and development program is focused on enhancing the environmental performance of hydroelectric generating systems. The Advanced Hydropower Turbine Systems Program was initiated in 1994 as a partnership with industry and other government agencies. Targeted improvements in environmental performance include greater survival of fish passing through turbines and improved water quality. Accomplishing these aims will support the Department’s Comprehensive National Energy Strategy goal of maintaining the viability of existing hydropower sources.

Current activities involve turbine field testing and laboratory, field, and computational studies in a coordinated effort to improve fish survival in turbines. New “fish-friendly” turbine design concepts have been developed, along with a better understanding of biological criteria for turbine design, and improved sensor technology for measuring the physical conditions inside operating turbines.

### **Accomplishments:**

- Conceptual designs for environmental upgrades of existing turbine designs were completed. Testing of one of these concepts, the minimum-gap runner, at Bonneville Dam resulted in 40 percent less fish injury than in the original design;
- An innovative conceptual turbine design was completed, and pilot-scale biological and engineering proof-of-concept testing activities have been initiated;
- Advanced “sensor fish” technology was developed and is now being used to measure the effects on fish passing through turbines; and
- Biological experiments to characterize and quantify shear and pressure stresses on fish in the turbine environment were completed.

### **Benefits:**

- Turbine technology capable of reducing fish mortality to 2 percent or less will be commercially available by 2010, compared to current mortality levels ranging up to 30 percent or greater.

**For More Information, Contact:** Don Richardson, Office of Biopower and Hydropower Technologies, (202-586-4541) or go to: [hydropower.id.doe.gov/](http://hydropower.id.doe.gov/)



# Crosscutting





## Promoting International Cooperation for Clean Energy

**DOE Challenge:** Mitigating the Environmental Impacts of Energy Production and Use

**Program Activity:** The Department of Energy is pursuing international cooperation to address the challenge of affordable, efficient and clean energy on a global scale. Specifically, U.S. policies seek to develop competitive international energy markets, facilitate the adoption of clean, safe, and energy efficiency systems, and promote international science and technology cooperation in clean energy systems.

**Accomplishments:** The Department has obtained the agreement of several dozen countries in supporting clean energy technology, energy efficiency, and the Clean Development Mechanism. We have energy efficiency programs with numerous countries, including Brazil, China, India, Mexico, Russia, South Africa, Ukraine and Venezuela.

Through the U.S./China Forum on Environment and Development, led by Vice President Al Gore and Premier Zhu Rongji of China, DOE established, in cooperation with the U.S. Export-Import Bank and the State Bank of China, a \$100 million Clean Energy Program, signed and implemented new protocols to promote clean fossil energy, renewables and energy efficiency, and launched a U.S.-China Oil and Gas Industry Forum to promote oil, natural gas and coal-bed methane development in China.

In October 1999, DOE signed a Joint Statement on Cooperation in Energy and Related Environmental Aspects with the Government of India. The Joint Statement has led to bilateral policy dialogue and a South Asia Regional Initiative on clean energy development and climate change. It set the stage for President Clinton's visit to India in March, 2000, at which time the Administration signed a Clean Energy and Environmental agreement. Also 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.

The Department has initiated a program of clean energy cooperation with Mexico, Costa Rica and Bolivia. In Mexico, the focus is on clean fossil technology development and deployment, while maintaining the affordability of fossil fuels and fossil-based power generation.

DOE has signed bilateral 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. The Administration has actively promoted energy efficiency and renewable energy in Russia through regional energy efficiency laws, renovation of district heating systems, improved efficiency in enterprise housing, energy-savings codes and standards, advances in energy-efficient window technologies, construction of wind-diesel hybrid power stations at remote sites in the Northern Territories, and a planned new geothermal power plant in Kamchatka. In Ukraine the Department has launched an \$850,000 initiative for financing energy efficiency projects, sponsored energy audits for 5 industrial firms, and helped facilitate a \$30 million World Bank loan to retrofit municipal buildings in Kiev. The Department has established a regional oil spill response system with the countries bordering the Black Sea. The effort includes a website for information exchange and technical workshops to build institutional capacity in the region.

**Benefits:**

- Accelerated deployment of clean energy technology in international markets;
- Reduced air and water pollution and a reduced rate of growth of greenhouse gas emissions worldwide; and
- More efficient use of fossil fuels.

**For More Information, Contact:** Matt Willis, (202-586-5800) or go to: [www.osti.gov/international](http://www.osti.gov/international)

## Promoting International Competition and Private Sector Investment

**DOE Challenge:** Enhancing America's Energy Security

**Program Activity:** The Department promotes the opening of global markets to U.S. trade and investment through encouraging competition, energy sector reform and regional market integration. In cooperation with U.S. business, the Department recently hosted three major international conferences involving Energy Ministers from the Western Hemisphere, Africa, and the Asia-Pacific Economic Cooperation (APEC) community. The Department is leading major energy initiatives in Africa, Asia, Latin America, and Europe.

**Accomplishments:** In the Asia-Pacific region, APEC energy ministers and leaders have endorsed the APEC natural gas initiative. This initiative seeks to accelerate investment in natural gas supplies, infrastructure and trading networks throughout the region, and has been developed in close collaboration with the business sector. The initiative aims to reduce investor risk through implementation of appropriate policies by the member governments of the APEC region. These policies include permitting 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.

With regard to China, the Department leads the Energy Policy Working Group of the US-China Forum on Environment and Development chaired by Vice-President Gore and Premier Zhu Rongji. The Department has set up an Oil and Gas Industry Forum, which encouraged China's decision to develop its natural gas resources, import liquefied natural gas, and permit foreign ownership of natural gas production and transportation infrastructure. DOE cooperative programs with Russia have resulted in passage of Production Sharing Laws to encourage investment in the oil and gas sector. In the Caspian region, bilateral policy dialogue with Turkmenistan, Turkey, Azerbaijan and Georgia has fostered an investment climate for private sector investment in oil and gas pipelines to transport oil and gas to markets outside of the region. In the Baltics and Eastern Europe, DOE has supported the efforts of U.S. companies to invest in the energy sector, and has encouraged host governments to adopt fair and transparent procurement practices, and to allow private investment. Through the International Energy Agency (IEA), the Organization for Economic Development and Cooperation (OECD), and the European Union (EU), the Department has accelerated the opening of the European gas and electricity sectors to competition and U.S. private investment.

### **Benefits:**

- Enhanced energy security of nations through interdependence and competitive markets;
- Increased opening of international markets to U.S. trade and investment; and
- Accelerated deployment of clean energy technology in international markets.

**For More Information, Contact:** Matt Willis, International Affairs (202-586-5800) or go to: [www.osti.gov/international](http://www.osti.gov/international)

## **Use of Energy Efficiency and Renewable Energy Technologies in Clean Air Act State Implementation Plans**

**DOE Challenge:** Mitigating Environmental Impacts, Enhancing Energy Security

**Program Activity:** Each year the nation spends over \$100 billion to clean up pollution that is an unintended consequence of energy use. Much of this pollution could be avoided through wider application and use of clean energy technologies through comprehensive multi-pollutant prevention strategies. In recent years, the Administration has been aggressively pursuing these broader strategies to prevent pollution.

EPA's Clean Air Act programs are implemented by State governments through state environmental agencies. Particularly for the ambient air programs, each State develops a State Implementation Plan (SIP) which characterizes the nature of pollution challenges within the state and provides a plan of action by which the state can attain and maintain National Ambient Air Quality Standards. In order for a state to receive federal funds, EPA must find each SIP responsive to the requirements of statute, compliance with regulation and the needs of the environment. EPA produces guidance documents that provide states with an idea of what EPA will accept as applicable pollution reduction strategies.

DOE and EPA are currently working together to help provide for the widespread adoption of clean energy technologies by the States as a preferred means of reducing and preventing pollution.

### **Accomplishments:**

- Development of Energy Efficiency & Renewable Energy Set-Aside in NOx Budget Trading Program;
- Assisted EPA with Monitoring & Verification strategies and requirements needed to implement this set-aside. In April, 2000, the EPA Office of Air and Radiation issued a Draft Guidance document entitled "Creating an Energy Efficiency and Renewable Energy Set-Aside in the NOx Budget Trading Program." This document is the second of three guidance documents that EPA is issuing to help states take advantage of the air quality benefits of voluntary energy efficiency and renewable energy actions; and
- Developed a strategy (with EPA and the Western Governors Association) for using renewable energy sources to help meet the regional haze rule.

### **Benefits:**

- Simultaneous improvements to energy use, environmental quality and significant cost reductions.

**For More Information, Contact:** John Atcheson, Energy Efficiency and Renewable Energy, (202-586-2369) and/or David Bassett, Office of Planning, Budget and Outreach, (202-586-7943) and/or Greg Kats, Energy Efficiency and Renewable Energy, (202-586-1392)

## Voluntary Partnerships with Industry

**DOE Challenges:** Enhancing Energy Security, Mitigating Environmental Impacts, and Increasing Competitiveness and Reliability

**Program Activity:** DOE actively seeks diverse partnerships to better develop, deploy and leverage the public investments in government and energy products and technologies. Our partnerships help develop the experience base, skill and knowledge pool, infrastructure, and user-familiarity that reduce the risk barriers associated with new technologies. They provide feedback to every stage of the continuous process of research, development, demonstration, production, deployment and market acceptance that is necessary for the accelerated evolution to a more balanced, efficient and productive energy economy.

### Accomplishments:

- The DOE/industry's USABC developed the longer range battery used by PNGV partners, GM and DaimlerChrysler in their EV car, S-10 pickup and EPIC minivan. Customer response to these vehicles show satisfaction with their longer range and more consistent performance;
- Industry partnerships: OIT developed and commercialized over 100 technologies, saving more than 115 trillion btu. These advances reaped productivity improvements, reduced resource consumption, decreased emissions, and enhanced product quality;
- Wind Partnerships: DOE partnered with Enron Wind Corp., Zond Energy Systems, manufacturers and utilities to produce one of the world's largest wind generation facilities;
- Building America partnerships, with DOE and building industry members, cost-shares development and demonstration of new homes that are more than 50 percent more efficient, with no cost or performance penalty;
- Rebuild America partners established nearly 250 community partnerships to date that will reduce the energy costs of over 500 million square feet of building space;
- Energy Star commercial laundry partners, through a comprehensive program with EPA, retailers, the laboratories, and the appliance industry are, for example, cutting water consumption by 50 percent and water energy use by 44 percent, with membrane water filtration technology;
- Climate Challenge utility partnerships developed nine initiatives with over \$50 million committed to accelerate commercialization of renewable energy technologies and energy-efficient electrotechnologies;
- Superconducting partnerships, utilizing superconducting cables in Georgia and Detroit, have set the world's benchmarks in transmission cables, transformers, motors, generators, and other electric power technologies. These are world firsts;
- Photovoltaic manufacturing partnerships have netted a 22 percent compound growth in the industry for the last 8 years, with 65 megawatts of U.S. manufactured PV sold in 1999 (200 megawatts total in 1999), and \$2 billion in total sales in 1999 (2/3 foreign sales); and
- Federal partnerships with energy service companies have generated total private sector investment in Federal alternative financial projects of nearly \$850 million.

**Benefits:**

- Pools large risks;
- Shares technology and resources;
- Accelerates research, development and deployment;
- Smooths market transformation; and
- The nations, its industries and consumers, receive energy, environmental, and cost savings years earlier and avoid significant opportunity costs.

**For More Information, Contact:** Mary Beth Zimmerman, Office of Planning, Budget and Outreach, (202-586-7249)