

United States

# Domestic Progress on Climate Change



November 2000

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# Executive Summary



## Executive Summary

Addressing climate change is the premier environmental challenge of the 21<sup>st</sup> century. Among the world's leading atmospheric scientists, agreement is now widespread that the Earth is warming and that greenhouse gas emissions from human activities are at least partly to blame.

The United States is committed to meeting this challenge, both through domestic actions to reduce greenhouse gas emissions and through environmentally sound, cost-effective international cooperation under the United Nations Framework Convention on Climate Change and its 1997 Kyoto Protocol.

Awareness is growing throughout U.S. society that global warming is a serious problem and that serious action is required. Most importantly, specific concrete actions by citizens, businesses, and governments are yielding tangible results. In fact, recent data show that growth in U.S. greenhouse gas emissions has begun to decline, even as the U.S. economy grows at an unprecedented rate—an important measure of progress in the fight against climate change.

*"The greatest environmental challenge of the new century is global warming ... If we fail to reduce the emission of greenhouse gases, deadly heat waves and droughts will become more frequent, coastal areas will flood, and economies will be disrupted. That is going to happen, unless we act."*

*President Bill Clinton  
State of the Union Address  
January 27, 2000*



## Challenging the Historic Link between GDP and Carbon Emissions

Historically, U.S. CO<sub>2</sub> emissions have grown at roughly half the rate of the gross domestic product (GDP). In recent years, however, very robust growth in the nation's GDP has been accompanied by a slowdown in the growth of U.S. greenhouse gas emissions. This trend grew even more pronounced in the late 1990s.

■ Over the 1990s, the U.S. GDP grew almost three times faster than energy-related CO<sub>2</sub> emissions.

■ In both 1998 and 1999, U.S. GDP grew by more than 4 percent each year while CO<sub>2</sub> emissions grew by less than 1.5 percent per year.

In addition, recent data demonstrate that from 1960 to 1996, energy intensity—the amount of energy used per unit of GDP—declined by an average of 1.3 percent per year. Even more telling, from 1996 to 1999, the nation's energy intensity declined at a rate of 3.2 percent annually. Finally, the carbon intensity of the U.S. economy—the amount of CO<sub>2</sub> emitted per unit of GDP—declined by 15 percent over the course of the 1990s.

Factors contributing to these trends may include a high rate of new investments and the rise of the digital economy. What is clear is that U.S. businesses, states and localities, and the Federal government are achieving real results in reducing growth in greenhouse gas emissions. There is also a commitment at all levels to ensuring that these positive results multiply in the years ahead.



## U.S. Business Community Stepping Forward

U.S. industry is undergoing a sea change in its attitude towards climate change. This, in part, reflects a realization by more and more companies that saving energy and reducing waste make sense not just for the environment, but also for their bottom line. The automobile industry, for example, is making important progress in reducing emissions from vehicles.

■ **Ford** and **GM** announced production plans for sport utility vehicles (SUVs) that are 15 to 25 percent more fuel-efficient than today's SUVs. Preliminary estimates by the U.S. Environmental Protection Agency indicate that these commitments could result in cumulative emissions reductions of up to 100 MMTCE through 2020.

■ Thanks in part to the public-private *Partnership for a New Generation of Vehicles (PNGV)*, **General Motors (GM)**, **Ford Motor Company**, and **Daimler-Chrysler** have all unveiled diesel-battery hybrid concept cars that are capable of traveling 70-90 miles per gallon (mpg).

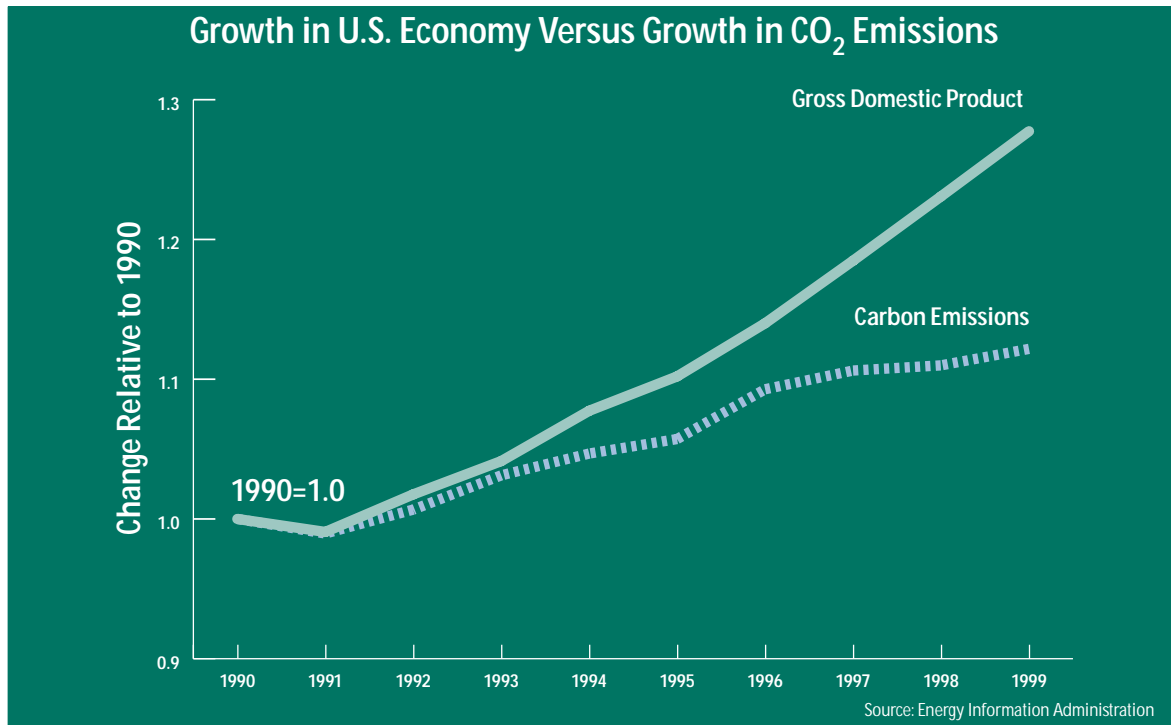
■ **Honda** and **Toyota** introduced gasoline-battery hybrids into the U.S. market with fuel economy ratings of up to 70 mpg on the highway.

Also, this year **Johnson & Johnson** and **IBM** became the first two companies to join a new partnership with the conservation community to help businesses voluntarily lower energy consumption. Under this partnership, companies make specific commitments to reduce their emissions and participate in an independent verification process. In so doing, these two companies join a host of major companies that are stepping forward with real plans to address climate change, including **DuPont**, **Motorola**, **United**

*"We have learned that a strong economy and a safe environment go hand in hand."*

*Vice President Al Gore  
April 2000*





**Technologies, Boeing, Shell, Weyerhaeuser, and Amoco and Arco**, subsidiaries of **British Petroleum**. And in May 2000, 11 major U.S. corporations, calling themselves the *Green Power Market Development Group*, began purchasing green energy and otherwise providing support to the development of green energy markets.

The rise in good corporate citizenship is further evidenced by the decline of business organizations dedicated to opposing international action to address climate change, and the rise of other, more constructive voices, such as those of the **Business Council for Sustainable Energy**, the **International Climate Change Partnership**, and the **Pew Center for Global Climate Change**.

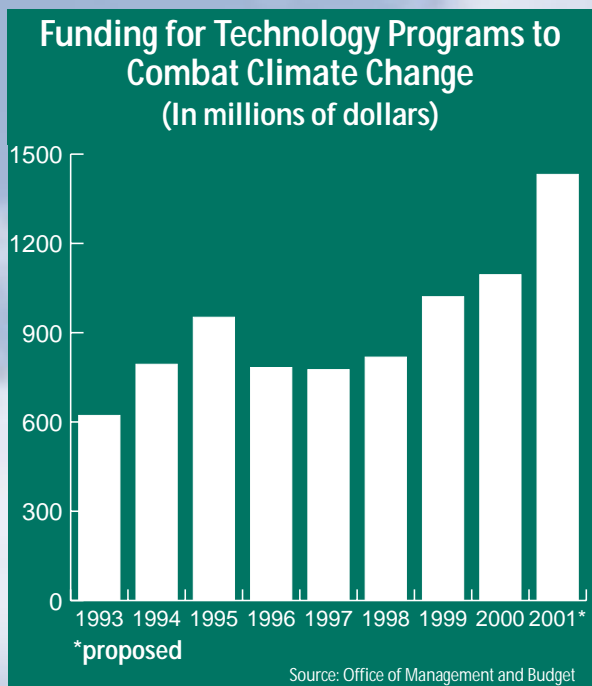
### Real Actions, Real Results

For the past seven years, the hallmark of the Clinton-Gore Administration's strategy for reducing U.S. greenhouse gas emissions has been to use R&D investments and tax incentives to increase energy efficiency, spur the broader use of renewable energy, and work with industry to promote voluntary, cost-effective reductions. Among the many U.S.

climate protection programs showing tangible results are the following:

- Minimum efficiency standards on residential appliances have saved consumers nearly \$25 billion through 1999, avoiding cumulative emissions by an amount equal to almost 50 million metric tons of carbon (MMTCE). Four pending appliance standards (clothes washers, fluorescent light ballasts, water heaters, and central air conditioners) are expected to save consumers more than \$10 billion and reduce cumulative emissions by 22 MMTCE through 2010.
- The ENERGY STAR® program promotes energy efficiency in U.S. homes and buildings. It is estimated that by 2010 ENERGY STAR will reduce cumulative U.S. greenhouse gas emissions by more than 100 MMTCE.
- Public-private partnership programs to reduce methane emissions are expected to hold methane emissions at or below 1990 levels through 2010. Partners in the methane programs will reduce cumulative emissions by an estimated 120 MMTCE by 2010.
- Programs designed to halt the growth in emissions of the most





### Targeted Tax Credits to Fight Global Warming

As part of the *Climate Change Technology Initiative*, President Clinton has proposed \$9.3 billion in tax incentives over 10 years for consumers who purchase energy-efficient products and for producers of energy from renewable sources. Highlights include the following:

■ **Tax credits for fuel-efficient cars.** The package extends the current tax credit (of up to \$4,000) through 2006 for qualified electric and fuel cell vehicles and also includes a tax credit of \$500-3,000 for the purchase of a qualifying hybrid vehicle from 2003-2006.

■ **Tax credits for energy-efficient homes.** Consumers can receive a \$1,000-2,000 credit toward the purchase of a new energy-efficient home; a 20 percent tax credit for the purchase of selected energy-efficient products for homes and buildings; and a \$1,000-2,000 credit for installing a solar energy system.

■ **Tax credits for clean energy.** The package extends existing tax credits for the production of electricity from wind and closed-loop biomass and creates credits for electricity from open-loop biomass facilities, coal-biomass co-firing, and landfill methane.

potent greenhouse gases—the so-called “high global warming potential (GWP) gases”—are achieving significant progress. Investments already made by partners in these programs will reduce cumulative emissions by an estimated 80 MMTCE by 2010.

### Growing Commitment by the U.S. Government

Over the past two years (FY 1999 and FY 2000), the Clinton-Gore Administration has secured more than \$7 billion in overall funding to fight climate change. This includes more than \$2 billion for the research and development of clean energy technologies in the four major carbon-emitting sectors of the U.S. economy: Industry, Buildings, Electricity Generation, and Transportation.

The President’s FY 2001 budget proposed \$2.4 billion in funding for renewable energy, energy efficiency, agricultural- and forest-based bioproducts and energy, research and development, and tax incentives for the purchase of clean cars, homes, appliances, and clean energy production. This represents a 43 percent increase over FY 2000 enacted levels and builds on the Administration’s consistent record of fighting for—and achieving—higher funding levels for climate programs.

### New Federal Initiatives

In addition to fighting for increased funding for existing climate programs, the Administration has proposed or implemented several major climate initiatives in the past year, including:

■ **Cutting Fuel Use by Federal Fleets.** An Executive Order from President Clinton requiring U.S. government agencies to reduce the amount of petroleum used by their vehicle fleets by 20 percent below 1999 levels by 2005. This action is expected to reduce greenhouse emissions by an amount equal to 160,000 metric tons of carbon (MTCE) per year.

■ **21<sup>st</sup> Century Truck Initiative.** A 10-year research and development partnership aimed at doubling—and, in most cases, tripling—the fuel economy of U.S. trucks.

■ **International Clean Energy Initiative.** The President proposed \$201 million for FY 2001 (a better than 100 percent increase over FY 2000 enacted levels) for a multi-agency initiative to accelerate the international development and deployment of clean energy technologies.

### States and Localities Taking Action

Many states and localities throughout the United States are coming to recognize the effects that climate change could have on their communities and economic well-being and are stepping forward to take real steps to reduce emissions:

■ A total of 78 U.S. cities are participating in the **International Council for Local Environmental Initiatives' (ICLEI) Cities for Climate Protection Campaign (CCP)**, a program that offers training and technical assistance to cities, towns, and counties for projects focusing on reducing emissions.

■ In June 2000, the **U.S. Conference of Mayors** passed a resolution recognizing the seriousness of global warming and calling for increased cooperation between cities and the Federal government in taking action to address the challenge

■ To date, **26 states have initiated voluntary climate action plans** and 17 have completed those plans.

### Conclusion

The United States is committed to doing its part to protect our climate and pass on a livable world to our children and grandchildren. The United States understands that domestic progress in reducing emissions is an important part of that commitment. We must also make more progress international-

### Measuring Greenhouse Gas Emissions And Emissions Reductions

Greenhouse gas emissions typically are expressed either in terms of metric tons of carbon equivalent (MTCE) or in metric tons of carbon dioxide equivalent. This report uses MTCE or million MTCE (MMTCE). To convert carbon equivalents to carbon dioxide equivalents, multiply by 3.67.

This report focuses on progress the United States is making at combating climate change on multiple fronts. Each chapter provides an overview of programs and accomplishments within key sectors of the U.S. economy. The greenhouse emissions from each sector—industry, buildings, electricity, transportation, and agriculture and forestry—are not mutually exclusive. For example, buildings house industrial processes; thus, greenhouse gas emissions related to the production of goods and services might be viewed as deriving from either the buildings or the industrial sector. Because of this overlap, it is not appropriate to add together emissions or emission reductions for each sector to produce an estimate of total U.S. emissions or emission reductions.

Likewise, because of the interactions among programs that are designed to reinforce each other, an estimate of aggregate U.S. reductions cannot be produced by adding up emission reductions for all of the programs discussed in this report. Estimates from different Federal government agencies, private sector entities, and state and local governments may rely on different baselines and cannot be directly compared. Finally, substantial uncertainty is associated with any of these projections because many of the estimates attempt to quantify the adoption of projected technologies and practices more than a decade into the future.

ly—both inside and outside of the Kyoto Protocol. In the long run, the United States' balanced approach to addressing climate change will allow us to continue to grow our economy and protect the environment at the same time—the essential challenge facing all nations.





# Industry



## Chapter 1. Industry

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Several positive trends characterize greenhouse gas emissions from the U.S. industrial sector, reflecting the basic economic fact that saving energy and reducing waste is in corporate America's interest. More and more companies are realizing that saving energy and reducing waste make sense not just for the environment, but also for their bottom line.

After 1997, carbon dioxide emissions from the combustion of fossil fuels by the U.S. manufacturing sector began to decrease, partly due to increasing efficiency, as measured by a reduction in emissions per unit of gross domestic product. Methane emissions from U.S. coal mining also are decreasing, owing at least in part to investments in methane recovery from coal mines and projects to use that methane. Emissions from natural gas systems are decreasing as well, primarily due to greater use of plastic piping for distribution. In fact, through voluntary public-private partnership programs and other actions, overall U.S. methane emissions are expected to be at or below 1990 levels through 2010.

Public-private partnerships are substantially reducing emissions of the "high global warming potential" (GWP) gases—perfluorocompounds (PFCs) and several hydrofluorocarbons (HFCs)—from industrial operations. These initiatives are underway in the semiconductor industry, aluminum production, the chemical industry, electric transmission and distribution systems, and the magnesium industry.

### Johnson & Johnson: A Win-Win

**Johnson & Johnson**, the pharmaceutical company, estimates that its efforts to improve energy efficiency in its manufacturing processes are saving \$3.8 million a year. Since 1991, the company has cut energy use by 8 percent while production has soared by 330 percent.

On top of that, Johnson & Johnson is saving an estimated \$9.7 million as a partner in the U.S. government's ENERGY STAR® buildings program through the company's effort to improve energy efficiency in its facilities. (See Chapter 2, "Buildings.")

### Majestic Metals

**Majestic Metals**, a precision sheet metal manufacturer in Denver, Colorado, achieved a 15 percent annual reduction in its natural gas bill—saving some \$40,000 per year—through energy efficiency improvements. Efficiency measures include the development of a cost-effective closed-loop rinse system in its metal pre-paint processing area. Other energy efficiency improvements included enhanced insulation and an upgraded heating system.

### Industry Initiatives on Climate Change

Awareness is growing among U.S. corporations that climate change is a serious issue deserving serious action. As a result, a number of companies are undertaking forward-looking initiatives:

In May 2000, 11 major U.S. corporations, calling themselves the *Green Power Market Development Group (GPMDG)*, began purchasing green energy and otherwise providing support to the development of green energy markets. (See Chapter 3, "Electricity.")

In 2000, **Johnson & Johnson** and **IBM** were the first two companies to join *Climate Savers*, a new partnership to help businesses voluntarily lower energy consumption and reduce emissions of greenhouse gases. In joining *Climate Savers*, companies make specific commitments to reduce those emissions and participate in an independent verification process.

In 1999, the *Business Roundtable*, a group of CEOs from leading U.S. corporations, released a report advocating "the deployment of more energy-efficient and breakthrough technologies" and called on government and industry to work together to find answers to the challenges of climate change.

The **Pew Center on Climate Change** launched a \$5 million campaign in 1998 to build support for taking action on climate change. **Boeing, DuPont, Shell, Weyerhaeuser**, and 17 other major corporations joined the center's *Business Environmental Leadership Council*, agreeing that "enough is known about the science and environmental impacts of climate change for us to take actions to address its consequences."

### Energy Efficiency in Industrial Processes

A cornerstone of the U.S. strategy to reduce greenhouse gas emissions from the industrial sector is the development of partnerships between the Federal government and private



## Greening the Cement Industry

Cement manufacturing accounts for approximately 5 percent of U.S. CO<sub>2</sub> emissions from industrial sources. Companies representing more than 70 percent of U.S. cement production are taking advantage of the latest methods for improving energy efficiency. These companies have produced action plans in which they have committed to reducing their CO<sub>2</sub> emissions by more than 736,364 MTCE by the end of 2000 with an expected cost savings of around \$2.3 million.

industry to improve efficiency and reduce waste.

One Federal program, *Industries of the Future*, works in partnership with the nation's most energy-intensive industries, enhancing their long-term competitiveness, and accelerating research, development, and deployment of technologies that increase energy and resource efficiency. For example, steel scrap generated in steelmaking plants is now being recycled at a rate close to 100 percent. By 2010, participating industries are projected to avoid 15 MMTCE and realize \$3 billion in energy savings annually.

The Federal government's *Best Practices Program* helps participating U.S. manufacturers lower energy bills with little to no added capital investment through the careful selection and adoption of new processes and component technologies. One best practice program, *Steam Challenge*, helps industrial partners retrofit, operate, and maintain their steam systems more efficiently and profitably. The program expects to achieve a 20 percent efficiency improvement by 2010, saving some 2 quads of energy annually.

A similar program, *Motor Challenge*, stresses a systems approach to the engineering, specification, and maintenance of motors, drives, and motor-driven equipment. Funded at just over \$5 million a year, Motor Challenge helps industry realize electricity cost savings

of \$25 million per year and avoid emissions of 130,000 MTCE.

*"We recognize that the debate over climate change goes well beyond the matter of the U.S. economy. We also believe that protracted debate about the adequacy of the science is something Texaco wishes to move beyond."*

J.G. Metzger  
Vice President, Texaco  
February 2000 announcement of  
Texaco's withdrawal  
From the Global Climate Coalition

## Recovering Useful Methane

U.S. industry works in concert with the Federal government through a variety of voluntary partnerships that are directed toward eliminating market barriers to profitable collection and use of methane that otherwise would be released to the atmosphere. Collectively, these programs are expected to hold methane emissions at or below 1990 levels through 2010. Partners in the methane programs will reduce cumulative emissions by an estimated 120 MMTCE by 2010.

One of these partnerships, the *Landfill Methane Outreach Program (LMOP)*, has assisted more than 140 planned and operational projects by providing decision support software, identifying potential partners, and addressing specific technical or regulatory issues.

The *Coalbed Methane Outreach Program (CMOP)* works with coal mines and project developers to develop technical and cost evaluation models. As a result, methane recovery by the coal industry has more than doubled since 1993. Nearly \$50 million in direct gas sales were generated in 1999.

*Natural GasSTAR* works with more than 70 gas production, transmission, and distribution companies,



### Lucent Shines with Clean Energy

Working with the *Landfill Methane Outreach Program*, **Lucent Technologies** found it could save approximately \$100,000 a year on fuel bills at its Columbus, Ohio, plant by using captured landfill gas instead of fossil fuels to power boiler operations that generate steam for space heating and hot water. Lucent's new fuel source is reducing annual greenhouse gas emissions by 100,000 MTCE—equivalent to removing more than 80,000 automobiles from the road. And because landfill gas is less expensive and easier to maintain than traditional fuels like coal and oil, Lucent saves money on fuel costs and operating expenses.



*Voluntary partnership programs are expected to hold methane emissions at or below 1990 levels through 2010.*

providing partners with detailed technical and economic information on how to reduce emissions. The program has identified more than 50 previously unrecognized ways of economically reducing methane emissions, which now are being widely adopted by industry.

### Reducing Emissions by Reducing Waste

The U.S. government's *WasteWise* program works to reduce municipal solid waste and greenhouse gas emissions through energy savings, increased carbon sequestration, and avoided methane emissions from landfills. WasteWise has grown from 361 partners in 1994 to its current membership of more than 1,000. The partners reported total reductions of 7.8 million tons of solid waste in 1998. Avoided disposal cost savings grew from \$38 million in 1994 to \$280 million in 1998. Since the program's inception, partners have avoided an estimated 19 MMTCE.

### Reducing High GWP Gases

Public-private *Environmental Stewardship Partnerships* are substantially reducing U.S. emissions of PFCs and several HFCs, the "high global warming potential" (GWP) gases, which are released as byproducts of industrial operations. Investments already made by partners in these programs will reduce cumulative emissions by an estimated 80 MMTCE by 2010.

### Company Gets Wise to Waste

**Herman Miller**, a Zeeland, Michigan, furniture manufacturer, saved \$422,000 in 1998 by switching to returnable packaging and changing its packaging design. The company also eliminated 40 tons of panel textiles and 27.5 tons of textiles for chairs through a life cycle analysis process and saved \$407,300. In 1998 the company prevented 725 tons of waste, collected 10,273 tons of recyclables, and purchased 37,423 tons of recycled-content products.

The *PFC Emission Reduction Partnership for the Semiconductor Industry* has served as a catalyst for companies in Europe, Japan, Korea, Taiwan, and the United States to join together to set the first global target for reducing greenhouse gas emissions: Participating countries will reduce PFC emissions to at least 10 percent below 1995 levels by 2010.

Since the launch of the *Voluntary Aluminum Industrial Partnership (VAIP)* in 1995, the program's membership has grown to include 11 of the nation's 12 primary aluminum producers, representing 22 smelters and 94 percent of U.S. production capacity. As of 1998, VAIP partners cumulatively achieved a dramatic 44 percent in PFC emissions from 1990 levels.

In the chemical industry, all four of the U.S. manufacturers that emit HFC-23 during the manufacture of HCFC-22 are significantly reducing emissions of this highly potent greenhouse gas through process optimization.

Two new partnerships, the *SF<sub>6</sub> Emission Reduction Partnership for Electric Power Systems* and the *SF<sub>6</sub> Emission Reduction Partnership for the Magnesium Industry*, are identifying and encouraging adoption of best management practices for reducing emissions of sulfur hexafluoride (SF<sub>6</sub>), a highly potent greenhouse gas. The program to reduce emissions from electric power systems now represents approximately 25 percent of the companies within this industry. The program to reduce emissions from magnesium production already represents 60 percent of U.S. magnesium industry emissions.



The Voluntary Aluminum Industrial Partnership (VAIP) is reducing PFC emissions while increasing the efficiency of primary aluminum production.





# Buildings



## Chapter 2. Buildings

There are several promising trends for reducing emissions from the U.S. buildings sector, including the increasing deployment of energy-efficient technologies and the growing application of whole-building and whole-community approaches. The sector has other good news to report as well. From 1984 to 1997, energy consumption per housing unit in the United States decreased, primarily as a result of a large reduction in energy consumption for space heating. Total energy consumption in commercial buildings remained roughly constant from 1989 to 1995, as did energy use per square foot.

Studies show that by investing in simple profitable building upgrades, many U.S. homes and businesses could reduce their annual energy use by nearly 30 percent. To meet this need, the U.S. government created a variety of programs that focus on developing and promoting the broader use of cleaner and more efficient building and appliance technologies.

The buildings sector, comprising primarily residential and commercial facilities, is responsible for approximately 35 percent of U.S. greenhouse gas emissions. Electricity consumption for lighting, heating, cooling, and operating appliances accounts for the majority of these emissions.

### Community Actions on Energy Use in Buildings

Improving the energy efficiency of buildings is a priority for U.S. state and local governments. One program, *Rebuild America*, helps communities identify clean energy opportunities by providing on-site technical assistance, training, and access to resources. The program's network of community partnerships—made up of municipalities, state agencies, schools and universities, nonprofit organizations, and businesses—tailors programs to local needs, choosing the buildings to renovate and the technologies to use.

Rebuild America partnerships in 51 U.S. states and territories are committed to performing energy retrofits on 469 million square feet of space. By August 2000, the number of partners was nearing 300. By 2005, energy efficiency measures undertaken by Rebuild America part-

### Rebuild Duke University Facilities

In 1998 the *Rebuild Duke University Facilities* partnership completed lighting and water conservation improvements in 114 academic buildings with 3.2 million square feet. This Rebuild America partnership is presently renovating inefficient and aging heating, ventilation, and air conditioning systems in the campus buildings that consume the greatest amount of energy. During fiscal year 1998-99, the partnership saved the university an estimated 10 million kilowatt-hours of electricity, 42 million pounds of steam, and 7 million cubic feet of water.

### Daniel Boone High School

Since 1995, *Daniel Boone High School*, located in Washington County, Tennessee, has realized a 34 percent reduction in annual energy costs due to the installation of a geothermal heating and cooling system. Annual savings have averaged \$82,000. With the installation of the geothermal system, the school also reduced maintenance costs, improved indoor air quality, and gained control over individual classroom temperatures. Because the geothermal system was sized to allow for changes, the school is able to add electric loads easily.

nerships are expected to achieve savings of \$1 billion annually and double that amount by 2010.

In addition, local governments that participate in ICLEI's *Cities for Climate Protection* program promote building energy efficiency, not only within their own facilities, but also in the commercial and residential building stock. Over the past year, participating governments have implemented a range of measures that are reducing emissions from both municipal and private sector buildings.

*"Energy conservation not only reduces global warming pollution, it also helps local businesses save money and remain competitive. That's a win-win for the city, and it's just one of the measures we're pursuing to meet our pledge to cut the emissions that cause global warming."*

*The Honorable Paul Schell  
Mayor, City of Seattle, Washington*

### Schools Saving Energy

America's schools spend more than \$6 billion each year on energy. Schools could save 25 percent by reducing energy consumption through better building design, widely available energy-efficient and renewable energy technologies, and improvements to operations and maintenance. In addition to saving money, the *EnergySmart Schools* program is reducing greenhouse gas emissions through gains in energy efficiency and the use of clean energy technologies. So far, more than 240 such community partnerships have been formed, involving 2,000 schools.

In addition, the *ENERGY STAR® label for school buildings* provides tools for schools to evaluate their own energy use, find ways to reduce it, and meet indoor air quality standards. A 25 percent reduction in schools' energy use will cut annual U.S. greenhouse gas emissions by 3 to 4 MMTCE.



## The Greening of The White House

On Earth Day 1993, President Clinton launched a new initiative, *The Greening of the White House*, to improve the energy and environmental performance of the White House complex with steps that can be taken in any home. Measures implemented include replacement of standard light bulbs with more efficient compact fluorescents, installation of weather-tight windows, heating and air conditioning upgrades, and composting of yard trimmings from the White House grounds for use as fertilizer. The recently released status report on *The Greening of the White House* found that the initiative is saving \$300,000 a year and reducing annual carbon emissions by 800 MTCE—the equivalent of removing more than 600 automobiles from the road.

Three of the buildings that house the **U.S. Department of Agriculture** in Washington, D.C., are designated as historic structures—a circumstance that means many of the simple solutions for reducing energy consumption, such as



installing energy-efficient windows or using window awnings, are not options. The solution was to implement an *Energy Management Program* that involves the continuous evaluation of existing conditions, a facility-wide energy tune-up, load reduction, equipment replacement, building façade restoration, and indoor air quality programs. The results are impressive. In 1992, electricity usage, which had been climbing by roughly 3 percent per year over the preceding decade, exceeded 41 million kilowatt-hours (kWh) and was expected to approach 50 million kWh by 2000. Instead, energy consumption had declined by more than 24 percent by 1997—for a cumulative savings of 2 million kWh per year, or 1,758 MTCE.

## Federal Government Leading By Example

The Clinton-Gore Administration has set aggressive goals for curbing greenhouse gas emissions by U.S. government agencies. In 1999, President Clinton issued Executive Order 13123 requiring all Federal agencies to take steps to cut greenhouse gas emissions from energy use in buildings by 30 percent below 1990 levels by 2010. At present, the U.S. government is the single largest energy consumer in the world. Its annual energy bill exceeds \$8 billion, including \$4 billion to heat, cool, and power 500,000 buildings.

As a result of the President's leadership, the Federal government's energy bill is \$2 billion

less (in constant dollars) than it was in 1985. Implementing the measures needed to comply with the Executive Order will result in an annual reduction in greenhouse gas emissions of 2.4 MMTCE and save U.S. taxpayers approximately \$750 million a year.

The Executive Order requires agencies to opt for purchases from cleaner, more efficient power generators. Agencies are directed to adopt policies to increase the use of electricity generated from renewable energy sources and to consider off-grid electricity opportunities that provide energy and environmental benefits, while allowing agencies to avoid the costs of building new transmission lines or digging up existing lines.



**ENERGY STAR Cumulative Benefits through 2010 for Buildings and Products (\$Billions)**

	ENERGY STAR Buildings	ENERGY STAR Products
Private Sector Investments	\$7.0	\$0.7
Savings on Energy Bills	\$19.8	\$26.3
Net Savings on Energy Bills	\$12.8	\$25.6
MMTCE Avoided	45	60

(measured since the early 1990s)

Source: U.S. Environmental Protection Agency

**Energy Efficiency in Private Buildings**

Public-private partnerships are producing important benefits in greenhouse gas abatement in buildings. What all of the partnerships have in common is that they all strive to lower costs for builders, developers, and homebuyers while reducing energy and environmental impacts and improving building durability and worker safety. One suite of programs, ENERGY STAR, promotes energy efficiency in the nation's homes and buildings. Based on actions already taken by partners, ENERGY STAR estimates that by the year 2010 more than 100 MMTCE of greenhouse gas emissions cumulatively will be avoided, and consumers and businesses will save more than \$38 billion.

ENERGY STAR labeled homes incorporate such features as improved insulation, sealed ducts, high-performance windows, and high-efficiency heating and cooling equipment. These homes are generally 30 percent more energy efficient than is called for by local building codes. Currently, more than 800 industry partners, including about 40 utilities, have signed agreements to promote ENERGY STAR qualified homes.

ENERGY STAR also collaborates with a wide range of building owners and users—retailers, healthcare organizations, real estate investors, state and local governments, schools and universities, and small businesses. Each partner commits to improving the energy performance of its facilities and to using the performance metrics and tools provided by ENERGY STAR. A new energy performance rating system for commercial buildings allows the most efficient buildings across the country to be awarded the ENERGY STAR label. More than 1,000 buildings were rated in 1999 using this new system, and 90 qualified for the new label.

More than 15 percent of the U.S. commercial, public, and industrial building market is enrolled in ENERGY STAR. Cumulatively, partners have invested more than \$3.6 billion in

energy-efficient technologies and, in 1999 alone, saved more than 20 billion kWh of energy.

Going forward, the recently introduced Building Benchmarking Tool, now allows building owners and managers to know whether their buildings have good or poor energy performance. Similar to a miles-per-gallon rating for automobiles, this new tool provides tenants and potential buyers with a better understanding of the operating expenses of buildings and thus produces additional incentives for energy efficiency via the marketplace.

### Partnering with Home Builders

The *Partnership for Advancing Technology in Housing (PATH)* is a public-private partnership including the National Association of Home Builders as a charter member, along with building product and equipment manufacturers, individual home builders, developers, and members of the finance community. PATH aims to cut the environmental impact and energy use of new housing by 50 percent or more, and reduce energy use in at least 15 million existing homes by 30 percent or more by 2010.

Along with the contributions of such Federal programs as *Building America* and Energy Star *Homes*, accomplishing these objectives would save consumers \$11 billion in annual energy costs and reduce annual carbon emissions in 2010 by nearly 24 MMTCE—roughly the amount that is produced by 20 million automobiles. There are more than a dozen field evaluation and demonstration sites across the nation. In addition, PATH projects are now underway in pilot communities in Denver, Los Angeles, Pittsburgh, San Fernando Valley, and Tucson, as well as an additional 25 demonstration and field evaluation sites nationwide.

The *Building America* program is a cost-shared partnership for incorporating whole-

building design improvements. To date, more than 1,200 houses have been completed under this partnership program that achieve ENERGY STAR or greater savings in heating and cooling energy usage. In the near future, an additional 4,100 houses will be built under this contribution to PATH. The energy saved annually by these 1,200 houses is more than 43,000 MBtu with a savings of more than 250 MTCE, 10,000 pounds of sulfur dioxide emissions avoided and 11,000 pounds of nitrogen oxide emissions eliminated.

### Solar Buildings

The Federal government's *Solar Buildings* program has provided \$2 million in funding to help develop *Transpired Solar Collectors*. Transpired solar collectors, located on building walls, are capable of converting 60-75 percent of the solar energy striking them into usable heat. Building owners and operators are finding them to be a reliable, low-cost technology that is well-suited for pre-heating the large quantities of ventilation air that most industrial and commercial buildings must pull in during the fall and winter. **Ford Motor Company, General Motors, Federal Express, and McDonnell Douglas** are on the growing list of industrial users of this technology.

### Energy-Efficient Products Help Consumers Fight Global Warming

Using more energy-efficient appliances and other products helps reduce overall energy use in buildings and thus carbon emissions from the buildings sector. Two types of Federal programs promote the use of more energy-efficient products: Appliance standards increase the minimum level of efficiency of products on the market, while the ENERGY STAR program promotes the voluntary use of highly efficient products.





### PATH Makes Waves in California

Rooftop photovoltaic solar panels and the first units of a new generation of high-efficiency gas absorption chillers are standard equipment in a new development in the San Fernando Valley outside Los Angeles, California. At Village Green, the homes of the future are here today. In 1999 families began moving into the first 22 of 186 planned homes, just about a year after President Clinton visited the site to launch the *Partnership for Advancing Technology in Housing (PATH)*. Village Green is one of five PATH pilot projects around the country.

The homes will use less than half of the electricity of a home built to the state's current energy-efficient building standards. Heating and cooling costs are guaranteed to be no more than \$38 per month. Most of the homes will have photovoltaic panels that will provide 90 percent of the electrical needs from the sun. Village Green will be on a mass transit line, making it the largest transit-based affordable housing development in the Los Angeles area.

"Village Green is living proof," says Los Angeles Councilwoman Ruth Galanter, "that the building industry can combine new environmental technologies with affordable housing right here in one of the largest housing markets in the nation."



Minimum efficiency standards on residential appliances such as furnaces, water heaters, air conditioners, and refrigerators saved consumers nearly \$25 billion through 1999, avoiding cumulative emissions of nearly 50 MMTCE. In 1999 alone, appliance standards saved the equivalent of the total annual energy consumption of more than three million American households. Four pending appliance standards (clothes washers, fluorescent light ballasts, water heaters, and central air conditioners) are expected to save consumers more than \$10 billion and reduce cumulative emissions by 22 MMTCE through 2010.

Based on one study, the ENERGY STAR label is recognized by 30 percent of the American public. At the close of 1999, more than 1,200 manufacturers were producing 7,000 product models with the ENERGY STAR label in 31 consumer product categories, and the public had purchased 380 million ENERGY STAR products to date. The list of products is continuing to grow. Recent additions include DVD players, CD players, and compact fluorescent light bulbs.

### Helping Low-Income Families Save Energy

The *Weatherization Assistance Program (WAP)* provides energy-efficiency services to low-income families and individuals who might not otherwise have access to energy-saving technologies. Created in 1976, WAP focuses on households with elderly members, persons with disabilities, and children. Since the program's inception, WAP has retrofitted almost 5 million homes, saving an estimated

7 MMTCE annually. In 2001, the Federal government expects to provide state grants to weatherize 74,751 homes, saving 110,000 MMTCE annually and \$1.80 in energy costs for every \$1.00 invested over the life of the measures.

*“Newmark Homes joined the ENERGY STAR homes program because, like our consumers, we feel that energy efficiency is important. We wanted our energy-efficiency program to be . . . several notches above our competitors, and being an ENERGY STAR builder guarantees that goal.”*

*Mick Beckett  
Senior Vice President  
Newmark Homes*



# Electricity





## Chapter 3. Electricity

**R**educing greenhouse gas emissions from the electricity sector is a national priority in the United States. U.S. climate efforts in this area include improving the efficiency of electricity generation, substituting lower carbon fuels and carbon-free renewables, reducing the demand for electricity through greater end-use efficiency, and restructuring the electric power industry.

At the Federal level, these efforts are being accomplished through a variety of voluntary partnerships. In addition, Federal funding is sponsoring research and development of promising low- or no-emission technologies for generating electricity from fossil power, hydroelectric power, wind power, solar power, biomass gasification, nuclear power, and geothermal heat pumps.

The U.S. private sector is also demonstrating its leadership and environmental stewardship with initiatives such as the *Green Power Market Development Group*, a group of 11 major corporations that is exploring a variety of green energy options. (See page 22.)

Electric utilities account for approximately 29 percent of U.S. emissions and are, collectively, the single largest source of the nation's greenhouse gases. Carbon dioxide ( $\text{CO}_2$ ), a byproduct of the combustion of fossil fuels, accounts for the majority of the sector's emissions, but methane ( $\text{CH}_4$ ), nitrous oxide ( $\text{N}_2\text{O}$ ), and sulfur hexafluoride ( $\text{SF}_6$ ) also are emitted during the generation, transmission, and distribution of electricity.

Carbon-free technologies such as nuclear energy, hydroelectric, and other renewables, supply 30 percent of the electricity produced in the United States while generating almost no greenhouse gas emissions. If these sources were not available, greenhouse gas emissions would be greater by at least 250 million metric tons of carbon (MMTCE) each year.

## Growing Green Power

A prime example of leadership by example in the corporate world is the **Green Power Market Development Group (GPMDG)**, which was organized in May 2000 to support the development of green energy markets in the United States. The members, a number of private corporations not directly involved with the electric utility industry, are exploring a variety of green energy purchase opportunities to identify those that are cost-competitive. This is a long-term process with companies hoping to support market development over a 10-year period.

As members of the GPMDG, 11 major U.S. businesses are working with the **World Resources Institute** and **Business for Social Responsibility** to purchase 1,000 megawatts of new green energy capacity and otherwise provide support to the development of green energy markets. The GPMDG believes that such markets are essential to provide competitively priced energy that also protects the Earth's climate and reduces conventional air pollutants. Corporate members of the group include **Alcoa, Cargill-Dow, Delphi, DuPont, General Motors, IBM, Interface, Johnson & Johnson, Kinko's, Oracle, and Pitney Bowes**. Together, these companies account for about 7 percent of industrial energy use in the United States.

## Electricity Sector Restructuring

A core element of President Clinton's climate change program involves restructuring the electricity industry in a manner that will reduce greenhouse gas emissions while cutting consumers' energy bills. The Administration's restructuring proposal involves using market forces to obtain the greatest amount of energy from each unit of fuel. Most states have restructuring activities underway.

The President's proposal also calls for a *Renewable Portfolio Standard* to increase the use of electricity from non-hydro renewable sources to at least 7.5 percent of sales by 2010. It also provides for a *Public Benefits Fund* of \$3 billion per year, some of which will be used to spur greater investment in energy efficiency and renewable energy technologies. This plan is projected to reduce carbon emissions by roughly 40 to 60 million MMTCE in 2010 while saving consumers at least \$20 billion per year on their electricity bills. The plan is now under consideration by the U.S. Congress.

*"We have a corporate goal of 10 percent of our energy supply from renewable sources. We're excited about participating in [the Green Power Market Development Group] because we hope it will help us to meet that commitment."*

*Paul Tebo  
Vice President for Safety,  
Health and Environment  
DuPont*

## Bioenergy

Biomass is plant matter such as trees, grasses, agricultural crops, and other material derived from living matter that can be used as a solid fuel or converted into liquid or gaseous fuels to supply electricity, heating, transportation, and other energy markets.

## Switchgrass to Reduce Coal Emissions

Switchgrass once grew abundantly in southern Iowa's rolling hills. The Chariton Valley Biomass Project, which was initiated in 1996, is evaluating the possibility of growing switchgrass on marginal land as a biomass crop to replace a portion of the coal burned at a local generating station. A public-private initiative that is expected to be complete in 2004, the Chariton project is also looking at the economic benefits of growing switchgrass as a profitable alternative to row crops. Other benefits include the fact that the plant's massive root system sequesters carbon and filters pesticides and herbicides. One of the project's additional goals is to ensure minimal



or no effect on wildlife when harvesting occurs. Co-firing 5 percent switchgrass with coal can reduce emissions by almost 44,000 MTCE per year.

Next to hydropower, more electricity is generated from biomass than from any other renewable energy resource in the United States. The 37 billion kilowatt-hours of electricity produced each year from biomass are more than the entire state of Colorado uses annually.



Vermont biomass gasification plant

On August 12, 1999, President Clinton issued Executive Order 13134 on *Bioproducts and Bioenergy*, coordinating Federal efforts to accelerate biobased technologies to convert sustainably grown crops, trees, and other biomass into fuels, power, and products. The goal is to triple U.S. use of bioproducts and bioenergy by 2010. Meeting this goal could create \$15 to \$20 billion in new income for farmers and rural America, and reduce annual greenhouse gas emissions by as much as 100 MMTCE—the equivalent of taking more than 70 million cars off the road.

In addition to aggressively sponsoring bioenergy, this initiative supported the development of the world's first efficient, low-pressure biomass gasifier capable of producing a high-quality fuel. The gasifier, which is operating in Vermont, can convert 200 tons of solid biomass per day into a clean-burning gas with an energy content that is high enough for electricity generation. In addition to providing clean energy (with extremely low emissions of SO<sub>x</sub> and NO<sub>x</sub>), gasifiers increase the number and types of biomass fuels suitable for power systems.

Another promising avenue being pursued is co-firing biomass with coal. Co-firing involves substitut-





### From Brownfields to Brightfields

The *New Center for Green Industry* in Chicago, Illinois, is an alliance between the City of Chicago, Commonwealth Edison, the Spire Corporation, and the U.S. government. The goal is to develop one of the city's brownfields by building a factory for manufacturing solar panels and constructing a solar energy system that will supply some of the company's electricity needs and serve as a demonstration site. The project will create 100 jobs in Chicago in manufacturing and supporting industries when the plant opens in the winter of 2000.

The *New Center for Green Industry* solar systems will produce more than 22 million kilowatts of power annually and spare the region's air almost 3,093 MTCE over the next five years. The plant will produce enough panels to meet local solar demand, and local production will lead to cost reductions for consumers in the region in addition to stimulating the market for photovoltaics.

ing biomass for a portion of coal in an existing power plant furnace. It is the most economic near-term option for introducing new biomass power generation. Compared to the coal it replaces, biomass reduces SO<sub>2</sub>, NO<sub>x</sub>, and net greenhouse gas emissions. There is little or no loss in efficiency from adding biomass, which allows the energy in biomass to be converted to electricity with the high efficiency (in the 33-37 percent range) of a modern coal-fired power plant. By the year 2010, the potential market for biomass power systems could approach 10,000 megawatts—enough electricity for 10 million households. (For more on bioenergy, see Chapter 4, Transportation, and Chapter 5, Agriculture and Forestry.)

### Distributed Energy

Utility restructuring, emerging technology, environmental concerns, and an expanding electricity market are important drivers facilitating the emergence of distributed generation as an important new energy option. Public-private partnerships such as the *Distributed Energy Resources* program offer the promise of producing electricity in a fundamentally different way through a dispersed fleet of small-scale electric generators providing power at or near customer sites to meet specific needs. The power also is to be produced near the grid to support economic operation of existing power stations.

Mostly fueled by natural gas, liquid fuels, or renewables, these dispersed generation resources can bypass congested portions of the electric transmission and distribution system. On-site cogenerated electricity and heat production, for example, can allow consumers to use the heat byproduct of electricity production, saving dollars as well as reducing primary energy loads.

Distributed systems include combined cooling, heat, and power systems, biomass-based generators, combustion turbines, concentrating solar power and photovoltaic systems,

## Leading the Way with CHP

**Malden Mills**, a fabric manufacturer in Lawrence, Massachusetts, installed a cogeneration system to replace generating and heating equipment destroyed in a fire. When completed, the combined heat and power system—developed with the assistance of the *Advanced Turbine Systems (ATS)* program—will lower the company's annual energy costs and reduce emissions of sulfur dioxide by 99.6 percent, NO<sub>x</sub> by 83 percent, and CO<sub>2</sub> by 26 percent compared with grid-supplied power.



fuel cells, microturbines, engines/generator sets, and wind turbines storage and control technologies.

## Combined Heat and Power

The U.S. government is actively supporting research, development, and deployment of combined heat and power (CHP) systems. Combined heat and power systems generate electricity and capture waste heat and use it to heat and cool buildings, or provide steam in industrial processes. The use of waste heat results in total system efficiencies of 70 to 90 percent—a considerable performance gain over the 33 percent average efficiency of conventional central electricity generating plants. In 1998, the U.S. government

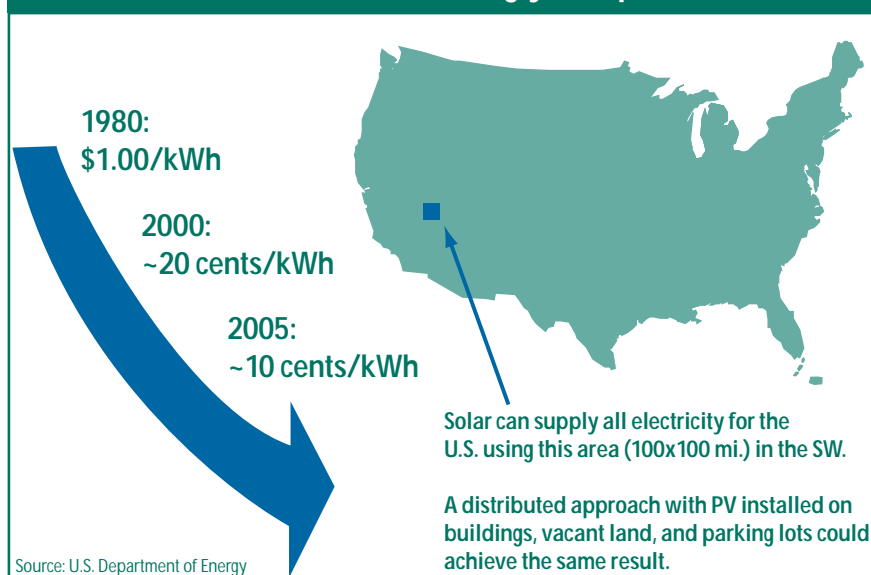
launched the *Combined Heat and Power Challenge* program with the goal of doubling U.S. combined heat and power capacity by 2010. By substituting 46 gigawatt of CHP capacity for conventional capacity, annual greenhouse emissions will be reduced by 30 MMTCE and annual NO<sub>x</sub> emissions by hundreds of thousands of tons. Recent analyses have concluded that this goal can be achieved through electric utility restructuring and modifications to tax policy and air regulations.

## Solar Power Equals Emission Free Electricity

The United States is capitalizing on opportunities to expand the use of solar energy. This

greenhouse gas-free technology promises to make a significant contribution to the nation's energy economy in the future. By 2010, solar power could help avoid emissions totaling 1.5 MMTCE. Although the cost of solar technologies has been reduced significantly in the last 15 years,

## Photovoltaics: Increasingly Competitive





### Catching Rays by the Lake

The Dangling Rope Marina, on the northern shore of Glen Canyon's Lake Powell in the state of Utah, is a popular rest stop for travelers and tourists. The facility was once run using a power system that consumed about 65,000 gallons of diesel fuel annually. To find a greener alternative, several private and public organizations teamed up on a \$1.5-million renewable energy project. In 1996, the marina replaced the old diesel power system with a new 115-kilowatt photovoltaics-hybrid system with 384 PV panels.

During the new system's 20-year operating life, it is expected to save as much as \$2.3 million in energy costs while dramatically reducing greenhouse gas emissions and other pollutants. The project at Dangling Rope Marina on Lake Powell is just one example of more than 30 U.S. government projects in 15 states that are producing electricity from photovoltaics.

more technical advances are needed to compete with low-priced fossil fuels in major energy markets. Toward this end, the U.S. government's solar energy program is providing support for research by world-class scientists and engineers in industry, universities, and the national laboratories.

Over the past 20 years, Federal support for *Photovoltaic Energy Systems R&D* has resulted in a 90 percent reduction in the cost of producing electricity from photovoltaics (PV). As a result, between 1994 and 1998, energy produced by PV modules more than doubled, growing from 26 megawatts in 1994 to more than 61 megawatts in 1998.

The lowest-cost solar power option available today is *Parabolic Trough* technology. These systems use curved mirrors to focus sunlight on a receiver pipe. Parabolic-trough technology is being used in California's Mojave Desert at nine power plants that sell their power to the local utility, **Southern California Edison**. The plants, which total 354 megawatts of installed capacity, generate enough power to meet the needs of approximately 500,000 people with no emissions of greenhouse gases.

President Clinton's *Million Solar Roofs* initiative seeks to place solar energy systems on one million roofs by 2010. To date, commitments for one million systems have been made, and more than 100,000 have been installed, indicating the potential for widespread market penetration of solar technologies. The President's *Climate Change Technology Initiative* includes \$132 million in proposed tax credits over five years to support this program. Meeting the initiative's 2010 goals will reduce carbon emissions by an amount equivalent to removing 850,000 automobiles from the roads.

The U.S. government's *Brightfields* initiative, launched in 1999, is aimed at using abandoned industrial sites—known as brownfields—for producing pollution-free solar



## A New "Crop" Sweeps the Plains

Since 1998 more than 260 megawatts of new wind generating capacity have been installed on farmlands in the Great Plains region of the United States. This new capacity is not only helping to satisfy the growing demand for clean electricity, it is also generating benefits in the form of substantial economic gains for farmers, landowners, and local communities. Wind farming creates construction and service jobs in rural regions and provides a new source of income for U.S. farmers, Native Americans, and other rural landowners, as well as a new source of tax revenues for local municipalities.

One example is the Lake Benton Wind Power Plant, which was the world's largest wind-generation facility when it was completed in 1998 by **Enron Wind Corporation**. This 107-megawatt plant can generate enough electricity to power 43,000 homes. The facility displaces greenhouse gases equivalent to removing 50,000 new cars and light trucks from the road.



energy. Currently, Brightfields projects are underway in cities across the United States, including Chicago, Miami, New Haven, and San Diego. The Brightfields model has proven extremely successful: Redeveloping brownfield sites with solar energy manufacturing benefits local communities through economic development and environmental protection.



*The Million Solar Roofs initiative seeks to place solar energy systems on one million roofs.*

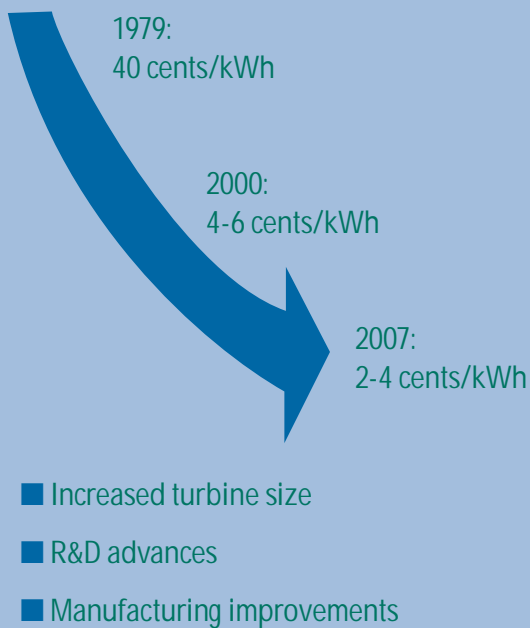
## Wind Power

In the 1990s, wind power was the world's fastest growing source of energy. Worldwide, wind-generating capacity grew 36 percent (3,600 megawatts) in 1999, bringing global wind-generating capacity to 13,400 megawatts. In the United States, more than 700 megawatts of new capacity was added, representing a 41 percent increase in capacity.

The U.S. wind industry is completing the research, testing, and field verification needed to develop fully advanced wind energy technologies that lead the world in cost-effectiveness and reliability. The U.S. government's *Wind Energy Systems* program was established to develop advanced wind turbine technologies capable of reducing the cost of wind energy to 2.5 cents per kilowatt-hour (in 15 mile-per-hour winds).



### Wind: New Cash Crop for the 21<sup>st</sup> Century



Source: U.S. Department of Energy

### Green Technology Invades the Army

In 1994 Fort Polk, Louisiana, adapted 4,003 U.S. Army housing units to use geothermal heat pump (GHP) energy. The resulting energy savings are extraordinary. Fort Polk achieved a reduction of 43 percent or 7.5 megawatts of peak summer load and improved its load factor from 52 percent to 62 percent. In addition, service calls on hot summer days dropped from 90 per day to virtually none, testifying to the reliability of GHP systems. The U.S. Army saved about 22 percent compared with previous maintenance costs. The Fort Polk project received Vice President Gore's "Hammer Award" for "hammering away at building a better government"—one that works better and costs less.

Another Federal initiative, *Wind Powering America*, was announced in June 1999 with a goal of supplying 5 percent of U.S. electricity through wind technologies by 2020. Meeting this goal will avoid greenhouse gas emissions of more than 30 MMTCE.

### Geothermal Power

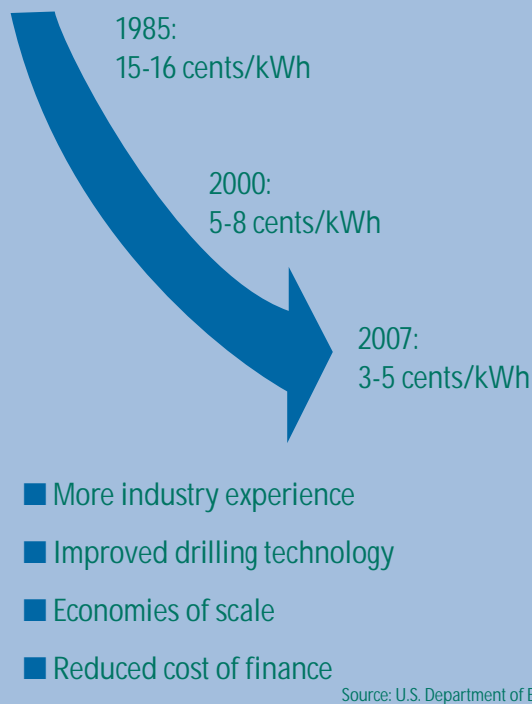
Geothermal heat pump (GHP) technology extracts heat from the ground during the heating season and discharges waste heat into the earth during the cooling season. The *Geothermal Heat Pump Consortium (GHPC)* is a partnership working to inform the public about the technology and to expand the GHP market in the United States.

GHPs can reduce energy consumption and corresponding emissions by 63 to 72 percent when compared with electric resistance heating using standard air-conditioning equipment. In addition, GHPs reduce peak demands. For that reason, some electric utilities offer special financing, rebates, or electric rates for customers who use GHPs.

Approximately 400,000 GHPs are in use today for heating and cooling of residential, commercial, and institutional buildings throughout the United States. Savings from GHP units installed between 1995 and 1998 are estimated to be \$29 to \$39 million. The growth target of the GHPC and the Federal government is to install 2 million GHPs by the year 2005. Achieving this goal will reduce greenhouse gas emissions by about 1.2 MMTCE per year.

In January of 2000, the public-private *GeoPowering the West* partnership was launched to increase dramatically the use of geothermal energy in the western United States. The goals are to convert 10 percent of electricity use in the western states to geothermal energy by 2020, increase the number of homes using geothermal energy to seven million by 2010, and double the number of states with geothermal facilities to eight by 2008. The benefits will include 20 MMTCE displaced in 2020.

## Geothermal: Heat and Power for the 21<sup>st</sup> Century



### Advanced Technologies for Fossil Fuels

The U.S. government sponsors a number of R&D programs to develop more efficient generating technologies and high-efficiency coal-fired generating plants.

The U.S. government's new *Power Systems Program* is developing more efficient coal and natural gas power generating technologies that can produce power with about 40 percent fewer carbon emissions than conventional technologies using those fuels. The program will result in "power-plexes" that can use multiple feedstock materials (coal, gas, biomass, and opportunity fuels like petroleum coke) to produce a slate of market-relevant energy products, including electricity, steam, chemicals, and alternative fuels.

Research is now underway on combining power-plexes with carbon sequestration in geological formations. The research itself will require a little over a decade to complete, followed by a period for market accep-

tance of the new technology. As a result, benefits will not begin to accrue until 2015 but will be quite substantial by 2030. Deployment of the new coal and gas systems in the United States is expected to yield reductions of 5 MMTCE by 2015 and 75 MMTCE by 2030.

### Nuclear Power

Nuclear energy provides approximately 20 percent of all U.S. generated electricity, and its continued role in electricity production is important for our economic and energy security. The Administration's policy focuses on the safety of existing reactors, advancing nuclear power plant designs, and safe long-term storage of spent nuclear fuel. Three programs are implementing these policies. The *Nuclear Energy Plant Optimization Program (NEPO)* is applying new technologies to increase plant life, reliability, availability, and productivity. The *Nuclear Energy Research Initiative (NERI)* is researching breakthroughs in nuclear fission and reactor technology. *Generation IV Nuclear Power Systems* is developing the next generation of reactors that are more economic, resistant to proliferation, produce less waste, and have improved safety features.

### Hydropower

Hydropower currently generates about 10 percent of the nation's electricity. Maintaining existing hydropower generation, however, is at risk due to a mix of environmental, regulatory, and economic pressures. The Federal government is supporting the development of advanced technology that will allow the nation to maximize the use of hydropower resources while minimizing adverse environmental impacts. The main focus is on the development of a "fish-friendly turbine" that will decrease fish mortality to 2 percent, compared with the current 5 to 30 percent mortality.





### Utilities Reducing Emissions Now

*Climate Challenge* is a voluntary effort between the Federal government and the electric utility industry for identifying and implementing cost-effective activities to reduce, avoid, or sequester greenhouse gases. Currently, Climate Challenge's partner utilities number more than 600 and represent 71 percent of 1990 U.S. carbon emissions from electricity generation. Utilities estimate that pledged Climate Challenge actions will reduce emissions by as much as 47 MMTCE in 2000



One goal of *GeoPowering the West* partnership is to double the number of states with geothermal facilities to eight by 2008.

### Superconductors

High-temperature superconductors (HTS) conduct electricity with high efficiency and very little loss when cooled to liquid nitrogen temperatures. A *Superconductivity Partnership Initiative (SPI)* stands at the forefront of worldwide efforts to advance research and development of high-temperature superconducting power equipment for energy transmission, distribution, and industrial use.

Among the accomplishments of the partnership is a new industrial HTS motor that is smaller, lighter, and more efficient than conventional motors. Other applications include current controllers that protect utility equipment, improve reliability, and increase stability of the distribution grid, and underground transmission cables that can double the power capacity of current technology. The potential global market for HTS products by the year 2020 might reach as high as \$100 billion, saving 5 MMTCE in 2015 and 9 MMTCE by 2030.

### SF<sub>6</sub> Emissions

The *SF<sub>6</sub> Emissions Reduction Partnership for Electric Power Systems*, initiated in early 1999, provides a forum for the electric power industry to work together with the U.S. government to reduce SF<sub>6</sub> emissions to technically and economically feasible levels. SF<sub>6</sub>, a gaseous dielectric used in circuit breakers, gas-insulated substations, and switchgear, allows for the safe transmission and distribution of electricity. As of May 2000, 58 electric utility companies had joined the partnership. (See Chapter 1, Industry.)

### State and Local Initiatives in the Electricity Sector

Many state and local governments have initiated their own programs to address climate change issues. Programs in Oregon, Idaho, and California are highlighted here.



*Design for a high-efficiency facility in Klamath, Oregon*

## Ambitious Goals—Flexible Means

According to an **Oregon** law enacted in 1997 and updated in 2000, energy facility developers may choose from several options to meet the CO<sub>2</sub> emission standards. These include building high-efficiency facilities using cogeneration, providing offset projects that avoid, reduce, or sequester CO<sub>2</sub> emissions, or paying a fee of \$2.30 per MTCE. A developer using the “monetary path” must provide funds to the **Climate Trust**, an independent, nonprofit organization that qualifies under the statutory requirements to receive offset funds and acquire CO<sub>2</sub> offsets.

In 1997 **Oregon** enacted legislation that authorizes the state’s Energy Facility Siting Council to set *CO<sub>2</sub> Emission Standards for New Energy Facilities*. Facilities for which the council has set standards include base-load plants, non-base load (peaking) plants, and non-generating energy facilities. The standard for base-load gas plants requires a net emissions rate of 0.675 pounds of CO<sub>2</sub> per kilowatt-hour, which is 17 percent below the most efficient plant in operation in the United States in 1999.

Geothermal energy has been used in **Idaho** to provide heat and water since 1892. Following the energy crisis of the mid-1970s, geothermal heating gained recognition as a viable alternative to petroleum-based energy generation. To ensure the sustainability of this resource, the Idaho Department of Water Resources created the *Boise Front Low Temperature Geothermal Resource Ground Water Management Area*. Currently, the ground water management area has geothermal projects at four locations, and the projects are saving an estimated 50.4 gigawatt-hours of electricity per year, which equates to an annual cost savings of \$1 million.

In 1997 **California** created a *Renewable Resources Trust Fund*, administered by the California Energy Commission, with the purpose of promoting renewable generation and developing a strong consumer market for renewable energy. The law authorizes the collection of \$540 million from investor-owned utilities to be used as incentives or rebates for buyers, users, producers, and promoters of renewable energy in the state. The fund provides financial incentives for 10 million megawatt-hours of renewable power per year, equating to a reduction of approximately 1.6 MMTCE of greenhouse gases, along with 140 metric tons of SO<sub>2</sub> and 1,727 metric tons of NO<sub>x</sub>, if the electricity were generated via conventional means.



# Transportation





## Chapter 4. Transportation

The United States is pursuing an array of strategies to reduce transportation-related greenhouse gas emissions. In 2000, the “big three” U.S. automakers all announced a number of important breakthroughs in the development of new more fuel-efficient vehicles. Among these were the unveiling of diesel-battery hybrid concept cars that are capable of traveling 70-90 miles per gallon (gasoline-equivalent) and commitments to more fuel-efficient Sport Utility Vehicles (SUVs).

Many of these breakthroughs depend on technology developed, at least in part, with the Federal government through the *Partnership for a New Generation of Vehicles (PNGV)*. In 2000 a new partnership, the *21<sup>st</sup> Century Truck Initiative*, was launched to develop heavy trucks aimed at doubling—and, in most cases, tripling—the fuel economy of U.S. trucks.

The Federal government also is seeking to lead by example by revamping its procurement policies to help stimulate markets in more fuel-efficient and alternative fuel vehicles. For example, the Administration recently issued an Executive Order that requires Federal agencies to reduce annual gasoline and diesel fuel consumption by at least 20 percent by the end of 2005.

At the state and local levels, governments are implementing a host of programs directed toward reducing transportation sector emissions by motivating consumer interest in fuel-efficient vehicles and promoting development patterns that reduce transportation demand and increase transit, bicycle, and pedestrian access.



New diesel-battery hybrid vehicles achieve 70 to 90 miles per gallon.

### Revving Up Hybrid Vehicle Incentives

On May 11, 2000, **Maryland** Governor Parris Glendening signed into law a new package of tax incentives for energy efficiency and renewable energy technologies. The Clean Energy Incentive Act is structured to increase the state's market for advanced technologies that save energy or generate electricity from renewable sources. Among the specific provisions included in this legislation is a \$2,000 reduction in the state titling taxes for buyers of new electric or qualified hybrid vehicles.

Accounting for 32 percent of all U.S. emissions, the transportation sector is the second largest and fastest growing source of greenhouse gases. Collectively, passenger cars and light-duty trucks contribute 58 percent of all of the sector's greenhouse gas emissions, and heavy-duty trucks contribute another 16 percent. Other sources—aviation, marine, recreational vehicles, rail, and farm equipment—account for the remaining greenhouse gas emissions.

*"Now is the time to lead the world in the emerging market for more fuel-efficient vehicles of all kinds."*

*Vice President Al Gore  
April 2000*

### Fuel-Efficient Trucks

The *21<sup>st</sup> Century Truck Initiative* is a 10-year research and development partnership that was announced by Vice President Gore in April 2000. This initiative between the U.S. government and corporate partners will seek to increase the fuel economy of four classes of vehicles that, together, account for more than 90 percent of all fuel used by U.S. trucks. The program's cost-share investments in advanced technologies will lead, within 10 years, to production prototypes that will do the following:

- Triple the fuel economy (measured in ton-miles/gallon) of heavy pickups, large delivery vans, and full-sized passenger buses (relative to today's comparable vehicles).
- Double fuel economy of 18 wheeler long-haul trucks.
- Improve safety (technologies will be designed to cut truck fatalities in half).
- Achieve superior operational performance and lower costs for truckers.
- Exceed expected emission requirements for 2010 (likely to be much more stringent than today's standards).

## Fuel-Savvy Sedans

The *Partnership for a New Generation of Vehicles (PNGV)* is a major 10-year research and development program to develop revolutionary new technologies that could triple the fuel economy (and cut carbon dioxide emissions by 67 percent) of midsize family sedans. PNGV aims to meet this stretch fuel economy goal as well as stringent criteria emissions standards by 2004 without sacrificing performance, safety, aesthetics, or affordability.

In 2000, the program achieved an important milestone when each of the participating automakers introduced concept cars that go a long way toward meeting the program's visionary goals:

■ **General Motors** introduced the Precept diesel-battery hybrid vehicle, which achieves 90 mpg using diesel fuel (equivalent to 80 mpg using gasoline).

■ **Ford Motor Company** introduced the Prodigy diesel-battery hybrid, which gets about 80 mpg using diesel fuel or the equivalent of 70 mpg with gasoline.

■ **Daimler-Chrysler** introduced the ESX3 diesel-battery hybrid, which achieves more than 70 mpg in gasoline equivalent.

To further promote the development of a market for advanced technology vehicles, the Administration has proposed a federal income tax credit of up to \$3,000 per vehicle for consumers who purchase hybrid vehicles that meet certain design criteria. This proposal has been introduced in the U.S. Congress.

## More Fuel-Efficient SUVs

Recently, U.S. automakers announced a series of commitments to improving the fuel efficiency of SUVs:

■ In April 2000, **Ford Motor Company** announced production plans for the gasoline-battery hybrid Escape, a small SUV, with

a target city fuel economy of 40 mpg. The Escape is slated for introduction to the market in 2003. In July 2000, Ford also announced that, between 2000 and 2005, it will voluntarily commit to improve the average fuel economy of its SUVs by 25 percent.

■ In August 2000, **General Motors** announced that a hybrid version of its Silverado/Sierra full-size pickup will be offered to consumers in 2004. The new vehicle is expected to be at least 15 percent more fuel-efficient than the company's conventional version. GM further announced that it intends to be the industry leader on overall fuel economy for light trucks in 2005.

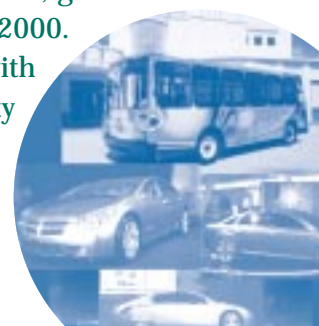
Preliminary estimates by the U.S. Environmental Protection Agency indicate that these commitments could result in cumulative emissions reductions of up to 100 MMTCE through 2020. In addition, **Daimler-Chrysler** announced that, if the Federal government offers tax incentives to make the vehicle cost-effective, it is prepared to bring out a hybrid version of its Dodge Durango SUV that would be 20 percent more fuel-efficient than its current model.

## Other Advances in the U.S. Automobile Market

Two Japanese automakers recently introduced advanced technology vehicles into the U.S. market, setting the stage for further progress in reducing greenhouse gas emissions from the U.S. transportation sector.

■ **Honda** introduced Insight, a gasoline-battery hybrid, in 1999. The Honda Insight offers fuel economy ratings of 61 mpg city and 70 mpg highway. Honda plans to sell approximately 6,500 of the cars during 2000.

■ **Toyota** introduced Prius, a compact, gasoline-battery hybrid, in August 2000. Toyota anticipates that the Prius, with fuel economy ratings of 45 mpg city





### Brewing Motor Fuel in Louisiana

Ground was broken for the first commercial biomass-to-ethanol plant in October 1998 in Jennings, Louisiana. **BC International Corporation** will use a patented, genetically engineered microorganism in its process of converting organic material to ethanol, a form of alcohol used as clean-burning motor fuel. The ethanol produced by the Jennings plant is expected to displace almost 0.5 million barrels of imported oil annually. The U.S. government invested \$11 million to help with the retrofit of an existing industrial site in Jennings. The total renovation cost is estimated to be \$90 million, for which the private sector is providing about 88 percent of the total capital investment.

### Powering Vehicle Fleets with Biodiesel

A blend of 20 percent biodiesel (an alternative motor fuel produced from renewable resources such as vegetable oil or animal fats) and 80 percent diesel fuel is referred to as B20. A one-year demonstration at a **U.S. government research center in Beltsville, Maryland**, began August 1999. Currently, all 64 diesel-powered vehicles on the east side of the facility use the B20 fuel blend. The vehicles include pick-up trucks, tractors, ride-on lawnmowers, and a compost turner.

Fuel blending is achieved on-site in underground storage tanks, and no engine conversion is required to use B20. Replacing petroleum diesel with B20 reduces carbon dioxide emissions 16 percent. B20 also reduces emissions of carbon monoxide (13 percent), particulate matter (18 percent), and sulfates (20 percent)—three pollutants that pose health risks in certain areas of the nation.

and 52 mpg highway will achieve sales on the order of 1,000 cars per month.

In addition, Honda announced plans to offer a fuel cell vehicle in 2003.

### Putting Clean Vehicles on the Streets

Over the past six years, nearly 80 communities across the country have joined the *Clean Cities* program. This voluntary, locally based, public-private partnership is accelerating the deployment of alternative fuel vehicles (AFVs) and building local AFV fueling infrastructure that can supply alcohol fuels, liquefied petroleum gas, electricity, and natural gas. The Clean Cities program counts among its successes approximately 170,000 AFVs in both public and private fleets, plus more than 4,000 alternative fuel refueling stations. In 1999, these vehicles and alternative fuels displaced approximately 170 million gallons of gasoline and diesel fuel and 310,000 MTCE.

### Leading by Example with Federal Fleets

On April 21, 2000, President Clinton signed Executive Order 13149, *Greening the Government through Federal Fleet and Transportation Efficiency*. By the end of Fiscal Year 2005, all Federal agencies operating 20 or more motor vehicles within the United States must implement a strategy for reducing their entire fleet's annual petroleum consumption by at least 20 percent, relative to FY 1999 petroleum consumption levels.

The Executive Order further directs the agencies to establish fleets by 2005 that use alternative fuels a majority of the time. In addition, agencies must increase the average fuel economy rating of their light-duty vehicle acquisitions by at least 1 mile per gallon (mpg) by 2002 and 3 mpg by 2005. They are required to explore a variety of other approaches to reducing fuel consumption, such as substituting cars for light-duty trucks, increasing vehicle load factors, and reducing vehicle miles traveled.

By reducing America's consumption of petroleum by some 14 million gallons and reducing greenhouse gas emissions by an amount equal to 160,000 MTCE, greening the Federal fleet will enhance U.S. energy security and reap significant environmental benefits.

## Developing Cleaner Fuels

In 1999, President Clinton issued the Executive Order that accelerates federal efforts to develop bioproducts and bioenergy. In the transportation sector, program goals include the development of low-cost biomass feedstocks and cost-competitive conversion technologies for producing liquid fuel from agricultural residues, forestry wastes, and energy crops. Since biofuels produce almost no net carbon on a life cycle basis, they are a promising supply side option for reducing carbon emissions in transportation.

Through 1998, the use of ethanol blends in gasoline is estimated to have displaced 1.2 quads of oil-based fuels (worth \$12 billion), thereby reducing carbon emissions by as much as 4 MMTCE. If Federal biofuels goals are met by 2010, annual emission reductions from using clean fuels will approach 3.4 MMTCE.

Through the *Ultra Clean Transportation Fuels Program*, U.S. government offices are researching near-term petroleum-based transportation fuel options, intermediate options that are based on petroleum and other fossil fuel feedstocks, and long-term options for renewable fuels such as biofuels.

Through the *Hydrogen Research Program*, the Federal government is accelerating advances in producing low-cost hydrogen production and storage systems—prerequisites to the widespread use of hydrogen as a fuel. Given the recent demonstration of high-performance Proton Exchange Membrane fuel cell systems by **Daimler-Chrysler**, **Ford Motor Company**, and other companies, hydrogen



*On April 21, 2000, President Clinton signed two Executive Orders aimed at reducing pollution generated by Federal fleet vehicles and Federal commuting.*

has the potential to create niche fuel markets in the near future.

## Commuter Choice Benefits Package

The Federal government's *Commuter Choice Leadership Initiative*, launched in 2000, encourages employers to offer a broad range of commuting options to their employees as part of company benefits packages. Some of the options include teleworking, carpooling and vanpooling services, transit vouchers, and cash in lieu of parking spaces. In support of the Commuter Choice Leadership Initiative, the U.S. government is launching a partnership program with employers with the goal of achieving partnerships with 500 businesses by the end of 2002 and 1,000 businesses by the end of 2003.

On April 21, 2000, President Clinton signed Executive Order 13150, *Federal Workforce Transportation*, which will reduce Federal employees' contribution to traffic congestion and air pollution. This order directs that Federal agencies in the Washington, D.C., area offer their employees up to \$65 per month in transit and vanpool benefits.

As part of the President's recently announced *Livability Agenda*, the Administration is increasing substantially the investment in trans-



### Intel-igent Commuting

The **Intel Corporation's** comprehensive and aggressively promoted *RideShare* program is a model for companies nationwide. The program promotes the use of transit, biking, walking, skating, and telecommuting. Participation is encouraged at Intel's facilities in Arizona, California, New Mexico, Oregon, and Washington. By taking the initiative in promoting transportation alternatives, Intel has reduced traffic congestion in the communities where its facilities are located.

The program provides preferential parking for carpools and vanpools, free or subsidized access to transit, and shuttles to and from transit and between Intel facilities. In addition, employees are encouraged to work from home or switch to compressed schedules to reduce the number of their commutes.

Employee response has been remarkable. Forty percent of the employees in Arizona and Washington and 32 percent in Santa Clara, California, participate. Collectively, these programs have avoided 20 million miles of vehicle travel and the resulting pollution. The success of Intel's *RideShare* program demonstrates the influential role that major corporations can play in environmental policy and in making it easy and convenient for employees to use alternative modes of transportation.

### Mixed-Use Approach

The city of **Portland, Oregon**, is taking a holistic approach to reducing emissions from transportation. By developing new housing units in the central city area, the city aims to decrease the number of commuter trips by suburban dwellers. Portland officials estimate that for each 2,500 units of housing created in the downtown area, a total of 303 MTCE will be reduced. This translates into a total reduced fuel cost of \$180,000 for those households.

portation programs that will help reduce greenhouse gas emissions by improving transportation and land use planning, strengthening existing transportation systems, and promoting broader use of transportation alternatives. These investments include \$6.1 billion for public transit.

### Relieving Congestion and Reducing VMT

The \$1.6 billion per year *Congestion Mitigation and Air Quality Improvement (CMAQ)* program funds projects that reduce congestion and greenhouse gas emissions, as well as other air pollutants. Under CMAQ, the cities of Dallas and Fort Worth, Texas, converted their public sector vehicles to alternative fuels. The Philadelphia Bicycle Network designed and constructed a city-wide network of bicycle routes. New York City obtained \$1.9 million in CMAQ matching funds to purchase a ferry and provide operating assistance for freight operations to remove 54,000 truck trips annually from the New York and New Jersey streets.

*"Through public-private partnerships and a new agenda supporting the future production and use of rail rather than automobiles, the City of New Orleans is aggressively working to showcase progressive energy-saving efforts. "*

*The Honorable Marc H. Morial  
Mayor of New Orleans, Louisiana*





### Ride the Wave of the Future—the Electrowave

The easy availability of **Florida's** first electric transit system in the rapidly growing South Beach community has residents and tourists abandoning their cars in favor of the nonpolluting *Electrowave* shuttle. The *Electrowave*, which was introduced in 1998, is a project of the City of Miami Beach, the Miami Beach Transportation Management Association, and business and community leaders who are concerned about the impact of increasing traffic congestion and resulting pollution on scenic South Beach, the state's second largest tourist attraction.

A recent rider survey documented that the availability of *Electrowave* is enabling nontransit users to change their traveling habits, with 90 percent stating that they did not use public transportation in the past. The *Electrowave* consists of a fleet of 11 electric buses with amenities such as air conditioning and state-of-the-art handicapped accessibility.

The *Electrowave's* unqualified success has exceeded all expectations. In its first year of operation, the emission-free shuttle buses carried 1.5 million one-way passengers, resulting in the avoidance of 900,000 vehicle miles, substantial reductions in the emission of both CO<sub>2</sub> and NO<sub>x</sub>, and less traffic congestion.



# Agriculture & Forestry



## Chapter 5. Agriculture and Forestry

**A**gricultural activities contribute about 7 percent of all U.S. greenhouse gas emissions (not including fuel used on farms) and are sources of methane and nitrous oxide as well as carbon dioxide. Greenhouse gas emissions from the agriculture sector can be reduced through implementation of technologies that improve land and resource management practices; improve energy efficiency on farms, forests, and ranch lands; abate methane emissions directly from ruminant animals and manure handling; and reduce nitrous oxide emissions from soils.

Unlike other sectors of the U.S. economy, agricultural and forestry activities can also actively remove carbon from the atmosphere. In its submission to the United Nations Framework Convention on Climate Change Secretariat, August 1, 2000, the U.S. government reported that based on updated inventory data for 1997, 310 million metric tons of carbon (MMTCE) were sequestered in managed forests and 24 MMTCE on crop and grazing lands, for a total of about 18 percent of the U.S. greenhouse gas emissions for the year. Most of the carbon sequestration occurred in the forestry sector (approximately 90 percent), primarily from tree growth and forest soils.

### Bioproducts and Bioenergy

Scientific advances in agriculture, forestry, and other biological sciences are making bioproducts and bioenergy technically feasible and economically viable. In 1999, the President issued the Executive Order on *Bioproducts and Bioenergy* coordinating Federal efforts to accelerate these 21<sup>st</sup> century technologies, which can convert sustainably grown crops, trees, and other biomass into fuels, power, and products. The Administration set a goal of tripling U.S. use of bioproducts and bioenergy by 2010. Meeting this goal could create \$15 to \$20 billion in new income for farmers, forest landowners, and rural America, and reduce annual greenhouse gas emissions by 100 MMTCE—the equivalent of taking more than 70 million cars off the road. (See also Chapter 3, Electricity, and Chapter 4, Transportation.)

Complementing the President's Executive Order is the *Biomass Research and Development Act*, signed on June 20, 2000. The Act authorizes \$49 million in funding and establishes a technical advisory committee and agency board to coordinate activities related to biobased products and bioenergy.

The U.S. government's *Commodity Credit Corporation (CCC)* will accelerate commercial investment in innovative bioproduct and bioenergy technologies by providing up to \$100 million in FY 2000 and up to \$150



## Biotechnologies: Real Products, Real Applications

A number of biobased products are already on the market. For example:

■ U.S. government scientists married cornstarch to a synthetic chemical to create a product so thirsty, it can absorb 2,000 times its own weight in water. The absorbent compound, called SuperSlurper, is used as an electrical conductor in batteries, as well as fuel filters, baby powders, and wound dressings. Superabsorbents are now a \$2 billion per year market.

■ Xanthan gum is a natural polymer fermented from glucose, by the action of a microorganism, *Xanthomonas campestris*. A small amount of the gum is sufficient to turn a free-flowing liquid into a viscous solution, which is widely used as a thickening agent in foods and also in non-food uses. Sales of xanthan are approximately \$80 million a year.

■ U.S. government scientists are working with **Lambent Technologies Corporation** of Norcross, Georgia, to develop new biodegradable hydraulic fluids made from oil seeds such as soybeans and sunflowers. This new lubricant has the industrial quality and performance characteristics of current petroleum-based hydraulic fluids.

Many others are in the pipeline, such as the following:

■ Fantesk is a starch-based chemical that can replace the resins used to make particle board, reducing or eliminating formaldehyde emissions, making the product safer for the consumer and the environment.

■ Hypoallergenic latex made from the domestic guayule plant could have a significant impact on the \$3.1 billion U.S. latex glove market. Guayule, a native plant of the desert Southwest, could stimulate economic development on Native American lands.

million in FY 2001 and 2002 in incentive payments to ethanol and other bioenergy producers to expand production of biobased fuels.

## Methane and Nitrous Oxide Mitigation

The U.S. government also is engaged in a variety of activities directed toward reducing emissions of methane and nitrous oxide associated with agricultural production. The *AgSTAR* Program provides important tools, guidance, and methods to encourage the use of methane recovery (biogas) technologies at certain confined animal feeding operations.

The *Ruminant Livestock Efficiency Program (RLEP)* promotes livestock management strategies that result in lower methane emissions per unit of milk or meat produced. In addition, many of the practices recommended by the RLEP for improving forage production remove carbon dioxide from the atmosphere by storing carbon in the soil as organic matter.

The *Nitrogen Fertilizer Efficiency* program is exploring alternative systems of nitrogen management for a variety of crops including corn, cotton, potatoes, and rice in order to reduce nitrous oxide emissions.

## Carbon Sequestration

Carbon sinks will play a critical role in helping the world meet the challenge of climate change. Significant gains in carbon sequestration and environmental co-benefits can be made through improved management of our forest resources. Research priorities include developing forestry practices that conserve soil carbon; increasing the potential for soils, forests, and forest products to sequester carbon; developing sustainable biomass production and management systems; and improving forest carbon inventory and accounting systems. The U.S. government has begun to analyze the net carbon effects of various conservation and environmental programs and to determine how they can be enhanced

to foster greater sequestration. Below are descriptions of some of these programs.

From its inception in 1985, the *Conservation Reserve Program (CRP)* has planted 3.5 million acres (1.4 million hectares) of trees on cropland. The entire 36.4 million acres enrolled in the CRP is estimated to be sequestering 11.3 MMTCE per year. Additional benefits from eliminating nitrogen fertilizer applications have been estimated at 1.8 MMTCE per year.

The *Wetlands Reserve Program (WRP)* offers private landowners financial incentives to restore wetlands in exchange for discontinuing the land's use for crop production. The *Swampbuster* program has preserved more than 5.8 million acres of wetlands that would otherwise have been converted to agricultural use.

From 1991 to 1997, more than 1 million acres of trees were planted through the *Forestry Incentives Program (FIP)* program. Another 273,000 acres of trees were planted through the *Stewardship Incentives Program (SIP)* program.

Research indicates that improved management of cropland soils through reduced tillage, erosion prevention, and cropping systems can sequester significant quantities of carbon. Improved management of grazing lands also can contribute significant sequestration benefits. Increasing soil organic content not only provides climate change benefits, but also improves water holding capacity, fertility, and productivity—helping soils resist erosion, keeping nutrients and pesticides from washing into water bodies, and reducing flooding.

## Helping Farmers Second-Guess Mother Nature

Unpredictable variations in weather and climate hinder efforts to manage resources effectively for agricultural uses. The U.S. government is working to adapt seasonal cli-

## Conservation Practices for Storing Carbon

Resource conservation practices on farms produce environmental benefits such as improving soil, water, and air quality on and off the farm. Economic benefits accrue from reducing the number and intensity of field operations, saving money, time, and labor. These practices, which also can enhance carbon storage in soil, include the following:

- Using conservation tillage and no-till conservation systems
- Rotating crops and incorporating small grains, hay, legumes, or other crops into rotations
- Planting cover crops
- Managing nutrients and irrigation efficiently and effectively
- Installing permanently vegetated conservation buffers, such as windbreaks, grass waterways, filter strips, and riparian buffers
- Restoring or protecting wetlands
- Converting marginal agricultural land to perennial grassland or forest

mate forecasts intended for a general audience to forecasts that will be specific to agriculture. The primary challenges are to apply the predictions to farms at time periods that are relevant to agricultural decision-making and to establish impacts on soil water and plant productivity. This information will provide opportunities for proactive planning to exploit favorable climate conditions and mitigate adverse climate extremes. The result will be information that can be used to determine the number of livestock that a farm can support during an upcoming season, the need for purchase of outside forage, decisions on winter wheat or other grains, fertilizer needs, and erosion protection.



# Research





## Chapter 6. U.S. Global Change Research Program

**T**he U.S. Global Change Research Program (USGCRP) seeks to provide a sound scientific understanding of the human and natural forces that influence the Earth's climate system, and thus provide a sound scientific basis for national and international decision-making on global change issues. The USGCRP seeks to observe, understand, predict, and assess the critical natural and human-induced dynamic states and trends of the Earth's global environmental systems across a wide range of time and spatial scales.

This multi-agency National Research Program is overseen by the National Science and Technology Council, the Office of Science and Technology Policy, and the Office of Management and Budget.

### FY 2001 Budget Highlights

For FY 2001, the President is requesting \$1.74 billion for the USGCRP, an increase of \$41 million above the amount enacted for FY 2000. Of this, \$845 million is for scientific research and improvements to surface-based monitoring. Another \$897 million is for development of Earth-observing satellites and associated data systems to monitor climate change and other global changes.

Important highlights include the following:

- \$28 million to enhance surface-based climate observations, including creation of a climate reference network to provide for the first time automated, simultaneous, and ideally located measurements of changing temperatures, precipitation, and soil moisture. Measurements of atmospheric trace gases, aerosols, ocean temperatures, and ocean currents also will be expanded.
- \$308 million for research on changes in the Earth's water cycle, which is one of the primary determinants of the Earth's climate. The launch of the EOS Aqua spacecraft in December 2000 will provide new global measurements of humidity, cloud properties, sea ice, precipitation, soil moisture, runoff, and snow to support this research.
- \$224 million for research on the potential impacts of climate change and other stresses on forests, coastal areas, croplands, and other ecosystems. New studies will improve our understanding of the relationships among land cover, land use, climate, and weather, and on identifying "thresholds" for significant changes in ecosystems.
- \$229 million for the multi-agency carbon cycle science initiative begun in FY 2000. This request includes funds to study how carbon cycles between the atmosphere, the oceans, and land, and the role of farms,

## United States: Domestic Progress on Climate Change

### Objectives of the USGCRP

- Determine the origins, rates, and likely future course of natural and anthropogenic global changes.
- Increase understanding of the combined effects of multiple stresses on ecosystems.
- Understand and model global environmental change and its processes on finer spatial scales and across a wide range of time scales.
- Address the potential for surprises and abrupt changes in the global environment.
- Understand and assess the impacts of global environmental change and their consequences for the United States.

forests, and other natural or managed lands in capturing carbon.

■ \$485 million for research on the Earth's climate system. This includes funds to study the interaction of long-term climate change and shorter-term patterns of climate variability, investigation of the radiative effects of clouds on climate, improving model simulations of the Earth's climate, and collection and analysis of new satellite observations of clouds, aerosols, trace gases, land surface and ocean properties, ice extent and topography, and the Earth's radiation budget.

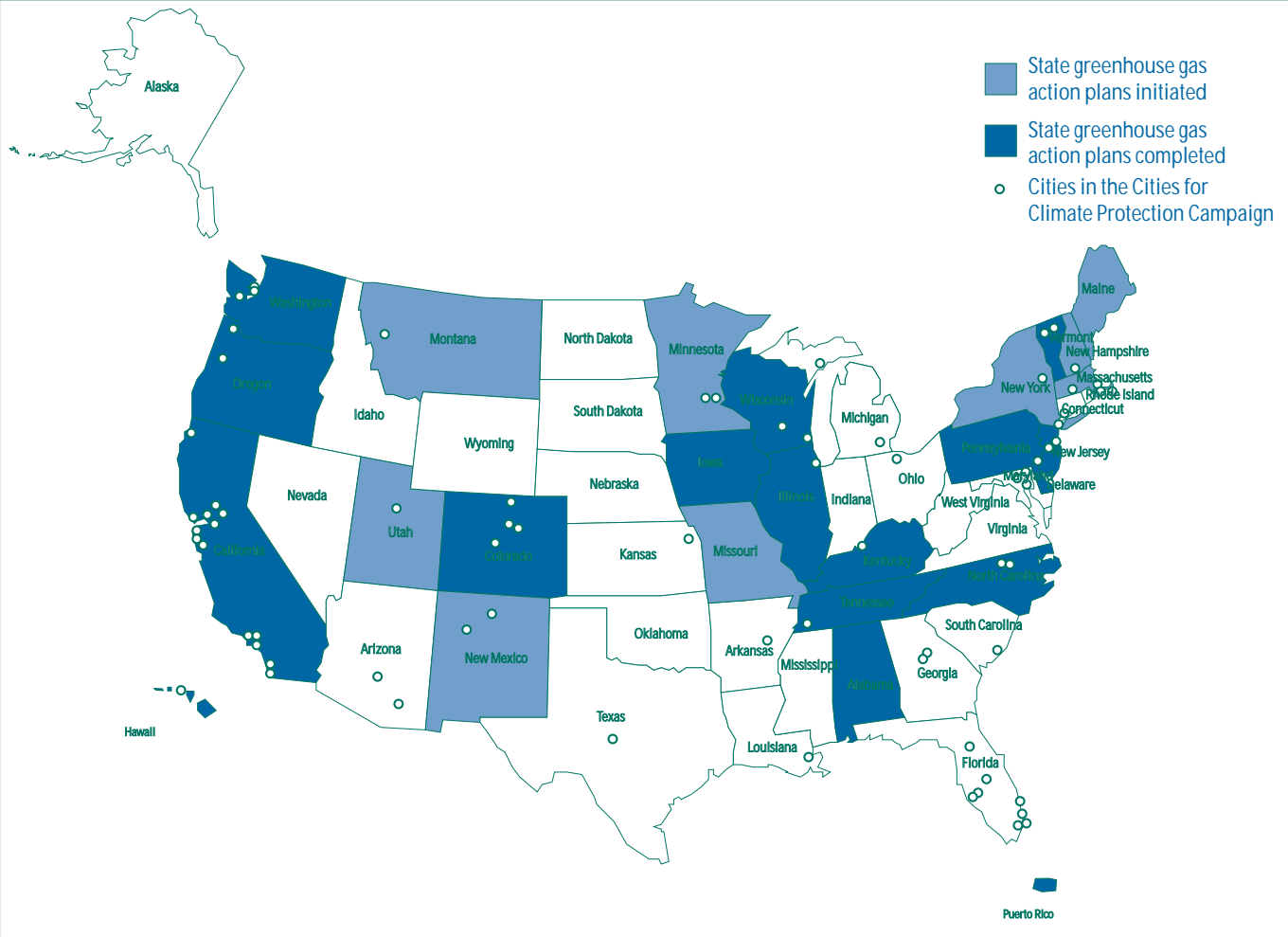
Other USGCRP-sponsored research focuses on the long-term climate record of the Earth, the human dimensions of global change, and changes in atmospheric chemistry.

### The National Assessment

The National Assessment of the potential consequences of climate variability and change undertaken by the USGCRP over the past several years has examined the potential ecological and socioeconomic impacts of climate change on the United States, and the degree to which particular regions and sectors of the nation are vulnerable to such change. Thus the National Assessment is providing important information to support decisions on how best to adapt and prepare for both the next few decades and the next century. In addition, the National Assessment will identify key information gaps and research needs (i.e., information that is still required to answer questions of interest to decision-makers).

The initial major product of the assessment process is a *National Assessment Synthesis Report*. This report has completed multiple layers of peer-review by technical experts and U.S. government agencies, and was posted on the World Wide Web for a 60-day public comment period. The assessment included regional workshops with a broad range of stakeholders, plus regional and sector analyses (Human Health, Water Resources, Coastal Areas, Forests, and Agriculture).

# State Governments and Localities Taking Action on Climate Change



Thanks in part to the U.S. government's State and Local Climate Change program, 26 state governments have initiated voluntary action plans to address climate change, and 78 cities and counties currently participate in the International Council for Local Environmental Initiatives' (ICLEI) Cities for Climate Protection Campaign.



## For More Information

### Advanced Turbine Systems

[http://www.oit.doe.gov/bestpractices/learn\\_others/pdfs/july\\_99.pdf](http://www.oit.doe.gov/bestpractices/learn_others/pdfs/july_99.pdf)

### Agricultural Research Service

<http://www.nps.ars.usda.gov/programs/programs.htm?NPNUMBER=204>

### Best Practices Program

<http://www.oit.doe.gov/bestpractices/>

### Bioproducts and Bioenergy

[http://www.eren.doe.gov/bioenergy\\_initiative/page1.html](http://www.eren.doe.gov/bioenergy_initiative/page1.html)

<http://www.bioproducts-bioenergy.gov/>

<http://www.ott.doe.gov/biofuels/>

<http://www.eren.doe.gov/biopower/main.html>

### Brightfields

<http://www.eren.doe.gov/brightfields/>

### Clean Cities

<http://www.cccities.doe.gov/>

### Climate Challenge

<http://www.eren.doe.gov/climatechallenge/>

### Combined Heat and Power Challenge

<http://www.oit.doe.gov/chpchallenge/>

### Conservation Reserve Program

<http://www.fsa.usda.gov/dafp/cepd/crpinfo.htm>

### Distributed Energy Resources

<http://www.eren.doe.gov/der/>

### EnergySmart Schools

<http://www.eren.doe.gov/energysmartschools/>

### ENERGY STAR

<http://www.energystar.gov>

### ENERGY STAR Buildings (including schools)

<http://www.epa.gov/buildings/>

### ENERGY STAR Homes

<http://yosemite.epa.gov/appd/eshomes/eshaware.nsf>

### ENERGY STAR Products

<http://www.energystar.gov/products/index.html>

### ENERGY STAR Small Business

<http://www.lisboa.com/clients/epa/hp.nsf>

### Environmental Protection Agency's (EPA) Climate Protection Division

<http://www.epa.gov/cpd>

### EPA's Global Warming Site

<http://www.epa.gov/globalwarming/>

### EPA's Methane and Agriculture-based Programs

<http://www.epa.gov/methane/>

### Federal Energy (Executive Order 13123)

<http://www.whitehouse.gov/Initiatives/Climate/fedenergy.html>

### Forest Service Cooperative Programs

<http://www.fs.fed.us/spf/coop/programs.htm>

### Geothermal Heat Pump Consortium

<http://www.ghpc.org/>

### Greening of the White House

<http://solstice.crest.org/environment/gotwh/index.html>

### Hydrogen Research Program

<http://www.eren.doe.gov/power/hydrogen.html>

### Industries of the Future

<http://www.oit.doe.gov/industries.shtml>

### Million Solar Roofs

<http://www.eren.doe.gov/millionroofs/background.html>

### Natural Resources Conservation Service

<http://www.nrcs.usda.gov/>

### Partnership for Advancing Technology in Housing

<http://www.pathnet.org/>

### SF<sub>6</sub> Emissions Reduction Partnership for Electric Power Systems

<http://www.epa.gov/highwp1/sf6/>

### Solar Buildings

<http://www.eren.doe.gov/solarbuildings/>

### Solar Parabolic Trough Technology

<http://www.eren.doe.gov/femp/prodtech/parafta1.html>

### Solar Photovoltaic Energy Systems R&D

<http://www.eren.doe.gov/pv/>

### State Actions for Promoting Energy Efficiency

[http://www.epa.gov/appdstar/state\\_local\\_govnt/state\\_outreach/](http://www.epa.gov/appdstar/state_local_govnt/state_outreach/)

### Steam Challenge

<http://www.oit.doe.gov/bestpractices/steam/>

### Superconductivity Partnership Initiative

<http://www.eren.doe.gov/superconductivity/>

### USDA Global Change Program Office

<http://www.usda.gov/agency/oce/gcpo/index.htm>

### Voluntary Aluminum Industry Partnership

<http://www.epa.gov/highwp1/vaip/>

### Waste Wise

<http://www.epa.gov/wastewise/main.htm>

### Weatherization Assistance Program

[http://www.eren.doe.gov/buildings/weatherization\\_assistance/index.html](http://www.eren.doe.gov/buildings/weatherization_assistance/index.html)

### White House Climate Change Web Site

<http://www.whitehouse.gov/Initiatives/Climate/main.html>

### Wind Energy Systems

<http://www.eren.doe.gov/wind/>

### Wind Powering America

<http://www.eren.doe.gov/windpoweringamerica/>

