Safe and Secure

MEETING AMERICA'S ELECTRICITY NEEDS

ENVIRONMENTAL DEFENSE
finding the ways that work

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Executive summary

Besides the increased security at airports and on airplanes, there are few areas where the changes that resulted from September 11 figure more prominently than the energy debate.

The discussion now is largely centered on what energy policies make us more secure and safe. All sides agree the United States needs policies that will provide greater energy independence from foreign oil.

However, the question before Congress is what type of domestic energy sources to encourage. Will our energy policy continue to subsidize technology that is vulnerable to terrorism, makes our economy more vulnerable to supply disruption, and accelerates the rate of heat trapping gases in the atmosphere, or will we redirect our energy investment to safer, cleaner resources?

Centralized power plants and their supply infrastructure are vulnerable targets for terrorism. The Bush Administration plan and the House bill to meet America's energy needs are mostly about subsidies for the building of more coal, gas, and nuclear plants. However, centralized plants, both fossil fuel and nuclear, as well as the infrastructure associated with them, such as pipelines, transmission lines, and liquified natural gas tankers are vulnerable targets for terrorists.

For example, in late November 2001, the FBI announced a generalized threat to natural gas pipelines. The United States has a total of 1,280,000 miles of natural-gas pipelines and 156,210 miles of electrical transmission lines. Many of these pipelines and transmission lines are located in rural or wilderness areas and so are not under constant visual supervision, leaving them vulnerable to accidental or intentional damage causing disruption.

Moreover, in his 2002 State of the Union Speech, President Bush revealed that U.S. soldiers in Afghanistan had found diagrams of U.S. power plants. The Nuclear Regulatory Commission warned nuclear power plant operators that an attack on a nuclear reactor by terrorists was possible in the near future. Analyses show that plants are vulnerable to both attacks from hijacked airplanes and more conventional terrorist tactics.

A well-executed attack on plants could result in great loss of life. But a lesser attack on smaller facilities could significantly affect the nation's economy. Virtually any region would suffer major, extended blackouts if more than three key substations were destroyed. Some power would be restored quickly, but the region would be subject to rolling blackouts during peak demand periods for many months.

In October, a single man fired a bullet into the Trans-Alaska pipeline, causing 150,000 gallons of oil to spill and forcing the line to be shut down for repair. A terrorist bombing could do much more damage to the environment and be much more difficult to intercept than an intoxicated man with a rifle.

Global climate change also threatens national security

In addition, the possibility of global climate change is another threat to national security, for it is, over time, as much a risk to the health and safety of Americans as are extremists' bombs. The United Nations Secretary General has warned that

"tomorrow's forecast" includes: melting polar ice caps and rising sea levels, threatening beloved and developed coastal areas with erosion; extreme weather causing billion-dollar calamities; and the spread of infectious diseases such as malaria and yellow fever. This forecast is not science fiction. "It is a sober prediction, based on the best available science."

In response to a request from the President, the National Academy of Sciences reaffirmed the mainstream scientific view that "greenhouse gases are accumulating in the earth's atmosphere as a result of human activities and that the earth is getting warmer and human activity is largely responsible." The report goes on to say that the leading cause of global warming is the burning of fossil fuels. Both the North American Commission for Environmental Cooperation and an independent analysis by American groups estimates that the Administration's energy plan could result in an increase of more than 30 percent in the emissions of carbon dioxide from the U.S. electricity sector.

Without any discussion of his energy plan or the energy security issue, on February 14, 2002, President Bush put forward his administration's proposals to deal with the issue of global warming. His proposals include some modest additional tax incentives to encourage climate friendly consumer behavior, and some additional research and development funding. As a target for his voluntary program, the President has chosen a continued increase in our U.S. increases in greenhouse gas emissions. The President also again aggressively ruled out any U.S. participation in the Kyoto accord, the global treaty under which the rest of the world is working to reduce heat trapping greenhouse gas pollution.

An energy plan that increases security

It is disappointing that after September 11th neither President Bush nor the House altered their proposals which would increase subsidizing the large, vulnerable, and dangerous energy facilities rather than supporting the more decentralized and safer resources that are ready now to meet the nation's needs and to reduce the threat of climate change. This report, in contrast to those plans, offers an energy plan that addresses our country's changed security needs.

The Bush Administration has argued that the United States will need to build 1300 or more new power plants over the next 20 years. Many studies have concluded that alternatives to such supply-side approaches are available, alternatives that combine improved efficiencies, conservation and increased development of renewable resources. For example, a program for boosting renewable energy with a 20 percent Renewable Portfolio Standard, combined with efficiency and cogeneration, would permit the United States to avoid building 975 new power plants, to retire 180 existing coal burning plants, close 14 existing nuclear plants, and eliminate hundreds of thousands of miles of natural gas pipelines that would otherwise be required. These alternatives would also have the direct result, as described in this paper, of providing power that was both cleaner and much less vulnerable to disruption or terrorism. These alternatives, therefore, can improve both our energy and our economic security.

Congress and the Administration should work to create a renewable energy economy, with increased efficiency investments and cogeneration, aligned on a more distributed basis that would make the nation's electricity grid a far less inviting target for future terror attacks.

The energy policy presented in this report also reduces the threat of global warming. The earth is already beginning to show the effects of global climate change, and while the United States sits on the sidelines, responsible nations are taking action. As the world's largest producer of heat trapping greenhouse gases, America must do its share to address the issue. The Administration's proposals simply don't begin to do that. A concentrated effort to shift our power production in the direction of less carbon intensive fuels, particularly to renewable sources, is the only policy approach that can begin to deal with the reality of global warming and both economic and energy security.

Below are specific recommendations made in this report.

TAP PLENTIFUL, AFFORDABLE RENEWABLE ENERGY RESOURCES

The Department of Energy finds that 12 states in the midsection of the country have enough wind energy potential to produce nearly four times the amount of electricity consumed by the nation in 1990. The U.S. Geological Survey estimates that the country's reserves of geothermal energy are thousands of times larger than our domestic reserves of coal.

Power from renewable resources is also affordable. The price of wind power has dropped by more than 90 percent since the early 1980s and is projected by the Department of Energy to drop by an additional 20 to 40 percent by 2005. The best wind resources from the Midwest, Northwest, and even some selected locations in the Northeast cost 3 cents or less per kilowatt-hour. These prices compare very favorably with those of the new coal plants that the House-passed bill and the Administration propose to subsidize. Moreover, emissions from coal plants have associated with them a number of costs not included in the price of electricity, such as the health costs of respiratory diseases like asthma, acid rain, visibility degradation at national parks, and global warming .

Renewable energy facilities are immune from the risk of a catastrophe from a terrorist attack. Renewables also tend to provide power through a less centralized distribution system and so can lessen the overall exposure of transmission lines. Many of the nation's experts believe that a renewable portfolio standard is needed to provide secure energy for America. Renewable energy is a cost-effective way of reducing carbon dioxide emissions according to the Intergovernmental Panel on Climate Change (IPCC).

We advocate a policy that utilizes a tradable national renewable portfolio standard to allow the country to tap the best and cheapest renewable resources to meet 20 percent of the nation's electric needs by 2020. To make it easier to meet the standard, we favor incentives for small residential and farm resources, along with a commitment by the federal government to use its purchasing power to promote renewable energy.

ENERGY EFFICIENCY REDUCES THE NEED FOR NEW FOSSIL FUEL POWER PLANTS

Another aspect of a safe and secure energy policy is energy efficiency. The United States has increased its energy efficiency by almost a third over a fifteen-year period. There are a number of energy efficiency success stories, but perhaps the potential of efficiency is best illustrated by the experience for California last year. When faced with the risk of blackouts, Californians reduced their peak demand

and energy use fell in every month of 2001 even after adjusting for the economic slowdown and changes in the weather. During the critical summer months, when electricity shortages were considered most likely, Californians' conservation efforts cut peak demand by 8 to 14 percent. We suggest specific provisions for national energy legislation to increase energy efficiency in the electricity sector, including an energy savings program for schools, incentives to construct energy-efficient buildings, and new efficiency standards for appliances.

Energy efficiency is the ultimate secure resource. Efficiency is dozens of specific technologies and actions, from better lightbulbs to more efficient motors. None involves building plants that could be bombed by terrorists or requires the transport of dangerous fuels or waste. Rather, the benefits of efficiency to the energy system are derived at the point of use without the need for transporting energy that is not needed. Moreover, by 2020, at "no net cost to the economy," efficiency could cut carbon dioxide emissions from electric generation by 13 percent below current levels.

FACILITATE COGENERATION

We also advocate that the Congress include provisions in national energy legislation that promotes cogeneration by establishing uniform and nondiscriminatory interconnection standards. Cogeneration, sometimes called combined heat and power, is a method to get more efficiency from power or industrial boilers. Cogeneration harnesses the heat and steam normally discarded when electricity is generated and redirects it to other uses, like heating industrial boilers or buildings. The efficiency of cogeneration plants results in 50 to 65 percent less energy use than separate power generation and industrial boiler technologies.

The security benefits of increasing the use of cogeneration are obvious. Cogeneration makes use of existing facilities reducing the need to build new facilities and to spend money guarding such new plants that are additional potential targets for terrorists. The ability of cogeneration to dramatically decrease emissions of carbon dioxide is illustrated by British Petroleum's planned construction of new power and steam cogeneration facilities at its Houston area facilities. Cogeneration allows BP to meet the stringent NO_x emission reductions required under the area's clean air plan, while reducing carbon dioxide (CO_2) emissions by 727,000 tons per year at no additional cost.

BREAK DOWN BARRIERS TO DISTRIBUTED ENERGY

The security and climate benefits of renewable energy, energy efficiency, and cogeneration can be enhanced if they are organized in a distributed manner. Distributed energy is the practice of placing energy resources at or near the end user's premises. It is possibly best defined in contrast to large central station power plants that are connected to end users through a system of transmission and distribution wires. Congress should direct the Federal Energy Regulatory Commission and state utility commissions to reduce technical, business practice, and regulatory barriers to distributed energy and require net metering to facilitate distributed resources.

Several of the benefits of distributed energy also make the electric system more secure. By definition, distributed energy is small, modular, and distributed; that is, energy sources are dispersed throughout the grid rather than being concentrated

in large targets. This dispersal throughout the electric system not only reduces the need for new transmission facilities but also lessens the impact of any attacks on major transmission facilities. Distributed energy resources are also less inviting targets because an outage has less widespread impacts.

Increased deployment of distributed energy can improve air quality by cutting carbon dioxide emissions in several ways. One climate change benefit of distributed power is a reduction in line losses, which means less generation is needed to supply a given demand and thus fewer carbon dioxide emissions from generation. Between 5 and 15 percent of electricity generated is lost during traditional transmission and distribution.

POLICY INSTRUMENTS

In our judgment, the most effective approach to diminishing our vulnerability to terrorism and global climate change would be to cap our energy-related emissions, including the greenhouse gas carbon dioxide, and to provide flexible means to achieve the reductions required by such caps. Such an approach would provide regulatory certainty and economic incentives to facilitate the investments necessary to help deal with energy security concerns, as well as reduce vulnerability to uncontrolled climate change.

We will continue to advocate for such policies. As the Administration has now proposed its own version of a cap and trade approach (excluding however, carbon dioxide), and the Senate has pending bills that would lower all four principle emissions from power plants, we expect additional debates on this approach. Unfortunately, none of these efforts are occurring within the energy bill discussions, so in this report we offer other practical steps for moving forward within the energy bill debate—steps which would result in cleaner and safer power generation than either the Administration/House bill—or in many cases the current Senate bill as well.

Introduction

In some ways, September 11, 2001 changed everything about the debate over a national energy policy. In other ways, it changed nothing.

Besides the increased security at airports and on airplanes, there are few areas where the changes that resulted from September 11 figure more prominently than the energy debate. For instance, six weeks after the attack on the World Trade Center, President George W. Bush added national security as a reason for Congress to pass his energy plan, released earlier in May. According to President Bush, "We need to be more self-reliant and self-sufficient. . . . It's in our national interest to get a bill to my desk, and I urge the Senate to do so."[1] Not to be outdone, Senate Majority Leader Tom Daschle responded, "Democrats have a plan that reduces our dependence on foreign oil."[2]

We agree with President Bush and Senator Daschle that greater energy independence—that is, more domestic energy production— is important to national security. But this aspect—domestic sources of energy—of the United States' energy security can be met by any combination of domestic resources: fossil fuel and nuclear or homegrown renewable; building new power plants or using existing resources more efficiently. In fact, from our perspective, the most cost-effective and flexible way to provide incentives for less vulnerable energy generation is to place a permanent limit on emission of heat trapping gases and other pollution from power generators, and to couple that with compliance flexibility for companies as they produce energy within those emissions limits. Such caps would provide real incentives to find cleaner sources of energy, and as this report demonstrates, such cleaner sources are inevitably more secure. Such an approach would both stimulate a faster transition to energy that is cleaner and more safe and secure and begin to reduce a real threat to our planet—uncontrolled climate change. We can, and should, recognize that energy policy is climate policy and deal with both at the same time. And we should recognize that to deal with both is to make significant strides toward energy security.

Congress and the administration may give serious consideration to such emissions caps during the current session of Congress, as bills to do so are being discussed in the Senate, and the administration has recently proposed its own approach to capping emissions from three of the four primary pollutants generated by power plants. Unfortunately, both efforts are occurring outside the energy security debate. We will continue to urge actions on caps.

In this paper, however, which focuses on the production of electricity, we look at key differences in the three leading proposals for a national energy policy, President Bush's policy proposal and the Senate (S. 1766) and House (H. R. 4) bills affecting both the new threat of terrorism and the growing threat of climate change. We also suggest improvements, not included in any of the three, which should be added to any national energy legislation.

Many of these suggestions have been proposed by leading government research centers, such as the U.S. Department of Energy's national energy laboratories, and other environmental organizations, such as the Union of Concerned Scientists, the Renewable Energy Policy Project, and the Natural Resources Defense Council. While this report deals only with electricity, additional work by Environmental Defense is examining steps that can be taken to reduce our use of

liquid fuels in the transportation sector. In addition, while the report does not discuss the additional local health and economic impacts of energy generation (other than relative costs), it is clear that safer energy sources would also provide significant local air quality benefits.

The choice for the country is simple: Will our energy policy continue to subsidize technology that is vulnerable to terrorists, makes our economy more vulnerable to supply disruption, and accelerate the accumulation of heat trapping gases in the atmosphere, or will we redirect our energy investment to safer, cleaner resources?

Economic security

The electricity system is, quite obviously, critical to our nation's economic security. Concerns about the direct economic effects of disruption led the Department of Energy to study, more than a decade ago; the potential economic impact of terrorists attacks on the existing electric system. DOE found the potential disruption to be long lasting, affecting key parts of the economy.

"Sabotage could cause the most devastating blackouts because many key facilities can be targeted. Substations present the greatest concern. The transmission lines themselves are even easier to disrupt because they can be attacked anywhere along the line, but they are also much easier to repair. Generating substations are somewhat more difficult than substations to attack because they are manned and often guarded. . . . Virtually any region would suffer major, extended blackouts if more than three key substations were destroyed. Some power would be restored quickly, but the region would be subject to rolling blackouts during peak demand periods for many months."[3]

"Virtually any region would suffer major, extended blackouts if more than three key substations were destroyed."

Until full restoration of power, customers would be faced with rolling blackouts, voltage reductions, or lower reliability. "Direct impacts include lost production and sales by industrial and commercial firms, safety (e.g., incapacitated traffic and air system controls), damage to electronic equipment and data, inconvenience, etc. Indirect costs include secondary effects on firms unable to conduct business with blacked-out firms, public health (e.g., inoperable sewage treatment plants), and looting. An additional impact is that the cost of the power that is available will be high if some of the most economical generating stations are damaged or isolated from loads by transmission system damage and therefore idled."[4]

The experience from last year in California shows that blackouts have very high costs. One economic analysis found that "each megawatt hour (MWH) of power that went undelivered represents about $16,000 of lost California economic output."[5] In one three-day period in March, the rolling blackouts resulted in "$75 million—100 million of lost output for the state."[6] According to the Silicon Valley Manufacturing Group, an industry association of 190 high tech companies, the January 2001 blackouts in California left 100,000 employees idle, costing tens of millions of dollars.[7] "[At] companies like Sun Microsystems, Inc., a blackout can cost as much as $1 million per minute."[8] For outages confined to parts of one state, albeit the largest state, the costs were huge. And the figure may be much higher for certain parts of the economy.

In this paper we propose policies that emphasizes renewable energy, energy efficiency, and cogeneration (to make our fossil generation more efficient), configured in a distributed manner. One important result of the development of such alternative resources would certainly be an improvement in the ability of our

national electricity system to minimize the economic disruption currently associated with physical damage to the system. Such alternative policies would reduce both the physical and economic security risks that have always existed in our electric system, but that are even more urgent in a post September 11 world. The President and Congress should revise their energy plans to reflect this new reality.

Energy security

After September 11, national security clearly came to mean maintaining the reliability of the energy network in the face of potential new threats. Although the reliability of the electric system has traditionally been assured by requiring reserves of generation and transmission capacity, it now means making sure that our energy system is not crippled by an attack at one or even a few places. Ironically, the reserve requirements for generation may simply provide more targets that have to be protected from terrorists. Accordingly, security must now mean an energy system in which less of the supply is vulnerable to being destroyed at any one plant or any one point along the transmission system.

Securing the reliability of the United States' electric system must therefore be more than "hardening" plants and transmission lines and must move toward a more decentralized system using safer resources. National security now must include reducing the potential for catastrophes from previously unimagined threats, such as suicide bombers attacking our facilities.

THE SECURITY RISKS OF PIPELINES AND TRANSMISSION LINES

In addition to electricity transmission, the United States' energy security applies to our oil and natural gas pipelines. Much of the debate about the Administration's energy plan has centered on drilling in the Arctic National Wildlife Refuge (ANWR), even though the potential benefits of drilling in the ANWR could not be realized for quite a long time, certainly not soon enough to alleviate our current dependence on Middle Eastern oil. "Even with nearby production infrastructure, 7 to 12 years would be needed for lease sales, permitting and environmental reviews after approval for leasing. It is projected that initial ANWR production could occur around 2010."[9]

This energy plan also is opposed by many for advocating drilling in other remote and scenic places, such as Yellowstone Park in Wyoming and areas off the coast of California and Florida.[10] Regardless of whether these are good sites to drill, oil and gas production in these locations would necessitate the construction of additional pipelines, further increasing our vulnerability.

Pipelines are, of course, necessary, and we do not oppose building necessary new ones. However, these centralized facilities are inherently vulnerable and to the extent possible, the number of pipelines and transmission lines should be minimized.

On October 4, 2001, a man fired a bullet into the Trans-Alaska pipeline, causing 150,000 gallons of oil to spill and forcing the line to be shut down for repair. After the September 11 terrorist attacks, the line's operator, Alyeska Pipeline Service Co., was required to increase its surveillance along the pipeline, much of which runs through wilderness. "It's important to understand that [the pipeline is] 800 miles long and it's a monumental task to protect every inch of that pipeline 24 hours a day," Alyeska's spokesman pointed out.[11] In 1978, near Fairbanks, about

670,000 gallons of oil spilled out after a hole in the pipeline was blasted open with explosives. As Dr. Brent Blackwelder, president of Friends of the Earth, asserted, "It is high time that our leaders begin to aggressively explore energy sources that are safe, resilient, and don't have a bull's-eye painted on them for terrorists."[12]

In late November 2001, the FBI announced a generalized threat to natural gas pipelines, prompting three key trade groups—the American Petroleum Institute, the Interstate Natural Gas Association of America, and the Natural Gas Supply Association—to encourage their members to increase the number of visual inspections of their pipelines by helicopters and low-flying aircraft and to reinforce security at natural-gas processing and compressor plants.

The United States has a total of 1,280,000 miles of natural-gas pipelines and 326,000 miles of oil gathering and transmission pipelines as well as 616.5 billion ton miles[13] of oil distribution pipelines.[14] These pipelines often are located in rural or wilderness areas and so are not under constant visual supervision, leaving them vulnerable to accidental or intentional damage causing disruption of fuel delivery and environmental harm.

In addition, the 156,210 miles of electrical transmission lines in the United States, often located in uninhabited, unpatrolled areas, are connected to hundreds of centralized power plants, which are organized into three electricity grids covering the country.[15] Damage to any of the three centralized grids could cause breakdowns in power distribution over wide regions.[16]

"It is high time that our leaders begin to aggressively explore energy sources that are safe, resilient, and don't have a bull's-eye painted on them for terrorists."

THE SECURITY RISKS OF NUCLEAR PLANTS

In his 2002 State of the Union Speech, President Bush revealed that U.S. soldiers in Afghanistan had found diagrams of U.S. power plants. The U.S. Nuclear Regulatory Commission (NRC) warned nuclear power plant operators that an attack on a nuclear reactor by terrorists was possible in the near future.[17] According to the FBI, a "credible source" reported that United Airlines' Flight 93 might have been headed to the Three Mile Island nuclear plant.[18] In 1982, the Argonne National Laboratory studied the effect that a plane crashing into a nuclear plant would have and found that it could create a terrible explosion inside the reactor building. When asked about the 1982 study, the Nuclear Regulatory Commission recently admitted, "Nuclear plants were not designed to withstand such crashes."[19] Likewise, a recent simulated attack on the Vermont Yankee nuclear plant demonstrated its vulnerability to even a small band of intruders.[20] Indeed, the legitimacy of these concerns is confirmed by the actions that have been undertaken or proposed to address the threat of terrorism at nuclear plants.

Since September 11, the NRC has advised the 140 licensed[21] nuclear reactors in the United States to maintain the highest level of security, including "increased patrols, augmented security forces and capabilities, additional security posts, heightened coordination with law enforcement and military authorities, and limited access of personnel and vehicles to the sites."[22] In addition, the governors of New York and Vermont have advocated stockpiling potassium iodide to protect people from developing thyroid cancers in case of widespread radiation exposure from an attack on nuclear plants in their states. The governor of Connecticut, John Rowland, has recommended using a missile air defense system to protect nuclear facilities directly and has approved $5.5 million to purchase three UH-60 Black Hawk helicopters to enhance the state's security and to use in emergency response missions. Senators

Harry Reid (D-NV) and Hillary Clinton (D-NY) are drafting legislation to deal with vulnerabilities in security forces, plant physical layouts, and emergency response capabilities of nuclear facilities. Congressman Edward Markey (D-MA) has proposed measures authorizing the president to dispatch military forces to guard and enforce no-fly zones over NRC-licensed facilities during national emergencies.[23]

In addition, industry is focusing on exemptions from liability in the case of a terrorist incident. The Price-Anderson Act, originally enacted to establish a system of financial protection for those liable for a nuclear accident, became a priority for the House of Representatives after September 11.

These steps are not an overreaction. Attacks on nuclear reactors or spent fuel pools at nuclear facilities could create economic, health and environmental damage on the scale of that at Ukraine's Chernobyl plant in 1986.[24]

Rather than responding to this new threat to nuclear plants by proposing fewer inviting targets or more secure nuclear designs, unfortunately the President's energy plan does the opposite. The Bush Administration proposes to triple federal spending for research to develop new nuclear plants.[25] It also advocates building more nuclear plants using a plant design called the Pebble Bed Modular Reactor. This kind of reactor would be constructed without the concrete "secondary containment" that shields most of the existing reactors from all but the most massive attacks. Although the design protects against melt-down accidents, the Pebble Bed Modular Reactor could still catch fire and spread radioactivity if it were attacked in other ways.[26]

In addition, the Administration continues support for using surplus military plutonium to generate electricity in commercial reactors increasing the chances that it could be stolen or diverted during the transfer of this highly dangerous material. "The use of plutonium in reactors was already a bad idea before September 11," said Dr. Arjun Makhijani, president of the Institute for Energy and Environmental Research. "It is simply appalling now. The risks of transporting plutonium fuel and the consequences of an attack on reactors that use it are far too grave to tolerate."[27]

THE SECURITY RISKS OF LIQUID NATURAL GAS (LNG) TANKERS

In recent years, the amount of natural gas from offshore imports delivered by LNG tankers has increased. Concerns about the vulnerabilities of these tankers to terrorists' bombs have been expressed from Boston Bay to the new LNG facility at Cove Point on the Chesapeake Bay, near the Calvert Cliffs nuclear power plant. These tankers are particularly vulnerable, because ports by design have many vessels frequently docking and disembarking. The amount of explosive power contained in a LNG tanker also makes them attractive targets.[28]

It is disappointing that neither President Bush nor the House altered their proposals after September 11 subsidizing the large, vulnerable, dangerous energy facilities to supporting the more decentralized and safer resources that are ready now to meet the nation's needs. This report offers an energy plan that addresses our country's changed security needs.

The security risks of global climate change

The threat of global climate change and how the United States' energy policy will help solve or exacerbate it have not changed since September 11. As UN

Secretary-General Kofi Annan told the 2001 graduating class at Tufts University in Boston, climate change "may well be the greatest global challenge that your generation will face."[29]

Indeed, the possibility of global climate change is another threat to national security, for it is, over time, as much a risk to the health and safety of Americans as are extremists' bombs. As Annan warned, "Imagine melting polar ice caps and rising sea levels, threatening beloved and developed coastal areas such as Cape Cod with erosion and storm surges. Imagine extreme weather causing billion-dollar calamities. Imagine a warmer and wetter world in which infectious diseases such as malaria and yellow fever spread more easily. This is not some distant, worse case scenario. It is tomorrow's forecast. Nor is this science fiction. It is sober prediction, based on the best available science."[30] The scientific evidence of global climate change is stronger since the President unveiled his energy plan. At the President's request, the National Academy of Sciences (NAS) examined the numerous scientific reports on the reality of increased accumulation of greenhouse gases in the atmosphere and their likely impact. The Academy reaffirmed the mainstream scientific view that "greenhouse gases are accumulating in the earth's atmosphere as a result of human activities and that the earth is getting warmer and human activity is largely responsible." The report goes on to say that the leading cause of global warming is the burning of fossil fuels.[31]

"Greenhouse gases are accumulating in the earth's atmosphere as a result of human activities and that the earth is getting warmer and human activity is largely responsible."

Additionally, sixteen highly regarded scientific panels from around the world sent an open letter to President Bush warning of the threat of climate change to the security of the world unless "prompt action" was taken to limit emissions of carbon dioxide from fossil fuels. The letter added that "the increase in temperatures will be accompanied by rising sea levels, more intense precipitation events in some countries and increased risk of drought in others and adverse effect on agriculture, health and water balance."[32] Unfortunately, neither the president's proposals nor the house energy bill was modified to reflect the scientific community's confirmation of the threat of global climate change.

The second change that has occurred since the Bush energy policy was announced is the completion of several analyses of the effect of that policy on global warming. Jan Pronk, chair of the UN Forum on Climate Change, deplored the Bush Administration energy plan as "a disastrous development."[33] The Commission for Environmental Cooperation, the trinational commission established under the North American Free Trade Ageement (NAFTA) to carry out environmental projects and analyses for North America, estimates that if the Administration's plan is implemented it will increase from 14 to 38 percent the emissions of carbon dioxide from the U.S. electricity sector.[34] Another analysis of the Bush plan concluded that it would raise by 35 percent the emissions of carbon dioxide from electric generation in the United States.[35]

Without any discussion of his energy plan or the energy security issue, on February 14th 2002, President Bush put forward his administration's proposals to deal with the issue of global warming.[36] His proposals include some additional tax incentives to encourage climate friendly consumer behavior such as purchasing of more efficient cars and appliances; some additional research and development funding; some renewed encouragement of companies to participate in reporting and registering their emissions with the government; and the rhetorical encouragement of voluntary efficiency improvements across the economy. As a voluntary

target for these efforts, the President has chosen a continued increase of U.S. greenhouse gas emissions. The President also again aggressively ruled out any U.S. participation in the Kyoto accord, the global treaty under which the rest of the world is working to reduce heat trapping greenhouse gas pollution. The Kyoto agreement requires actual emissions reductions in both the United States, the largest emitter of greenhouse gas pollution, and from most other developed countries around the world. Clearly the Administration has no policy intention of linking global warming concerns to energy policy or energy security discussions. In our view, this intention not only results in missed opportunity, but also as Jan Pronk suggested, will—over time—be "disastrous."

"The increase in temperatures will be accompanied by rising sea levels, more intense precipitation events in some countries and increased risk of drought in others and adverse effect on agriculture, health and water balance."

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Times, February 2, 2001; Ross Gerber; State of Connecticut, Governor's press release, "Governor Rowland Announces New Helicopters, Building Measures Will Boost Homeland Security," January 24, 2002; State of New York, Senator Hillary Rodham Clinton, press release, "Reid, Clinton Announce Plans to Federal Security Force at Nation's Nuclear Power Plants," November 16, 2002; "House Lawmakers OK Nuclear Plant Security Measures," *Reuters*, October 3, 2001.

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CHAPTER 1

Renewable energy

Renewable energy is like the air we breathe; it is so much a part of our daily lives that we scarcely notice it. It encompasses the sunlight that warms us, the breezes that send sailboats across the water, and the rivers that carry barges to the sea. Renewable energy technologies make use of these natural systems and cycles, transforming their ever-present power into forms that make our lives more comfortable.

Wind power is currently the most successful renewable energy source for generating electricity. Most simply described, wind—rather than a fossil fuel—is used to turn a turbine. *Biomass energy* is the use of crops, wind, and waste products—rather than oil, gas, or coal—as a fuel in boilers. *Geothermal energy* is the heat beneath the earth's surface that is captured to turn turbines. *Solar photovoltaic cells*, the best-known form of solar-generated electricity, use silicon in a way similar to a computer chip. They are the flat panels increasingly seen on rooftops and at remote sites at emergency call boxes on highways or at railroad crossings.

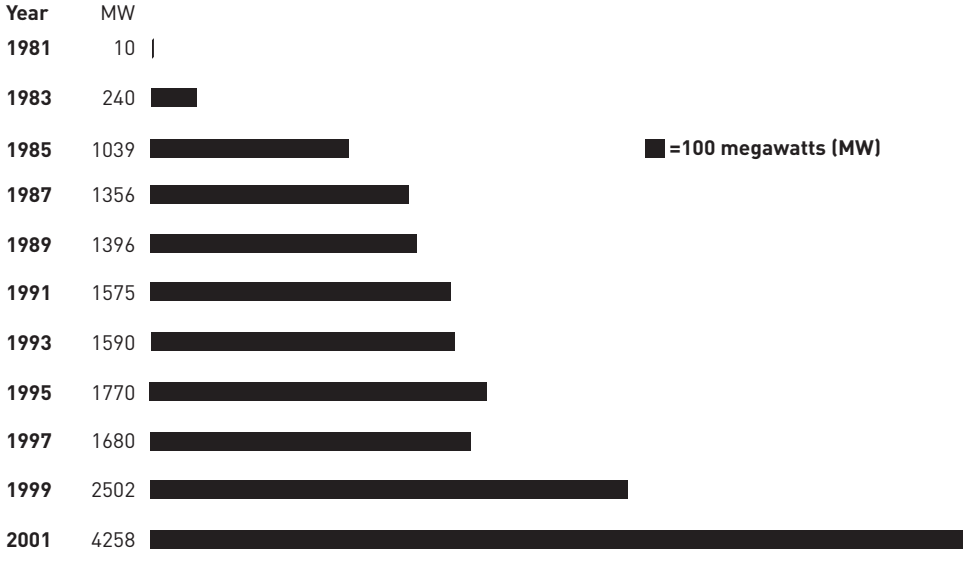
Renewable energy and the country's current capacity needs

Both the Administration's energy plan and the House bill contain an abundance of subsidies for fossil fuels and nuclear power but few for renewable energy. Either assume that renewable energy cannot now, or even in the foreseeable future, provide more than a very small part of the nation's renewable energy needs.[1] Such thinking is outdated. For example, the current installed capacity of wind in the United States is more than 40 times greater than what was in place just 20 years ago.

As shown in Figure 1, the growth rate of wind power has increased in recent years. Largely as a result of state policies encouraging the development of renewable

FIGURE 1

Wind power: U.S. installed capacity



Source: U.S. Department of Energy, Wind Energy Program and American Wind Energy Association (AWEA).

TABLE 1

The top 12 states for wind energy potential

(as measured by annual energy potential in billions of kWhs, factoring in environmental and land use exclusions for wind classes of 3 or higher)

1. North Dakota	1,210	7. Wyoming	747
2. Texas	1,190	8. Oklahoma	725
3. Kansas	1,070	9. Minnesota	657
4. South Dakota	1,030	10. Iowa	551
5. Montana	1,020	11. Colorado	481
6. Nebraska	868	12. New Mexico	435

Source: Pacific Northwest Laboratory, "An Assessment of the Available Windy Land Area and Wind Energy Potential in the Contiguous United States," 1991.

resources, enough new wind capacity (more than 60 percent increase) was added in the United States in 2001 alone to power the needs of almost 475,000 households and, not incidentally, to displace the emissions of 3 million tons of carbon dioxide.[2]

The power of wind is just beginning to be felt. According to estimates by the Department of Energy's Pacific Northwest Laboratory, "A group of 12 states in the midsection of the country have enough wind energy potential to produce nearly four times the amount of electricity consumed by the nation in 1990."[3] Moreover, a large amount of this wind capacity is available from Texas to North Dakota (see Table 1).

"A group of 12 states in the midsection of the country have enough wind energy potential to produce nearly four times the amount of electricity consumed by the nation in 1990."

The opportunity for wind to become a significant part of the United States' electricity resources is not, however, limited to these and the nearby states to which the power can easily be transmitted. Significant new wind projects were completed or announced in 2001, mainly in the Northwest (Oregon and Washington) but also in New York, Pennsylvania, and even West Virginia, where coal has long ruled.[4]

Wind power is growing so fast that even large private utilities like Florida Power and Light (FPL) are investing in wind projects. In 2001, FPL began operating five wind power facilities—two facilities in Texas, one in Washington, and one in Kansas and one in Wisconsin. They now generate 1,830 megawatts of wind power from facilities in seven states.[5]

"In the United States, most people think wind energy is still smocks-and-sandals stuff—hippie stuff," says Andrew Garrad, an energy consultant in Britain. "Europe is so far ahead. Nearly all countries here have some program—tax incentives, whatever—to encourage wind power. It has become competitive with conventional energy." Last year, European Union countries produced more than four times as much energy through wind as the USA, and experts predict that within 10 years at least 10 percent of Europe's electrical energy needs will be supplied by giant wind turbines hooked up to main power grids. [6] With the right federal policies, the United States can dramatically increase the share of its electricity from this safe and clean resource. Even though large-scale wind power production would not lessen dependence on the grid, such an outcome would be a huge environmental win.

The claim that large-scale sources of wind energy will consume vast quantities of land is a myth. For example, wind turbines placed on 4,000 square miles of

Texas land, could generate 280 million megawatts hours per year—the state's approximate annual electric consumption.[7] Using only a small amount of the good sites for windpower will generate enough capacity alone to meet 20 percent of the nation's electricity needs. Other renewable energy types could also provide significant capacity. Using only a small amount of the good sites for windpower could provide enough wind generated electricity to meet 20 percent of the nation's needs. In addition, other renewable energy types could also make significant contributions toward satisfying the need for electricity. Biomass now provides about 3 percent of the United States' annual consumption of energy, but biomass crops and crop residues currently available in the U.S. could provide five times that amount.[8] U.S. geothermal power plants have a total generating capacity of 2,700 megawatts, enough electricity to power the homes of 3.5 million people, as yet a small number. But the U.S. Geological Survey estimates that the country's reserves of geothermal energy are thousands of times larger than its domestic reserves of coal.[9]

Although solar power is still a very small source of the United States' energy, it has a very bright future. Currently, the solar thermal electric systems operating in the United States meet the needs of approximately 350,000 people.[10] Solar electric energy demand has been growing at between 20 and 25 percent annually over the past 20 years, at the same time that its cost has been rapidly declining.[11] Solar collectors covering an area less than half the size of Nevada could supply all of the country's energy needs.[12] Furthermore, solar power does not require open land: the energy needs of a typical single-family home in Texas could be met by covering only half its roof with solar electric panels.[13] The capacity of solar energy could soon increase dramatically. While most of the solar photovoltaic cells currently in use can convert about 15 percent of the sun's energy into usable power, scientists at a unit of Hughes Electronics and the Department of Energy's National Renewable Energy Laboratory have been able to create cells with a 32.3 percent efficiency.[14] In other words, this technological breakthrough means, in the long-term, the doubling of the efficiency of solar cells and a corresponding increase in solar energy per square foot of photovoltaic cell.

"Europe is so far ahead. Nearly all countries here have some program—tax incentives, whatever—to encourage wind power. It has become competitive with conventional energy."

The potential of renewable energy can be seen not only in large grid-connected projects but also in so-called niche applications. Renewable energy is filling a wide variety of energy needs, including call boxes on highways, navigational beacons and buoys, ranger stations, oil wells, traffic control messages, crosswalk signs, remote islands, and even shelters for illegal aliens in Southern California.[15] Though significant amounts of potential renewable capacity would still be connected to regional grids, by filling niche roles that can significantly displace grid connected power, an increasing shift to renewables (particularly solar) could, perhaps significantly over time, reduce the hazards of terrorism.

The competitive cost of renewable energy

Critics of efforts to deal with global warming, including the Bush administration, argue, among other things, that the transition to a cleaner, healthier energy system would be too costly.[16] Such an argument would also have to apply to efforts to truly improve our energy security, as such a transition would involve many of the same policy decisions. Both arguments fail on the facts.

For example, government data shows that the price of wind power has dropped by more than 90 percent since the early 1980s[17] (see Figure 2).

Even more important, the Department of Energy projects that by 2005, the price of wind power will fall an additional 20 to 40 percent.[18]

This large amount of electric capacity from wind can be derived at little or no additional cost to consumers. Encouraged by the production tax credit (PTC), which until recently had been in place since 1992, on-line wind projects in Minnesota, Oregon, North Dakota, South Dakota, Texas, Washington, and even the northeastern states cost 3 cents or less per kilowatt-hour.[19]

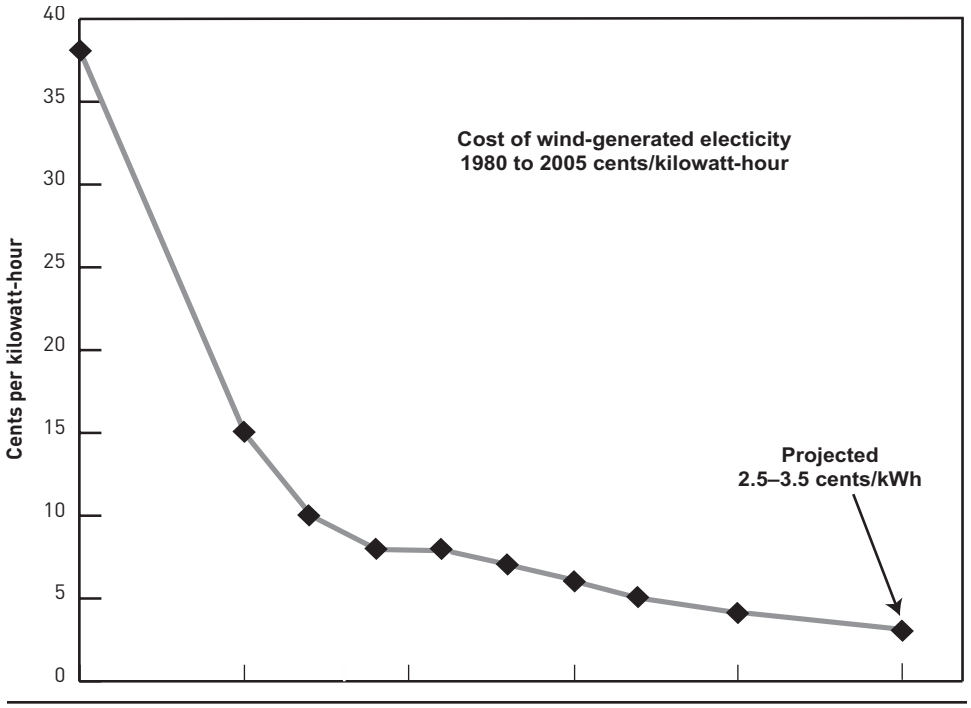
These prices compare very favorably with those of the new coal plants that the House-passed bill and the Administration propose to subsidize. The energy costs of new coal plants would be 3.5 to 4 cents per kilowatt-hour.[20] Thus, large amounts of wind power could be made available in many states at less than 1 cent per kilowatt-hour, lower than even the cheapest coal plants offer.

However, the federal production tax credit for wind generation has lapsed, and this creates a perilous economic environment for wind projects across the nation. We urge Congress to promptly take action to extend the existing production tax credit for wind and biomass generation, and to expand it to other renewable energy technologies, including geothermal and solar.

It is worth keeping in mind, that even if the additional subsidies that are included in the Bush plan and the House bill are not passed, the taxpayers are already subsidizing electricity generated by burning coal. For example, in one the most

FIGURE 2

Wind energy, significant decline in cost



Assumptions: levelized costs at excellent wind sites; large project areas; production tax credit not included after 1994.

Source: American Wind Energy Association. Web site at http://www.awea.org/faq/cost.html.

If they can save money at the Texas governor's mansion . . .

The Texas governor's mansion signed up for the Austin Energy's (City of Austin Municipal Utility) GreenChoice program in 2000 while George W. Bush was the state's chief executive. This program is designed to hedge against fuel cost increases by substituting fuel charges with a ten-year, fixed renewable energy charge through the GreenChoice program. Because gas prices rose in the second half of 2000, the governor's mansion actually saved about $6,600 that year in electricity costs.

egregious examples of the external costs associated with energy choices, the federal black-lung disease program has already cost more than $35 billion dollars over the last 28 years. The dust in mines kills 2,000 miners in the United States each year.[21] This is one of the true costs of our current system of energy, and should be considered when comparing the cost of power from coal to the cost of renewable energy.

Moreover, the health effects of electricity from coal just begin with black-lung disease in miners. The emissions from the use of coal to generate electricity also cause and exacerbate other respiratory diseases, such as asthma, and are a primary contributor to acid rain, smog, visibility degradation at national parks, and global warming.[22] Small particulates from the burning of coal have even been linked to heart attacks and birth defects.[23] A rational energy policy would compare the total costs of electricity options with one another. When all the health and environmental costs are included, coal-powered electricity costs between 5.5 and 8.3 cents per kilowatt hour,[24] making the cost of wind power a real bargain.

The cost of many of the wind facilities in several states is already competitive with that of new coal plants. Moreover, when coal's health and environmental costs are included, the power from wind plants is actually cheaper than the power from coal.[25] In addition, if taxpayers' subsidies of these resources were added, many more wind and renewable resources would be cost effective. A fair assessment of the relative costs also would include the costs to taxpayers of protecting the plants and fuel supply lines and the subsidies for limiting legal liability (Price-Anderson Act) to the cost of nuclear and fossil fuel plants.

Other renewable energy forms are reasonably priced as well. Whereas electricity from biomass cost 10 cents per kilowatt-hour in the early 1980s, the cost is just under 5 cents today.[26] U.S. geothermal power plants, which generate power for the homes of more than 2.5 million people, is produced at 5 to 7.5 cents per kilowatt-hour.[27] Although solar power is more expensive, in the many niche uses described above, it costs less than electricity from traditional power sources.

Another argument in favor of wind generation is its ability to provide a buffer against fuel-price shocks and other risks. A report to the U.S. Department of Energy's Wind Technology Division estimated the financial benefits of reduced

Now that's a farm policy

An acre of grain grown to produce ethanol nets a farmer approximately $600 per year, but an acre of windmills producing energy would earn him close to $2,000 per year.

Windy Area Power Association

To take full advantage of the inexpensive and plentiful wind resources available in North and South Dakota, some additional transmission lines to population centers like Chicago and Minneapolis will be needed. We suggest that the Western Area Power Association (WAPA)[28] undertake this task immediately. In addition to providing new clean renewable power for the Upper Midwest, WAPA could at the same time help put in place (appropriately developed and managed) hydro resources and the new wind resources. Hydroelectric power is principally a summer resource from water captured from melted snow, and wind power in the region is abundantly available on blustery winter days.

risk as ranging between $2.9 and $6.7 per megawatt-hour (MWh) in a competitive market characterized by a mixture of short- and long-term contracts. The report concluded, "For the most part, accounting for risk makes wind energy appear more attractive than gas-fired power plants, as the benefits of reduced exposure to fuel-price and environmental regulatory risks outweigh the greater uncertainty in the annual average availability of wind plants."[29]

"For the most part, accounting for risk makes wind energy appear more attractive than gas-fired power plants, as the benefits of reduced exposure to fuel-price and environmental regulatory risks outweigh the greater uncertainty in the annual average availability of wind plants."

Security benefits

Sunlight, wind, and falling water can be neither attacked nor eliminated, for they are delivered everywhere each day at no cost. Renewable energy is not a commodity to be fought over. Renewable energy does not use explosive fuels or radiation or require fossil fuel or nuclear power plants. Thus there is no possibility of a catastrophe from a terrorist attack. Renewables also tend to provide power through less centralized distribution and so can lessen the overall exposure of transmission lines. As John Turner at the National Renewable Energy Laboratory (NREL) remarked, "Energy security is national security and there is no question that we could have it based on renewables."[30]

Many of the nation's security experts believe that a renewable portfolio standard is needed to provide secure energy for America. For instance, James Woolsey, former director of the Central Intelligence Agency; Robert McFarlane, former national security adviser; and Admiral Thomas Moorer, former chair of the Joint Chiefs of Staff, recently urged Congress to enact, among other measures, a federal renewable portfolio standard in order to enhance the nation's security.[31]

Climate benefits

Each megawatt of wind power displaces 4.65 million pounds (2,317 short tons) of carbon dioxide, the leading greenhouse gas associated with global warming, as well as large amounts of emissions of other air pollutants.[32] A 1-MW wind turbine can power the equivalent of 300 average U.S. households.

The Intergovernmental Panel on Climate Change (IPCC), a large international group of scientists and other experts that has been researching the issue for several years, has identified wind energy as one of several technologies that could help combat global warming. In a 2001 report, the group concluded that significant

technical progress has been made that, with political foresight and the will to change policies, could reduce emissions of carbon dioxide at a lower cost than earlier predictions suggested.

In estimating the cost of reducing carbon dioxide emissions, the IPCC found that "half of these potential emissions reductions may be achieved by 2020 with direct benefits (energy saved) exceeding direct costs (net capital, operating and maintenance costs)."[33]

Recommendations to Congress

20 PERCENT RENEWABLE PORTFOLIO STANDARD BY 2020

To address the threats of terrorism and climate change to national security, a national energy bill should adopt a national renewable portfolio standard of 20 percent by 2020 with interim requirements of 10 percent by 2010 and 15 percent by 2015. The 20 percent requirement is also contained in the Renewable Energy and Energy Efficiency Investment Act (S. 1333) sponsored by Senator James Jeffords (I-VT) and five other senators.

A renewable portfolio standard (RPS) is a market-based mechanism that requires utilities and other generators to gradually increase the portion of electricity produced from renewable resources such as wind, biomass, geothermal, and solar energy. The experience at the state level has shown that a RPS can jump-start the local market for wind energy. Its effectiveness has been demonstrated in the Texas wind rush that began when a RPS was included in the state's electricity-restructuring legislation, which was signed by Governor Bush. As a result, by the end of 2001, Texas had more than 800 megawatts of generating capacity from wind, twice the interim statutory requirement and a full year in advance. This new wind power will produce some 2.5 billion kilowatt-hours (kWh) of electricity, enough to serve about 200,000 Texas households.[34]

Twelve other states have adopted a RPS, some as part of their restructuring laws, although none has had the success of Texas. To maximize the benefits of a RPS, national energy legislation should include key provisions from Texas and:

- Set the requirement high enough to make the market grow;
- Make the requirement apply to all electricity providers;
- Allow the renewable energy credits to be traded, to ensure flexibility and the least expensive implementation of the requirement; and
- Set penalties for noncompliance.

A national portfolio standard with tradable credits allows utilities to find the cheapest and best renewable resources in the country. It allows those with exper-

Jack be nimble, Jack be quick

The 25-MW Foote Creek wind project in Wyoming was completed in a mere four months.[35] The average wind power project takes only 18 months to complete,[36] which compares favorably to the six to ten years that it takes to build and license a new coal plant.[37]

tise in the renewable energy production business to develop renewable energy projects; other utilities need only find a developer with whom to contract. A national portfolio standard will encourage the many forms of renewable energy (including the so-called niche uses) because each renewable kilowatt-hour generated receives credit toward the RPS.

A RPS with tradable credits will provide the resources necessary to make use of the plentiful and inexpensive wind resources in the Southwest, Northwest, and Midwest, just as for much of the past century, federal policy enabled the oil companies to use their dollars to extract oil from the Arabian peninsula at minimal cost. A national RPS provides the flexibility to permit the 20 percent requirement to be met over the next 20 years at little or no cost to consumers.

Neither the Administration plan nor the House-passed bill contains a RPS, which is surprising, given the success of the Texas legislation signed into law by the President. The Senate bill contains a 10 percent national RPS by 2020. In light of the boom in new renewable energy projects, particularly wind power, and their falling prices, a 20 percent target is achievable and affordable and provides the security and climate benefits that this country needs now.[38]

The Department of Energy's Five Laboratories study, completed in 1997 before the recent improvement in renewable technology and additional price reductions, showed that an 18 percent RPS could be obtained under its advanced scenario at a reasonable cost.[39] Moreover, the Union of Concerned Scientists and the Tellus Institute demonstrated that a 20 percent RPS by 2020, coupled with the type of efficiency program that we also advocate, would result in net savings for customers.[40] One state has already gone a long way toward the 20 percent in 2002 RPS. Nevada has set a 15 percent RPS by the year 2013.

SHIFT RESEARCH AND DEVELOPMENT FUNDING

The funding for research and development should be shifted from fossil fuels and nuclear power to renewable energy sources. Although the President's energy plan does call for funding renewable energy projects, it does not restore the 50 percent cuts in wind, solar, and geothermal energy programs in the Energy Department's budget for fiscal year 2002. Moreover, the President proposes funding the research on renewable energy with the $1.2 billion in revenues from oil and gas exploration of the Arctic National Wildlife Refuge (ANWR). In light of intense controversy over ANWR, this funding appears ill considered, and even illusory. The Bush proposal and H.R. 4 both contain $2 billion for "clean" coal programs and $172 billion to $186 billion for other coal programs.[41] The House bill also contains $27 billion in tax cuts for research on fossil fuels and nuclear power and only $6 billion in incentives for research on renewable energy.[42] Taxpayers for Common Sense calculate that the House bill would double subsidies to the oil, coal, and nuclear industries over the next decade.[43] On a more positive note, the president's proposal for a 15 percent tax credit for consumers who buy photovoltaic or solar water-heating equipment for their homes is commendable and a step in the right direction.

Senate Bill 1766 would provide funding for a more secure national energy future by authorizing funding at the Department of Energy for renewable energy research and development programs. We support the incentives in S. 1766 that would triple the amount of electricity produced by nonhydroelectric renewable

sources by 2020.[44] Even though the Senate bill is better than the House bill, it still contains disproportionate subsidies for old, dirty technologies. At the very least, a bill to give us a secure energy future would provide as much in funding and tax credits for wind, solar and geothermal energy technologies as for electricity from fossil and nuclear sources.

TAX CREDITS FOR HOME AND FARM WINDMILLS

An important element that is not contained in any of the proposals is a tax credit for investing in small wind energy systems, such as has been proposed by Congressman J.C. Watts. This bipartisan legislation (H.R. 2322) was also introduced in the Senate by Senator Richard Durbin (D-IL) and provides a 30 percent tax credit to offset the capital cost of installing small (fewer than 75 megawatts) distributed wind facilities.

At the beginning of 2000, 9,800 small wind systems were providing power to family farms, businesses, telecommunications systems, and isolated communities in the United States,[45] largely because of policy support at the state level. The potential for small wind turbines has barely been tapped, however. These small wind systems should be provided special incentives because they bring the ultimate security and transmission benefits described in the section on distributed generation below. Congress should therefore include the 30 percent investment tax credit of S. 1810 and H.R. 2322 in the final version of the energy bill that it sends to the White House.

RENEWABLE ENERGY MANDATES FOR FEDERAL AGENCIES

Congress should also impose renewable energy mandates on the federal government, to make it easier to reach the 20 percent requirement of the RPS. In particular, a national energy bill should include the 7.5 percent federal purchase requirement of renewable energy by 2010 and the provisions promoting the development of renewable energy production on federal lands contained in S. 1776.

[1] For instance, White House Economic Adviser Lawrence Lindsey told a bankers' conference, "Even if you exploited alternative energy (sources) as much as possible, we still have to build those power plants." *Reuters,* "Cheney Pushes Energy Plan to Keep U.S. Economy Strong," May 22, 2001.

[2] American Wind Energy Association, "U.S. Wind Industry Ends Most Productive Year, More Than Doubling Previous Record for New Installations," January 2002, web site at www.awea.org/news/html.

[3] Pacific Northwest Laboratory, "Wind Energy Potential in the United States," September 1993, p. 6.

[4] Energy Efficiency & Renewable Energy Network, "New Large U.S. Wind Projects Go on Line at Year End," January 9, 2001; Exelon Corporation Newsroom, "Exelon Power to Double Its Wind Capacity," December 28, 2001; U.S. WindForce, "Mt. Storm, the Largest Most Productive Park in the East," January 9, 2002; CHI Energy Projects, "Fenner Wind Power Project," January 1, 2002.

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[6] Ellen Hale, "Wind power picks up as it crosses Atlantic: Technology was developed in USA, but Europe reaping the biggest benefits," *USA Today*, February 8, 2001.

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[8] National Renewable Energy Laboratory, "Biomass Energy," December 1998.
[9] U.S. Geological Survey, "Assessment of Geothermal Resources in the United States."
[10] National Renewable Energy Laboratory, "Energy, Our Future Is Today!" October 1994.
[11] National Renewable Energy Laboratory, US PV Industry Technology Roadmap Workshop 1999; and Solarbuzz Inc.
[12] National Renewable Energy Laboratory, "Energy, Our Future Is Today!" October 1994.
[13] State Energy Conservation Office, "Introduction to Photovoltaic Systems," Fact Sheet 11, p. 1.
[14] Environmental News Network, "Solar Cells Becoming More Efficient," October 27, 1999.
[15] Renewable Energy Policy Project, "Clean Government: Options for Governments to Buy Renewable Energy," 1999; Astropower, "Remote Off-Grid Industrial Systems" at www.astropower.com/offgrid.htm; XANTREX, "Off Grid"; Solar Works, Inc. at www.traceoffgrid.com/home.html; Solarworks, "Why Solar Energy?" at www.solarworks.com.
[16] The Cheney task force adopted the reasoning of Haley Barbour, former chairman of the Republican National Committee, Bush strategist, and lobbyist for several electricity producers. Barber was successful in helping to get Bush to renege on his campaign promise to reduce the emission of greenhouse gas from power plants. Barber argued in a March 1, 2002 memo to Cheney that complying with carbon dioxide limits would be so expensive that Bush should reverse his position. , "Going Backwards: Bush's Energy Plan bares Industry Clout", *L.A. Times*, August 26, 2001.
[17] Natural Resources Defense Council, "Responsible Energy Policy for the 21st Century", March 2001.
[18] *Ibid.*
[19] Renewable Energy Policy Project (REPP)-Center for Renewable Energy and Sustainable Technology (CREST), "Renewable Energy Policy Project's Fact Sheet," 2001; AWEA, "Wind Energy's Costs Hit New Low," New Cost Factsheet, 1999 news release, March 6, 2001; Evworld People & Technology, "Tapping America's Ocean of Wind," (news release), December 20, 2001; AWEA, "Net Energy Billing for Wind Energy," January 10, 2002, web site at http://www.awea.org/faq/netbill.html
[20] U.S. Department of Energy, Office of Fossil Energy, web site at fossil.energy.gov/oal_power/special_rpts/market_systems/market_sys.html.
[21] National Institute for Occupational Safety and Health (2001) website at www.cdc.gov/niosh/mngfs.html.
[22] C.A. Pope, *Aerosol*, Science Technology, 32, 4 (2000).
[23] Marla Cone, "Studies Link Heart Attacks to Moderate Air Pollution," *Los Angeles Times,* June 5, 2000; Gary Polakovic, "Air Pollution Harmful to Babies, Fetuses, Studies Say," December 16, 2001.
[24] Mark Z Jacobsen and Gilbert M. Masters, "Exploiting Wind Versus Coal," *Policy Forum: Energy*, Science 293, August 24, 2001.
[25] R.Y Redlinger et al, *Wind Energy in the 21st Century,* New York: Palgrave, 2001.
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[27] National Renewable Energy Laboratory, website at www.nrel.gov/documents/geothermal.
[28] Western Area Power Administration (WAPA) markets and transmits hydroelectric power services from 56 power plants operated by the Bureau of Reclamation, the U.S. Army Corps of Engineers and the International Boundary and Water Commission in 15 states from California to Minnesota. Source: http://www.wapa.gov/geninfo/fsabout.htm.
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[30] Marianne Lavelle, Harvey Black and Cynthia Salter, "Wind Revolution: The Private Sector Is Breezing Toward U.S. Energy Independence," *U.S. News & World Report*, November 6, 2001, p. 36.
[31] Union of Concerned Scientists, "Clean Energy Blueprint," *Air Daily,* web site at www.ucsusa.org http://www.ucsusa.org/, October 2001.
[32] American Wind Energy Association, fact sheet on comparative costs of wind and other energy sources, available on AWEA's web site at http://www.awea.org/pubs/factsheets.html. Local air

pollution benefits from 1 MW of wind are 24,000 pounds (12 short tons) of sulfur dioxide, the lead agent causing acid rain; and 15,900 pounds (7.95 tons) of nitrogen oxides, the leading agent in the formation of smog.

[33] Intergovernmental Panel on Climate Change, web site at www.ipcc.ch/press/pr28-3.html.

[34] American Wind Energy Association, News Release, "Texas' Renewable Energy Policy Is Nation's Most Effective, Survey Shows," March 21, 2001.

[35] American Wind Energy Association, news release, "Wind Powers America," August 10, 1999.

[36] See web site at http://www.seawestwindpower.com/studies/creek.html.

[37] Abraham McLaughlin, "Can the US Really Build a Power Plant a Week?" *Christian Science Monitor*, May 2, 2001.

[38] We recognize that to make this requirement cost effective, the Federal Energy Regulatory Commission (FERC) and the states need to provide certain transmission lines and to ensure fair transmission access for intermittent generation.

[39] U.S. Department of Energy, "Five National Energy Laboratories Study: Scenarios for a Clean Energy Future," Washington, DC, November 2001.

[40] Steven Clemmer, et al, "Clean Energy Blueprint," Union of Concerned Scientists, 2001.

[41] Congressional Research Service, "Energy Policy: Setting the Stage for the Current Debate," December 6, 2001.

[42] See web site at CNN.com, August 2, 2001.

[43] Brody Mullins, "Environmental Groups Highlight Pork in House Energy Measure" January 31, 2002.

[44] American Geological Institute, "Energy Policy Overview," December 2001.

[45] American Wind Energy Association, "Wind Energy Outlook 2000."

CHAPTER 2

Electric energy efficiency

Experience has shown that the fastest, cheapest way to address electricity needs is to increase the use of energy efficiency technologies, technologies that we continue to improve every year. Efficiency means we can have more—more comfortable, well-lit houses and buildings, for example—without using more resources or harming the environment, and also doing this at a lower cost.

Studies show that we will have many opportunities in the next quarter century to use electricity more efficiently. In doing so, we will reduce our reliance on fossil fuels, create less air pollution that contributes to health problems, and cut the emissions of carbon dioxide, the prime contributor to global warming.

Energy efficiency success stories

MORE ECONOMICAL FLUORESCENT LIGHTING

Standard fluorescent lights—like those found in commercial buildings—rely on a "ballast" to provide the proper flow of electricity for the fluorescent tube. Improved electronic ballasts were introduced to the market in 1976, and by 1980 they were widely available, with reliability and performance equal to or better than the older versions, along with significant energy savings.[1]

By 1987 five states—including the two largest, California and New York—were requiring the use of electronic ballasts in new and replacement fluorescent fixtures. But in states without such requirements, building owners and maintenance personnel are continuing to buy the older, less efficient ballasts, even though the new electronic ballasts are more economical, with payback periods of less than two years for nearly all commercial buildings. In fact, in these states, people chose the less economical lighting by a ten-to-one margin. Why did people make the wrong economic choice? Frequently the cause is inertia and lack of information. For example, maintenance personnel tend to ask for the same model number when ordering replacement parts. And in order for people to order the new electronic device, which costs a bit more, they have to understand the energy savings it provides. It is thus no surprise that businesses and individuals have difficulty making the best economic decisions in every aspect of purchasing. Clearly, this is a case in which a simple policy could lead to better market decisions. Indeed, since 1990, federal standards have pushed the older, inefficient designs off the market.

Preaching and practicing energy conservation

As blackouts loomed in California last summer, Home Depot stores throughout the Golden State offered free weekend energy conservation clinics, distributed a free coloring book teaching kids how to help their parents save energy, and alerted customers to utility rebates for energy-saving products. A new web site helps residents of all 50 states lower their energy bills. America's leading home improvement retailer also set a good example for Californians by implementing energy conservation measures in its 143 California stores that it estimates saved enough in just the first half of 2001 to power 10,000 homes for a month.[2]

Q. How many economists does it take to change a lightbulb?

A. None. The market will take care of it.

The market has been incredibly effective in increasing the energy efficiency of the U.S. economy. Over the last quarter century, energy use per dollar of economic activity has declined by about 35 percent. Nevertheless, it is clear that the right government policy can boost the effectiveness of the market, as the following discussion demonstrates.

Source: Interlaboratory Working Group

MORE ECONOMICAL REFRIGERATORS

In 1983, a major national retailer inadvertently conducted an experiment in economic decision making, offering for sale two models of the same refrigerator. In outward appearance, they were identical, differing in only two ways: one used less energy but cost more. As was the case with the more efficient fluorescent lighting, the more expensive model was actually the better deal, again with payback periods of less than two years in almost all cases. Nevertheless, more than half the purchasers chose the worse economic deal.[3] Why? Again, lack of information appears to be the culprit: how were consumers to know about and accept the energy savings or to understand what they were worth? Simple policies can clarify economic decision-making. Since that time, energy consumption and cost labels have been required on all refrigerators in stores, and efficiency standards have mandated higher levels of efficiency.

MORE ECONOMICAL MOTORS

Newer, more efficient industrial motors are a wise economic investment that is often overlooked, according to the Department of Energy's laboratories. As they reported, "Monitoring and validation of energy use data . . . underscor[e] the large gap between current practice and potentially economically smart investments."[4] This is important, since such motors account for fully 23 percent of U.S. electricity consumption.

What explains the gap here between what businesses do and the economically better choice? The laboratories point out that even these relatively sophisticated consumers lack information and, sometimes, expertise. The laboratories also cite

A bright idea that saves money and lives

New stoplights that use the same technology as alarm clock numerals and flashing sneakers now glow yellow, red, and green at intersections throughout California. More than 40 percent of California cities have replaced conventional incandescent bulbs with light-emitting diode LEDs, which use 85 percent less electricity. Over their seven-year life, these energy-saving LED signals more than make up for their higher initial cost. Furthermore, those cities that make the switch will have many fewer burned-out signals (incandescent bulbs last only a year). This in turn will save the cities money, as workers will not have to make as many trips to replace the burned-out signals and the LED signals will lower the risk of accidents that burned-out incandescent bulbs may cause. LED signals also are brighter than incandescent bulbs, which makes them easier to see in bad weather.[5]

another factor: limited capital to make the best investments. Again, simple policies could help. For example, a number of utilities provide rebates and low-interest loans to make it easier for businesses to make these wise investments.

MORE ECONOMICAL INDUSTRIAL PLANT DESIGN

Chemical plants built by DuPont in the United States and Europe are another example of imperfect economic decision making. Despite energy costs that are twice as high in Europe as in the United States, DuPont's European plants are no more energy efficient than its U.S. plants. Why? "All the plants were designed by the same people, using similar processes and equipment."[6] While such standardization may have some benefits, more information that incorporated energy costs in Europe would probably have led to different, more efficient designs.

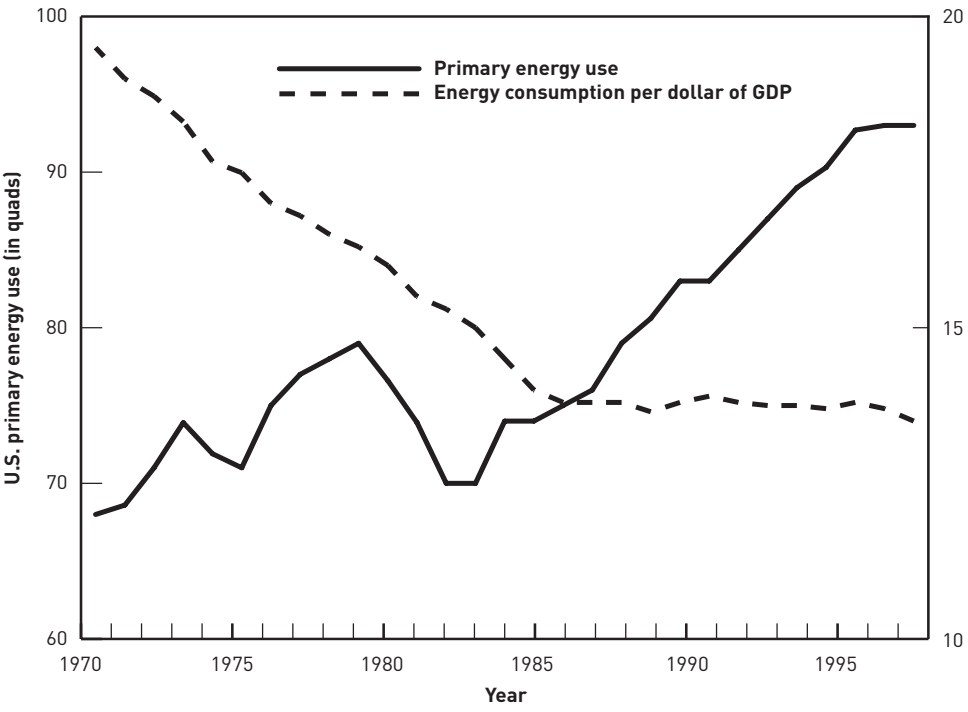
Benefits of energy efficiency

COST AND ENERGY SAVINGS

The Department of Energy's national laboratories describe the gains in energy productivity—the amount of energy used per dollar of economic activity—between 1973 and 1986 as "one of the great economic success stories" of the twentieth century. In 1970, nearly 20,000 BTUs of energy were needed for each dollar of gross domestic product (GDP), but by 1986, only 14,000 BTUs were needed per dollar of GDP (see Figure 3, in which the numbers have been adjusted for inflation by expressing all GDP amounts in 1992 dollars).

FIGURE 3

Energy use and energy intensity of the U.S. economy



Source: Interlaboratory Working Group, p. 2.7

Save me the money!

The aggressive implementation of conservation measures in California state buildings slashed energy use by 20 percent in the summer of 2001, helping prevent blackouts and saving taxpayers' money. Another 100 megawatts in permanent savings are expected over the next few years as the state carries out an extensive retrofit program. New state buildings are being designed to use energy as efficiently as possible; for example, Sacramento's new East End complex of state offices exceeds California's energy efficiency building standards by 30 percent and is expected to save taxpayers over $400,000 per year.[7]

The Department of Energy's analysis found that while both energy efficiency and structural changes in the economy (less reliance on energy-intensive economic activity) led to this result, the contribution of energy efficiency was twice as great as the effect of structural changes. Since that time, the amount of energy has remained relatively constant, at about 13,000 BTUs per dollar, despite declining energy prices (in inflation-adjusted terms).

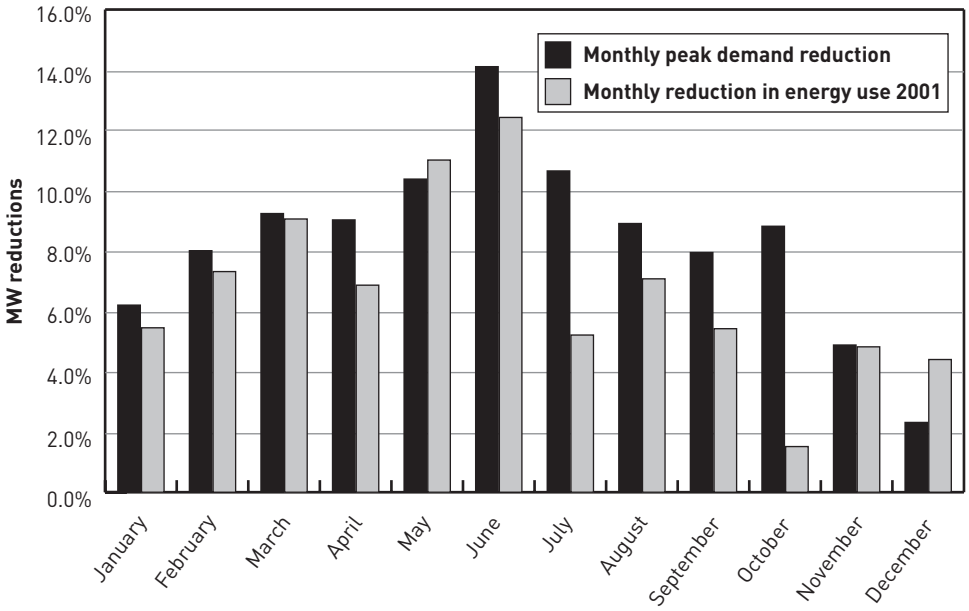
How was this achieved? Technical advances throughout the economy are one answer. Refrigerators are a case in point. In 1980, the average new refrigerator used 1,278 kilowatt-hours per year, but in 2001, the typical new refrigerator used only 476 kilowatt-hours per year, a decrease of 63 percent. At the same time, features such as through-the-door water and ice have been added, and requirements for ozone-safe insulation have been met.[8] Much of this progress has been spurred by energy efficiency standards, and in a number of states, electric utility energy conservation programs have contributed to the utilities' improved economic performance. A RAND Corporation study reports that since 1977 these appliance standard programs have saved approximately $1,000 for each California resident and helped the state's economy expand.[9] In addition, because of California's energy conservation building codes, the state's use of energy is significantly below that of other large states such as Texas, Florida, and New York.

TIME SAVINGS

After the power outages in the spring of 2001, the failure of California's electricity deregulation plan threatened to bring large and constant rolling blackouts last summer. Many officials wrung their hands because new plants could not be built in time to offset the combined problems of a shortage of new construction, the shutdown of fossil fuel plants for repairs, and the low water levels at hydroelectric facilities. But the lights did not go out in California last summer. Instead, residents dried their laundry on clotheslines, painted their roofs white, and switched off idle equipment in offices and factories and stores. It all added up to big energy savings that shaved thousands of megawatts off the state's peak electricity demand and hundreds of millions of dollars from Californians' energy bills all in a matter of a few months.

As Figure 4 shows, in California, peak demand and energy use fell in every month of 2001 even after adjusting for the economic slowdown and changes in the weather. During the critical summer months, when electricity shortages were considered most likely, Californians' conservation efforts cut peak demand by 8 to

FIGURE 4
California peak load savings



Source: California Energy Commission: http://www.energy.ca.gov/electricity/peak_demand_reduction.html

14 percent. And in each summer month, more than one-third of utility customers earned rebates in the state's 20/20 program, which rewarded them for cutting their electricity use by 20 percent from the previous year.[10]

In 2001, Californians showed that energy conservation is not just a "sign of personal virtue" but a way to get out of an energy shortage in a hurry. And many of the changes that Californians made to meet the challenge of last year's crisis are here to stay. Sacramento resident, Cheryl Stepp, says that in her five-person household, avoiding energy waste has become a habit, "just like brushing your teeth." Everyone still religiously turns off lights and TVs when they leave a room, long after she took down signs exhorting them to do so. Preliminary results from a telephone survey of Southern California residents found that 82 percent of the respondents reported taking some kind of conservation measure last summer, and 73 percent said they were willing to continue their energy-saving efforts.[11]

Not only did Californians change the way they used electricity last year; they also invested in new energy-efficient equipment that will mean savings on their utility bills for years to come. Thanks to intensive advertising and expanded utility rebate programs, residential and business customers learned about the savings that they could earn by replacing their old lightbulbs and appliances. In Northern and Central California, nearly 100,000 energy-efficient refrigerators and 4 million compact fluorescent lightbulbs were bought with utility rebates.[12] The effectiveness of these energy conservation efforts did not end with summer; Californians are continuing to enjoy the economic and environmental benefits of efficiency.

In addition to all its other benefits, energy efficiency enables energy needs to be met in a very short time. California made clear that you don't have to build or drill your way out of a crisis. If speed is an issue, increased efficiency is the quickest response.

SECURITY BENEFITS

Energy efficiency is the ultimate secure resource. Efficiency is dozens of specific technologies and actions, from better lightbulbs to more efficient motors. None involves building plants that could be bombed by terrorists or requires the transport of dangerous fuels or waste. Rather, the benefits of efficiency to the energy system are derived at the point of use without the need for transporting energy that is not needed.

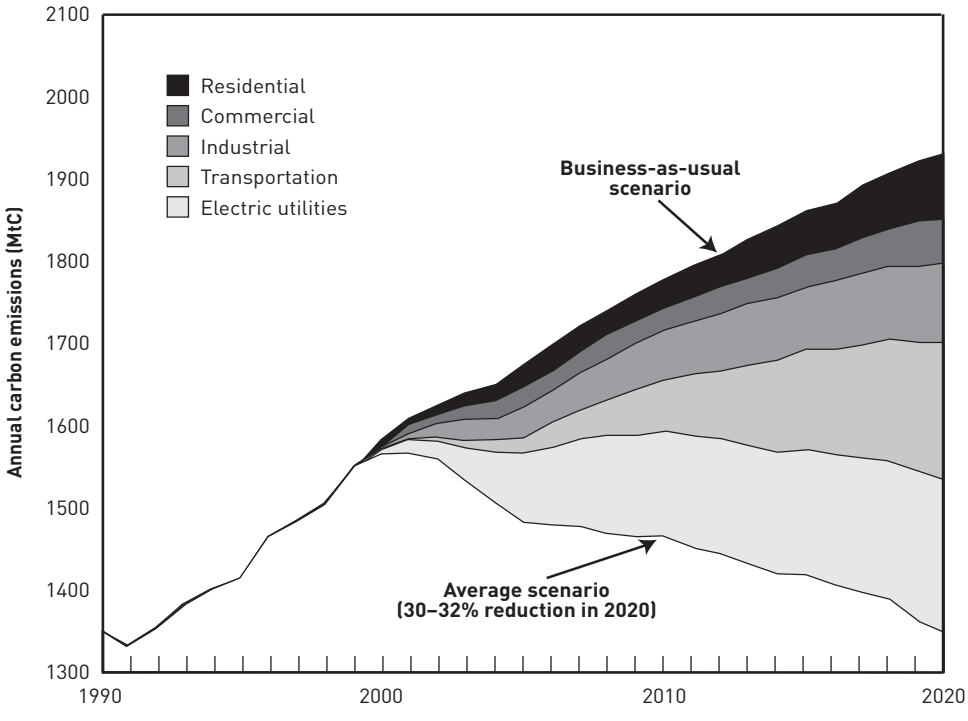
CLIMATE BENEFITS

Policies to boost energy efficiency are an economically wise strategy for the country. A study by the Department of Energy examined the effects of efficiency policies in combination with greater reliance on renewable energy sources for electricity generation. The results show a dramatic reduction by 2020 in the use of fossil fuels, in air pollution, and in emissions of greenhouse gases.[13] Figure 5 shows the results of all policies examined in the study, including those that affect transportation, buildings, and industry.[14] Note that emissions of carbon dioxide are approximately one-third lower than under a "business-as-usual" approach. By 2020, at "no net cost to the economy," these emissions could be reduced by 13 percent below current levels.

In the electricity sector, by 2020 the combination of increased efficiency and increased reliance on renewable energy sources would result in 46 percent fewer emissions than under the "business as usual" approach.[15]

FIGURE 5

Carbon emission reductions by sector from business-as-usual scenario



Source: Interlaboratory Working Group, "Scenarios for a Clean Energy Future," http://www.ornl.gov/ORNL/Energy_Eff/CEF.html.

And we need policies to support energy conservation

Buoyed by the success of the energy conservation measures initiated in response to California's energy crisis, Albertson's (a supermarket chain) is expanding the program to all of its 2,500 U.S. food and drug stores. Albertson's expects the move to cut its annual energy consumption by 10 percent—approximately 480,000,000 kilowatt-hours of electricity per year—enough power to meet the average annual energy needs for approximately 50,000 American families. Albertson's move won plaudits from the EPA's Christie Whitman, who observed, "If all businesses, organizations and consumers would exercise this level of commitment to energy conservation, the savings and effect on our environment would be staggering."

Source: Albertson's press release: "ALBERTSON'S EXPANDS ENERGY MANAGEMENT PROGRAM TO INCLUDE ALL OF ITS STORES THROUGHOUT THE COUNTRY," July 21, 2001.

Recommendations to Congress

Many of the policies encouraging energy efficiency and renewable energy production have already found their way into proposed legislation sponsored by members of both parties. Unfortunately, however, many of these proposals were not included in the House's energy bill.

The following are Environmental Defense's policy recommendations for federal legislation:

1. **Energy audits for schools.** Energy audits should be funded for all elementary and secondary schools, conditioned on a commitment to implement all energy-saving opportunities with a payback of less than five years. Incentives or matching funds should be provided for such implementation in any national security bill sent to the President.
2. **Tax credits for efficient buildings.** Environmental Defense supports the proposals contained in the Energy-Efficient Buildings Incentives Act (S. 1709) introduced by Senators Robert Smith (R-NH) and Dianne Feinstein (D-CA) and the companion House bill, H.R. 3455. This legislation would provide tax breaks for energy-efficient commercial buildings, schools, rental housing and new homes that cut their energy needs by 30 to 50 percent. It also would provide tax incentives for purchasing energy-efficient air conditioners, heating and cooling systems, and solar water-heating and photovoltaic systems.
3. **Air conditioner standards.** New central air conditioners should be required to meet the higher standard—a 30 percent increase in efficiency over the current average—that was implemented early in 2001, rather than the rollback to 20 percent proposed by the Bush administration several months later.[16] Analysis by the Department of Energy shows that the energy savings are worth the costs of the increased efficiency, even before such benefits as less pollution and less dependence on fossil fuels are counted. By 2020, the greater efficiency would reduce fossil-fueled power generation by 5,000 megawatts,[17] which is equivalent to 20 large power plants. Senate Bill 1766 includes this provision for central air conditioners.
4. **Standards for refrigerators and clothes washers.** In addition, the Resource-Efficient Appliance Incentives Act, introduced in the last Congress by Congressman Jim Nussle (R-IA) and Senator Charles Grassley (R-IA) with the

support of a broad bipartisan group of stakeholders, would require new federal standards that would substantially improve the energy efficiency of new refrigerators and clothes washers, two of the largest consumers of energy in American households.

5. **National compact fluorescent lamp program.** The new generation of ultra-compact fluorescent lamps is a huge, cost-effective energy savings opportunity. Rebates in California helped increase the adoption of this technology. Pacific Gas and Electric Company customers alone bought a record 4 million compact fluorescent bulbs, instantly receiving a $3 discount for each one.[18] As a manager at a Home Depot store noted, "The compact fluorescent program has been huge for us. It's been astronomical, the sales we've had." It is time to achieve this kind of breakthrough nationally. A national in-store rebate program should be funded in any national energy bill sent to the President.
6. **Efficiency standards for the federal government.** A bill recently introduced by Senator Jeff Bingaman (D-NM), S. 72, would cut the energy use of the nation's biggest consumer: the federal government. The bill would expand the authority of federal agency managers to contract with private companies to install and retrofit federal facilities with energy-efficient and cost-effective technology and equipment.

[1] Interlaboratory Working Group, "Scenarios for a Clean Energy Future", Oak Ridge, TN: Oak Ridge National Laboratory, and Berkeley, CA: Lawrence Berkeley National Laboratory, November 2000, ORNL/CON-476 and LBNL-44029, web site at www.ornl.gov/ORNL/Energy_Eff/CEF.html.

[2] Home Depot, press releases, "Conservation Efforts at Home Depot Stores Save Enough Energy to Power Thousands of California Homes," June 26, 2001.

[3] *Ibid.*

[4] Interlaboratory Working Group, "Scenarios for a Clean Energy Future," p. 2.11.

[5] Carolyn Said, "Lighting the Way: Switch to Power-Stingy LEDs in Traffic Signals Saves Money, Improves Road Safety," *San Francisco Chronicle*, March 10, 2001.

[6] Amory Lovins and Hunter Lovins, "Mobilizing Energy Solutions," *The American Prospect*, January 28, 2002, p. 3, web site at www.prospect.org/print/V13/2/lovins-a.html.

[7] California Energy Commission, personal communication, January 2, 2002; California Department of General Services, "Construction Underway on Capitol East End Complex in Sacramento: Largest, "Greenest" State Office Project in California History," News Release, April 26, 2000 at www.dgs.ca.gov.

[8] James E. McMahon, Peter Khan, and Stuart Chaitkin, "Impacts of U.S. Appliance Standards to Date," Proceedings of the 2nd International Conference on Energy Efficiency in Household Appliances and Lighting, Naples, Italy, September 27-29, 2000, website at http://eappc76.lbl.gov/tmacal/45825_McMahon_Impacts.pdf.

[9] Dan Morain, "Saving Energy Called Boon to California," *Los Angeles Times*, April 19, 2000.

[10] Eddie Lau, "People Power: State Slashes Energy Use," *Sacramento Bee*, January 1, 2002.

[11] *Ibid.*

[12] Jason B. Johnson, "Sales of energy-saving items set record: PG&E's program of rebates used up," *San Francisco Chronicle,* December 7, 2001, p. A-21.

[13] Interlaboratory Working Group, "Scenarios for a Clean Energy Future," http://www.ornl.gov/ORNL/Energy_Eff/CEF.html.

[14] The key policies examined in the study's advanced scenario include efficiency standards for building equipment, deployment and labeling programs for such equipment, agreements with individual industrial consumers and industrial trade associations to increase energy efficiency, an increase in vehicle mileage standards to an average of 40 miles per gallon (mpg) for automobiles

and 30 mpg for light trucks in 2010, and to 50 mpg for automobiles and 40 mpg for light trucks in 2020, distance based ("pay-at-the-pump") automobile insurance, an electric-sector renewable energy portfolio standard equivalent to a production tax credit of 1.5 cents per kilowatt-hour, and a domestic carbon trading system with a permit price of $50 per metric ton of carbon. We see these policies as illustrative, without specific endorsement, of the kinds of policies that can produce substantial environmental benefits. *Ibid*. pp. ES.3 and 1.8–1.11.

[15] *Ibid*., table 7.12. Emissions of nitrogen oxides and sulfur dioxide—the principal contributors to smog and acid rain, respectively—can also be significantly reduced by efficiency policies. In 2020, nitrogen oxide emissions would be 42 percent lower than under the business-as-usual scenario, and sulfur dioxide emissions would be 48 percent lower.

[16] Jenifer Warren, "State Joins Challenge to Bush on Air-Conditioner Standards," *Los Angeles Times*, June 20, 2001.

[17] U.S. Department of Energy, Office of Building Research and Standards, "Energy Efficiency Standards for Consumer Products: Central Air Conditioners and Heat Pumps," October 2000, web site at http://www.eren.doe.gov/buildings/codes_standards/reports/cac_hp_tsd/index.html.

[18] Jason B. Johnson, "Sales of Energy Saving Items Set Record," *San Francisco Chronicle*, December 7, 2001.

CHAPTER 3

Cogeneration

Cogeneration, sometimes called combined heat and power, is a method to get more efficiency from power or industrial boilers. Cogeneration harnesses the heat and steam normally discarded when electricity is generated and redirects it to other uses, like heating industrial boilers or buildings. In 1998, three manufacturing industries—pulp and paper chemicals, and petroleum refining—accounted for 85 percent of all industrial cogenerated electricity.[1]

Whereas conventional power plants are 33 percent efficient, cogeneration plants are more than 80 percent efficient,[2] using efficient gas turbines that require as much as 50 percent less energy than do conventional approaches. Some companies are finding even greater energy benefits from cogeneration. For example, the Trigen Energy Corporation has based several of its recent cogeneration projects using 30 percent efficiency for gas turbines used solely as electric generators. But it calculates 80 to 90 percent efficiency for these turbines when applied as cogeneration, which means three times as much energy for the same amount of emissions and energy input.[3] Because cogeneration power plants need to be close to their target market for the heat they produce, the distance over which the electricity needs to be transmitted is shortened as well, thus cutting transmission losses, which can be up to 10 percent in traditional transmission.[4] The installed capacity of cogeneration is a little more than 50 gigawatts,[5] and "the projected additional [cogeneration] capacity by 2010 is 73 GWs (which is more than the current capacity needs of Texas) with carbon dioxide emissions reductions of 74 million metric tons."[6]

"The projected additional [cogeneration] capacity by 2010 is 73 GWs (which is more than the current capacity needs of Texas) with carbon dioxide emissions reductions of 74 million metric tons."

The security benefits of increased use of cogeneration are obvious. Cogeneration makes use of existing facilities, reducing the need to build new facilities and to spend money guarding such new plants that are additional potential targets for terrorists.

The ability of cogeneration to dramatically decrease emissions of carbon dioxide is illustrated by British Petroleum's construction of new power and steam cogeneration facilities at its Texas City and Chocolate Bayou refining and chemical sites. These facilities will allow BP to shut down older, less efficient power units, thereby enabling it to meet the stringent NO_x emission reductions required under Houston's clean air plan. In addition to less NO_x, the sites will also reduce carbon dioxide (CO_2) emissions by 727,000 tons per year at no additional cost. BP's cogeneration facilities will produce 805 megawatts of electricity and 3.5 million pounds per hour of steam. The power generation units will also be able to produce more electricity than required by the two sites, enabling the excess to be sold on to the open market to other energy users.[7] BP has trumpeted the economic benefits of its cogeneration plant, also pointing out that the use of cogeneration helps meet its commitment to reduce by 2010 its emissions of greenhouse gases by 10 percent over its baseline 1990 totals.[8]

Recommendations to Congress

Any national energy policy should include provisions to promote cogeneration. In particular, S. 933, proposed by Senators James Jeffords (I-VT), Hillary Clinton

(D-NY), Patrick Leahy (D-VT), Joseph Lieberman (D-CT), and Charles Schumer (D-NY), should be incorporated. This legislation would ensure that by establishing uniform and nondiscriminatory interconnection standards, cogeneration sources of electricity would be able to interconnect nationwide with the electricity grid. Congress should also adopt the provision contained in H.R. 4 that promotes cogeneration by shortening the depreciation life of such equipment.

[1] Gas Research Institute, "Energy and Environmental Analysis: Summary of the 1998 Industrial Cogeneration Projection," July 1998.
[2] Senator James Jeffords, "Energy Interconnect Legislation Introduced Today," Northeast-Midwest Senate Coalition press release, May 22, 2001.
[3] Mark Hall, vice-president of external affairs, Trigen Energy Corporation, testimony at Senate hearings on S. 933, July 19, 2001.
[4] International Council for Local Environmental Initiatives (ICLEI), "Cogeneration" (fact sheet), 1993.
[5] U.S. Department of Energy, EIA, "International Energy Outlook 1998," 1998.
[6] T. Kaarsberg, R. N. Elliott, and M. Spurr, "An Integrated Assessment of the Energy Savings and Emissions-Reduction Potential of Combined Heat and Power," American Council for an Energy-Efficient Economy, 1999, p. 498.
[7] Press release, British Petroleum, October 19, 2000.
[8] PRNewswire, October 21, 2000.

CHAPTER 4

Distributed energy

Distributed energy refers to the practice of placing energy resources at or near the end user's premises. It is possibly best defined in contrast to large central station power plants that are connected to end users through a system of transmission and distribution wires. Although located at or near the end user, distributed energy may also be connected to the electricity grid, allowing others to use the energy when it is not needed on the principal user's premises. While most applications of distributed energy are significantly smaller than those of traditional power plants, some applications, such as in industrial cogeneration projects may be quite large.

Besides offering many benefits to the end user, distributed energy can also benefit the electricity grid as a whole. Examples are a lighter load during peak hours (which lowers electricity prices for everyone), less investment in transmission and distribution, mitigation of market power, and congestion management. Benefits of distributed energy, however, should not come at the expense of air quality. Policies should be designed to encourage deployment of the cleanest technologies such as fuel cells and restrict the operation of much dirtier diesel backup generators.

The evolution of distributed energy

During the twentieth century, the development of electric generation stations followed a path of increasing size and centralization. This path was predicated in part on growing economies of scale in coal-fired production facilities and the concomitant need to keep the plant's negative environmental characteristics at a distance from the customers using the power generated at the plant. To do this, large expensive networks of transmission facilities were needed to connect the customer with the source of power.

The capture of economies of scale simultaneously met its zenith and nadir in large nuclear power plants. Nuclear power plants were expected to stretch economies of scale to their limit, producing power that would be "too cheap to meter." Instead, cost overruns, safety and security concerns, and other developments in the electric industry prompted a move toward smaller, more efficient generating units.

In the 1990s, technology advanced beyond the accepted model of economies of scale in electric generation. Now, smaller power plants can achieve the highest efficiencies. New combined cycle gas turbines (CCGT) produce heat efficiencies approaching 60 percent, almost double those of coal-fired power plants. When installed, distributed cogeneration efficiencies can reach 80 percent. Advances have also been made in microturbines and fuel cells, for clean, reliable, and cost-effective power.

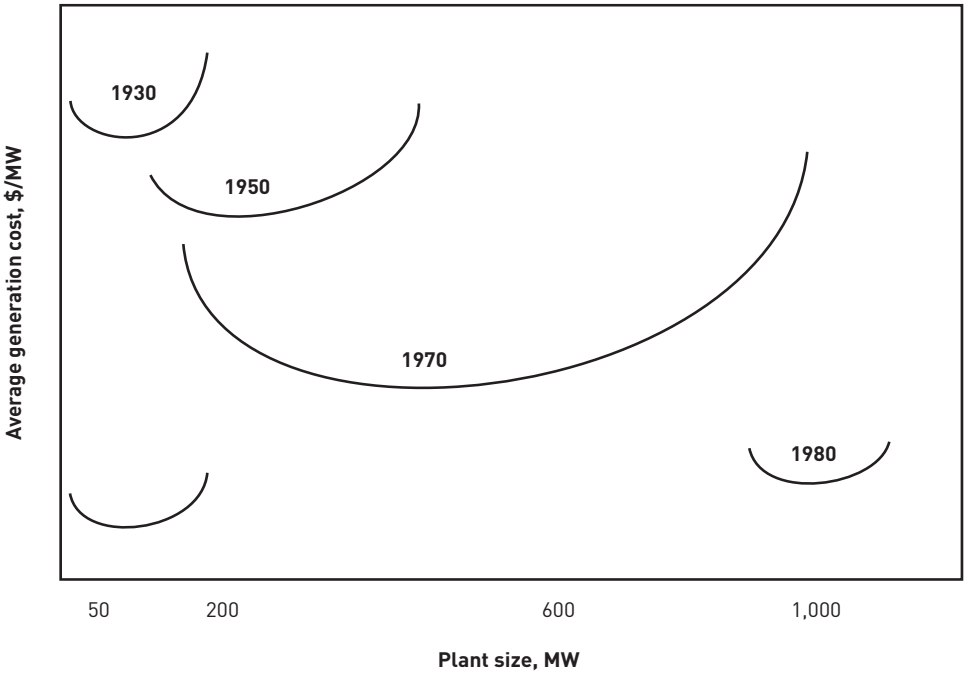
Distributed resource technologies

RECIPROCATING ENGINES

Reciprocating internal combustion (IC) engines are by far the most common ditributed generation technology deployed today,[1] with the most familiar form being the emergency backup diesel generator. The advantages of IC engines are their low first costs, easy start-up, and reliability. Their disadvantages are high emissions of air pollutants (especially from diesel-fueled engines) and noise. As a

FIGURE 6

Optimal generation plant size for a single plant based on cost per megawatt (MW), 1930–1990.



Source: Charles E. Bayless, "Less is More: Why Gas Turbines Will Transform Electric Utiliites." Public Utilities Fortnightly 12/1/94.

distributed power resource, IC engines are currently used most often in portable or emergency operations.

COMBUSTION TURBINES

Combustion turbines (CT) are a common technology that uses heat from burning gases to turn turbine blades inside an electric generator. Between 1 and 30 megawatts are commonly produced in distributed applications, which can reach hundreds of megawatts in utility applications. CTs burn natural gas or a variety of petroleum products. Because they are relatively inefficient users of fuel, producing a lot of waste heat, CTs are often used in large industrial combined heat-and-power operations.

MICROTURBINES

Microturbines are essentially very small combustion turbines. They increase efficiency by using a recuperator to transfer heat energy from the exhaust back into the incoming airstream. Microturbines are still an evolving technology, but companies such as Honeywell and Capstone have already installed commercial products. Microturbines are significantly cleaner and quieter than IC engines of a similar size primarily fueled by natural gas.

FUEL CELLS

Instead of combustion, fuels cells use electrochemical processes to produce electricity and heat. A hydrogen fuel cell is composed of two electrodes sandwiched around

an electrolyte, in which hydrogen reacts with oxygen to produce electricity and water. Because of the laws of thermodynamics, fuel cells can be far more efficient than electric generators that rely on combustion. Fuel cells emit 100 times less air pollution than do combustion generators. The consistent heat produced by the electrochemical process makes fuel cells well suited to combined heat-and-power applications. Because they produce minimal emissions of air pollutants, require little maintenance and are relatively quiet, they are suitable for a wide range of applications. Significant resources are currently being invested by private markets in pursuit of commercially viable fuel cells for transportation, though expectations currently place large scale applicability ten to fifteen years into the future.[2] Larger stationary source applications, though still relatively expensive, are already in use in some industries where the reliability of a constant power supply is essential.

ENERGY EFFICIENCY AND LOAD MANAGEMENT

While often overlooked in an examination of distributed generation technologies, energy efficiency and load management are equally valid distributed energy resources, which have many of the same characteristics and meet many of the same goals of on-site generation. For instance, when electricity prices spike during peak hours, customers can respond by using load management techniques such as air conditioner cycling, or they can start a peaking unit. Similarly, the use of energy efficiency measures reduces the total amount of electric generation capacity required.

Benefits of distributed energy

TRANSMISSION SYSTEM BENEFITS

The Federal Regulatory Commission (FERC) recently estimated that $12.6 billion would be needed to increase the capacity of the transmission system. Most of this investment will be spent on reducing the congestion along major transmission pathways. Transmission congestion results from too much power trying to move in one direction over the electric grid. Power typically moves from generation centers to load centers, and at some point, the transmission facilities reach their thermal limit of available capacity. Besides the incredible expense, constructing new transmission facilities concentrates the vulnerability of the electric system. A less expensive and more secure way of reducing congestion is to install distributed energy resources.

LOWER DISTRIBUTION COSTS

Besides reducing the need for more transmission infrastructure, distributed energy also reduces the need for new distribution facilities. According to a report by the Regulatory Assistance Project, the average cost of distribution is approximately 2.5 cents per kilowatt-hour, whereas the marginal cost of distribution can range from zero to more than 20 cents per kilowatt-hour. On a capacity-cost basis, new transformers, substations, feeders, and lines can add $700 per kilowatt-hour to the cost of new central station generation.[3]

ENHANCED RELIABILITY FOR END USERS

The advance of electronic commerce, which relies on telecommunications, computers, and the Internet, has raised reliability concerns to a new level. In fact, for

many businesses engaged in electronic commerce, the reliability of electricity is more important than the cost of electricity. Even short power disruptions or fluctuations in power quality can be disastrous for high-tech industrial processes such as microchip fabrication. Table 2 provides some examples of the losses from power outages, losses that will have many businesses looking for alternatives to grid levels of reliability.

EMERGENCY POWER

For reasons such as the need to stabilize prices, businesses and individuals may prefer on-site customer-owned electricity generation. Accordingly, if distributed energy is widely deployed, it can serve as a reserve of backup power that can be used in emergencies. Owner-operators of distributed generation units can direct all or part of their power onto the grid if there have been outages of central station power plants that threaten the provision of essential public services. The ability to direct power to the grid should be limited to distributed generation units whose emission limits are comparable to central station power plants.

REDUCTION OF PEAK LOAD

Distributed energy in generation or efficiency forms relieves pressure on the electric grid during peak load periods, which offers two benefits. First, because all electrical systems, generators, substations, and transformers are more likely to break down when they are under stress, relieving the stress of peak loads lowers the probability of outages. Second, the extreme price spikes that the industry has experienced in recent years have been limited to relative short periods of peak load, so reducing that load can dramatically affect market-clearing prices.

INCREASED MARKET PARTICIPATION

Allowing distributed energy to participate fully in electricity markets can have several benefits as well. Merely increasing the amount of capacity available to the market also increases its liquidity. Greater numbers of sellers and their associated capacity can reduce the opportunity of large power providers to exercise market power. Finally, the presence of large numbers of providers may lead to innovative service offerings.[4]

SECURITY BENEFITS

Several of the benefits of distributed energy also make the electric system more secure. By definition, distributed energy is small, modular, and distributed; that is,

TABLE 2
Cost of downtime due to power failures

Industry	Average cost of downtime
Cellular communications	$41,000 per hour
Telephone ticket sales	$72,000 per hour
Airline reservations	$90,000 per hour
Credit card operations	$2,580,000 per hour
Brokerage operations	$6,480,000 per hour

Source: U.S. Department of Energy, Distributed Energy Resources Program and Strategic Plan, September 2000.

Bank of Omaha: Distributed generation puts them in the money

Omaha, Nebraska, was the unlikely site of the event that most focused attention on the role of distributed energy at the end of the last decade: the groundbreaking fuel cell project developed by the First National Bank of Omaha, the nation's seventh largest credit card—processing center. After the bank experienced failures in its battery backup systems in the early 1990s, it began to search for a more secure way to provide the greater reliability that its computer systems required. The bank estimated that each hour of power outage would result in $6 million in losses. To address this need, it acquired two sets of fuel cells that could provide 1,000 times the reliability offered by the local grid. Installations similar to this can significantly reduce the $29 billion lost to U.S. businesses each year because of computer failures caused by power outages.

Source: "Distributed Generation: Fuel Cells Deliver Hugh-Quality Power," American Gas Magazine, 11/13/00

energy sources are dispersed throughout the grid rather than being concentrated in large targets. This dispersal throughout the electric system not only reduces the need for new transmission facilities but also lessens the impact of any attacks on major transmission facilities. Distributed energy thus can serve as an emergency backup system in the event of a catastrophic failure.

AIR QUALITY AND CLIMATE CHANGE BENEFITS

The greater deployment of distributed energy can improve air quality by cutting carbon dioxide emissions in several ways.

- *Reduced line losses are equivalent to reduced emissions.* Between 5 and 15 percent of electricity generated is lost during transmission and distribution. In other words, for a given amount of electricity usage by the end user, an additional 5 to 15 percent must be generated at the central station power plant. Using distributed energy and foregoing transmission and distribution avoid the additional generation and its accompanying air emissions.
- *Cleaner technologies are substituted for existing power plants.* The use of fuel cells in place of fossil fuel—fired generation can provide significant air quality benefits.
- *Load management and energy efficiency measures avoid generation and associated emissions entirely.* Adopting these measures cuts emissions, an important consideration for urban areas struggling to maintain air quality standards.

PROTECTION AGAINST THREATS TO AIR QUALITY

Although distributed energy can improve air quality, unless new safeguards are adopted, the increased deployment of distributed energy is far more likely to harm air quality. Currently, small electric generators (which can produce 40 to 100 times the emissions of new, combined-cycle gas turbines), are largely exempt from federal Clean Air Act provisions and face little state regulation as well; thus their potential for air pollution emissions is unlimited.

When the Clean Air Act was amended in 1990, small diesel generators still were used only for emergency backup operations when the local distribution grid

failed. With an electric grid designed for 99.9 percent reliability, emergency backup generators were expected to be used for only 8 hours a year. In this situation, limitations on emissions were never a binding constraint for generator operation.

Today, with the economics of electricity production having changed and with rules being written to facilitate the development of owner-operated distributed generation, existing diesel generators may be operated for economic reasons and

Texas tackles DG emissions

The 1999 Texas Electric Restructuring Act gave consumers the right to use distributed generation units (DG) smaller than 10 megawatts in size. The Public Utility Commission then adopted rules to expedite the interconnection of these units, including the precertification of makes and models. At the same time, Texas was grappling with significant air quality problems, with more than 70 percent of its population living in areas with unhealthy air. To address the air quality problem, the state implementation plans (SIPs) proposed for Dallas and Houston require power plants to reduce their emissions of NO_x by 88 percent and 93 percent, respectively; plants located in the rest of eastern Texas must reduce their emissions of NO_x by 50 percent.

Policymakers became aware that these independent utility and emissions policies were on a collision course because the proliferation of small generation units, lacking meaningful emissions standards, could undermine the measures adopted to reduce NO_x emissions in the SIPs. In fact, because of their high emission rates, just 400 megawatts of diesel-powered generation could exceed the total emissions budget assigned to the entire generation system of more than 5,000 megawatts.

This situation prompted the Texas Natural Resource Conservation Commission to develop rules to prevent an excessive growth of emissions from small-scale or distributed generation sources.

TABLE 3
Impact on DFW airshed of additional 100 MW of generation by type

Emissions comparisons	
New CCGT	0.08 lb./MWh
Existing gas plants (2005)	0.23 lb./MWh
Microturbine	0.40 lb./MWh
Gas-powered IC engine	3.20 lb./MWh
Diesel IC engine	17.0 lb./MWh
Daily NO_x emissions (additional 100 MW, assuming 4 hours peak generation)	
New CCGT	0.02 tons/day
Existing gas plants (2005)	0.05 tons/day
Microturbine	0.08 tons/day
Gas-powered IC engine	0.64 tons/day
Diesel IC engine	3.40 tons/day
Current daily cap for entire Texas Utility system	**13.8 tons/day (greater than 5,000 MW)**

not just because of distribution grid failure. But because their emission rates are so high, a relatively small number of these generators can dramatically undermine the reductions of emissions achieved by large generators in nonattainment areas. Several states, including Texas and California, have thus begun to adopt new rules to limit emissions from this sector.

Recommendations to Congress

In 1999 the Department of Energy sponsored a study of the barriers to a closer interconnection of distributed generation with the grid. In this study, 58 of 65 projects reported three significant barriers to interconnection: technical barriers, business practice barriers, and regulatory barriers. The study notes, "Resolution on a state-by-state basis will not address what may be the biggest barrier for distributed generation—a patchwork of rules and regulations which defeat the economies of mass production that are natural to these small modular technologies."[5] The study then suggests the following actions to ease or remove these barriers. Accordingly, Congress should direct the Federal Energy Regulatory Commission and the state utility commissions to:

"Resolution on a state-by-state basis will not address what may be the biggest barrier for distributed generation—a patchwork of rules and regulations which defeat the economies of mass production that are natural to these small modular technologies."

1. Reduce technical barriers.

- *Adopt uniform technical standards for interconnecting distributed power to the grid.* Uniform interconnection standards would allow manufacturers to assure customers that their distributed resource units could be used in "plug and play" applications.
- *Adopt testing and certification procedures for interconnection equipment.* Similar to uniform standards, certifying interconnection equipment in advance would permit the employment of distributed resources without requiring redundant and expensive testing for each installation.
- *Accelerate the deployment of distributed power control technology and systems.* Grid operators will need advanced network control systems for distributed energy to be integrated into and to support the grid.

2. Reduce business practice barriers.

- *Adopt standard commercial practices for any required utility review of interconnection.* Such practices are required to prevent intentional or unintentional delays in processing interconnection requests.
- *Establish standard business terms for interconnection agreements.* Terms and conditions such as fees, studies, insurance, and indemnification requirements should be consistent with the size and type of interconnection requested.
- *Develop tools for utilities to assess the value and impact of distributed power on any point on the grid.* The potential benefits of specific distributed resource applications should be identified so that customers, utilities, and society can make the appropriate benefit-cost comparison.

3. Reduce regulatory barriers.

- *Develop new regulatory principles compatible with distributed power choices in both competitive and utility markets*. Customers should not be penalized for making choices that result in a loss of load for utilities.

- *Adopt regulatory tariffs and incentives to fit the new distributed power model.* Tariffs should be designed to promote distributed resources when they benefit the grid.
- *Expedite dispute resolution processes for distributed generation project proposals*. Because of the relative size of distributed resource projects (compared with large central station power plants), procedural delays have a disproportionate impact on a project's economic viability.
- *Define the conditions necessary for the right to interconnect*. The right to connect customer-owned equipment should be established in federal law in a manner similar to that in telecommunications law.

4. Mandate net metering

- *Net metering* is the ability of owners of distributed energy to sell their excess power to the electric grid without the need for complicated contracts and tariffs. The sale of electricity is registered by running the electricity meter in one direction when the customer is purchasing power from the grid and then reversing the meter when the customer is selling power to the grid. A uniform net-metering national standard as provided in S. 1766 or in Congressman Barton's (R-TX) Electric Supply and Transmission Act (but without his proposed limitations) rewards owners of distributed energy for the benefits of their energy production for the electric grid.

5. Require rules setting emission rates

Congress should direct the Environmental Protection Agency to establish rules for any new distributed generation source not exclusively operated during distribution grid failures. These rules should ensure that the emission rates from these units do not exceed those of larger central station power plants. Congress should also establish rules for existing backup and emergency generators that clearly restrict their use to distribution grid failures.

6. Provide tax incentives

Congress should adopt the provision of H.R. 4 that promotes distributed energy resources, including cogeneration and energy efficiency, by shortening the depreciation life of such equipment to no more than 15 years.

[1] Gas Research Institute, "Distributed Generation in Competitive Energy Markets," Chicago, March 2000.

[2] John DeCicco, et.al, "Technical Options for Improving the Fuel Economy of U.S. Cars and Light Trucks by 2010-2015," Study, American Council for an Energy Efficient Economy, June 2001.

[3] Regulatory Assistance Project, "Distributed Resource Distribution Credit Pilot Programs: Revealing the Value to Consumers and Vendors," September 2001.

[4] Regulatory Assistance Project, "Accommodating Distributed Resources in Wholesale Markets," September 2001.

[5] U.S. Department of Energy, National Renewable Energy Laboratory, "Making Connections: Case Studies of Interconnection Barriers and Their Impact on Distributed Power Projects," May 2000, p. iv.

Conclusion

We're completing this report as the U.S. Senate begins to consider legislation that would commit the United States to energy investment patterns for at least the next decade. The investment patterns and energy usage that would result from enactment of the Administration/House proposal would continue a pattern of unwise decisions and environmentally destructive actions that should be changed.

Certainly after September 11, it is clear that we should design energy policies that provide clear incentives to reduce both the economic and physical vulnerability which results from our current energy system. Any policies that move forward after September 11 must take such vulnerabilities into account.

In our judgment, the most effective approach to meeting both needs would be to cap our energy related emissions, including the greenhouse gas, carbon dioxide, and to provide flexible means to achieve the reductions required by such caps. Such an approach would provide regulatory certainty and economic incentives to facilitate the investments necessary to help deal with energy security concerns, as well as reduce vulnerability to uncontrolled climate change.

We will continue to advocate such policies. However, given that the Administration continues to take such approaches off the table, in this report we've offered other practical steps for moving forward—steps which would result in more cleaner and safer power generation than either the Administration/House bill—or in many cases the current Senate bill as well.

The Bush Administration has argued that the United States will need to build 1300 or more new power plants over the next 20 years. Many studies have concluded that alternatives to such supply side approaches are available, alternatives that combine improved efficiencies, conservation and increased development of more renewable resources. For example, a program for boosting renewable energy with a 20 percent Renewable Portfolio Standard, combined with efficiency and cogeneration, would permit the United States to avoid building 975 new power plants, to retire 180 existing coal burning plants, close 14 existing nuclear plants, and eliminate hundreds of thousands of miles of natural gas pipelines that would otherwise be required.[1] These alternatives would also have the direct result, as described in this paper, of providing power that was both cleaner and much less vulnerable to disruption or terrorism. These alternatives, therefore, can improve both our energy and our economic security.

Accordingly, we recommend that federal policy be reshaped along the following lines:

- Include a national renewable portfolio standard of 20 percent by 2020, with interim requirements of 10 percent by 2010 and 15 percent by 2015.
- Shift funding for research and development from fossil fuels and nuclear power to renewable energy.
- Provide tax credits for home and farm windmills.
- Establish an energy savings program for schools.
- Provide incentives to construct energy-efficient buildings.
- Require more efficient appliances.

- Fund a national program of ultracompact fluorescent lamp rebates and/or promotion.
- Set energy efficiency standards for the federal government's operations.
- Promote cogeneration by establishing uniform and nondiscriminatory interconnection standards.
- Shorten the depreciation life of certain cogeneration and energy-efficient equipment.
- Direct the Federal Energy Regulatory Commission and state utility commissions to reduce technical, business practice, and regulatory barriers to distributed energy.
- Require net metering.
- Direct the Environmental Protection Agency to establish uniform air quality rules for distributed generation.

In sum, Congress and the Administration should work to create a renewable energy economy, with increased efficiency investments and cogeneration, aligned on a more distributed basis that would make the nation's electricity grid a far less inviting target for future terror attacks. The earth is already beginning to show the effects of global climate change, and while the United States sits on the sidelines, responsible nations are taking action. As the world's largest producer of heat trapping greenhouse gases, America must do its share to address the issue. The Administration's proposals simply don't begin to do that. A concentrated effort to shift our power production in the direction of less carbon intensive fuels, particularly if those fuels are from renewable sources, is the only policy approach that can begin to deal with the reality of global warming and both economic and energy security.

America can, and should, begin that shift now.

[1] Steven Clemmer, et al, "Clean Energy Blueprint," Union of Concerned Scientists, 2001.

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