Chapter 2

Public Benefits of Renewable Energy Use—Why Switch?

Renewable energy can supply a significant proportion of the United States' energy needs, creating many public benefits for the nation and for states and regions, including environmental improvement, increased fuel diversity and national security, and regional economic development benefits.

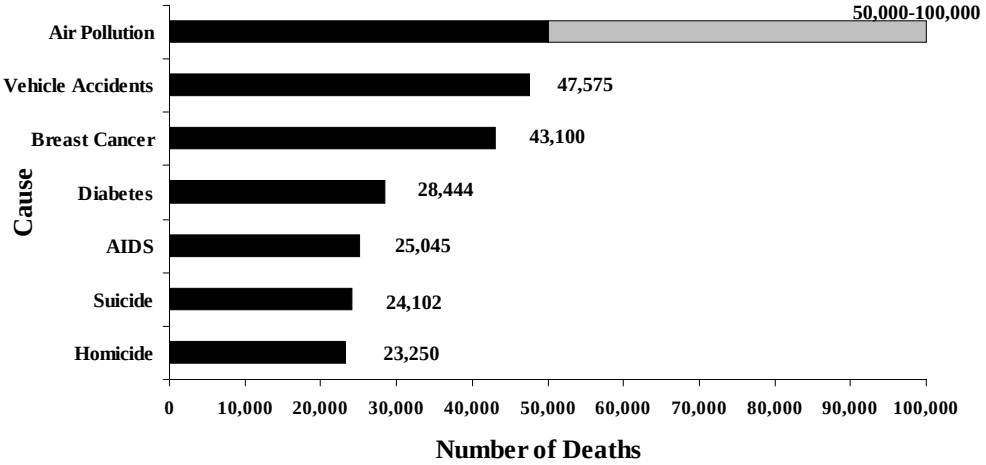
Environmental Benefits

Using fossil fuels—coal, oil and natural gas—to make electricity dirties the nation's air, consumes and pollutes water, hurts plants and animal life, creates toxic wastes, and causes global warming. Using nuclear fuels poses serious safety risks. Renewable energy resources can provide many immediate environmental benefits by avoiding these impacts and risks and can help conserve fossil resources for future generations. Of course, renewable energy also has environmental impacts. For example, biomass plants produce some emissions, and fuel can be harvested at unsustainable rates. Windfarms change the landscape, and some have harmed birds. Hydro projects, if their impacts are not mitigated, can greatly affect wildlife and ecosystems. However, these impacts—which are discussed in Appendix A—are generally much smaller and more localized than those of fossil and nuclear fuels. Care must nevertheless be taken to mitigate them.

Air Pollution. Clean air is essential to life and good health. Air pollution aggravates asthma, the number one children's health problem. Air pollution also causes disease and even premature death among vulnerable populations, including children, the elderly, and people with lung disease. A 1996 analysis by the Natural Resources Defense Council of studies by the American Cancer Society and Harvard Medical School suggests that small particles in the air may be responsible for as many as 64,000 deaths each year from heart and lung disease.[1] Figure 1 shows that air pollution is responsible for more deaths than motor vehicle accidents, and ranks higher than many other serious health threats.[2] A few of the most important pollutants are discussed below.[3]

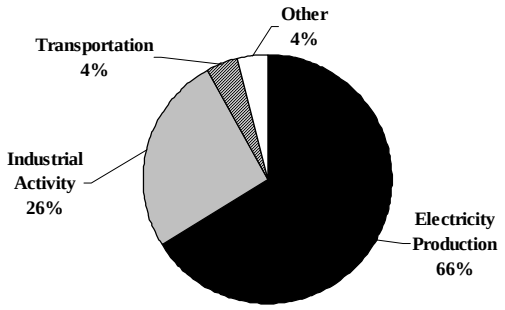
Sulfur oxides. Electricity production, primarily from burning coal, is the source of most emissions of sulfur oxides (SO_x), as figure 2 shows. These chemicals are the main cause of acid rain, which can make lakes and rivers too acidic for plant and animal life. Acid rain also damages crops and buildings. National reductions in sulfur oxides required by the Clean

Figure 1. Number of Deaths by Cause (1989)



Source: Curtis Moore, "Dying Needlessly: Sickness and Death Due to Energy-Related Air Pollution", Renewable Energy Policy Project Issue Brief #6, February, 1997. On-line at solstice.crest.org/renewables/repp.

Figure 2. Sources of Sulfur Dioxide

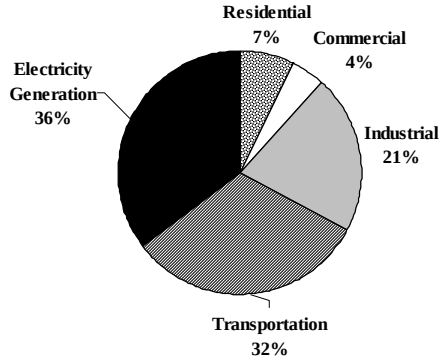


Source:EPA National Air Quality and Emissions Trends Report, 1996.

Air Act Amendments of 1990 may not be sufficient to end damage from acid rain in the northeastern United States.[4] SO_2 is also a primary source of fine particles in the air.

Nitrogen oxides. Burning fossil fuels either to produce electricity or to power transportation emits nitrogen oxides (NO_x) into the air (see figure 3). In the presence of sunlight, nitrogen oxides combine with other chemicals to form ground-level ozone (smog). Both nitrogen oxides and ozone can irritate the lungs, cause bronchitis and pneumonia, and decrease resistance to respiratory infections. In addition, research shows that ozone may be harmful even at levels allowed by federal air standards. The U.S. Environmental Protection Agency (EPA) has published a new rule reducing nitrogen oxide emissions from 0.12 parts per million to 0.08 parts per million. States have until 2003 to submit plans for meeting the new standard and up to 12 years to achieve it.[5]

Figure 4. Sources of Carbon Dioxide

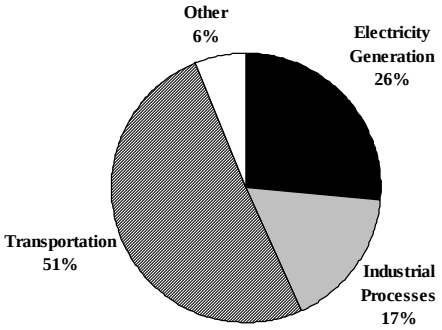


Source:EPA National Air Quality and Emissions Trends Report, 1996.

Carbon dioxide. Carbon dioxide (CO_2) is the most important of the greenhouse gases, which contribute to global warming by trapping heat in the earth's atmosphere. Electricity generation is, as figure 4 shows, the largest industrial source of carbon dioxide emissions and a close second to the transportation sector.

Samples from air bubbles trapped deep in ice from Antarctica show that carbon dioxide and global temperature have been closely linked for 160,000 years (see figure 5). Over the last 150 years, burning fossil fuels has resulted in the highest levels of carbon dioxide ever recorded. In 1995, the Intergovernmental Panel on Climate Change—an authoritative international scientific body—concluded that "the balance of evidence suggests that there is a discernible human influence on global climate."[6] All 10 of the warmest years on record have occurred in the last 15 years. The 1990s have already been warmer than the 1980s—the warmest previous decade on record, according to the Goddard Institute of Space Studies.[7]

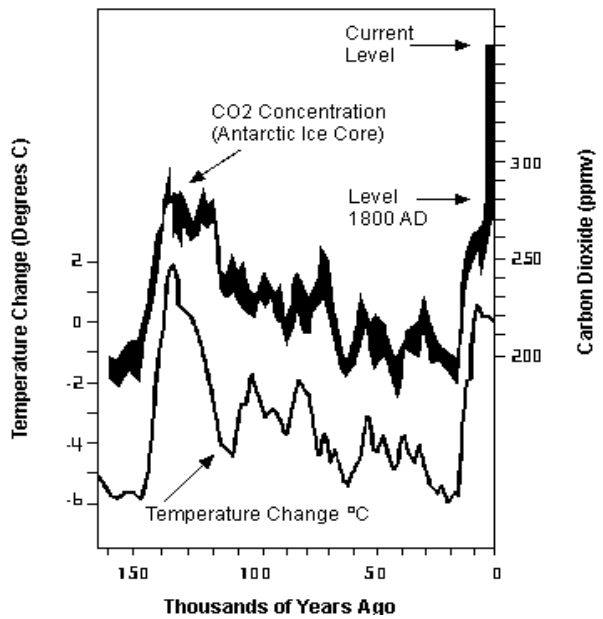
Figure 3. Sources of Nitrogen Oxides



Source:EPA National Air Quality and Emissions Trends Report, 1996.

Without action, carbon dioxide levels would double in the next 50 to 100 years, increasing global temperatures by 1.8 to 6.3 degrees Fahrenheit. The heat trapped in the atmosphere would cause expansion of the ocean's volume as surface water warms and melt some glaciers. A two-foot rise in sea level could flood 5,000 square miles of dry land in the United States, and another 5,000 square miles of coastal wetlands, as figure 6 shows. From 17 to 43 percent of coastal wetland—prime fish and bird habitat—could be lost. Building dikes and barriers could reduce flooding of dry land, but would increase wetland loss. Impacts on island

Figure 5. Atmospheric Carbon Dioxide Concentration and Temperature Change



Source: *White House Initiative on Global Climate Change*, October, 1997. On line at www.whitehouse.gov/Initiatives/Climate/greenhouse.html.

would increase wetland loss. Impacts on island nations and low-lying countries, like Egypt and Bangladesh, would be much worse.

Altered weather patterns from changes in climate may result in more extreme weather events. Some areas will suffer more drought and others more flooding, putting crop production under great stress in some regions. The character of our forests could change dramatically. Other expected impacts include an increase in heat-related deaths, increased loss of animal and plant species, and the spread of pests and diseases into new regions with less resistance to them.[8]

In 1997, at a conference in Kyoto, Japan, the developed nations of the world agreed to reduce carbon dioxide emissions. The United States agreed to 7 percent reductions from 1990 levels by the period 2008–2012. Senate ratification of this agreement remains uncertain, however.

Other air pollutants. Burning fossil fuels, especially coal and oil, produces a host of other air pollutants in addition to those discussed above. Among them are

- Carbon monoxide (CO), which can cause headaches and place additional stress on people with heart disease
- Hydrocarbons (HC), which come from unburned fossil fuels and contribute to smog
- Large particles such as dust, soot, smoke, and other suspended matter, which are respiratory irritants
- Small (so-called "fine") particles, which have been linked to chronic bronchitis, aggravated asthma, and premature deaths

Large particles (10 microns in diameter) are regulated by the Clean Air Act. In 1997, the Environmental

A typical 500-megawatt coal plant produces 3.5 billion kilowatt-hours per year—enough to power a city of about 140,000 people.

It burns 1.4 million tons of coal (the equivalent of 40 train cars of coal each day) and uses 2.2 billion gallons of water each year. In an average year, this one plant also generates the following:

- 10,000 tons of sulfur dioxide
- 10,200 tons of nitrogen oxide, equivalent to half a million late-model cars
- 3.7 million tons of carbon dioxide, equivalent to cutting down 100 million trees
- 500 tons of small particles
- 220 tons of hydrocarbons
- 720 tons of carbon monoxide
- 125,000 tons of ash and 193,000 tons of sludge from the smokestack scrubber
- 170 pounds of mercury, 225 pounds of arsenic, 114 pounds of lead, 4 pounds of cadmium, and other toxic heavy metals
- Trace amounts of uranium

Protection Agency published a new rule limiting emissions of fine particles (2.5 microns). States have until 2005 to 2008 to submit plans to the EPA for meeting the standard, and another 12 years to actually comply.[9]

In addition, coal and oil contain air toxics—metals like mercury, arsenic, and lead. Although only trace amounts of these metals are present in coal and oil, they are difficult to catch using pollution-control equipment. Utility coal burning accounts for 40,000 tons of toxic air pollutants per year.[10] For example, coal plants are responsible for over a third of the 150 tons of mercury that are released into the air each year.[11]

Once deposited in nature, toxic metals can accumulate in the fatty tissue of animals and humans. They can cause severe health problems, such as mental retardation, nervous system damage, and developmental disorders. Due to the accumulation of toxic metals in fish—some of it as a result of air pollution—35 states have advisories against eating fish caught in lakes and rivers. Children and pregnant women are the most at risk.[12]

Water, Land, and Thermal Pollution. Energy production and use also have profound impacts on water and land. There are direct impacts, such as oil spills and coal mining, and indirect impacts from air emissions settling out on land and water. Land and water damage can occur throughout the life cycle of fossil fuels, from mining, drilling, and refining, to shipping, use, and disposal.

Coal mining contributes to land and water pollution. New mining practices sometimes level mountains. Toxic chemicals brought to the surface during the mining process can leach into water supplies.[13] Railroad and barge transportation of coal releases coal dust and is vulnerable to accidents. Finally, after the coal is burned, ash is left as a waste product.

Drilling for oil and natural gas can also pollute the immediate environment. Oil spills kill plants and animals, often leaving waterways and the surrounding shores uninhabitable.

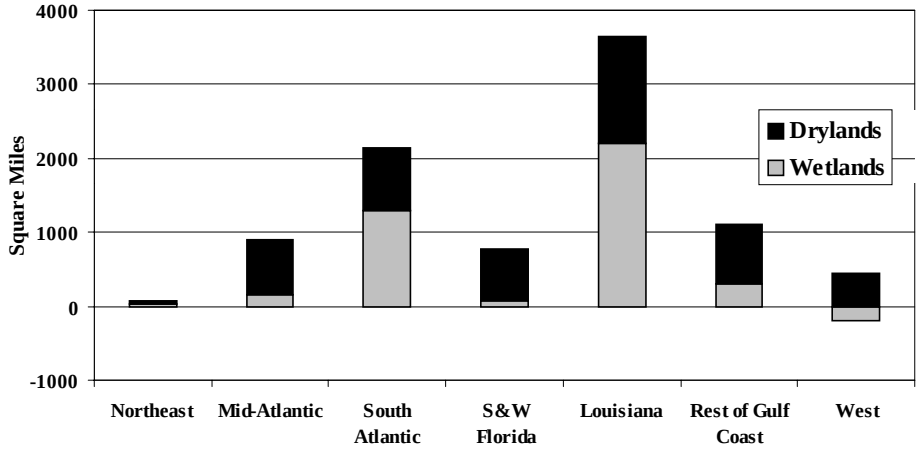
Fossil fuels produce heat energy when burned, some of which is used to generate electricity. Because the process is inefficient, about two-thirds of the heat is released to the atmosphere or to water used as a coolant. Heated water, once returned to rivers or lakes, can upset the aquatic ecosystem. And water intake, outflow, and cooling systems can trap and kill fish and fish larvae.

Economic Benefits of Reducing Environmental Impacts

The many environmental impacts described above result in real costs to society and to individuals. When such costs are not included in energy prices, they are referred to as "externalities." During the 1990s, efforts have been made to calculate the dollar costs of such externalities and, in some cases, to include them in energy planning decisions.[14] In 1998, the Minnesota Supreme Court upheld a state law requiring that utility planning consider externalities.[15]

The largest external costs from pollution are probably human health costs, in the form of health treatment costs, higher health insurance rates, missed work, and lost life. According to an exhaustive survey of health

Figure 6. US Coastal Lands at Risk from a 20-inch Sea-Level Rise in 2020



Source: EPA Air Quality and Emissions Report, 1996.

impacts by the Pace University School of Legal Studies and studies by the American Lung Association, the annual US health costs from all air pollutants may be as high as hundreds of billions of dollars.[16] However, unless policies are adopted so that utility rates account for these societal and environmental costs, customers may ignore them when deregulation enables customers to choose their generating sources. Such policies might include pollution taxes or placing total limits on each emission for the geographic area affected by the emission (see Chapter 4).

Even without considering externalities, both industry and individuals stand to gain from increased reliance on renewable energy. Because renewables produce little or no pollution, they can reduce regional pollution and thereby reduce the costs for neighboring industry to comply with environmental regulations.

The savings are not always obvious. Environmental regulations usually focus on one pollutant at a time, as scientific knowledge about the impacts of the pollutant develops. Then, when government imposes a new regulation, industry may add a series of new pollution controls. Compared with any single pollution-control requirement, replacing the fossil fuel generator with a renewable energy technology may look expensive. But if all potential future controls are considered together, renewable technology can look far more attractive. As of 1998, a host of new environmental regulations were pending:

- The level of ozone (smog) allowed in ambient air is being reduced from 0.18 to 0.08 parts per million.
- Nitrogen oxides have long been regulated under the Clean Air Act. In determining how to allot reductions among industries, state governments are likely to target utilities for major reductions.
- Sulfur dioxide limits will be tightened in the year 2000 when Phase II of the Clean Air Act goes into effect. This will affect every coal-burning power plant in the country.
- Fine particles are being regulated for the first time, with final rules expected by 2005.

Figure 7. Nuclear Power Plant Cooling Tower

- Mercury and other toxic metals have been the subject of substantial research by the Environmental Protection Agency. The EPA has announced it will require coal-fired plants to disclose discharges, and it will use the data to decide on regulations by late 2000.[17]
- Carbon dioxide emissions would need to be reduced to implement the Kyoto agreement on global warming.[18]

Conversion now to renewable technologies would forestall the need for future retrofits to achieve compliance with these regulations.

A 1997 study—*The Hidden Benefits of Climate Policy: Reducing Fossil Fuel Use Saves Lives Now*—illustrates the benefit of multi-emission reductions. Researchers found that measures to reduce global carbon

dioxide emissions—including increasing the use of renewables—could save 700,000 lives each year and a cumulative total of 8 million lives worldwide by 2020, in part by such pollutants as fine particles.[19]

Nuclear Risks

Although nuclear power plants avoid many of the air emissions associated with fossil fuel plants, they create unique environmental risks. A combination of human and mechanical error could result in an accident killing several thousand people, injuring several hundred thousand others, contaminating large areas of land, and costing billions of dollars.[20] While the odds of such an accident are low, the Chernobyl accident in 1986 showed that they can occur.

Major nuclear accidents can only result from many failures occurring at about the same time. But in order to maintain safety margins, inspectors and tests must identify equipment problems, and plants must have accurate procedures to minimize worker errors. A 1998 report by the Union of Concerned Scientists found a breakdown in quality assurance during a one-year study of a 10-plant focus group. The plants' internal auditors did not identify in advance any of more than 200 problems reported in 1997. In addition, many problems resulted from worker errors or poor procedures.[21] A 1997 report by the US General Accounting Office criticized the Nuclear Regulatory Commission (NRC) for failing to catch declining performance at some plants.[22] These findings are especially significant at a time when nuclear plants are cutting costs to become more competitive. Cutting costs need not jeopardize nuclear safety, but maintaining safety in this environment requires increased attention.

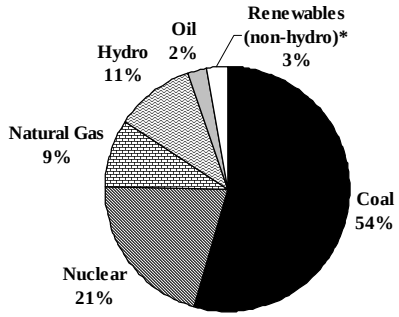
Pressure to cut costs at marginal nuclear plants could reduce the margin of error on safety. For example, the Nuclear Regulatory Commission attributed safety problems at the closed Maine Yankee nuclear plant to "economic pressure to be a low-cost energy producer"—pressure that limited the resources available for repairs.[23]

The erosion of safety measures can be subtle. Staff downsizing programs often target senior employees who receive high compensation. Their departure lowers the corporate experience level and may possibly increase the frequency of human error. Some nuclear utilities reduce costs by scaling back safety monitoring efforts, such as inspecting and testing safety equipment less often and postponing preventive maintenance.

In addition to safety issues, nuclear plants continue to be problematic because of their spent fuel rods and other radioactive waste. By 1995, US nuclear plants had produced almost 32,000 metric tons of high-level radioactive waste.[24] Finding a way to keep this waste out of the environment for the thousands of years it remains radioactive has proven difficult. Problems such as groundwater contamination led to four of the six commercial facilities that store low-level radioactive waste being closed.[25] And, despite years of research, the permanent repository the government hopes to build at Yucca Mountain still has unresolved issues.[26]

But regardless of the environmental issues, it is economics that is most hurting the nuclear industry. In 1998, about 40 percent of the nuclear plants in the United States were producing power at prices above the short-term market rate.[27] A study by the Washington International Energy Group concludes that about 37 percent of the combined nuclear capacity of the United States and Canada could be retired as a result of competition.[28] If fossil fuels are the only replacement option, early nuclear retirements will raise the cost for the country to comply with emission-reduction goals. Most of the planned increases in US natural gas capacity could be needed to replace these retiring nuclear plants, which means that little new capacity would be available

Figure 8. Sources of US Electricity (1996)



*includes cogeneration

Source:Annual Energy Outlook 1998, Energy Information Administration.

to displace coal generation. Even if the nuclear plants were to operate until the end of their license periods, abundant low-emission replacement options would be needed. The availability of significant renewable generation could help to mitigate these nuclear-replacement problems, lowering the costs of regulatory compliance for industry as well as utilities and avoiding the risks inherent in nuclear power generation.

Diversity and Energy Security Benefits

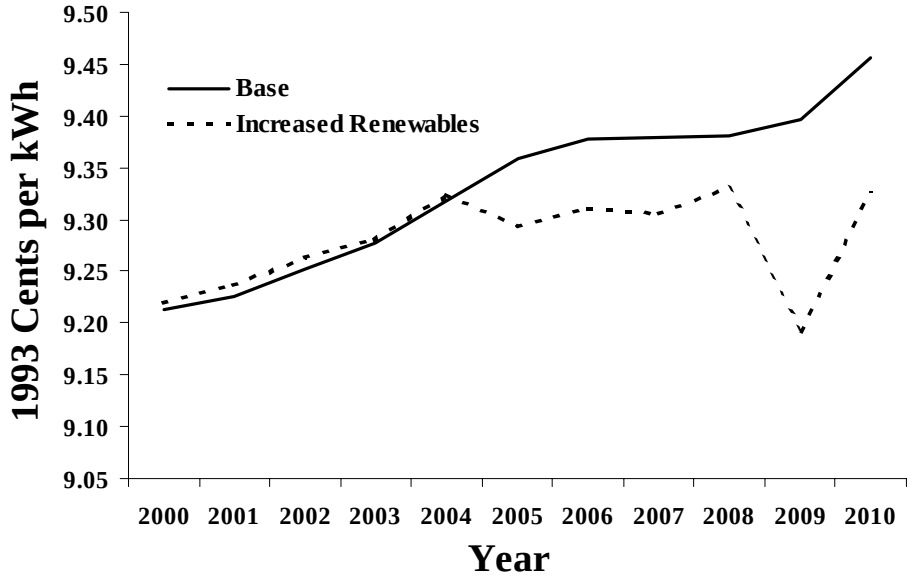
Renewables offer benefits not only because they can reduce pollution, but because they add an economically stable source of energy to the mix of US generation technologies. Depending on only a few energy resources makes the country vulnerable to volatile prices and interruptions to the fuel supply. As figure 8 shows, the United States relies heavily on coal, with nuclear power and natural gas supplying most of the rest.

Natural gas is generally considered the fuel of choice for new power generation, because it is cleaner than coal and sometimes less expensive. But overreliance on natural gas could also create problems. Fossil fuels are susceptible to supply shortages and price spikes.[29]

Since most renewables do not depend on fuel markets, they are not subject to price fluctuations resulting from increased demand, decreased supply, or manipulation of the market. And since fuel supplies are local, renewable resources are not subject to control or supply interruptions from outside the region or country. Some industrial customer trade groups have supported new renewable energy development primarily for their diversity benefits. For example, Associated Industries of Massachusetts, a trade group of manufacturers, testified in support of a utility restructuring settlement including a renewables fund, stating: "Fuel diversity is important to the Commonwealth's future. It would not be advisable to place all our eggs in the natural gas basket."[30]

An additional benefit of increased competition from renewables—and thus reduced demand for fossil fuels—could be lower prices for electricity generated from fossil fuels. Several analyses reviewed in Chapter 2 show that competition from increasing renewables could reduce natural gas prices. A comprehensive modeling project of the New England Governors' Conference found that an aggressive renewables scenario, in which renewables made up half of all new generation, would depress natural gas prices enough to lead to a slight overall reduction in regional electricity prices compared with what prices would be if new generation came primarily from fossil fuels.[31] (See figure 9.)

Figure 9. Average Electricity Prices



Source: Assessing New England's Future, New England Governors' Conference, Inc., 12-11-1996

The nation's fossil fuel dependence also has serious implications for national security, since the United States could again be forced to protect foreign sources of oil to meet our energy needs. During the Persian Gulf War in 1991, US troops were sent in partly to guard against a possible cutoff of the US oil supply. The public continues to pay taxes to support the protection of overseas oil supplies by US armed forces.

Reliance on foreign oil also makes the United States vulnerable to fuel price shocks or

shortages if supply is disrupted. In 1997, about a third of US oil came from the Middle East. By 2030, if energy policy does not change, the country may be relying on Middle Eastern, and possibly Central Asian, oil for two-thirds of its supply. Some analysts believe that oil discovery peaked in the early 1960s and that a decline in global oil production, and the beginning of increasingly high prices, will occur within 10 to 12 years.[32]

Some regions, especially New England, still use significant amounts of oil for electricity generation even though nationwide most oil is used for transportation. Electric vehicles, especially if powered from renewable sources, could also play an increasingly important role in reducing oil use and emissions from the transportation sector. And higher oil prices, absent sufficient fuel competition, could lead to higher prices for other fossil fuels.

TABLE 1
Employment in the Renewable Electricity Industry

	Direct Employment	Indirect Employment	Total Employment
Wind (1992)	1,260	4,350	5,610
Biomass (1992)			66,000
Photovoltaics (1994)			15,000
Solar Thermal (1994)	250	250	500
Geothermal (1996)	10,000	20,000	30,000
Total			**116,860**

Economic Development Benefits

Renewable energy technologies can not only keep dollars in this country, but also create significant regional benefits through economic development. Many states are dependent on energy imports. Iowa and Massachusetts, for example, each import about 97 percent of the energy they use.[33] Renewable technologies create jobs using local resources in a new, "green," high-tech industry with enormous export potential. They also expand work indirectly in local support industries, like banks and construction firms. As table 1 shows, during the 1990s, the US renewable electricity industry employed nearly 117,000 people.[34]

Some renewable technologies, like biomass, are relatively labor intensive, which is one of the reasons they are slightly more expensive than their fossil fuel counterparts. For example, growing, harvesting, and transporting biomass fuels all require labor, as does maintaining the equipment. This means that much of the revenue for installing, fueling, and operating renewable power plants remains within the region where the power is used.

Renewables can mean increased revenues for local landowners. A Union of Concerned Scientists (UCS) analysis found that farmers could increase their return on land by 30 to 100 percent from leasing part of it for wind turbines while continuing to farm.[35] Another study found that adding 10,000 MW of wind capacity nationally would generate $17 million per year in land-use easement payments to the owners of the land on which the windfarms are situated, and $89 million per year from maintenance and operations.[36]

Renewables can contribute heavily to local taxes. Wind farms in California pay $10 million to $13 million in property taxes. And manufacturing capital-intensive renewables technologies can also be done domestically. According to the American Wind Energy Association, at least 44 states are involved in manufacturing wind energy system components.[37]

A UCS analysis for Wisconsin found that, over a 30-year period, an 800-megawatt mix of new renewables would create about 22,000 more job-years than new natural gas and coal plants would.[38] A New York State Energy Office study concluded that wind energy would create 27 percent more jobs than coal and 66 percent more than a natural gas plant per kilowatt hour generated.[39] A study of energy efficiency and renewable energy as an economic development strategy in Colorado by Economic Research Associates found an energy bill savings of $1.2 billion for Colorado ratepayers by 2010 with a net gain of 8,400 jobs.[40]

The California Energy Commission estimates that the 600 MW of new renewables that will be built using $162 million in public benefits funding in the state restructuring law will induce

- $700 million in private capital investment
- 10,000 construction jobs, with over $400 million in wages
- 900 ongoing operations and maintenance jobs with $30 million in long-term salaries
- gross state product impacts of $1.5 billion during construction and $130 million in annual ongoing operations[41]

In addition to creating jobs, renewables can improve the economic competitiveness of a region by enabling it to avoid additional costly environmental controls on other industries, as well as by stabilizing long-term energy prices.

Renewables can also contribute to economic development by providing opportunities to build export industries. In developing countries that do not have electricity grids, pipelines, or other energy infrastructure, renewable energy technologies can be the most cost-effective options for electrifying rural villages. The American Wind Energy Association has estimated that global markets for wind turbines alone will amount to as much as $400 billion between 1998 and 2020.[42]

Other industrial countries are leaping ahead of the United States in renewable energy production, however, because they value the environmental benefits more highly and because they recognize the opportunity to supply export markets. In fact, Japan and various European nations are encouraging the development of renewables by providing greater subsidies than does the United States.[43]

Other Nontraditional Benefits

Because some renewable technologies are small and modular, they can be sited in or near buildings where energy is used. These distributed generation technologies offer some benefits that utilities have usually not considered.

Perhaps most importantly, distributed generation technologies can avoid costly expenditures on transmission and distribution. For example, a utility putting distributed generation in a new neighborhood might be able to use smaller transformers or reduce the size or number of power lines going to the neighborhood. Distributed generation reduces the wear and tear on existing distribution equipment, thereby delaying the need to replace or upgrade the equipment. And distributed generation reduces power losses through the transmission system, so that less electricity needs to be produced in the first place.[44]

A UCS study found that in certain neighborhoods in the Boston area, the value of avoiding transmission and distribution expenditures would more than pay for the extra cost of using such distributed renewables as photovoltaics, solar water heaters, and fuel cells.[45] Many other studies during the 1990s have also pointed to added value from distributed generation.[46]

Distributed generation can also provide "premium power" to customers, improving power quality and system reliability.[47] Companies with critical electricity needs, like hospitals, airports, and computer-dependent firms, pay a premium to ensure reliable power, since the cost of outages can be huge. Generation on site, with small renewable generators, is one way to meet those needs.

Because renewables are typically small, modular, and require short lead times for installation, they can benefit electricity companies' planning. Companies using modular technologies can add capacity in small increments as needed, rather than planning large power plants many years in advance, only to find that they may not be needed when they finally go on line.

Finally, the concept of *value* is changing the perception of renewables, as is consumer choice. Many surveys have shown that customers value the environmental benefits of renewables more than conventional polluting energy sources and prefer electricity companies that supply at least part of their power from renewable energy technologies.[48] Renewables provide options that service-oriented companies can use to improve customer satisfaction. They can improve a company's public image and can create profitable new business opportunities for electricity generation or distribution companies that are customer-oriented.

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[18] See the US Environmental Protection Agency web site at www.epa.gov.

[19] These results are based on a hypothetical "climate policy" scenario that assumes carbon dioxide emissions would be reduced 15 percent below 1990 levels in developed countries and 10 percent below 1990 levels in developing countries. See *The Hidden Benefits of Climate Policy: Reducing Fossil Fuel Use Saves Lives Now*, Resources for the Future, 1997.

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[27] Jim Riccio, *Questioning the Authority*, Public Citizen, April, 1998. On-line at www.citizen.org.

[28] Washington International Energy Group, *Need for Natural Gas Increases With More Nuclear Shutdowns, Washington International Energy Group*, May 1998, on line at www.wieg.com/nu/narchive.htm#Nuclear Industry/Regulation.

[29] For example, in the winter of 1995–96, natural gas prices rose to $31 per million Btu, an increase of about 15 times above normal prices. Strategic Energy Ltd., "Weathering the Winter Without Interruptions," *Energy Watch*, March 11, 1996, on line at www.sel.com/ew031196.html. See also John Herbert, James Thompson, and James Todaro, "Recent Trends in Natural Gas Spot Prices," *Natural Gas Monthly*, December 1997.

[30] Comments of Associated Industries of Massachusetts, to the Massachusetts Department of Public Utilities, 96-100, April 24, 1996, p. 12.

[31] New England Governors' Conference, *Assessing New England's Energy Future*, A Report of the Regional Energy Assessment Project (REAP), December 11, 1996, p. V-6.

[32] Colin Campbell and Jean Laherrere, "The End of Cheap Oil," *Scientific American*, March 1998, pp. 78–83.

[33] US Department of Energy, *Dollars from Sense: The Economic Benefits of Renewable Energy*, 1998, on line at www.eren.doe.gov/utilities/pdfs/dollars.pdf. Includes many excellent examples of renewables/economic development synergy.

[34] The US geothermal industry as a whole employs about 40,000. According to the National Corn Growers Association the corn-to-ethanol industry employs about 55,000 people (5,800 direct and 48,900 indirect).

[35] Michael Brower, Michael Tennis, Eric Denzler and M. Kaplan, *Powering the Midwest: Renewable Electricity for the Economy and the Environment*, Union of Concerned Scientists, 1993

[36] Jamie Chapman, OEM Development Corp. and Steven Wiese, Planergy, Inc., *Expanding Wind Power: Can Americans Afford it?*, Renewable Energy Policy Project Research Report No. 6, October 1998. Available on-line at www.repp.org/index_ar.html.

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[38] Brower et al., *Powering the Midwest*, Union of Concerned Scientists, 1993, pp. 107–108. The study assumed 400 MW of wind, 110 MW conventional biomass, and 300 MW advanced biomass. Energy-employment studies are necessarily resource- and region-specific.

[39] A.K. Sanghi., *Economic Impacts of Electricity Supply Options*, New York State Energy Office, July 1992.

[40] Skip Laitner and Marshall Goldberg, *Energy Efficiency and Renewable Energy Technologies as an Economic Development Strategy*, April 1996. on line at solstice.crest.org/renewables/era/index.html. Similar conclusions were found for the US and for nine other states studied.

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[48] Barbara Farhar, *Trends in Public Perceptions and Preferences on Energy and Environmental Policy*, National Renewable Energy Laboratory Report TP-461-4857, February 1993. See also *Energy and Environment: The Public View*, Renewable Energy Policy Project Issue Brief, November 1996, on line at www.repp.org.