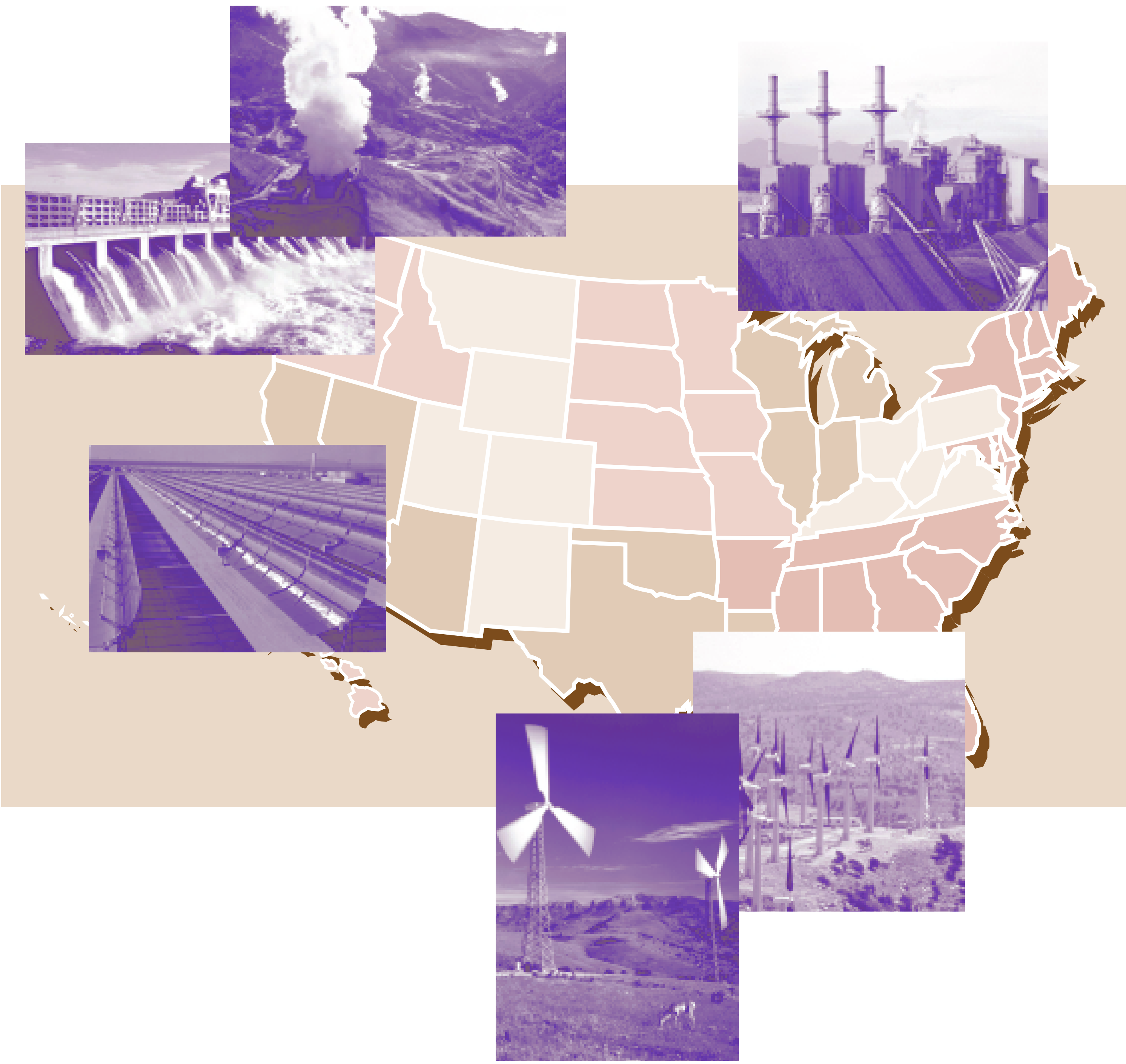
Choices for A Brighter Future

Perspectives on Renewable Energy



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Perspectives on Renewable Energy—A Summary

We have an obligation to act responsibly in assessing potential damages, and to protect our economy and national security by investing in efficient energy technologies. — Vice President Al Gore

Electricity consumers' power to choose suppliers could have dramatic consequences for renewable energy as the nation begins to transition to the next millennium. How can we ensure that the nation will make the most of this new found opportunity? What role can renewable energy play in our future energy system? What approaches and mechanisms will be needed to support renewables in the new energy marketplace? This document identifies and explores some of the major opportunities and challenges surrounding the greater use of renewable energy in the United States.

Perspectives on the Evolving U.S. Electricity Future

The United States relies heavily on fossil fuels for electricity generation. Due to concerns about fossil fuels' environmental effects, and their long-term availability, the U.S. should be moving toward a policy environment that will facilitate a transition to an energy future with an array of choices.

Renewable energy, as a key element of that future, will provide jobs, promote local economic development, and create international business opportunities. In fact, a number of major energy producers are taking a fresh look at renewable energy, as the realities and implications of "business-as-usual" grow more apparent. Renewable energy use lowers concerns about climate change, acid rain, and other environmental effects. As the electric power industry is restructured to facilitate competition in the wholesale and retail markets, the opportunity for renewable energy should grow.

The Renewable Electric Technology Portfolio

The U.S. is blessed with abundant renewable resources. One of the most valuable attributes of renewables is its diversity — creating renewable energy options in every region of the U.S. The renewable electric portfolio includes hydropower, biomass, geothermal, wind, solar thermal, and photovoltaics. Each technology has unique characteristics and can provide high value service to the electric system. The chapter discusses their current status, resource availability, and applications for these technologies.

The Regional Outlook

For this report, the U.S. has been divided into eight regions plus Alaska and Hawaii regions. Each region has unique energy needs, electrical system constraints, policy issues, and environmental problems. The opportunities for renewable energy in each region are as unique as the regions themselves. This chapter provides examples of how renewables are already meeting some regional challenges.

Opportunities to Move Forward In an Era of Change

Renewables are at a critical juncture in today's domestic marketplace. Their competitiveness has improved dramatically over the past decade, yet the pace of market adoption has stalled as the power industry deals with the implications of the emerging competitive marketplace. These issues are often regional in nature and, in many cases, regional solutions will be required. Policy options include tax incentives, Renewable Portfolio Standards, Systems Benefits Charges, and net metering. Policy support is also required to protect customer choice and ensure that green power is available to those who choose to buy it. Support for U.S. industry participation in the global renewable energy marketplace will foster U.S. industry growth and technological superiority. Finally, federal support for U.S. industry research and development (R&D) efforts will accelerate the realization of the economic and environmental benefits of a sustainable energy path.

We can act now to ensure that renewable energy will play a major role in meeting the challenges of the evolving energy future, and the decisions we make today will have implications for many generations. We have the power to choose.

Acknowledgements

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Perspectives on the Evolving U.S. Electricity Future

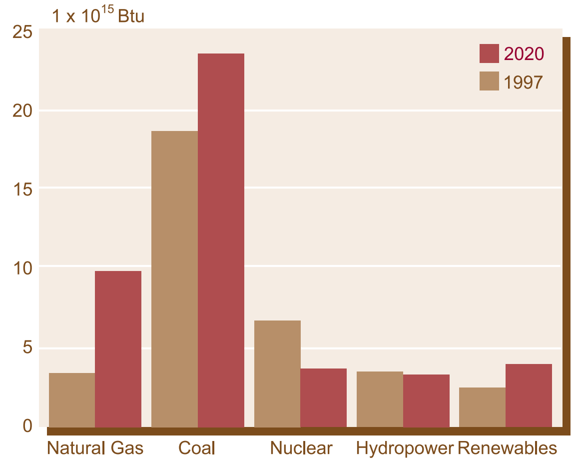
There is clearly a limit to fossil fuel. [Fossil fuel] resources and supplies are likely to peak around 2030 before declining slowly. Far more important will be the contribution of alternative, renewable energy supplies.
— Chris Fay, Chairman and CEO, Shell UK Ltd., Presentation at the Aspen Institute, 1995

The choices we make today about our energy future will affect the global economy and environment for many decades to come. Electricity consumers' power to choose suppliers could have dramatic consequences for renewable energy as the nation begins to transition to the deregulated marketplace. How can we ensure that the nation will make the most of this newly found opportunity? What approaches and mechanisms will be needed to help renewables achieve their full potential in the new energy marketplace? This document identifies and explores some of the major opportunities and challenges surrounding the increased use of renewable energy in the United States as we move into the next millennium.

Current Projections of Our Energy Future

Fossil-fuel resources currently supply about 75 percent of the world's energy needs and about 85 percent of the energy needs in the United States. In most planning scenarios, the fossil-fuel share of the future energy supply mix is not projected to change significantly. Although analysts disagree about the exact time-frame in which supplies of fossil fuels will begin to decline, it is clear that they do not represent an endless resource. In fact, the challenges presented by the need to use fossil fuels wisely will only grow as our appetite for energy services grows. Global electricity supplies are at greatest risk from this trend because they rely mostly on fossil fuels. However, demand for electricity is certain to increase as a result of population growth, continued economic development, and expanding electrification in developing countries. Analysts at the World Bank predict that global electricity capacity needs will climb by more than 60 percent in just 25 years, from about 3 million megawatts now to 5 million megawatts by 2020.

In the United States, the Department of Energy's Energy Information Administration (EIA), in its Annual Energy Outlook (1999 reference case), projects that by 2020, U.S. electric generation capacity needs will increase by 33 percent. During that period, our electricity supply situation will be made even more difficult because nearly half of the United States' nuclear plant capacity is projected to be retired. If coal and gas are used to replace most of the nuclear capacity, in addition to meeting the expected electricity demand growth, their rate of consumption will increase significantly. Under the assumptions in the EIA reference case, the use of coal-fired electricity generation increases by one-quarter while the amount of natural gas-fired electricity generation nearly triples. As a result of these increases, early in the next decade for the first time ever, U.S. coal production for electricity generation will exceed one billion tons per year. In addition, natural gas use will exceed nine trillion cubic feet per year (equivalent to 1.6 million barrels of oil). At the same time, however, the proportion of generation from non-hydropower renewables will remain essentially unchanged.



Source: EIA, Annual Energy Outlook, 1999

As the United States moves into the 21st century, we expect to see a leveling off of the use of coal for electricity generation and a steady decline in nuclear power production. These resources will be replaced by natural gas, and, to a lesser extent, non-hydropower renewable energy.

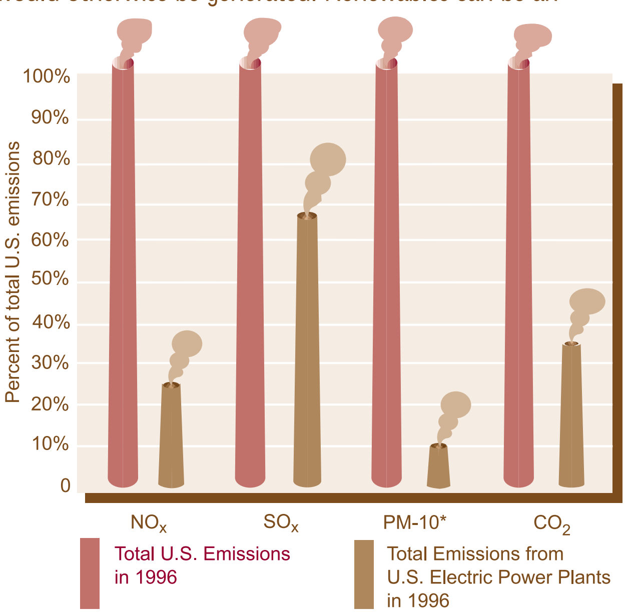
Increasing our use of coal and natural gas for power generation, as EIA projects, will clearly have environmental consequences. Combustion of coal, and to a lesser extent natural gas, to produce electricity now results in the emission of almost 2 billion metric tons of carbon dioxide (CO_2) each year. This is more than a third of the total emissions for the nation of this "greenhouse gas," which is considered the principal contributor to global warming. In fact, the United States emits more carbon dioxide into the atmosphere each year than any other nation.

Power plant emissions, other than CO_2, also represent a significant challenge for the United States' electric utility sector, despite progress that has been made over the past 10-20 years. For example, the largest proportion of sulfur oxide (SO_x) emissions, which contribute to acid rain deposition, comes from electric power plants. Similarly, the electric utility sector is the nation's single largest source of nitrogen oxide (NO_x) emissions which contribute to ground-level ozone and which are a precursor of smog. The Environmental Protection Agency recently promulgated more stringent NO_x reduction requirements on fossil-energy power plants and new standards for particulate matter and hazardous emissions, such as mercury and ozone.

Renewable Energy's Role in Our Supply Mix

Fortunately, our nation does not need to follow a business-as-usual energy path. We can choose to use energy more efficiently, and we can begin to deploy cleaner renewable power technologies. Renewable energy, as a key element of our supply future, is environmentally responsible, abundant, and can provide jobs and promote local economic development.

Renewables are generally clean sources of energy. Their use will lessen concerns about climate change, acid rain, and other environmental effects. Several of these technologies, namely solar thermal, photovoltaics, wind, and hydropower, produce no emissions during power generation. Biomass plants, with a properly managed fuel cycle and modern emissions controls, contribute no net greenhouse gases (carbon dioxide) to the atmosphere and only minimal amounts of emissions that cause acid rain and ground-level ozone. Geothermal facilities are much the same — these plants contribute relatively minor amounts of gases to the atmosphere. When we choose renewable technologies in place of fossil fuels to generate electricity, we avoid air emissions that would otherwise be generated. Renewables can be an



U.S. electric utilities were the nation's largest single source of emissions.

Global Warming and Climate Change

Since the early 1970s, evidence has grown that suggests that human activities, particularly our industrial and land-use practices, have caused atmospheric concentrations of greenhouse gases to increase substantially. These greenhouse gases, especially carbon dioxide and methane, help to trap heat within the earth's atmosphere, resulting in global warming. Climate scientists generally agree that the earth's average temperature has risen in the past century. Scientists are concerned that if this buildup of greenhouse gases in the atmosphere continues, global warming will intensify, and floods, heat waves, droughts, and other extreme weather conditions will be more frequent.

To address these growing concerns about global climate change, world leaders and citizens of 176 countries attended the United Nations Conference on Environment and Development (also known as the Earth Summit) in Rio de Janeiro, Brazil, in June 1992. Since that conference, the United States and many other countries have signed the Framework Convention on Climate Change, agreeing to take action to mitigate global warming.

In October 1993, the United States released a Climate Change Action Plan that detailed the initial U.S. response to the global warming treaty. The plan committed the nation to a voluntary goal of reducing emissions of greenhouse gases to their 1990 levels by the year 2000 and increasing aid to developing countries to fund the transfer of energy efficient technologies.

At the third Conference of the Parties to the Treaty on Climate Change, held in Kyoto, Japan, in December 1997, 160 countries agreed to further reduce greenhouse gas emissions. Under the Protocol, the United States agreed to cut emissions by 7 percent relative to 1990 levels by 2008-2012. Over that same period, the European Union will cut emissions by 6 percent and Japan by 8 percent relative to 1990 levels. The Accord has been open to ratification since March 1998 and will go into effect when signed by 55 countries, accounting for at least 55 percent of the total 1990 carbon dioxide emissions of developed countries.

However, even if the agreement is ratified and implemented, scientists are saying that it would only be a first step, slowing but not stopping the buildup of greenhouse gases.

important element in our portfolio of technologies for a clean environment and for a world less threatened by the impacts of global warming in the future.

David Patryas Photography

U.S. manufacturers are expanding their output to meet domestic and international demand for photovoltaic systems. This creates skilled jobs at production facilities in several states, such as this thin-film plant in Golden, Colorado.

Renewables are virtually inexhaustible. Solar and wind resources are replenished on a daily basis; biomass can be grown through managed agricultural programs to provide continuous sources of fuel; geothermal power can be extracted from virtually unlimited thermal resources; and hydropower, using low-head and run-of-the-river facilities, can tap into many of the nation's small streams and rivers.

Renewables are abundant and widely available. Unlike non-renewable resources, they are broadly distributed across the country. Each of the 50 states can draw upon one or more of these resources to produce electricity. Certain regions, however, tend to have greater access to one type of renewable resource than another. For example, the Midwest has very high quality wind resources — enough to produce the equivalent of the total U.S. electricity needs. High-level solar resources predominate in the Southwest — 10 percent of Nevada's solar resource could satisfy total U.S. electricity needs. Geothermal (hydrothermal) resources tend to be concentrated in the west; biomass resources in the eastern part of the United States (agricultural and forest residues/by-products and energy crops) could potentially provide more than a quarter of our electricity needs.

Renewables are already bringing important economic benefits to the nation because they are domestic energy resources. For example in 1996, the photovoltaic industry generated more than $800 million of revenues and employed 15,000 people at over 850 companies, most of them in high-quality jobs, such as manufacturing, engineering, sales, installation, servicing, and maintenance. The biomass power generation industry employs more than 66,000 people nationwide and has created more than $1.8 billion in personal and corporate income, generating more than $460 million in federal and state taxes. A recent study showed that the geothermal industry pays about $40 million each year to the U.S. Treasury for rent and royalties from geothermal plants.

Renewable resources help states stem the flow of energy dollars outside of their borders. Wisconsin, a state with no indigenous fossil-fuel resources, reports that investing in renewable energy technologies generates more than three times as many jobs, earnings, and sales as the same level of imported fossil fuel and investment. In recognition of these economic benefits, several states and numerous localities have established incentive programs to bring renewable technology manufacturing plants to their areas. For example, two companies in Virginia have taken advantage of an economic incentive program to build photovoltaic manufacturing plants and have created more than 100 new jobs.

Taking Control of Our Energy Future

A number of major companies in the traditional energy business have recently predicted that there will be a significant role for renewable energy in the longer term. These forecasts are generally rooted in the knowledge that fossil fuel supplies are finite and the belief that environmental issues will become even more pressing over the coming years.

The Royal Dutch/Shell Group supports the idea that we can meet an ever-increasing share of our power needs with renewable energy resources. This view is based on the continuing ability of renewable energy technologies to improve their performance and cost through research and development (R&D). The result, according to the Shell Group, will be that renewables will increase their market share as total energy demand grows, and, by 2020, when renewables are fully competitive with conventional energy sources, they will supply more than 30 percent of the world's energy. By the year 2060, the Shell Group believes that more than half of the world's energy will come from renewable resources.

The Shell Group is apparently so confident in this outlook that it has announced an investment of one quarter of a billion dollars over a five-year period in the development of renewable energy, mainly solar and biomass, power projects. Shell is not the only energy company investing in environmentally friendly technologies. BP Amoco has invested heavily in solar energy and is now the largest manufacturer of solar modules in the world. BP Amoco Chief Executive Officer Sir John Browne recently stated: "We see solar in particular as a major contributor to world energy needs by the middle of the next century."

In similar fashion, Enron Corp., a Houston-based energy company, is also diversifying its business portfolio. The company purchased California-based Zond Corporation, the leading U.S. wind turbine manufacturer, in 1997 and followed that acquisition with the purchase of Tacke Windtechnik GmbH, the world's fifth largest wind turbine manufacturer in 1998. Until recently, Enron was also a partner with Amoco in Solarex. These acquisitions were designed to make Enron a key player in supplying renewable energy in a competitive electric marketplace. After a recent conference at the Aspen Institute, Enron Chairman and Chief Executive Officer Kenneth L. Lay joined with Roger Sant, of AES Corporation (a leading international energy project marketer and developer), in declaring that "we should significantly increase public and private spending for research and development of lower carbon and carbon-free fuels, technologies, and systems."

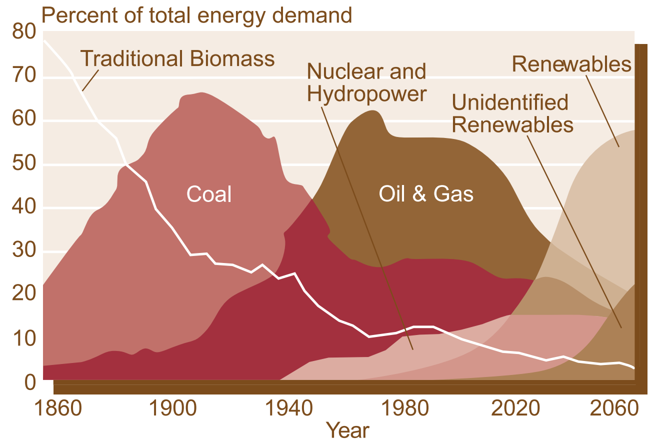
The Power to Choose

The U.S. electric power sector is changing at an unprecedented rate. A number of states have passed laws that will restructure their electric power industry to facilitate competition in wholesale and retail markets. The federal government and other states are considering similar legislation. Increased competition in electricity supply markets should result in lower prices, among other outcomes. At the same time, environmental concerns, such as climate change, are driving the development of cleaner power technologies for the nation's energy mix.

These changes will provide electricity consumers with a wide range of choices including new small-scale, modular, and environmentally friendly distributed power technologies. Using these technologies, consumers will be able to self-generate part or all of their electricity needs, for example, by installing roof-mounted photovoltaics (solar cells). Other distributed technologies, such as advanced biopower systems and fuel cells, will produce both electricity and thermal energy in a highly efficient manner for on-site use (combined heat and power). Also, these small modular technologies could be connected directly to the distribution system to both provide for local electricity needs and enhance the reliability of the power delivery system.

For many years, national public opinion polls have shown that 40 to 70 percent of American consumers value a clean environment and are willing to pay more, if necessary, for cleaner sources of energy. In a few states, consumers who value clean air and a healthy environment can now choose to purchase their electricity from renewables. This desire for a clean environment will only intensify as the public's attention to the consequences of global warming grows.

How can we ensure that the nation will make those choices that are best for future generations? What approaches and mechanisms will be needed to help renewables meet their full potential in the new energy marketplace? The answers to these questions are far from simple. To devise such answers, U.S. policy makers need a clear understanding of the opportunities to use renewables in every region of this country. To enhance that understanding, the remainder of this document describes the technologies, discusses regional energy perspectives, and identifies and explores some of the major issues and opportunities surrounding the greater use of renewable energy in the United States.



Source: Royal Dutch/Shell Group, ***The Evolution of the World's Energy Systems,*** 1994

According to Shell International Limited, a resource and its technologies generally take several decades to penetrate energy markets to a significant degree. If renewable energy technologies follow a growth path similar to that of coal and oil, renewables may dominate the energy market by the mid-21st century.

A Note About Electricity Terms

In discussions of electricity supply, the terms electric power (or capacity) and electric energy (or electricity) are often used. Power is the ability to do work, and energy is the actual performance of the work, or the use of that ability over a period of time. The unit used here for electric power, or capacity, is the megawatt. The unit used for electric energy, or electricity, is the kilowatt-hour. It takes 60 watts of capacity to power a 60-watt light bulb; to power a million 60-watt light bulbs 60 megawatts of capacity is required. To light a 60-watt light bulb for 1,000 hours, 60,000 watt-hours, or 60 kilowatt-hours, of electricity is required. For reference, the United States currently has 748,000 megawatts of electricity generating capacity; an average household uses 10,000 kilowatt-hours annually; and 10,000 megawatts are required to service a state the size of Oklahoma or Massachusetts each year.

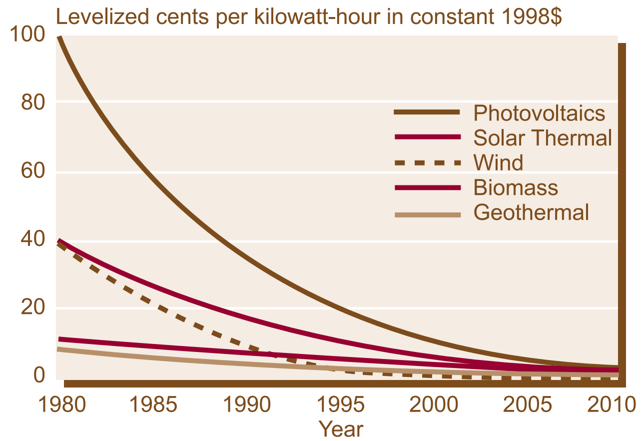
The Renewable Electric Technology Portfolio

A robust energy future for the United States requires a diverse portfolio of technologies and options that allow us to modify our current energy supply system — Science and Technology: Shaping the 21st Century, Office of Science Technology Policy, April 1997

A portfolio of renewable electricity generation technologies is available today to produce electricity for both grid and non-grid applications. The cost, performance, and reliability of these technologies have improved dramatically over the past 20 years due to extensive government and industry R&D investments. The cost of electricity from several of these technologies is now comparable to that from fossil-based plants. In particular, certain types of geothermal and biomass plants can compete with new fossil plants, when both construction and operating costs are considered. Generation from wind plants is approaching competitiveness with the variable operating costs of existing power plants, and the economic competitiveness of solar thermal and photovoltaic systems is also improving. Already cost-effective in many off-grid applications, photovoltaics are being installed in distributed grid-connected applications to provide benefits such as electric transmission and distribution system support. In addition, a market is emerging for photovoltaics for building rooftop and building-integrated systems. With continued R&D progress, the entire portfolio of renewable technologies will contribute significantly to U.S. and global electricity supplies over the coming decades.

Because the quality and availability of renewable resources vary across the country, having a portfolio of renewable technologies permits the selection of the most appropriate resource in a particular region and for a specific application. In electric grid systems, a renewable technology portfolio supports the entire range of power services. For example, renewables such as biomass and geothermal power technologies provide dispatchable, load-following service comparable to that of conventional, central station fossil-fuel technologies. Intermittent technologies such as wind and solar systems have value as determined primarily by the time of day and year during which electricity is produced. In some regions, solar power output tends to follow the summer peak. Because power delivered during peak periods is more valuable to the utility system, these solar technologies can provide high-value electricity and be significant contributors to a reliable power supply system at critical times in those regions. Combining intermittent resources with storage technology extends their daily operating hours and enhances their value as dispatchable electricity generators.

Renewable electricity technologies can be built in a capacity appropriate to electric system demand or to local



Source: Department of Energy

The cost of producing electricity (levelized cost of energy) from non-hydropower renewable sources, where costs have been traditionally high, has declined significantly. In a growing number of applications, the value to the utility system of a renewable energy plant is equivalent to, or greater than, that of a conventional power plant.

needs. This technology characteristic, which is called modularity, significantly reduces the lead time required for construction of a new electric generation facility. These smaller-sized facilities can also be placed closer to the local load center, reducing the cost of developing or upgrading transmission and distribution systems and improving reliability and power quality.

The following discussion provides an introduction to the electric supply technologies that constitute the nation's renewable supply portfolio. It describes their uses, discusses the availability of the resource, and illustrates their current technology configurations.

Hydropower

Hydropower is the most mature and largest source of renewable power, producing about 10 percent of the nation's electricity. Existing U.S. hydropower capacity is about 77,000 megawatts (not counting pumped storage) — enough electricity to meet the needs of 35 million households. This represents the energy equivalent of 140 million tons of bituminous coal and the avoided emissions of roughly 400 million tons of carbon dioxide. Hydropower plants produce no air emissions and are an important part of a strategy to minimize global climate change.

Hydropower plants convert the kinetic energy in flowing water into electricity. The quantity of electricity generated is proportional to the volume of water flow and the height of the water above the turbines. The most common form of hydropower uses a dam on a river to retain a large reservoir of water. Water is released through turbines to generate power. Other hydropower facilities, "run-of-the-river" plants, do not use large impoundments, but divert water from a stream and direct it through a pipeline to a hydraulic turbine.

Hydropower projects can affect water quality and fish and wildlife habitats. As existing hydropower plants are evaluated during relicensing, these concerns are often raised. To mitigate these impacts, many hydropower projects are diverting a portion of the flow around the dams to encourage downstream migration and maintain downstream wildlife habitats. While beneficial for wildlife, reduced water flow through the turbine lowers the power plant's output. This reduced output must be replaced by other generating resources to meet system needs. An advanced, environmentally friendly hydroelectric turbine, considerably more efficient than today's turbines but significantly less harmful to fish and other aquatic life, is now being developed for installation at existing and new sites.

Potential sources of hydropower capacity include many flowing rivers and streams on which low-head hydroelectric systems could be installed. These small, run-of-the-river facilities could use existing earthen impoundments, flood control or water-supply structures. Such plants, in the 1-10 megawatt range, can supply enough electricity to power a small town or village.

Biomass Power

Biomass power is a proven electricity-generating option that currently accounts for about 11,000 megawatts, or

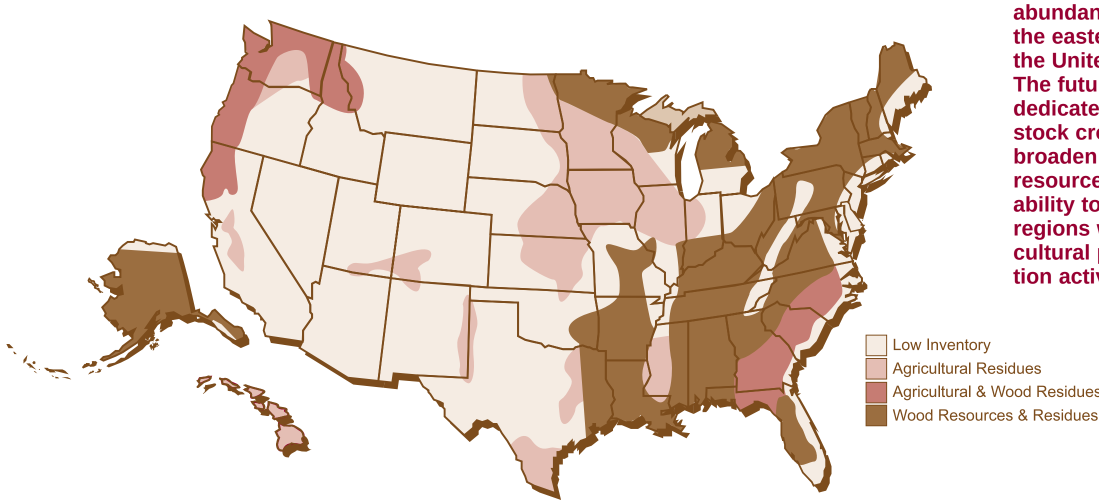
Warren Gretz, NREL

The growth and harvesting of trees can, in the future, provide a replenishable source of fuel for electricity generation. The 50-megawatt McNeil station in Burlington, Vermont (shown here) currently burns wood chips prepared from wood waste directly. A gasifier that will use the fuel more cleanly and more efficiently is presently being tested at the site.

slightly more than 1 percent of the installed generating capacity in the United States. At approximately 11 percent of the renewable-based generation, biomass ranks second only to hydroelectric power. Biomass is unique in that it represents stored solar energy that can be converted into solid, gaseous, or liquid fuels. It is the only form of carbon that is replenished on short time scales. The biomass resource base capable of being converted into biopower (biomass-to-electricity power generation) includes various agricultural and industrial residues and processing wastes, municipal solid waste, and landfill gas. This resource base can also be augmented to include various feedstocks grown specifically as a fuel source.

Direct-combustion steam turbine technology is the principal process currently used to convert biomass into electricity. One form of direct-combustion technology, co-firing of biomass in pulverized coal boilers, is currently being practiced in a number of electric utility-scale boilers, where it offers benefits in fossil fuel savings and reduced sulfur oxide, nitrogen oxide, and carbon dioxide emissions. Other conver-

U.S. Biomass Resources



Biomass resources are abundant across the eastern half of the United States. The future use of dedicated feedstock crops can broaden the resource availability to all regions with agricultural production activity.

Source: NREL Center for Renewable Energy Resources sion technologies that are available and/or currently under development to produce biopower include pyrolysis and gasification. Biomass gasification (using high-efficiency combined cycle and, in later years, steam-injected gas turbines) represents the most promising approach to large-scale biopower development.

Biomass-fueled electric generation facilities have several attractive commercial applications, including cogeneration (production of both steam/heat and electricity in industrial facilities), and central station generation. At the end of 1998, nearly 1,900 megawatts of wood-fired, biomass-fueled utility power plants were operating in the United States. Another 5,500 megawatts of wood-fired cogeneration plants were operating, primarily in the pulp and paper industry. Similar to pulverized coal-fired plants, biomass-fired plants produce dispatchable, baseload and load-following power. Additionally, a packaged, modular power plant that can be specifically tailored to meet domestic and international market requirements for smaller-scale, grid-connected and off-grid power systems is under development.

The future direction of biomass power is to create a new energy industry in which farms would cultivate dedicated energy crops including fast-growing trees (such as poplar or willow), switchgrass, and alfalfa. This trend will convert the biomass power industry from one that depends on transport of forest and agricultural residues to the power plant to one that grows its own dedicated fuel supply, thereby greatly expanding the size of this domestic renewable resource.

Geothermal

Geothermal power is a proven renewable technology with 70 plants in the United States (all in California, Nevada, Utah, and Hawaii) representing about 2,800 megawatts of installed electric generating capacity. The earliest domestic geothermal power plants were installed in the early 1960s at The Geysers geothermal field. Located north of San Francisco, California, The Geysers remains the most significant developed domestic geothermal resource.

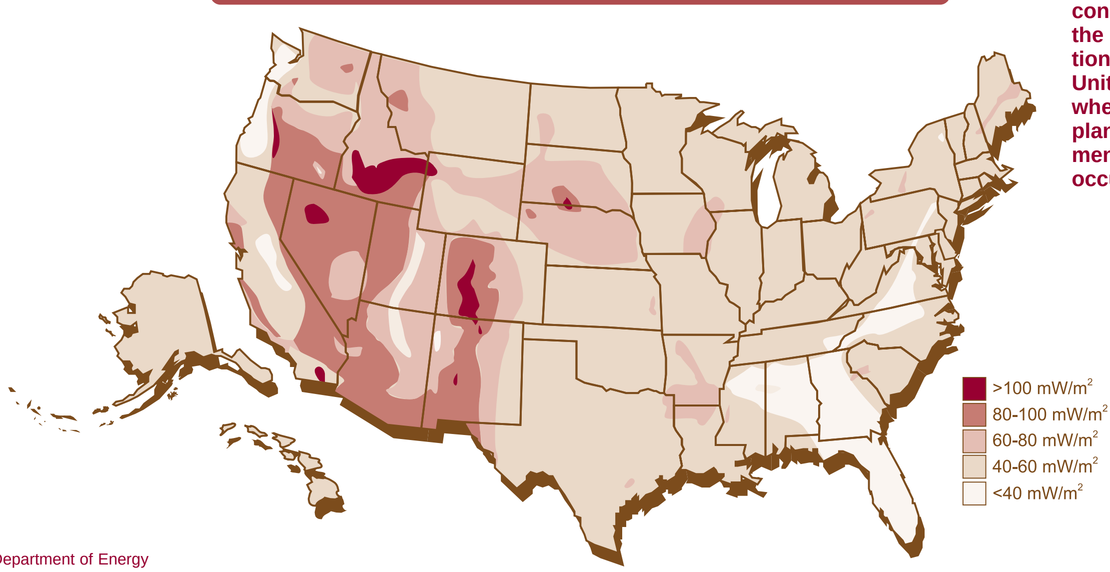
Geothermal Resources Council

The Mammoth geothermal plant, located in the eastern Sierra Nevada mountain range in California, showcases the environmentally friendly nature of geothermal power. Three air-cooled binary units generate a total of 28 megawatts of electricity, and release essentially no emissions into the atmosphere or land surface.

Today, geothermal electricity production supplies the residential electricity needs of more than 5 million people. With continued improvements in technology, geothermal energy has the potential to supply as much as 50 percent of the nation's electrical power needs. Although the present industry is based solely on hydrothermal resources (those containing hot water and/or steam), the long-term future of geothermal energy lies in developing technology that uses the full range of the geothermal resource, including those that tap into hot rock that contains no natural water.

Geothermal energy is heat from the earth. The earth's

Geothermal Resources



Geothermal resources are concentrated in the western portions of the United States where most of the plant development has occurred to-date.

Source: Department of Energy

center reaches temperatures greater than 4,000° C, and an immense amount of heat flows continuously to the surface. This flow of heat drives many global geologic processes. Some of these processes concentrate heat in shallow areas of the earth's crust, where they can be more easily accessed.

A few high-temperature resources produce dry steam, rather than hot water, which is fed straight to a turbine (dry-steam geothermal power plants). In the more usual case of flashed-steam geothermal power plants, however, hot water is brought from underground hydrothermal reservoirs to the surface through production wells. As the pressure is reduced, much of the hot water flashes to steam, which is then separated from the liquid and fed into a turbine. The remaining geothermal fluid is recycled by pumping it back into the reservoir.

Advanced technologies offer the promise of allowing use of presently non-economic geothermal resources. For example, variations in binary cycles are extending the commercial use of geothermal power to hydrothermal reservoirs with moderate temperatures (100° to 160° C). Binary power plants use a secondary working fluid, evaporated by the geothermal fluid, to drive the turbine. Current research in enhanced geothermal systems — extracting heat from underground rock by injecting and circulating water through man-made fissures — has the potential to supply a significant portion of the nation's electricity and to bring geothermal power to every state.

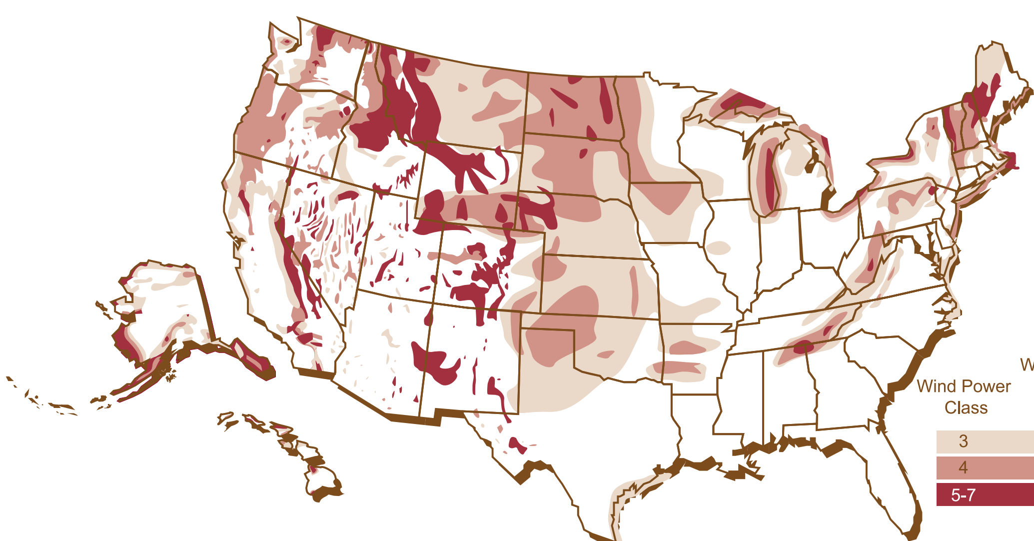
Since no combustion process is involved in producing electricity, a geothermal power plant has no nitrogen oxide emissions. However, dry and flashed-steam plants do release some hydrogen sulfide and dissolved carbon dioxide, but these emission rates are usually a small percentage of those from a fossil-fueled power plant. Abatement systems are commonly used to limit hydrogen sulfide emissions to legally permissible levels. Emissions from a binary geothermal power plant are minimal because the geothermal fluid is never exposed to the atmosphere.

Traditionally, geothermal power systems have been operated to provide baseload electricity. Feasibility tests indicate that most of the installed systems can be cycled to follow the system load, thereby increasing their value in certain grid-connected and/or stand-alone applications. There is also interest in building small geothermal power plants, taking advantage of the modular nature of these units (from 200 to 3,500 kilowatts) to supply mini-grid power in remote locations with geothermal resources.

Wind Power

Wind power generation is a commercially available and competitively viable renewable technology option for producing electricity. Extracting energy from the wind is a centuries-old practice, however, modern turbines use aerodynamic designs that are far more efficient. The installed wind electric generation capacity of approximately 1,800 megawatts is about 2 percent of the total U.S. renewable electric capacity. Although California has the most installed wind electric capacity (1,600 megawatts), wind resources are broadly available across the United States. A Department of Energy study looked at the wind resources associated with land available for wind development in the continental United States. Excluding urban areas, much of the forest and agricultural land, and land that is environmentally sensitive, the study found that the new fleet of wind turbines could generate more than one and one-half times as much electricity as is now being used in the entire country. Moreover, future design improvements will make it cost effective to generate power in regions with lower average

Average Annual Wind Power



Wind Power Class	Wind Energy Resource Potential	Average Wind Speed (mph) at 10m height
3	Moderate	12.5
4	Good	13.4
5-7	Excellent	14.3

Source: National Renewable Energy Laboratory

Moderate to excellent wind resources are found in most regions of the country. The majority of the usable wind resource is found in class 4 sites.

The Louisville Gas and Electric Company operates a 35-megawatt wind farm in west Texas. The local utility, Lower Colorado River Authority, purchases its electricity production, and land lease payments go to the Texas school systems.

Lower Colorado River Authority

wind speeds than the study considered. These advances could boost the potential for wind-generated electricity to more than four times as much electricity as the nation is now using.

Most wind facilities installed to date use propeller-like blades to capture the wind's energy. The rotating blades are connected through a shaft to a generator to produce electricity. Wind turbines are currently available in sizes from tens of watts up to the megawatt range. In the United States, the bulk of the installations is in windfarms where tens to hundreds of turbines are interconnected to the utility transmission grid through dedicated substations. However, there is growing interest in distributed wind facilities with individual or a small number of turbines connected directly to the local utility distribution system.

Wind power is a clean source of electric power with no air, water, or solid waste emissions. Development of windfarms, however, does carry with it potential localized environmental impacts associated with avian interactions, aesthetics, and acoustic emissions. The degree of these impacts can vary from none in some areas to levels of concern in others, depending on the site-specific characteristics of the project. Ongoing research, particularly avian studies, is seeking to identify ways to mitigate impacts at current installations and to minimize impacts from future developments.

Stand-alone or off-grid uses include power production for rural villages, communication stations, and use in conjunction with diesel systems. In a wind/diesel hybrid system, such as those being investigated in remote areas such as Alaska, the wind turbine can enhance reliability, reduce fuel costs, and provide local environmental benefits through emissions reductions.

Solar Thermal Power

Three solar thermal electric technologies are now in use or under development in the United States: parabolic trough systems, parabolic dish/engine systems, and central power towers. There are more than 350 megawatts of parabolic trough systems operating in southern California, which account for most of the world's grid-connected solar energy capacity. A number of parabolic dish/engine systems, which are in limited commercial production, are also operating in various locations in the United States and abroad. Finally, a 10-megawatt demonstration power tower has been tested in southern California.

Solar thermal systems use the sun's heat to generate electricity. Sunlight is focused with mirrors or lenses onto a thermal receiver/heat exchanger. The heat generated is used either to produce steam for electric power production or to drive a heat engine directly. Since solar power systems rely on the sun for energy, there are virtually no air, water, or solid waste emissions. Further, solar thermal plants can be built in modules and thus can be easily adapted to meet a variety of power needs and requirements. For example, small solar thermal systems can be used in applications ranging from electrification of remote villages, to distributed generation applications on existing power systems. Large solar thermal systems are suitable for central station applications to provide peaking power and, if integrated energy storage is incorporated, dispatchable power at other times of the day. In a hybrid configuration (solar and gas-fired combustion turbines), these plants can run continuously throughout the day and night, resulting in significant natural gas savings and emissions displacement.

Warren Gretz, NREL

Parabolic trough systems reflect and concentrate sunlight onto a receiver pipe located along the focal line of a curved, trough-shaped reflector. The heat generates steam to drive a turbine. This trough system is located at Kramer Junction, California, and has been operating since 1980.

Warren Gretz, NREL

Parabolic dishes are similar to trough systems except that they use a dish-shaped reflector. A heat engine (Stirling engine) mounted on the receiver drives a generator to produce electricity.

Dish/Stirling systems in the 5 kilowatt to 50 kilowatt range are being developed for grid-connected and remote power applications.

Photovoltaics

The total grid-connected photovoltaic generating capacity in the United States currently stands at about 25 megawatts, spread across 36 states. This grid-connected capacity is small compared to the total capacity of photovoltaic systems installed for non-grid-connected uses. Because the systems can be configured for a large variety of applications, they are finding their way into specialized markets where their relative economics are more favorable than those of the bulk power market. One such market that may grow rapidly is photovoltaic systems for buildings. The Clinton Administration's Million Solar Roofs Initiative will add about 3,000 megawatts to the United States' installed base of grid-connected photovoltaic systems by 2010. More importantly, with an increased volume of photovoltaic sales, the per unit cost of manufacturing will drive down photovoltaic system prices — following the "learning/experience curve."

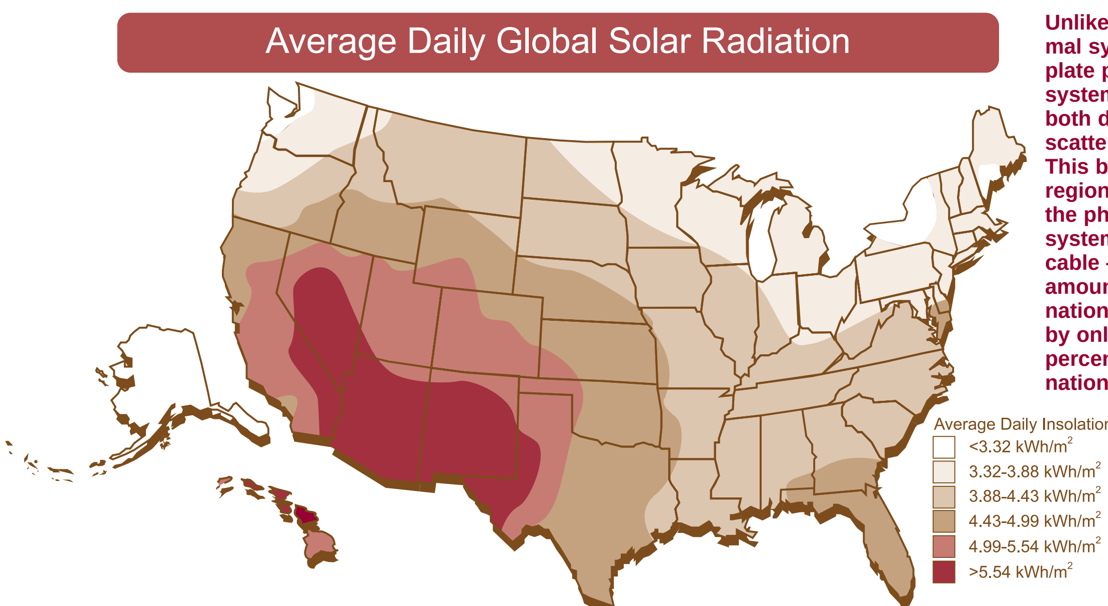
The basic unit in a photovoltaic system is the photovoltaic cell, which is made of semiconductor materials similar to those used in computer chips. Incoming sunlight is absorbed by these materials, freeing electrons from their atoms, and allowing the electrons to flow through an external circuit to generate electricity. The greater the intensity of the light, the more power is generated in the cell. Photovoltaic cells, which produce DC electricity, are usually connected together and enclosed in protective casings called modules. These in turn may be connected to an inverter to supply AC electricity.

Since photovoltaic systems use no moving parts to produce electricity, they are durable power systems with low maintenance, high reliability, and low environmental impacts. Because their basic building block, the module, is small, photovoltaic systems are suitable for both large and small electricity supply applications. For example, systems of several hundred kilowatts in size have been built in a number of locations. Some of these have been installed to supply electricity to the system owner, and others have been installed to provide operational support to the local utility distribution system.

Terry O'Rourke

Pacific Gas and Electric Company (PG&E) installed a 500-kilowatt photovoltaic system at its Kerman substation in 1993 to reinforce a weak feeder. PG&E found that distributed systems like this have measurable benefits such as increased system reliability and peak-shaving capabilities.

As described earlier, most systems installed to-date have been in off-grid or in customer-sited applications. Manufacturers are beginning to make photovoltaic arrays that not only produce power but also serve as an integral part of a building. These may take the form of photovoltaic shingles, light-filtering skylights, or overhangs. In off-grid or stand-alone applications, markets for photovoltaic systems include individual homes, campsites, and village power (providing lighting, refrigeration, and electricity for remote villages). They can also be used as fuel savers in hybrid systems, particularly those using diesel fuel and propane. Currently, the largest market for rural electrification is in developing countries.



Source: NREL Center for Renewable Energy Resources

Unlike solar thermal systems, flat-plate photovoltaic systems can use both direct and scattered sunlight. This broadens the regions in which the photovoltaic systems are applicable — the amount of sunlight nationwide varies by only about 30 percent from the national average.

The Regional Outlook

In the Midwest's search for new strategies to rejuvenate its industrial base and secure its economic future, renewable energy is a good place to start. — Powering The Midwest, Union of Concerned Scientists, 1993.

Every region in the country has sufficient indigenous renewable resources to supply all of its electrical needs. The Southwest, Mountain, and Gulf regions, for example, have enormous solar resources; the Northwest has hydropower and geothermal resources; the Midwest has more than enough wind energy to provide electricity for the entire nation; the Central region has large resources of wind and biomass; the Northeast could tap a combination of biomass, wind and solar; the Southeast region has vast areas of biomass; and Alaska and Hawaii could exploit their ample resources of wind, solar, hydropower, and biomass. Yet, with the exception of large hydroelectric dams, renewable energy provides very little of the nation's electricity.

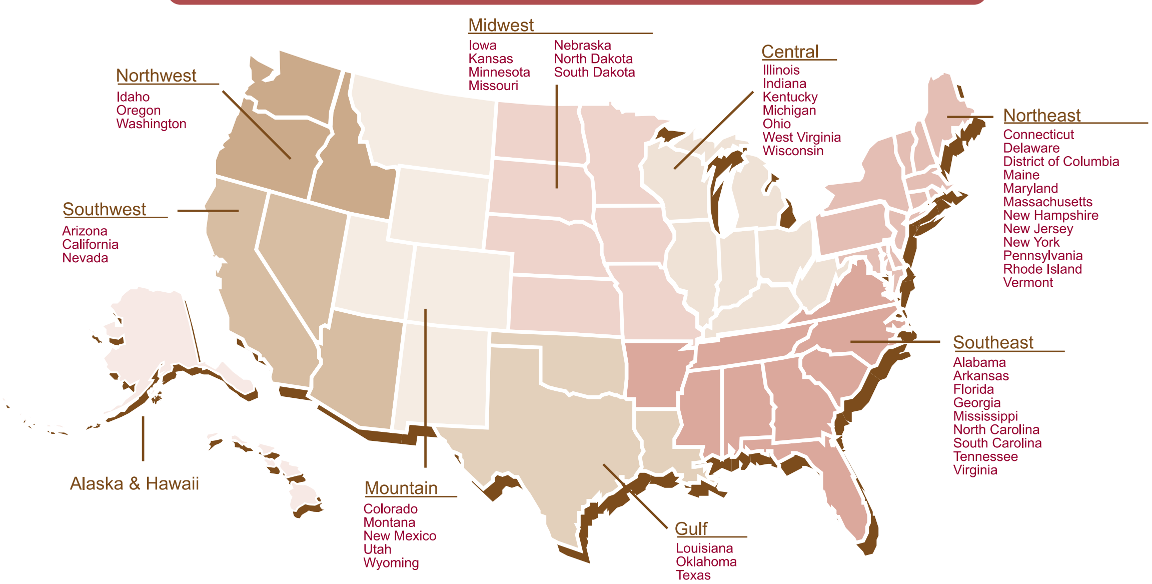
Most regions of the country continue to rely on coal-fired, nuclear, or oil- or gas-fired electric generation plants to meet their needs. It would certainly not make economic sense to abandon this capacity. However, it does make sense to consider adding renewable electric generation technologies in one or more of the following circumstances:

- When building new generation capacity to meet increased demand or to replace retired plants
- To reduce the environmental impacts of fossil fuel use
- To retain income for regional development
- As a hedge against fuel price fluctuations and future environmental regulations
- To satisfy customer preferences.

The reasons for turning to renewable energy vary from state to state and region to region and are as diverse as the utilities or independent producers that generate electricity.

To better understand these variations, this section presents a discussion of the current and future energy picture throughout the United States. This section divides the country into eight regions plus Alaska and Hawaii, based on similarities in geography, resources, current energy mix, and other characteristics. Each regional overview explores some of the issues that arise from the region's dependence on its current energy mix, pointing out opportunities that this mix provides for exploring renewable energy technologies. Already, every region of the country has a success story to tell about its experience with renewable electric generation, and these stories are included.

Division of Regions



For the purposes of this section, the United States is divided into eight regions, plus Alaska and Hawaii. States within a region have common characteristics such as geography, resources, and energy mix.

The Northwest Region

Idaho, Oregon, Washington

An Increasing Use of Fossil Fuels

The Northwest has the highest proportion of renewable electricity generation in the United States, primarily because of past federal investments in hydropower resources.

Although the Northwest currently uses relatively small amounts of fossil fuels for electric generation, the outlook for the next 15 years suggests that the use of these fuels will steadily grow as coal- and natural gas-fired generation are added. Because the region has limited coal production and small reserves of natural gas, most of the fossil-fuel requirements for this new capacity will be met by imports from other energy-producing states. The expanding base of fossil-fuel generation is also contributing to an increase in air emissions. Spurred by regional growth and rising energy demand, carbon dioxide emissions in Washington have increased 40 percent during the last 10 years.

The Promise of Non-Hydropower Renewables

The Northwest is taking steps to include non-hydropower renewables in its energy mix. The region currently has 520 megawatts of non-hydropower renewable energy, with a potential for much more. Most of the existing non-hydropower renewable energy comes from biomass-fired power plants. Conservative estimates have found that sufficient logging, mill, and agricultural residues are available to more than double the existing renewable capacity.

The region's geothermal resources could provide as much as 4,600 megawatts of electric generation at costs approaching those of coal-fired power plants. Three geologic areas in Washington have the potential to supply significant quantities of geothermal energy: the Cascade Mountain Range, the Northern Basin and Range, and the Snake River Plain.

There is also a very large wind resource potential to tap. The Idaho Department of Water Resources, Energy Division, is currently compiling wind power data, providing low interest loan programs in addition to the existing income tax deductions, and providing technical assistance. A 25-megawatt project recently came online in Umatilla County, Oregon.

The potential of the solar resource in southern Idaho and southeastern Oregon is excellent. The solar energy received in these areas is generally about 80 percent of that received in Phoenix, Arizona, one of the nation's best areas for solar energy. Recognizing its solar potential, Idaho adopted a rule that requires utilities to provide their remote customers with cost comparisons between extending a distribution line and installing a photovoltaic system. In fact, to stimulate greater use of off-grid photovoltaic systems, Idaho Power created a pilot program to lease photovoltaic systems to customers with remote electricity needs.

Biomass power plants, such as the Kettle Falls, Idaho, wood-burning plant, comprise most of the non-hydropower renewable power in the Northwest. This plant produces 42.5 megawatts of power from lumber mill waste, which was formerly incinerated in burners that had no pollution controls.

George Parks, Washington Public Power Company

Large hydropower plants such as the Bonneville power plant on the Columbia River provide most of the Northwest's electricity. Although one benefit is low air emissions, these plants have adverse effects on the riparian ecosystems. To minimize these effects, most dams maintain a minimum flowrate of water through the dam. Many have installed fish ladders to aid in upstream migration and nets or other devices to divert fish from turbine intakes.

Bonneville Power Administration

Two municipalities in the Northwest have committed to the purchase of electricity from a diverse set of renewable resources. Salem Electric Cooperative reached a 5-year agreement with the Bonneville Power Administration to purchase enough electricity from new renewable resources to supply 17 percent of its total electric needs, at a price of 3.5 cents per kilowatt-hour. The renewables purchased include wind and geothermal and will displace energy previously provided by coal, natural gas, and nuclear sources. The remainder of Salem Electric's renewable energy (roughly 83 percent of its electricity) will come from hydroelectric resources.

The city of Portland, Oregon, through an agreement with Portland General Electric, is packaging power from a 25-megawatt wind project for sale to its city accounts. The city has contracted to purchase 11.25 million kilowatt-hours of wind energy — equivalent to 5 percent of its power — under a 5-year contract with the utility. The wind energy costs will be blended with lower "market-based" rates; the resulting "blended rate" will still be lower than the city's former contract rate.

The Mountain Region

Colorado, Montana, New Mexico, Utah, Wyoming

Pioneers of Off-Grid, Independent Power Sources

Renewable energy technologies have gained a firm foothold as off-grid independent power sources in the Mountain region. Renewable energy systems are well-suited for this region, where densely populated urban centers are separated by vast expanses of prairie, rangeland, or rugged mountain terrain. Because of the terrain, power line extensions are very costly to build, and extreme weather conditions make maintenance difficult and expensive. To avoid expensive line extensions, the utility commissions of New Mexico and Colorado have adopted regulations requiring utilities to provide customers with information on stand-alone photovoltaic systems.

K.C. Electric Association of Colorado has been a leading pioneer in the use of renewable energy systems on farms and ranches. The utility services about 6,000 customers in a 4,000-square-mile territory. During a typical winter, heavy snow will down 500 to 1,000 utility poles and 40 miles of power line, requiring maintenance expenditures of about $400,000. More than 50 percent of these power lines serve small loads such as water pumping for a single stock tank. Many ranchers are now purchasing their own photovoltaic systems to pump water, charge electric fences, operate irrigation flow controls, and power remote lights. Photovoltaic systems have also been installed at many parks and recreation areas in the West, often providing power at a lower cost and with less environmental impact than other power options.

Significant Potential for Utility-Scale Renewable Energy Systems

Some of the best solar resources in the nation are located in the Mountain region — like those in the southwestern deserts. Additionally, wind resources in this region are the second largest in the nation. The region could feasibly develop thousands of megawatts of grid-connected wind power and even export wind power to other regions.

In 1998, the City of Fort Collins Light and Power began delivering power generated by two 600-kilowatt turbines located near Medicine Bow, Wyoming. The first major wind development in the region has occurred in Arlington, Wyoming, where PacifiCorp and the Eugene Water and Electric Board constructed a 42-megawatt project. The Public Service Company of Colorado (PSCo) has subscriptions for its Windsource program that have reached the equivalent of 20 megawatts. PSCo also has photovoltaic programs that include 15 kilowatts of off-grid generation and residential solar roof installations.

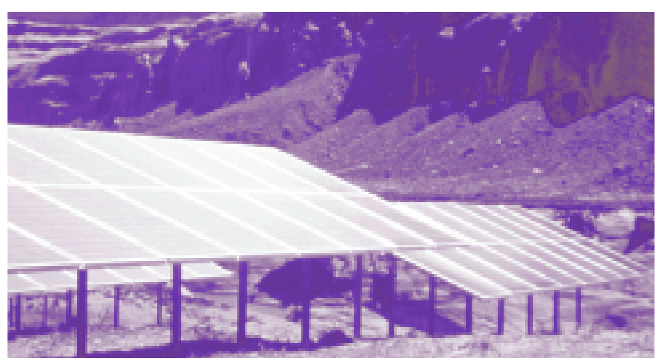
In addition to wind and solar, the region contains significant geothermal and biomass resources. Colorado, New Mexico, and Utah have large geothermal resource reserves, capable of providing an additional 1,600 megawatts of electric generation capacity.

Dependence on Coal, Rapid Population Growth, and Pressing Environmental Concerns

The emerging renewable energy technologies will still face intense competition from fossil-fuel energy sources in the Mountain region. This area contains roughly 120 billion metric tons of the nation's known recoverable coal reserves, almost half the U.S. total. The Mountain region now relies on coal for nearly 90 percent of its electric energy production.

The region produces 75 percent more electricity than it consumes and sells electricity to neighboring utilities. The abundance of conventional energy resources has resulted in some of the lowest electricity rates in the nation — about 20 percent lower than the national average. With such favorable economics, fossil fuels are likely to remain the source of baseload utility power for years to come.

Since 1970, the region's total population grew by almost 50 percent — twice the national average. Along with rapid population growth comes an increase in electricity demand and concern about emissions from fossil-fuel based electricity production. The amount of coal-fired electricity has grown six-fold since 1970, causing increased emissions of nitrogen oxide, particulates, and carbon dioxide. Renewable energy offers an alternative for maintaining environmental quality in a region that derives much of its income from outdoor activities such as agriculture, ranching, tourism, and recreation.



National Park Service

At Dangling Rope Marina, on the north shore of Lake Powell in southern Utah, diesel generators once provided power for lights, gas and waste pumps, and a small store. The diesel power system was expensive to operate, ran 24 hours a day, and was noisy. Today, a new photovoltaic array, generating 110 kilowatts of electric power, supplies the Marina's electricity needs — quietly, cleanly, and efficiently.

The Southwest Region

Arizona, California, Nevada

A Diversity of Renewable Resources

The Mojave Desert in southern California, along with much of the Southwest, is home to some of the most intense solar energy on the face of the earth. But solar energy is not the only renewable resource in this region. To the northwest and southeast lie the geothermal power plants of Coso Hot Springs and the Salton Sea. To the west and south are the wind plants of Tehachapi and San Gorgonio. Further north, just east of San Francisco, is the Altamont Pass, another major wind resource area. Considering these resources, along with the region's more limited biomass and hydropower resources, the Southwest has the most diverse renewable energy resource base in the United States.

California — Renewable Energy Pioneer

California leads the nation in producing electricity from renewable energy technologies, relying on wind energy, biomass, geothermal energy, solar thermal energy, and photovoltaics for almost 15 percent of its capacity. California produces about 90 percent of the nation's wind and geothermal electricity. All of the nation's solar thermal electric capacity can be found in California.

Just east of Barstow, California, nine solar thermal electric plants track the sun's daily movement across the desert sky. These plants, producing a total of 354 megawatts, are the largest solar installations in the world. In fact, they represent more than 90 percent of the world's capacity of utility-scale solar thermal power plants. In 1998, these plants generated just over 1 billion kilowatt-hours for the Southwestern grid. Also near Barstow stands the 10-megawatt Solar Two power tower demonstration project.

For wind energy, California relies primarily on three mountain passes — San Gorgonio, west of Palm Springs; Altamont, east of San Francisco; and Tehachapi, north of Los Angeles. In total, California wind farms boast almost 15,000 wind turbines that provide more than 1,600 megawatts of electric generation.

Geothermal energy is also prevalent in California. Much of the state lies in the Pacific "Ring of Fire," where tectonic plates meet, fissures form, and the heat of the earth's interior comes close to the surface. North of San Francisco in the Coastal Range, for example, is The Geysers, a large region of hydrothermal resources with temperatures often reaching 300° F. This is one of only two locations in the world where high-pressure dry steam is used directly to turn turbines and generate electricity.

Today, there are more than 20 geothermal generating units at The Geysers, owned and operated by electric utilities and independent power producers. The plants supply 1,655 megawatts of power and produce more electricity than any other geothermal field in the world — enough for approximately 1 million typical California homes. They provide this electricity at rates comparable to conventional power sources. Geothermal fields exist in other locations throughout the state. Several companies and utilities have already tapped these resources for more than 780 megawatts of power. Experts believe that the state has the potential for another 4,000 megawatts, using existing technology.

In California, electricity customers have been able to choose their electricity suppliers since March 1998. Some suppliers are offering "clean" electricity services and options to the state's electricity consumers. Commonwealth Edison Corporation provides 100% "green power" to more than 50,000 residential and small business customers from renewable energy sources.

Patagonia, a Ventura, California-based outdoor clothing manufacturer, purchases 100 percent renewable energy from Enron Energy Services. Enron will provide approximately 1 million kilowatt-hours per year to power Patagonia's 14 California facilities from a new 16-megawatt wind power facility in Palm Springs, California.

Toyota Motor Sales is the single largest purchaser of 100 percent renewable power. Edison Source will supply approximately 38 million kilowatt-hours per year for Toyota's U.S. headquarters and several other California facilities.

In 1998, Santa Monica became the first local government in California to commit to buying green power for its municipal needs. The 5 megawatts of green power required to serve the city's electricity loads were obtained through a competitive process.

Pacific Gas & Electric

Geothermal power plants are located throughout California. The largest geothermal field in the world is The Geysers, near San Francisco.

Even though California leads the nation in its use of renewable electricity, it also leads the nation in consumption of natural gas. Importing 90 percent of the gas it consumes cost the state's electric utilities some $1.5 billion in 1997. Since 1990, the state's utilities have increased their consumption of natural gas by one-third.

Ed Linton

California's Altamont Pass wind plant produces enough electricity to power the residential sector of a city the size of San Francisco. Wind plants are compatible with other land uses such as agriculture and ranching. Cattle graze under the wind turbines at Altamont Pass.

California has taken important policy steps to ensure that renewables will play an important role in its restructured electric power industry. In its 1996 restructuring legislation, California adopted a nonbypassable distribution system charge for "public interest" programs, including $540 million over 4 years to fund a mix of production incentives, project financing support, and customer rebates for renewables. These incentives will provide near-term support to existing projects and increasing levels of support to new technologies. Beyond that, emerging technologies such as photovoltaics, solar thermal, renewable-based fuel cells, and small wind, will be provided support through rebates, buy-downs, or similar incentives. Customers who purchase renewable electricity will also receive rebates of up to 1.5 cents per kilowatt-hour.

Nevada and Arizona Plan for the Future

Unlike California, the Southwest's other two states, Arizona and Nevada, aren't facing problems with electricity imports—they are both net exporters. They are also unlike California in that, although they share a large renewable resource base, they are just beginning to exploit it. Although nearly 17 percent of Arizona's electrical capacity is supplied by hydroelectric power, almost none of Arizona's capacity comes from other forms of renewable energy. In addition, Nevada has less than 4 percent of its electricity supplied by non-hydropower renewables.

Nevada has 218 megawatts of installed electric capacity from renewable energy. Of this, 210 megawatts are from geothermal resources, supplying enough electricity for 150,000 homes. The electricity generated annually by the Nevada geothermal sites is enough to offset the need to import more than 700,000 tons of coal or 15 trillion cubic feet of natural gas. It also offsets power plant emissions—geothermal plants emit no nitrogen oxides, negligible particulate matter, 90 percent less sulfur dioxides than fossil fuels, and far less carbon dioxide than coal.

The Sacramento Municipal Utility District

At the Sacramento Municipal Utility District's (SMUD's) Rancho Seco power plant site, a field of photovoltaic arrays generates as much as 2 megawatts of power. Nearby are the inactive twin cooling towers of the site's nuclear plant.

While decommissioning the plant, SMUD has been procuring and building alternative energy systems. As a result, it has installed more photovoltaic power than any other utility in the nation today. One SMUD program has helped over 400 homeowners install 4-kilowatt photovoltaic systems on their roofs; another offers an opportunity for residential and commercial customers to fund community rooftop photovoltaic systems. Building on the success of its first installation, SMUD is adding 360 kilowatts of photovoltaics to the Rancho Seco site.

Photovoltaics represents only a part of the utility's alternative energy strategy. In the Montezuma Hills of Solano County, 5 megawatts of wind turbines are producing approximately 100 million kilowatt-hours of energy per year. SMUD also purchases power output from biomass and geothermal plants. SMUD is cooperating with Folsom Prison in a program to use methane from biomass to produce electricity. SMUD is one of the principal collaborators on Solar Two, the 10-megawatt power tower in Barstow, California.

In response to the competitive California electricity market, SMUD is now offering its customers a variety of green power choices, including an option to purchase all or part of their power from renewable sources. By the year 2000, SMUD expects to generate enough electricity from renewable energy systems to power 375,000 typical Sacramento homes.

In 1998, Arizona Public Service (APS) began operating a new 82-kilowatt solar power plant built in Tempe, for which more than 600 residents are paying a premium price to receive clean power. A 100-kilowatt solar electric plant in Gilbert built by the Salt River Project (SRP) has been equally successful. The 100-watt block subscriptions sold out in the first week to 700 customers. There are currently 2,000 other customers on a waiting list. In addition to a second solar plant, SRP is planning a solar-methane plant at an East Valley landfill run by the Salt River Pima-Maricopa Indian Community north of Mesa.

The Midwest Region

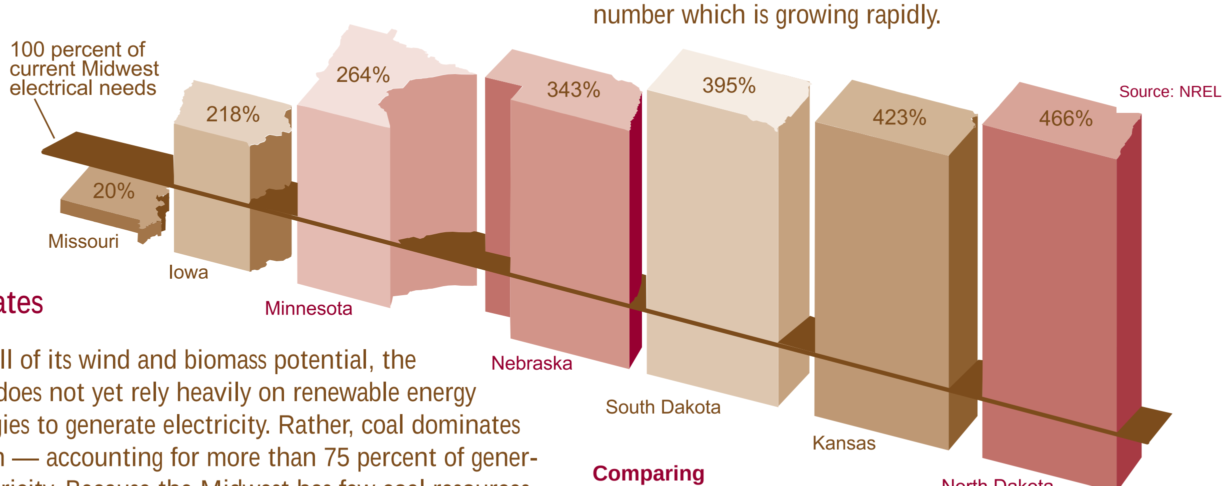
Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, South Dakota

Vast Wind and Biomass Resources

One of the major indigenous energy resources in the Midwest is wind. The entire Midwest region could potentially produce 5.4 trillion kilowatt-hours of wind-generated electricity per year. This is nearly twice the electricity that the entire United States consumes annually. Six of the seven states in the region have more than enough wind energy available to supply all of their electricity. In 1996, for example, North Dakota consumed approximately 8.3 billion kilowatt-hours of electricity. Yet the state has sufficient exploitable wind energy to generate nearly 1,200 billion kilowatt-hours in a year—roughly 150 times as much electricity as the state currently consumes.

The Midwest does not have to rely only on wind for its renewable electricity. The region also has vast areas of fertile land. Much of this land—several million acres—lies fallow or has been set aside. If used to grow dedicated energy crops such as switchgrass, alfalfa, or fast-growing hybrid poplar trees, this land could produce enough biomass each year to generate about 310 billion kilowatt-hours of biomass power, which is nearly one-and-a-half times more electricity than the region currently consumes.

The biomass resource of the Midwest is not limited to land that could be used for energy crops. Crop residues in the Midwest could be used to supply the region with another 80 billion kilowatt-hours of electricity per year. Plus, the region could derive another 6 billion kilowatt-hours a year from its wood waste and municipal solid waste.



Comparing each state's potential wind power with the Midwest's current electrical needs, it's obvious that the region has excellent wind resources. Even when much of the land is excluded and conservative estimates of viable wind resources are used, the region still has the potential to be a net exporter of wind power.

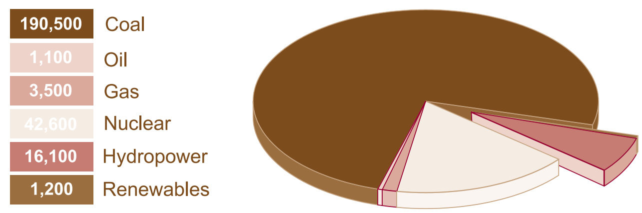
Coal Dominates

With all of its wind and biomass potential, the Midwest does not yet rely heavily on renewable energy technologies to generate electricity. Rather, coal dominates the region — accounting for more than 75 percent of generated electricity. Because the Midwest has few coal resources, the region imports nearly all of its coal at a cost to the region's economy of more than $1.6 billion.

Primarily because of this reliance on coal, the region's utilities emitted 641 thousand tons of nitrogen oxides and 300 million tons of carbon dioxide in 1995. On average, power plants in the Midwest produce nearly 60 percent more nitrogen oxides and 30 percent more carbon dioxide for each kilowatt-hour of electricity generated than power plants in the rest of the country.

The fact that the region has a poorly diversified supply base for its electrical needs argues strongly for the Midwest to exploit its indigenous renewable resources, especially its enormous wind energy potential.

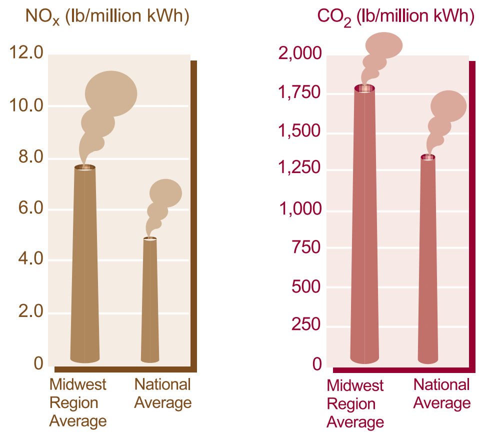
Annual Electricity Production (million kilowatt-hours)



Although it has large resources of wind and biomass, the Midwest relies on coal to generate the great majority of its electricity. In 1996, all other energy sources provided 25 percent of the region's electricity.

Growing in the Midwest: Renewable Power

Renewable energy already has a small presence in the Midwest. Biomass power plants, using timber residues, municipal solid waste, and landfill methane as their energy sources, total more than 1,000 megawatts of capacity. In addition, there are more than 500 megawatts of wind — a number which is growing rapidly.



In 1995, power plants in the Midwest produced 31 percent more carbon dioxide and 59 percent more nitrogen oxides for each kilowatt-hour of electricity generated than power plants in the rest of the country.

Wind plants are now being built throughout the Midwest. In Nevada, Iowa, a recently installed 250-kilowatt turbine provides power to the town's sewage treatment plant. At the Sibley Wind Plant in Iowa, 1.2 megawatts are now operating, with another 10.5 megawatts being planned. Based on its experience with an 80-kilowatt wind turbine, Waverly Light and Power has completed a 3.5-megawatt wind project and is discussing installation of a large wind plant in cooperation with neighboring utilities. Three very large wind projects in Iowa include 42 megawatts in Cerro Gordo, and two projects, 75 megawatts and 112 megawatts, in Buena Vista County near Storm Lake. In all, Iowa has seven projects totaling 252 megawatts under construction, with intended completion dates before the middle of 1999.

Northern States Power, Minnesota's largest utility, plans to build or purchase at least 425 megawatts of wind capacity by the year 2000, and as much as 825 megawatts by the year 2012. In the first phase of the plan, 25 megawatts of wind power were installed in a facility in Southwest Minnesota (Buffalo Ridge) which became operational in 1994. Two additional project phases totalling 210 megawatts came on line in late 1998 and early 1999. The electricity from these projects will cost Northern States Power roughly 3 cents per kilowatt-hour, averaged over the 30-year power purchase agreement. This price includes the net impact of the federal production tax credit, which amounts to 1.5 cents per kilowatt-hour for the first 10 years, plus a state property tax levy. It's the lowest price yet for a wind power plant.

Northern States Power has awarded contracts for 125 megawatts of biomass power capacity to three companies. The biomass power plants will use hybrid poplar trees, alfalfa, and clean waste wood as feedstocks.

Altogether, more than 500 megawatts of renewable capacity is in the planning stages for the Midwest. This is the first step for the region toward harvesting its abundant bounty of renewable energy.

Minnesota Legislature Encourages Renewables in the Midwest

Most of the renewable power capacity planned in the Midwest is being developed because of actions taken by state legislatures and utility regulators, particularly in Minnesota. For instance, Northern States Power's (NSP) decision to install renewable generation capacity stems from an agreement between the utility and the Minnesota legislature that permits the utility to store spent nuclear fuel at its Prairie Island Nuclear Plant in exchange for the utility building or purchasing renewable generation technology.

Minnesota has also passed sweeping legislation that will encourage the use of renewable energy throughout the state. In 1995, the legislature passed a bill to further spur the development of wind energy by providing loans and financial incentives for family farms and agricultural cooperatives to develop wind energy. The law provides a 10-year state tax credit of 1.5 cents per kilowatt-hour, to a statewide total of as much as 100 megawatts of capacity. This state tax credit is in addition to a similar federal tax incentive.

The Minnesota legislature requires the state's public utility commission to consider renewable energy projects as their first choice for new power projects. The legislation also requires NSP to contribute as much as $8.5 million by 2003 to a renewable energy account.

Warren Gretz, NREL

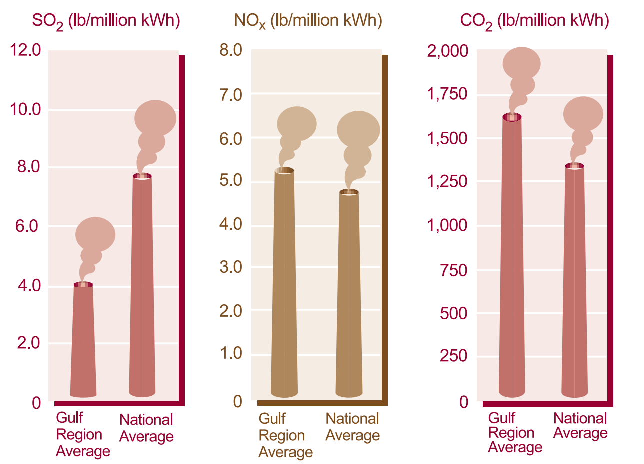
The Gulf Region

Louisiana, Oklahoma, Texas

A Reliance on Natural Gas

The Gulf region produces nearly 70 percent of the United States' natural gas and 33 percent of our domestic oil. Not surprisingly, nearly two-thirds of the Gulf region's generating capacity is fueled by natural gas, supplying almost half of its electricity. The prominent role of natural gas in this region is expected to continue. Over the next decade, utilities in the Gulf region plan to add 8,000 megawatts of capacity, two thirds of which will be gas-fired plants.

Although the Gulf region's natural gas use is increasing, its natural gas production is not. From a peak production of about 18.5 trillion cubic feet of natural gas in 1973, the Gulf region's production is now down to 13.2 trillion cubic feet, and holding steady at that level.

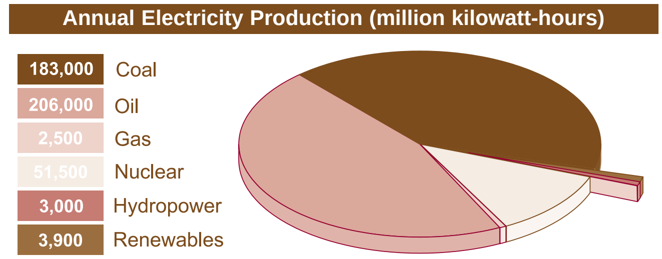


Power plants in the Gulf produce 8 percent more nitrogen oxides and 23 percent more carbon dioxide per kilowatt-hour of electricity generated than those in the rest of the nation, although the use of natural gas for much of the generation capacity results in sulfur dioxide emissions that are 48 percent lower than the national average.

The Gulf region has several large renewable energy resources that can help diversify its energy portfolio. Texas, for example, has a wind energy potential estimated at nearly 525,000 megawatts—far more than the area would ever actually need. Solar resources in the region are also enormous, ranking very close to the Southwest in daily average solar radiation received. Because the Gulf region is one of the nation's major producers of agricultural and forest products, it has a significant biomass energy resource.

Building Renewables in Texas

Recognizing this potential, several Texas utilities are exploring renewable energy opportunities. Four Texas utilities—Lower Colorado River Authority, TXU (formerly

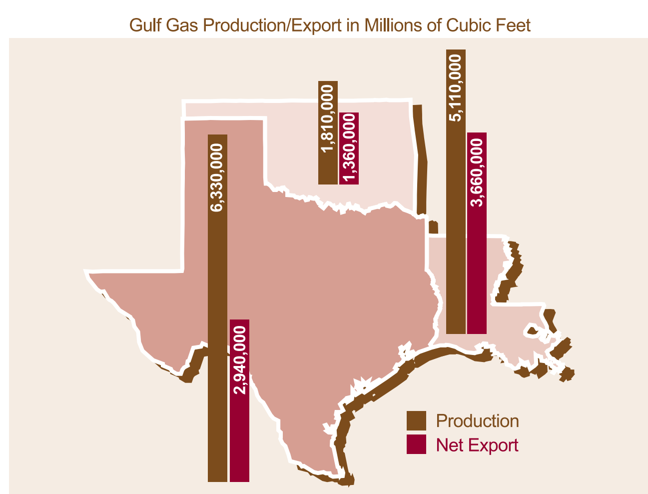


In 1996, coal and natural gas dominated the production of electricity in the Gulf. All other sources of energy combined produce only 14 percent of the region's electricity.

Texas Utilities Electric), Reliant Energy HL&P, and Central and South West Corporation—are starting to exploit the state's wind and solar resources. In addition, the City of Austin's municipal utility (Austin Energy) has been a pioneer in photovoltaics system applications. These activities have laid the groundwork for an RPS that will result in 2,000 megawatts of new renewable capacity which will be added in Texas by 2009 under the state's 1999 Electricity Restructuring Law.

Lower Colorado River Authority

By bringing a 35-megawatt wind project on line in 1995, the Lower Colorado River Authority became the first utility in Texas to commercially exploit wind for electricity. The City of Austin has a 25-year agreement with the Lower Colorado River Authority to purchase a 10-megawatt share in the project, at a price competitive with electricity generation from fossil fuels.



Although a large producer of natural gas, the Gulf region now uses as much natural gas as it exports — and demand is growing. Utilities in the Gulf plan to add more than 5,000 megawatts of gas-fired power plants in the next decade.

TXU

In 1995, TXU launched a broad-based initiative to diversify its energy supply resource base and buffer itself against future price increases or changing environmental standards. The utility committed itself to the future use of wind and other renewables. In 1999, a 35-megawatt wind plant came on-line at Big Springs, Texas. TXU has also built an Energy Park near the Dallas/Fort Worth International Airport. This facility is providing vital hands-on experience with advanced technologies. The site has an innovative Fresnel lens, concentrating cell photovoltaic system producing 100 kilowatts in peak sunlight. It also has three 300-kilowatt wind turbines producing 800,000 kilowatt-hours of electricity annually in moderate winds. The utility has found the Energy Park to be an excellent means of teaching employees and customers about renewable energy.

Reliant Energy HL&P

Reliant Energy HL&P is buying power from a 22.5-megawatt windfarm to supply its customers. The utility's purchase is a response to their customers' preference to have renewable energy meet a greater portion of future energy needs.

Central and South West Corporation

Central and South West Corporation (CSW) is pursuing renewable energy because it believes that renewables will be an important service offering for customers in a more competitive electric market. CSW is offering the "Clear Choice" green pricing program to its residential customers. Participants subscribe to fixed monthly blocks of electricity and pay a premium of 2 cents/kilowatt-hour.

The utility installed 6.5 megawatts of wind power in late 1995 near Ft. Davis. Through the summer of 1998, the wind plant's twelve turbines had generated some 30 million kilowatt-hours of electricity. Based in part on the experience gained with this facility, CSW signed a power purchase agreement for the output of a 75-megawatt wind plant that was completed in mid-1999. Nearby, at its Solar Park, CSW has installed three photovoltaic systems — a 100-kilowatt flat plate system, an 85-kilowatt linear Fresnel lens system, and a high concentrating, dual-axis tracking system that concentrates the sun to 200 times and generates 18 kilowatts.

Austin Energy

In 1998, Austin Energy dedicated the first photovoltaic power system constructed under the Austin Energy Solar Explorer program. The photovoltaics system is a 32-kilowatt installation, which provides shaded parking for about 40 vehicles while generating power for Austin's power grid. The Solar Explorer program has 1,000 members that are Austin residents and sponsor one or more 50-watt "blocks" for as little as $3.50 per month. Austin Energy recently issued a Request for Proposals for 100 megawatts of additional renewables.

Texas Utility Responds to Customer Desires for "Green Power"

Central and South West Corporation has established a renewables target program that will deploy 40 to 50 megawatts of renewable energy resources. The utility commitment is a result of an elaborate customer polling process that was conducted by its three retail utility subsidiaries during 1996. Using a Deliberative Polling™ technique, a random sample of customers was gathered together for extensive education on the utility resource planning process to help them develop a truly informed, deliberated opinion.

Customers overwhelmingly determined that a mix of energy resource options was the preferred way to accomplish several objectives including low cost, reliability, environmental quality, and further development of renewable resources. Because of this strong customer interest, the CSW companies have each instituted targeted purchase goals for renewable energy and energy-efficiency resources.

The targets are based on acquiring resources with a net rate impact of an additional 25 cents per month for an average residential customer. More than 80 percent of customers indicated a willingness to pay at least $1 more per month for the companies to acquire more renewable resources, and there were blocks of customers who indicated a willingness to pay as much as $10 more per month.

Polling participants also voiced a desire for their children to learn more about environmentally beneficial electricity generation. For this reason, the CSW companies have a pilot program for the installation of 50 rooftop solar photovoltaic systems at schools, accompanied by classroom materials for teaching students about the installations.

Central and South West Services

The Central Region

Illinois, Indiana, Kentucky, Michigan, Ohio, West Virginia, Wisconsin

Coal Country

At 120 billion tons, the Central region holds about one-quarter of the nation's coal reserves, second only to the Mountain region. The region ranks first in the nation in coal production and exportation. In 1995, these states accounted for 80 percent of the nation's coal exports. With Kentucky and West Virginia leading the way, the region produced 42 percent of the nation's coal.

It's not surprising that the Central region has taken advantage of this indigenous resource for its own electricity production. The region relies on coal-fired plants for more than two-thirds of its generating capacity and three-fourths of its electricity. The region's reliance on coal has come at an environmental cost. The region's power plants produce more sulfur dioxide per kilowatt-hour of electricity generated than those in any other region. Kentucky and West Virginia are among the top 10 states for emissions of carbon dioxide, nitrogen oxides, sulfur dioxides, and particulates from utility power plants.

Renewables Beginning to be Tapped

Because of growing environmental concerns, state policies and governmental programs are now promoting the increased use of renewable energy to meet the Central region's expanding energy needs. Utility regulators and legislators have recognized that, by exploiting its abundant biomass and wind resources, the Central region can address its environmental concerns, build a more diverse energy portfolio, and create a catalyst for economic development.

For example, Illinois' Biomass Energy Program is investigating the development of biomass resources such as wood, wood waste, crop residues, and new energy crops such as switchgrass.

In Indiana, legislation is guiding the increased development of biomass energy. Waste-to-energy systems, which must meet federal Clean Air Act standards, are reducing waste disposal problems while mitigating environmental concerns. In Michigan, biomass provides more than 1 percent of the state's electricity needs, mostly from wood, and its contribution is expected to grow.

Biomass is not the only renewable energy resource in the Central region. Many states, such as Michigan, are also investing in photovoltaics and wind technologies. For example, Detroit Edison is promoting photovoltaics through a green pricing program to sell about 55 kilowatts of capacity in 100-watt power units. The program is currently oversubscribed, with subscribers committing to purchase between 200 and 700.

Traverse City Power & Light in Michigan has had similar success with a green pricing program to develop wind power. Wind power is expected to gain in importance in the Central region, because the region has a wind power potential estimated at 21,000 megawatts.

Wisconsin law requires that utilities in the eastern portion of the state add 50 megawatts of renewables by 2000. It further states that energy efficiency and conservation are the preferred approaches for meeting future state energy needs, and if new electrical generation is needed, renewable resources are the preferred generation source. Wisconsin already supplies more than 5 percent of its electricity needs with renewable energy, and that percentage could grow. Wisconsin utilities currently plan to install 22 megawatts of wind power by the year 2000.

Renewable Pathways

Detroit Edison Company

Detroit Edison has installed 54.8 kilowatts of grid-connected photovoltaics and plans to install another 135 kilowatts of photovoltaic power.

Some of the region's aging coal-fired plants will soon face retirement or possibly repowering decisions. Although some of this capacity will be replaced with fossil fuel, the new capacity needs may also be met with renewable power generation. One driver for renewable generation will be customer choice, which allows power users to select their own electric supplier.

The region has significant

renewable resources that can be tapped to diversify the energy mix and provide environmental and economic benefits. Only a small amount of the region's electricity now comes from renewable resources, yet the region is high in biomass resources including mill residues, construction waste, and woody municipal waste such as tree trimmings.

An Aging Power Supply System

Although the Central region's generation and energy mix result in electricity prices slightly lower than average, that low cost is due in part to a reliance on older power plants. Coal currently provides 60 percent of the region's electricity capacity and nearly two-thirds of its electrical energy, but one out of every seven of the region's coal-fired plants is more than 40 years old. Decisions will soon be required on whether to extend the life of these plants, which would require new capital investments, or to retire them, which would create a need for significant new replacement capacity.

A similar situation exists for nuclear power, which supplies 20 percent of the region's capacity and nearly 30 percent of its electricity. Almost one-third of the region's 21 nuclear reactors are more than 20 years old. The steam generators in several of these plants will need to be replaced within the next 7 years at a significant capital cost. Some aging plants are showing further signs of deterioration and are facing decommissioning well before the 40 years for which they were licensed to operate. If this happens, new capital investment in generating capacity will be needed to replace them.

Although the Central region faces many challenges, the retirement of aging coal and nuclear power plants presents an opportunity for the region to use renewables to a greater extent. This switch to renewables would help to reduce both the level of fossil-fuel imports and the environmental effects of power production.

Biomass is used primarily by industrial and commercial businesses to generate electricity and steam, reducing their use of fossil fuels while eliminating their wood wastes. More than 7 million tons of fuel wood and black liquor (paper processing waste) are consumed each year in Kentucky and West Virginia, resulting in more than 4,100 jobs and $100 million in annual income.

The potential for increasing hydropower use does not necessarily mean building large dams—many small hydropower projects use diversion canals or rely on existing impoundments to generate hydropower without significantly impacting the river's ecosystem. Several hydropower developers have refurbished existing dams and powerhouses in the region.

Customer Choice Supports Wind

Traverse City Light and Power, a municipal utility in Michigan, did not need new capacity but it did want to harness wind power to diversify its resource base.

Under a green pricing program, the utility solicited customers who were willing to pay an increase of 1.58 cents per kilowatt-hour to obtain all of their needs from renewable energy. The utility found more than enough subscribers to install a 600-kilowatt wind turbine. It also found that interest in the project went beyond the subscribing customers to the community, the city council, and the Michigan Public Service Commission, which provided a $50,000 grant to the project.

For their commitment to pay extra for wind energy, the customers get more than just a good feeling about helping the environment. They also get a guarantee that their rates will not increase if fossil fuel prices increase or if environmental standards become more stringent. Customers who participate are proud to display a special window sticker that recognizes their commitment to a brighter energy future. There are 26 small businesses participating in the program who have committed to purchase all of their electricity from this clean power source for 10 years.

As described in a recent report prepared for the Renewable Energy Policy Project on Traverse City's green power program, "because business customers—individually and as a class—use more energy than residential customers, even relatively few participants can have a large impact on renewables development."

The Southeast Region

Alabama, Arkansas, Florida, Georgia, Mississippi, North Carolina, South Carolina, Tennessee, Virginia

Diverse and Nonindigenous Energy Sources

The Southeast depends on a diversity of resources to generate electricity: coal, nuclear power, natural gas, hydropower, and biomass. Yet, with the exception of its renewable resources, the Southeast lacks indigenous resources. Although the Southeast holds less than 2 percent of the nation's coal reserves, the region uses coal to generate nearly 60 percent of its electricity. Consequently, the region imports 80 percent of the coal it uses. The Southeast also has a very small natural gas resource, accounting for only 3.5 percent of the nation's natural gas production, yet is looking to natural gas to meet added capacity needs.

Nuclear power is well established in the Southeast, with 32 reactors on-line for a total installed capacity of slightly more than 32,000 megawatts — the most of any region. Currently, the region uses nuclear power to generate about one-fourth of its electricity. Oil and hydropower provide the region with another 37,000 megawatts of capacity.

Environmental and Economic Challenges

With its heavy reliance on coal and nuclear power and its plans to add a large amount of natural gas capacity, the Southeast faces several problems. First, it leads the nation in emissions of carbon dioxide and is second in total production of sulfur and nitrogen oxides. This environmental concern is also an economic concern. The Tennessee Valley Authority (TVA) has estimated that it could cost as much as $1.3 billion to upgrade its aging coal-fired plants to meet the emissions reduction requirements of Phase I and Phase II of the Clean Air Act.

The region has additional economic challenges. It spends $5.6 billion annually to import the coal and oil it uses to generate electricity, money that could be better invested in the region's own economy. Another economic issue derives from the Southeast's dependence on nuclear power. Eventually, the reactors must be decommissioned and the capacity replaced. This is not only a potentially expensive undertaking, but it raises the question of how to replace this capacity — no new nuclear plants are being built or planned.

Renewable Resources Available

The Southeast has the nation's largest biomass resource base, mostly due to abundant supplies of wood. This region already has about 3,000 megawatts of non-hydropower renewable capacity, mostly from biomass power plants owned by industrial firms. These are primarily pulp and paper mills that burn wood waste residues to meet internal energy requirements. Because of these non-utility generators, the Southeast has the highest concentration of biomass capacity in the nation — about one third of the nation's total — more than 80 percent of which uses wood as the fuel source. Based on current technologies and practices, the Southeast utilities, non-utility generators, and the pulp and paper mills could deliver nearly 19,000 megawatts of power from wood; this is about as much power as is currently derived from natural gas, and more than enough power to take care of the region's planned capacity additions.

In the future, the region may be able to derive much more from biomass by using the fast-growing energy crops that are currently being researched. Using such energy crops would also alleviate environmental pressures because, when managed correctly, tree plantations used for electricity would produce no carbon dioxide, no sulfur dioxides, and minimal nitrogen oxides.

Now, several utilities, taking their cue from the forest products industry, are treating biomass as a valuable fuel. They are investigating cofiring — burning the wood along with coal to produce electricity. Introducing biomass as a supplementary energy source in an existing coal-fired power generation system has environmental advantages. Because biomass, in general, has significantly less sulfur than coal, there is a sulfur dioxide benefit, and early test results suggest there is also a reduction in nitrogen oxide emissions.

In addition to biomass, the region has ample supplies of other renewables. For example, Arkansas has enough wind to provide up to 80 percent of its electricity. There is also ample solar energy in this region — averaging about 5 kilowatt-hours per square meter per day.

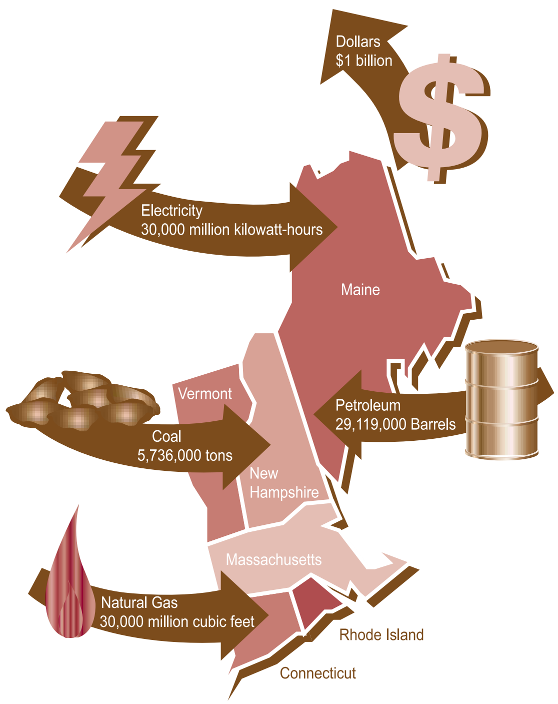
The TVA has requested competitive proposals for green power options to be available to customers beginning in 2002. The amount of green power purchased will depend on the level of customer interest expressed. Up to 300 megawatts of green power could be added. TVA defines green power as solar, wind, biomass, and geothermal. While existing resources will be considered, new renewable resources will be given preference. Several electric utilities in Florida are exploring green pricing programs as a way to supply solar-generated electricity to customers.

The Northeast Region

Connecticut, Delaware, District of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont

Importing Energy

The Northeast region stretches from Maine to the Mid-Atlantic. As a whole, the Northeast region uses fossil fuels to generate more than half its electricity. The region also relies on nuclear power to generate about one-third of its electricity and supplements its needs with power imported from Canada and the Central region. For example, New Jersey imports one-third of its electricity at a cost of approximately $2 billion. The region's electricity rates are among the highest in the nation.



New England sends about $1 billion each year to other regions for the fuel it uses in its power plants.

The Search for Diversity

In the early 1970s, New England relied on oil-fired plants for as much as 60 percent of its electricity. Then, in response to the oil embargoes and the increasing cost of oil, New England utilities began to diversify their generation mix, adding nuclear power and converting oil facilities to coal-burning plants. As a result, today New England depends on nuclear power for 40 percent of its electricity and coal for almost 20 percent.

Much of the nuclear power, however, may soon become unavailable. The operating licenses of five of New England's eight nuclear generating units are due to expire by 2010. The operator of at least one of those nuclear plants does not intend to renew its license, and other plants may be shut down before their operating licenses expire.

As nuclear power's contribution decreases, any increased use of coal will heighten New England's air pollution problems. Coal plant emissions contribute significantly to acid rain and smog in the region and will soon become the dominant source of airborne emissions.

The Mid-Atlantic states face environmental problems. High population density, extensive use of fossil fuels for transportation, and fossil-fueled power plants cause air quality problems in this area. As a result, the U.S. Environmental Protection Agency has designated large portions of the Mid-Atlantic as violating the air quality standards set for ozone, and has classified New York City as exceeding carbon monoxide standards. Nitrogen oxide emissions are now also being targeted by the U.S. Environmental Protection Agency, and substantial state-by-state reductions are being proposed.

What options does the region have for reducing the use of coal and preparing for reduced nuclear generation? Its power producers are following the national trend toward a greater reliance on natural gas-fired generators. In fact, there are several gas-fired merchant power plants coming on line. Pursuing this strategy will keep the region dependent on imported resources and vulnerable to price fluctuations. New England is also physically limited in the amount of power that can be imported over the transmission lines from Canada.

The other supply option that is being explored is renewable energy. This option draws on ample, readily available renewable resources; provides economic and environmental benefits; and is generally greeted by a supportive public.

Biomass Power Fuels the Northeast

Roughly 90 percent of Maine is covered with forest — more than any other state. The timber industry in Maine is one of the state's largest employers, and power producers have relied on wood and wood waste to provide as much as 25 percent of the state's electric power, supporting as many as 2,500 jobs in the process. Today, Maine relies on waste from timber and other sources for about 500 megawatts of capacity.

Similarly, Vermont, with about 80 percent of its land covered by forests, currently receives about 20 percent of its power (165 megawatts) from a diverse mix of renewables, including hydropower, wind energy, and biomass resources such as wood and refuse. New York is estimated to have nearly 4,000 megawatts of biomass potential.

Growing Willows for Power Generation

Niagara Mohawk Power Corporation of New York, representing the Salix Consortium, has entered a cost-sharing cooperative research and development agreement with the U.S. Department of Energy to grow willows as an energy feedstock, generating electricity from this renewable fuel. The project is part of the White House's Biomass Power for Rural Development Initiative.

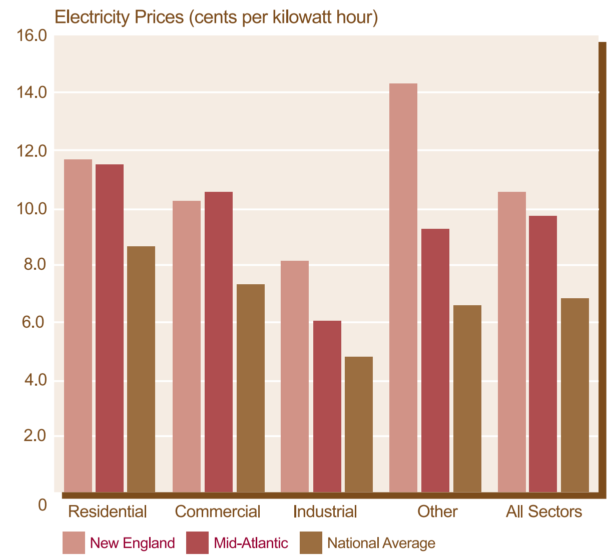
The project is a multiphase effort to establish willow trees as one of the first commercial energy crops for production by the year 2000. The Salix Consortium pools the combined research and investment power of more than 25 corporations, associations, academic institutions, and regional government agencies with five power-generating companies. Together, they will develop a new energy crop on 2,600 acres of land during the first phase of the project. The various facilities involved in this project are expected to produce between 37 and 47 megawatts of electric power through cofiring of the biomass.

This project is estimated to cost about $14 million over a 6-year period, with a 45 percent federal investment. A major goal will be to achieve a delivered cost of willow feedstock without subsidies at less than $2 per million British thermal units by 2001. The projected 40,000 to 60,000 acres of willow trees (in central and western New York alone) to be planted by 2010 will produce energy crop fuel sales of almost $20 million annually. As many as 300 new jobs will be created in rural areas of New York alone once the project is fully implemented.

This project will not only help farmers and landowners maximize their earning potential through crop diversification and alternative land use, it will help meet our nation's environmental challenges. For the local environment, the willow project improves watershed control and soil conservation. Wood ash from combustion can also be recycled back to the land to improve the soil.

For the regional environment, willow contains virtually no sulfur and may reduce nitrogen oxide emissions when cofired with coal, helping to reduce acid rain. In terms of the global environment, the willows take carbon dioxide out of the air when they grow, then release it again when burned, for a net zero contribution to carbon emissions.

One biomass power plant in particular, the McNeil Generating Station in Burlington, Vermont, is leading the Northeast into a new era of biomass power production. Although almost all biomass power facilities use direct burning of the biomass to produce power, the 50-megawatt McNeil plant is testing a prototype of a brand new technology—an efficient biomass gasifier. One of the nation's largest wood-burning facilities, the McNeil plant is increasing its power output by 30 percent with the new gasifier, which is being installed under a cost-shared agreement with the U.S. Department of Energy.



Direct burning of wood converts only 25 percent of the wood heat into electricity. The new technology, developed by Battelle Columbus Laboratory under a U.S. Department of Energy program, gasifies the wood — it converts wood to a gas similar to natural gas. This gas is then burned in a modified gas turbine to produce electricity. This technology is not only 40 percent more efficient than the technology the McNeil plant currently uses, but it is also cleaner. Because of this greater efficiency, the cost of the electricity generated will approach that of conventional fossil-fuel generation.

Untapped Resources: Wind and Solar

New England's wind resource may be as great as that of biomass, and equally as accessible. The winds are consistent and strong along most of the coastline and along the ridges and hills that dominate New Hampshire, Massachusetts, Vermont, and Maine. Maine could potentially rely on strategically placed wind turbines to provide more than four times the electricity the state currently uses. Vermont could rely on wind for nearly all of its electricity, and New Hampshire could use wind to supply nearly half of its needs.

Although New England has not aggressively taken advantage of its wind resources, several communities and power producers are beginning to tap its potential. On Nantucket

Island, where the winds run at average speeds of 18 mph, the town of Nantucket has decided to install wind turbines to power a solid-waste processing facility. The town estimates that the wind turbines could generate electricity for 4.5 to 5 cents per kilowatt-hour.

Another wind plant has been built on a ridge near the town of Readsboro, in southern Vermont. The 6-megawatt wind plant uses 11 550-kilowatt wind turbines to generate approximately 12 million kilowatt-hours of electricity per year—enough electricity to power 1,500 homes. Green Mountain Power pooled nearly $7 million of its own money with $3.5 million provided by the Electric Power Research Institute and the U.S. Department of Energy to build the wind plant.

Utilities are exploring various options for using photovoltaics. Conectiv Power Delivery, formerly known as Delmarva Power and Light Company, is testing the concept of using photovoltaic systems as a utility load reduction program. Initial results have shown that such systems are a cost-effective alternative to capacity additions. Niagara Mohawk Power Corporation has a similar photovoltaic demonstration project, and New York State Electric and Gas Company has installed photovoltaic systems for both roof-top and off-grid uses. Moving beyond demonstrations, General Public Utilities (GPU) has a joint venture through its subsidiary, GPU International, with AstroPower, Inc., to manufacture and market photovoltaic systems. The systems range in size from 1 to 4 kilowatts. The local utility in Gardner, Massachusetts, equipped 28 houses with 2-kilowatt photovoltaic systems as an experiment in residential photovoltaic applications and distributed generation. The photovoltaic systems have operated successfully and the utility plans to expand that program next year.

Bill Eager

Photovoltaics and small hydropower have the potential to reduce New England's dependence on coal and nuclear power. This furniture factory in Gardner, Massachusetts, incorporates photovoltaic panels into its design.

Renewable Policies Integral to Electric Restructuring

States in the Northeast are among the leaders in bringing competition to the electric industry.

Rhode Island became the first state in the country to phase in retail electric competition in 1998. The state adopted a nonbypassable "systems benefit charge" (SBC) that is imposed on electric customers through 2002 to support programs in energy efficiency and renewables. The 0.23 cents per kilowatt hour charge will create a fund of about $20 million annually. To date, the fund has supported investments in photovoltaic systems resource assessment, and possible investment in a small wind project. New York also has a SBC that is in effect from 1998 through 2001. About $234 million will be collected over 3 years, and about $11 million will be expended on renewables, mostly for wind and photovoltaics.

Maine became the first state to adopt a renewable portfolio standard (RPS) when the state enacted restructuring legislation in 1997. The 30 percent RPS, the highest in the nation, reflects the state's plentiful renewable resource base and state policies to utilize that resource base. Interestingly, the Maine RPS is not just limited to renewables in the state but encompasses all renewables in New England. The state also allows fuel cells and high-efficiency cogeneration systems to qualify.

In Pennsylvania, customer choice under restructuring is already providing cost savings to consumers who switch suppliers. Three green power marketers are offering environmentally sensitive retail electricity products and wind power is emerging as an important component of those offerings.

Connecticut, Massachusetts, and New Jersey have enacted both an RPS and an SBC for renewables. The three states have split their RPS into two parts, one to cover existing renewable facilities (typically hydropower, biomass and municipal solid waste), and another to cover emerging renewable technologies such as wind, solar, and biomass gasification. A combined RPS and SBC expands the available market opportunities for renewables, as the RPS will likely assist renewables that are closest to prevailing electric market prices, and the SBC will assist emerging renewable technologies that are at an earlier stage of development.

Alaska and Hawaii

Isolated Grid Systems

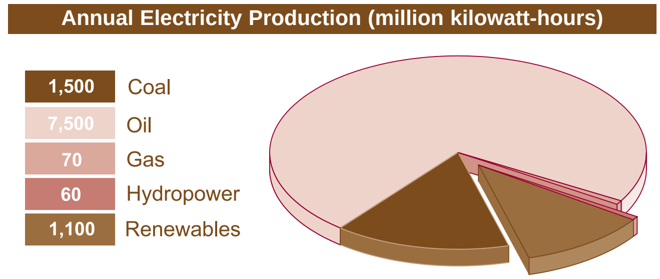
Far out on Alaska's Aleutian chain is Shemya Island, a lonely stretch of rock in the northern Pacific closer to Japan and Russia than to the mainland United States, or even to mainland Alaska. The winds blow so severely and constantly here that pedestrians walk hunched against the wind. Yet the island's lone community, Earekson Air Force Station, does not tap the wind resource for its electricity. Instead, it relies on diesel fuel transported over thousands of miles of ocean.

Alaska, in a sense, is made up of islands: islands of communities isolated by stretches of land or sea and islands of small electric generating plants isolated from grid networks. Alaska has a single interconnected grid system that serves only Anchorage, Fairbanks, and the Kenai Peninsula. Much of the rest of the state relies on small diesel generators, with many communities dependent on state subsidies to provide them with affordable electricity.

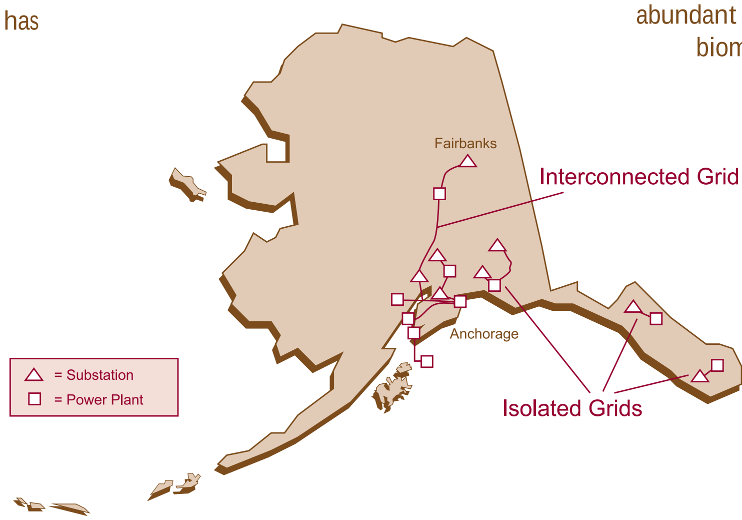
Like Alaska, Hawaii also has small and isolated electricity grids. Each island provides electricity for its own residents. As a result, utilities are unable to take advantage of shared generating reserves available in large power systems. Hawaii must depend on small power plants, which cost more per unit of generated energy than large plants. Hawaii's problems are exacerbated by the fact that it has no reserves of fossil fuels. Yet it depends on oil and coal, imported at premium prices, to generate about 85 percent of its electricity.

Sustainable Local Resources

There's not much that Alaska and Hawaii can do to interconnect their isolated grids, but there is plenty they can do to reduce their dependence on imported resources. Both states have large reserves of local renewable resources that can be harnessed to provide almost any community with the electricity it requires. Hawaii, for example, has abundant solar, geothermal, wind, and biomass resources. The state already uses this abundance to provide more than 300 megawatts of capacity. Alaska and Hawaii also have high electricity rates, which provide an incentive to tap into renewable resources.



In 1995, the primary energy source for electricity production in Hawaii was oil. Although Hawaii has abundant renewable resources, renewables provide only 12 percent of its electricity.



Alaska has only one interconnected grid system which covers only a small portion of the state. Much of the rest of the state depends on small diesel generators.

Hawaii

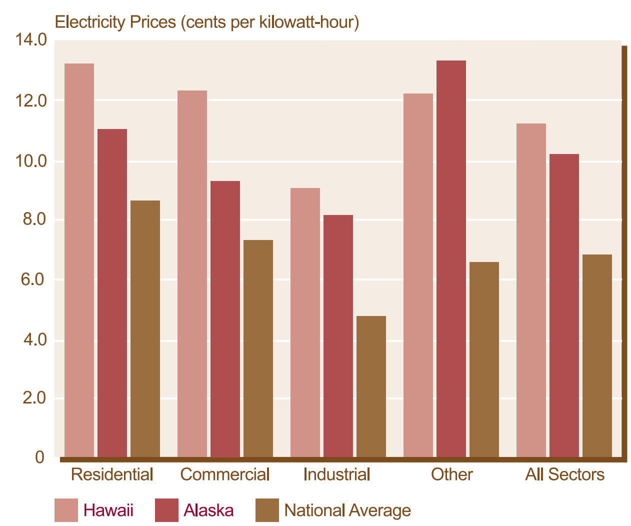
Most of Hawaii's renewable energy comes from bagasse (the remains of sugar-cane once the juice has been extracted). The state also has small amounts of wind, hydroelectric, and geothermal capacity. In addition, Hawaii takes advantage of its solar energy to offset electric energy with more than 60,000 solar water heating systems. The state recently published a report concluding that renewable energy could provide nearly 3,000 megawatts of generating capacity during the next decade. Some of the islands, including Kauai, Hawaii, and Oahu, have solar resources that rival those of southern California. In June 1998, 10,000 square feet, totalling 75 kilowatts of lightweight photovoltaic roofing tiles, were installed on the Mauna Lani Bay Hotel on the big island of Hawaii. It is the largest rooftop photovoltaic system in the state. Hawaii may also represent the best market in the nation for distributed photovoltaic systems. In 1997, the islands of Hawaii, Maui, and Oahu initiated a 2-year pilot program called "Sun Power for Schools," which involved a dozen schools and installation of

2-kilowatt photovoltaic panel systems. Customers are currently paying as much as 20 cents per kilowatt-hour for their electricity, creating a prime opportunity for the installation of more solar hot water systems to offset the need for electricity.

A similar, and possibly larger, opportunity exists for using wind energy. With the exception of Niihau, each island has a large wind resource. Some islands have enough wind energy resources to supply all of their electrical needs. The state could also expand its use of biomass, including landfill gas, or further exploit its relatively small hydroelectric potential.

Alaska

In 1995, the primary energy source for electricity production in Alaska was natural gas. Including hydropower, renewables provide 18 percent of Alaska's electricity. More than 75,000 Alaskans live in the 175 communities that are not grid-interconnected and must supply their own electricity. Even with state subsidies, these communities pay up to twice as much for electricity as do the residents of Anchorage. Alaska can expand its use of indigenous renewable resources in its isolated grid networks. Kotzebue Electric Association has embarked on a program that plans to install 2 to 4 megawatts of wind over the next several years. One strategy would to be to expand the use of hybrid systems. A hybrid system is one that uses a combination of resources and technologies to generate electricity. Such systems could use wind readily (especially along the Aleutian chain, the Gulf of Alaska, and the Coastal Range in southern Alaska) when that resource is available and then switch to a fossil fuel or to wood, wood waste, or hydroelectricity when the wind isn't blowing. Hydroelectric power may also prove to be a good solution, either as a stand-alone or in hybrid configurations.



In 1995, Alaskans paid as much as 21 cents per kilowatt-hour for electricity and average electricity prices are 46 percent higher than the U.S. average. The average electricity prices in Hawaii were 54 percent higher than the national average.

Small-Scale Hydropower — An Inexpensive Alternative

Communities in Alaska and Hawaii find that their electricity is expensive. A less expensive source of power for these areas may be small-scale hydropower plants. It is this fact that led King Cove, Alaska, and Hilo, Hawaii, to turn to locally available hydroelectricity.

Before December 1994, King Cove, Alaska, a remote mountain village 624 miles southwest of Anchorage, paid 21 cents per kilowatt-hour for its electricity. That is because the village had depended on diesel fuel to generate its electricity. The diesel fuel it used was expensive and unreliable because it could only be delivered by air or sea, and only when the weather permitted.

Now, King Cove has a new hydroelectric facility to replace its diesel generator. This facility not only provides King Cove with clean electricity derived from local streams, it promises to drop the cost of the town's electricity by 10 to 15 percent. It does this by using a run-of-the-river design in which water is drawn from two creeks and sent to a powerhouse 250 vertical feet below the water intakes. The falling water turns a turbine, which generates 800 kilowatts of electric power.

Duane Hippe, HDR Alaska

A facility near Hilo on the island of Hawaii also uses a run-of-the-river design. This facility relies on the natural water flow of a nearby river to provide 12 megawatts of power. Unlike the King Cove facility, the Hilo hydroelectric plant does not provide electricity just to nearby Hilo. Rather, the power is sold to the Hawaiian Electric Light Company and distributed throughout the island. The Hilo facility provides the island with about 6 percent of its electricity.

Opportunities to Move Forward

Renewable energy will capture a significant share of the world energy market over the next 20 years.
— Kenneth L. Lay, Chairman and Chief Executive Officer, Enron

Renewables are at a critical juncture as the domestic electricity marketplace moves toward an era of increased choice and greater diversity. The cost and performance of these technologies have improved dramatically over the past decade, yet their market penetration has stalled as the power industry grapples with the implications of the emerging competitive marketplace. The challenge today is to build on past progress and create new opportunities for renewables in the future.

Those making decisions regarding our nation's energy use can lead the way to a brighter energy future. Legislators and policy makers at all levels of government are playing an important role in shaping this future. The energy choices we make today can improve the economy, the environment, and the way we conduct our nation's business in the future. This section describes many of the issues facing renewable energy development in the electricity sector and identifies key areas where policy and decision makers can positively affect the energy path that we as a nation will follow.

Policies Affecting Renewables

Most of the non-hydropower renewable electricity development in the United States has been policy driven. The Public Utility Regulatory Policies Act of 1978 (PURPA) is a federal law that created early opportunities for renewables in the electricity market during the 1980s. PURPA required electric utilities to purchase power from small, unregulated power producers, including renewable electric generators, at favorable prices. It spawned an entrepreneurial industry that built power plants using both renewable technologies and highly efficient cogeneration technologies. More than 10,000 megawatts of renewable generating capacity was developed through this broadening of the electricity generating business.

With the passage of the Energy Policy Act of 1992 (EPAct), Congress established several incentives: (1) a permanent extension of the 10 percent business investment tax credit for solar and geothermal projects, excluding those owned by public utilities; (2) a production tax credit of 1.5 cents per kilowatt hour for wind

	Income Tax	Corp. Tax	Sales Tax	Property Tax	Industry Recruit.	Accel. Deprec.	Special Grants	Loan Programs
Alabama	■							■
Alaska								■
Arizona	■		■		■			■
Arkansas							■	
California							■	■
Colorado							■	
Connecticut		■	■		■			■
Delaware								
D.C.								
Florida			■					
Georgia								
Hawaii	■	■	■					
Idaho	■							■
Illinois				■			■	
Indiana				■				
Iowa			■	■			■	■
Kansas							■	
Kentucky								
Louisiana								
Maine								
Maryland			■					
Massachusetts	■	■	■	■	■			
Michigan								
Minnesota			■	■	■	■		■
Mississippi								■
Missouri								
Montana	■			■				
Nebraska								■
Nevada				■	■			
New Hampshire				■				
New Jersey			■					
New Mexico								
New York							■	
North Carolina	■	■		■	■			
North Dakota	■			■				
Ohio								
Oklahoma	■	■						
Oregon	■	■		■				
Pennsylvania								
Puerto Rico								
Rhode Island	■	■		■				
South Carolina								
South Dakota				■				
Tennessee								
Texas		■		■	■			■
Utah								
Vermont								
Virgin Islands							■	
Virginia				■	■			■
Washington			■					
West Virginia								
Wisconsin				■				
Wyoming								
Totals	11	8	10	16	8	1	8	12

Source: Database of State Incentives for Renewable Energy, North Carolina Solar Center, 1999

Local governments have recognized the leadership role that they can play in lowering barriers to the use of renewable energy. Special financial incentives to foster the use of renewable energy have been enacted by 35 states or jurisdictions.

energy and "closed-loop" biomass systems, available to qualified projects; and (3) a 1.5 cent per kilowatt-hour production incentive payment for solar, wind, biomass (excluding waste-to-energy), and geothermal (excluding dry steam) generation by publicly owned utilities and rural electric cooperatives. No action has been taken by Congress to extend the two production incentives beyond 1999, although proposals for such extensions have been offered.

State policies have also encouraged the development of renewable electricity. In keeping with the requirements of PURPA, many states have required utilities to offer power purchase contracts to renewable energy developers to help promote the growth of the industry. The availability of these contracts was the primary reason why California has led in the development of wind, solar, and geothermal resources.

Other state policies that have promoted renewables include financial incentive programs, integrated resource planning, and net metering. State financial incentives have included tax reductions and exemptions and low interest loans. However, they are not universally available or promoted. Integrated resource planning (IRP) was developed as a regulation tool for comparing the values of different resource alternatives. IRP addressed both the direct costs of power generation that have driven traditional resource decisions and indirect costs and benefits, such as relative environmental impacts. However, as electric utility restructuring has gained momentum, the role of IRP has greatly diminished.

Under net metering, electricity generated by a utility customer is sold back to the utility at the prevailing retail rate. In effect, this means that small-scale generators, such as homeowners, can run their meter backwards. The higher the prevailing customer retail rate, the more attractive the renewable investment becomes. Net metering policies for small renewable generators have been implemented in 27 states, and their prevalence appears to be growing.

Domestic Market Opportunities

Competition has come to the electric power industry. As of June 1999, 22 states had either passed legislation on electric restructuring or had issued regulatory orders by which all customers will eventually be allowed to choose their supplier. Other states are considering restructuring their electric power industry to allow customer choice. Also, several bills have been introduced in the U.S. Congress to develop national guidelines for retail competition.

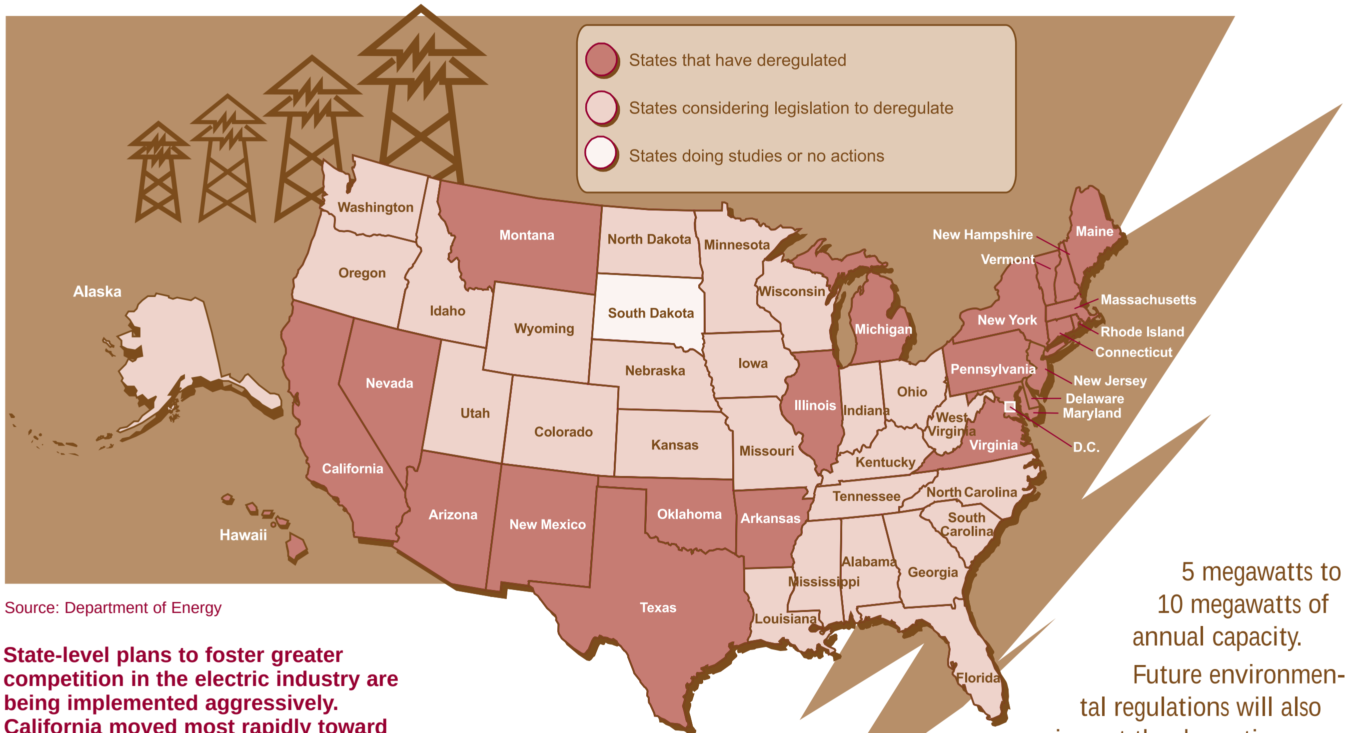
In a more competitive electricity market prices will fall, making the cost threshold for renewables more demanding. If electricity is treated as just another commodity, price will be the primary factor when choosing among electricity supply options and many of the non-price attributes of renewables will continue to be undervalued. At the same time, however, market competition will give customers the opportunity to choose among power suppliers and types of electricity services. Market competition will also give customers the opportunity to choose new technologies, products, and types of energy services that could radically change the way electricity is produced and delivered.

New small-scale, modular and highly efficient generation and storage technologies such as photovoltaics, fuel cells, solar thermal dish engines, biopower, wind, and flywheels will make self-generation and storage of electricity an attractive option for homeowners and businesses. These new power technologies can be interconnected to the local distribution system to provide competitive energy services and products. Industry estimates suggest that distributed power technologies will account for between 25 to 35 percent of new generation by 2010. However, to accommodate this market in a restructured electric power industry, institutional and regulatory regimes must be redesigned. A number of states are actively examining the barriers to increased adoption of distributed technologies including New Mexico, Texas, New York, California, Iowa, and Vermont. These efforts include regulations for grid interconnection standards, contractual issues, and control and safety.

Customers with a preference for cleaner energy sources will be able to select a provider that meets those requirements. The term "green power marketing" describes the offering of environmentally responsible electricity services in a competitive marketplace. Green power marketing gives consumers an option to purchase renewables-based electricity services. Customer preference and response to green power options are expected to be important drivers of future renewable electric project development, provided that fair and open competition can be realized. In California, 18 months after the start of retail competition, there are 16 green power products available for the residential sector alone. An independently administered Green-e certification program is now available to certify the 50 percent minimum renewable content of a green power product.

In addition to renewable offerings in customer choice pilot programs and retail competition programs, nearly 50 utilities currently either offer, or are exploring ways to provide, renewables-based electricity services through "green pricing" programs. These programs offer their customers a way of supporting a greater level of utility investment in renewables. Through these programs, customers agree to pay a premium price for green power, either as a fixed additional cost on their bill or as a higher per kilowatt-hour price. However, the full potential for green power lies in a truly competitive marketplace where consumers have a greater choice of suppliers and services and are equipped with adequate information regarding the relative attributes of different energy options.

Traditionally, the regulated utility industry has provided important public benefits such as low-income energy assistance, energy R&D, and energy efficiency and renewable energy programs. Two policies, an RPS and an SBC, have



Source: Department of Energy

State-level plans to foster greater competition in the electric industry are being implemented aggressively. California moved most rapidly toward restructuring, but has now been joined by 21 other states in the push to allow customer choice.

been proposed at both the state and federal levels to ensure that these activities continue to receive support. An RPS would impose a minimum renewable energy requirement on a state's (or the nation's) electricity mix — every entity participating as an electricity supplier would be required to provide and maintain a certain percentage of its supply from renewable energy sources. Electricity suppliers could alternatively purchase tradable credits to meet their portfolio requirement. Such a trading scheme would enhance the value of renewable energy resources and at the same time use market forces to minimize the costs of developing and maintaining the renewables supply portfolio. The RPS is envisioned as an interim policy to help ensure that a market for renewable electricity continues to develop during the transition to a truly competitive market. An SBC would impose a fee to be collected from all electricity customers to fund electricity-related public goods programs, including renewables. Thirteen states have established firm plans to introduce retail electric competition and have adopted one or both of these policies.

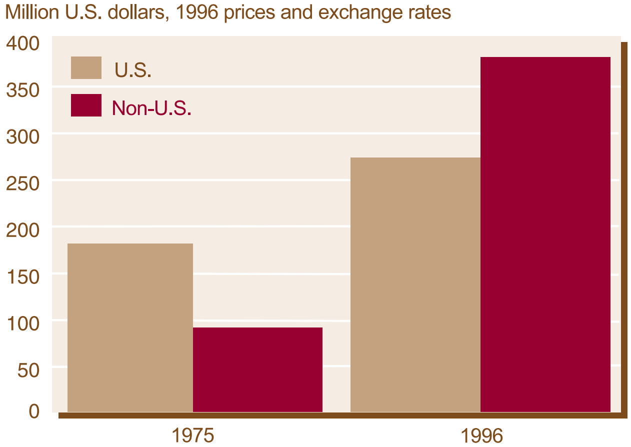
Ultimately, a key argument for policies such as the RPS or SBC lies in their potential to help expand domestic markets for renewables. As market size grows, production costs should decline, allowing renewables to become fully competitive with traditional sources. For example, BP Amoco Solar has estimated that it can cut photovoltaic production costs by 30 percent by doubling its manufacturing plant size, from 5 megawatts to 10 megawatts of annual capacity.

Future environmental regulations will also impact the domestic market. For example, regulatory action on fine particulates and toxic air emissions, and future international agreements on global warming mitigation, could stimulate a greater use of renewables for electricity production.

International Markets and Barriers

Today, the most rapidly growing markets for many renewable energy technologies are overseas. These markets are growing because other industrial countries are responding more aggressively to environmental concerns and because of the exploding growth in many developing countries. Developing countries have limited infrastructure and high energy prices, which create numerous market opportunities for renewable energy technologies. In 1996, for example, about 80 percent of the world market for photovoltaics was outside of the United States and two thirds of U.S. photovoltaics production was exported. The world market for wind turbines was about 1,550 megawatts in 1997, with almost all of that market outside of the United States. Similarly, large markets for biomass, geothermal, and solar thermal power are increasingly found outside of the United States.

Numerous barriers exist to the increased use of renewable energy in developing countries. These include taxes and tariffs on imported equipment, which increase costs of non-locally produced technology, lack of distribution infrastructure for selling and maintaining systems in rural areas, lack



International public sector investment in renewable energy R&D has grown more than two-fold since 1975. During that period, however, the United States' leadership position has eroded to the point where the U.S. government now ranks sixth among industrialized countries in renewable energy R&D per dollar of gross domestic product.

of finance mechanisms to enable the purchase of systems, lack of information, lack of a trained work force, lack of familiarity with and thus confidence in renewable technologies, and others. However, many renewable energy technology companies do not have the financial strength needed to make these investments.

In addition, the international marketing efforts of U.S. companies are frequently hindered by the public-private partnerships of other governments. Concessionary financing is often used by European countries and Japan to establish a company's presence in these markets and to capture early market share. A recent review found that concessionary finance, roughly equivalent to a 10 percent capital subsidy, supported the establishment of 9 of 13 wind farms in China. U.S. companies find it difficult to compete against these foreign subsidies without similar federal support. In addition, U.S. companies are not able to match the extensive technical assistance and other forms of support that are provided by foreign governments to promote their own companies.

The Role of Research and Development

Although the costs of renewables have fallen, there are still many opportunities to achieve lower costs and greater reliability through technical advances. A robust federal R&D program has been an essential element of a government/industry partnership to achieve these technical advances. In order to maintain this progress, the U.S. Department of Energy, Office of Power Technologies has established a goal of 30,000 megawatts of non-hydropower renewable capacity by 2020. One way to conduct this R&D is through cost-shared partnerships between the federal government and industry. For example, the federal government has been partnering with the photovoltaic industry on the Photovoltaic Manufacturing Technology project, which has led to significant cost reductions in photovoltaic manufacturing.

The federal government is also partnering with the electric utility industry. This allows utilities to gain experience with renewables while contributing to technology development. One example is the utility consortium that was formed to build the Solar Two project in Barstow, California. Another example is industry development efforts on biomass gasifier technology, which offers significant cost, efficiency, and emissions improvements over conventional biomass combustion.

A stakeholder consensus building effort for wind power is being led by the National Wind Coordinating Committee (NWCC). The NWCC's objective is to ensure the responsible use of wind power in the United States. Through the establishment of a dialogue among key electric market stakeholders, the committee identifies and addresses issues that impact the use of wind power. The committee's vision is the development of a self-sustaining commercial market for wind power.

At a time when worldwide government support for renewable R&D is on the upswing, federal funding for renewable energy is on the decline. In 1975, the United States accounted for nearly three fourths of industrialized nations' investments in renewable energy R&D; in 1997, it accounted for less than half. This decline placed the United States eighth among industrialized nations in renewable energy R&D spending as a percentage of total energy R&D and sixth in renewable energy R&D investment per dollar of gross domestic product.

Conclusion

Renewable energy technologies already contribute to the global energy mix and are ready to make an even greater contribution in the future. However, the renewables industry faces critical market uncertainties, both domestically and internationally, as policy commitments to renewables at both the federal and state levels are being reshaped to match the emerging competitive marketplace.

The energy decisions that we make, or fail to make, today will have long-lasting implications. Do we follow the path of business-as-usual, a path that does not begin to lay the foundation for a sustainable energy future and threatens the viability of our domestic renewables industries? Or do we choose a path toward a brighter future, one in which renewables play a larger role in meeting our future energy needs? We have the power to choose.

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