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.

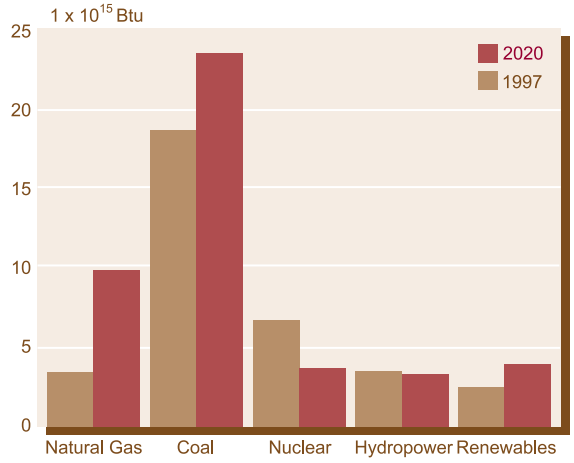
— Chris Fay, Chairman and CEO, Shell UK Ltd., Presentation at the Aspen Institute, 1995

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.

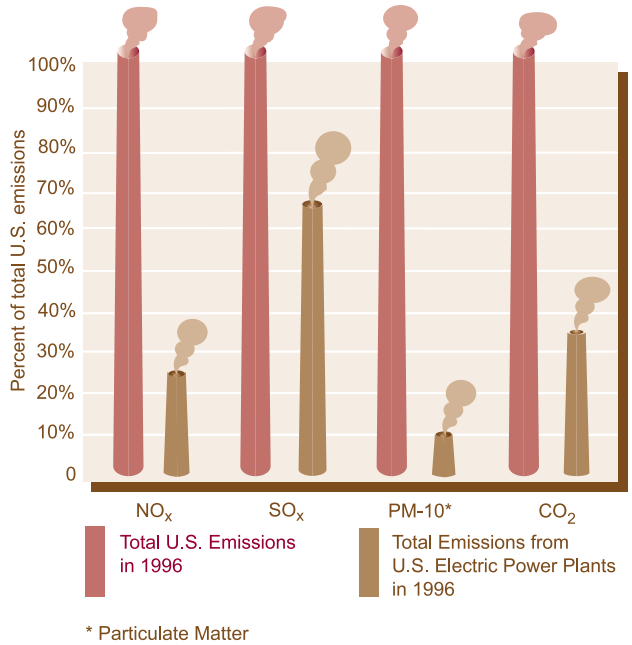
Power plant emissions, other than CO_2, also represent a significant challenge for the United States' electric utility sector, despite progress that has been made over the past 10-20 years. For example, the largest proportion of sulfur

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



* Particulate Matter

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."

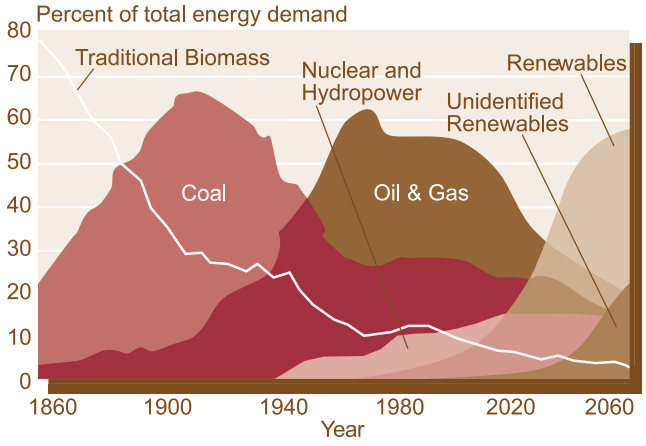
The Power to Choose

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.