Chapter 1
The Development of Energy

Throughout recorded history, humans have searched for ways of putting energy to work for them. Humans have found ways of growing food instead of foraging for it out in the wild. Instead of walking, they ride in cars they have built for getting from one place to another. Humans even learned how to send messages electronically instead of using a messenger or a postal service. This quest for faster, easier, and more efficient ways of meeting the needs of a growing human population has led to increasingly high energy demands. But the resources currently used for generating energy are running out. The pollution created by the use of these resources is also causing significant damage to the planet's natural systems. For these reasons, people are beginning to turn to alternative energy sources to reduce pollution while meeting their energy needs.

A Brief History of Power Use

The sun is by far the oldest source of energy. It has provided heat and light for millions of years and is directly responsible for sustaining all life on earth. Energy, in almost all its forms, starts with the sun. For example, wind is created by temperature changes caused by the sun. Plants and trees, which provide energy in numerous ways, gain their nourishment from the sun. Streams and rivers, providing energy by the force of their downhill flow, are formed from rain and snow. Rain and snow fall at high elevations after being evaporated from lakes and oceans by the sun. The variety of life-forms depending on the sun's energy in one manner or another is impressive.

Although the sun provides vast quantities of energy in many forms, humans could not control it, and so they began to explore other sources of energy. For example, humans discovered a way to generate their own energy from wood, somewhere between five hundred thousand and seven hundred thousand years ago, by most scientists' estimates. At first, wood was burned for warmth, light, and for preparing food. Then the

heat from fire began to be used to change the form of some materials to make them more useful, such as clay into pots or bricks, and certain types of metal, such as copper, bronze, and iron, into tools.

This ancient Egyptian mural depicts farmers at work. By exploring new ways to utilize the sun's energy humans began to grow and harvest food.

As the human population increased over time, so did humanity's dependence on fire. This increase in population led to severe shortages of wood in some areas of the world. By the sixteenth century, for instance, Great Britain had so few trees left because of overcutting that the British people had to switch to a completely new source of fuel. In place of trees, they began to use coal. Coal, oil, and gas are called fossil fuels because they are extracted from fossilized plant and animal material from deep under the ground.

Although coal had been used in different parts of the world since the second millennium B.C., its potential uses had not been fully explored. Once coal began to replace wood as a fuel, inventors found many ways that coal could be used as a source of energy. This time of exploration and invention started a period in history called the Industrial Revolution.

The Industrial Revolution marked a big change for people of the world. Many of the agricultural societies that used human muscle power and animals to do work quickly became industrialized and began using machines to do work. When the coal-burning

steam engine was invented, a race was begun to see who could create and build bigger, better, and faster machines. The machines were used to provide transportation and to do the work formerly done by people and animals. Coal continued to be used in great quantities until the twentieth century. Then came the invention of the internal combustion engine and the automobile, which used oil and gas instead of coal. Over the years automobiles were modified to use oil and gas more efficiently and with less pollution, but the sheer numbers of automobiles that have come into use over the years have offset the potentially positive impact of these changes. Oil and gas also came into use in other areas, such as for manufacturing and power production, and remain in high use today.

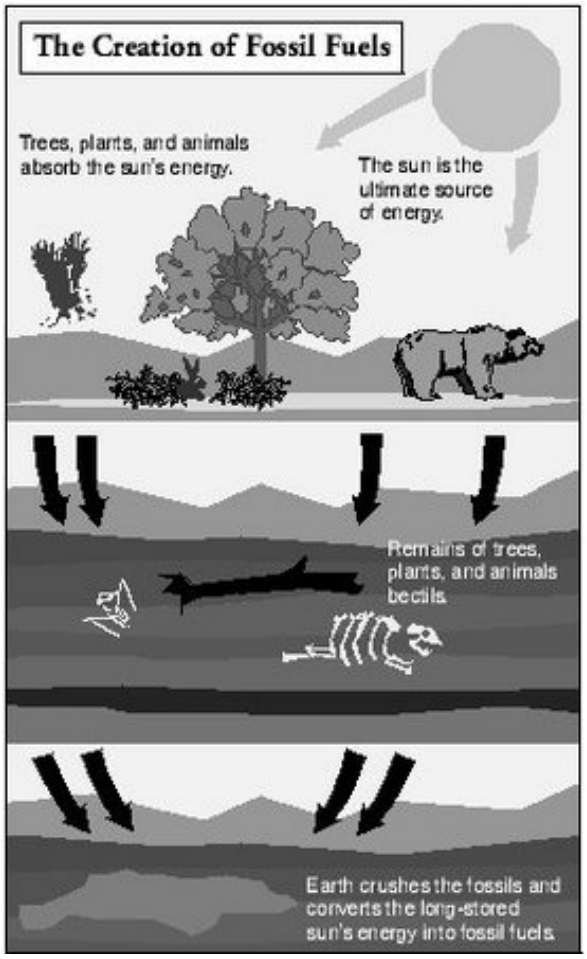
Fossil Fuels

Ever since the Industrial Revolution, humans have sought to generate power from a variety of energy sources. This

With the advent of the internal combustion engine, machines began to employ oil and gas as fuel. Here, Henry Ford sits on a gas-powered tractor he invented.

remains true today, especially as some energy sources are being used up. Current power needs are continuing to climb while the resources of the planet are steadily being depleted. Technology that operates on electricity, including everything from the typical refrigerator in the kitchen to street lights, is now a part of the lives of most people in industrialized nations, such as the United States. Much of that electricity is generated in power plants, which use large quantities of fossil fuels.

The process that created fossil fuels is a natural process of the earth's systems. The remains of plants and animals that died millions of years ago were slowly buried under sediment from the earth and compressed by the weight of the sediment. Over the course of millions of years, the pressure of being compressed by the sediment turned the dead plants and animals into oil, coal, and natural gas. The earth took 500 million years to produce these fuels. Humans have severely depleted them in just over one hundred years, a rate that is 50 million times greater than the rate at which they are formed.



There are three primary types of fossil fuels: coal, oil, and natural gas. Coal is a hard, black substance found close to the earth's surface or mined from deep in the ground. There are over two thousand mines in the United States from which more than eight hundred thousand tons of coal are removed each year, supplying approximately 1,566 coal-burning electric power plants. Coal is responsible for providing much of the energy for producing electricity. In fact, there are currently ninety-four new coal-burning power plants that have been proposed, which would power approximately 62 million homes.

Oil can almost be considered a liquid version of coal. It is usually black, but it can also be dark green or even almost clear. Oil is often found underground in dome-shaped spaces directly above coal deposits. Different types of fuels, also called petroleum products, are made from oil, which come in varying thicknesses. Dissolved gases make up the thinnest oils while asphalt oil is regarded as the thickest. Petroleum ether, gasoline, kerosene, gas oil, lubricating oils, and fuel oils are the various grades that fall in between. Much of the oil extracted each year is used in the engines of the various modes of transportation such as cars, trains, boats, and planes. According to a report released by the U.S. Department of Energy, Americans used approximately 19,593,000 barrels of petroleum products a day in 2001.

Natural gas is made up mostly of methane and is highly flammable. Natural gas is thought to have been created from large amounts of plant material that did not become coal. Natural gas will usually flow from a drilled well under its own pressure. In the United States, about 20 trillion cubic feet of gas are produced each year. Natural gas is used primarily for heating purposes and for powering industrial production, especially in manufacturing. According to the U.S. Department of Energy's 1998 Manufacturing Energy Consumption Survey, just six manufacturing industries account for 84 percent of natural gas use, which is primarily for producing heat and steam for making glass, aluminum, metals, wood products, chemicals, and petroleum products. Altogether these fossil fuels are used for about 82 percent of the power produced in the United States.

Nuclear Energy

While fossil fuels are the main source of energy, another of today's energy sources is nuclear power. The first full-scale nuclear power plant in the United States became operational in Shippington, Pennsylvania, in 1957. Nuclear power plants use the energy found in the nuclei of atoms to make electricity. Atoms, which are made of protons, neutrons, and electrons, require a lot of energy to hold these particles together. This energy is released in the form of heat when an atom is split apart. The process of splitting atoms apart is called nuclear fission.

Nuclear power plants harness the heat energy released when nuclear fission occurs. The heat is used to boil water and create steam. The steam is used to turn turbines connected to a generator. As the turbines spin, the generator produces electricity.

A major drawback to nuclear power plants is that they rely upon unstable atoms such

as uranium 235 to generate electricity. Unstable atoms are used because they are the easiest to break apart. After uranium 235 undergoes nuclear fission, however, it becomes a highly radioactive waste material that is extremely difficult to dispose of safely.

When nuclear power became a usable source of energy for producing electricity in the 1950s it was thought that it would be the new power for the future. Some sources report that by 1993 about 20 percent of the nation's electricity was generated from nuclear power. Although over one hundred nuclear power plants are still in operation in the United States today, nuclear power has not lived up to its promise. Due to the threat of nuclear accidents and the difficulty and costs associated with the disposal of the toxic waste by-products, nuclear power has not become the primary source of power production it was once thought it would become. Only about 7 to 8 percent of the energy produced in the United States comes from nuclear power.

The Environmental Impact of Modern Power Consumption

Weighing the benefits and drawbacks of one power source versus another is a complicated process. There are many factors to consider, including everything from understanding

Giant cooling towers dominate the landscape near a nuclear power plant. Although nuclear fission is an efficient energy source, it produces radioactive waste.

the environmental effects of a particular type of power production and consumption, to

addressing the power needs of the people and finding methods for delivering the power. Throughout this process, decision makers rely upon scientists to supply the necessary data to make informed decisions. What forms the basis of this science includes the knowledge that carbon dioxide, which is released into the atmosphere when fossil fuels are burned, is creating a lot of harm to the planet and its systems.

Gases that form the atmosphere completely surround the planet. A part of the atmosphere called the ozone layer acts as a sort of shield from the sun, filtering out harmful radiations. Today, human activities release about 433,000 metric tons of nitrous oxide into the atmosphere each year. Nearly 40 percent of the world's nitrous oxide emissions come from burning fossil fuels. The atmosphere has a certain amount of nitrous oxide naturally, but too much nitrous oxide causes a depletion of the ozone layer. Over the last decade scientists have reported that the hole in the ozone layer is growing rapidly.

Carbon dioxide is another harmful gas released into the atmosphere. It comes back to the surface as acid rain, poisoning water supplies, killing plants and animals, and eroding and blackening buildings. In addition, carbon dioxide reflects light and heat back to the planet's surface. As the carbon dioxide levels increase in the atmosphere, more heat from the sun is held in, changing the climate of the entire planet by making it warmer. This is called the greenhouse effect and is considered a form of pollution. Author Laughton Johnston claims that, "Carbon dioxide levels in the atmosphere are at their highest in 20 million years." [1]

The planet Earth operates on delicate systems of natural balance. Scientists believe warming the atmosphere by even a few degrees could cause enormous changes to the environment. Some scientists also believe an increase in the temperature of the planet, brought on by the greenhouse effect, will lead to more weather-related natural disasters such as tornadoes, floods, droughts, and hurricanes. Scientists also predict a significant rise in sea levels, which will reduce land size. Considering that half of the human population lives near a coastline, the effects could be dramatic. In the future, many nations may need to struggle with the question of where all of their people should live if their towns and cities become submerged under oceanic water.

For example, according to a report released by the British Broadcasting Corporation in 2003, the Arctic ice cover is shrinking by an area the size of the Netherlands every year. The Arctic ice cap has thinned from an average thickness of more than nine feet to

less than six feet in the last thirty years. In 2002, for the first time in recorded history, a twelve-thousand-year-old ice shelf the size of Luxembourg came adrift from the Antarctic and melted into pieces in just thirty-five days. The glaciers of Kilimanjaro, a mountain in Africa, and of the tropical Andes mountains in South America are melting so fast that experts believe they could disappear within the next twenty years. In October 2001 about eleven thousand people in Tuvalu, a group of nine islands in the Pacific Ocean, tried to abandon their homes because of the rising ocean. The Australian government refused to let them into Australia and so most of the people have remained on the islands, living in fear of being submerged in the ocean.

Burning fossil fuels for energy releases much of the harmful gases that exist today. Scientists estimate that about 35 percent of the greenhouse gases, such as carbon dioxide, being released into the atmosphere are from the United States. With only about 5 percent of the world's population, the United States consumes about one quarter of the world's energy production. At this rate, according to writer Ralph Nansen, "we will destroy both the breathable air and the energy reserves of our only home." [2] In fact, according to a recent BBC Radio Scotland report on global climate change, if the rest of the world consumed energy at the same rate as the United States, "we would need at least two more planet earth's to sustain us all." [3]

Fossil Fuel Supplies Depleted

Not only are these high levels of consumption causing equally high levels of pollution, but the world's fossil fuel supplies are quickly being used up. For example, today's total oil supply is estimated at between 2,000 and 2,800 billion barrels. About 900 billion barrels of oil have already been consumed, 28 million barrels of that just in the year 2000. Addressing resource depletion is not an easy task. As Tom Hansen, vice president of Tucson Electric Power, says, "It is like trying to change the wings of an airplane while you are in flight." He describes a difficult process, but one with what he considers a great payoff. "We have to wean ourselves off traditional fuels, because it is going to get harder for us to build more power plants and install more transmission lines." [4]

The future of energy production will certainly determine what the overall health of the planet will be. Most scientists agree that the choices that support fossil fuel use will only worsen the environmental damage that has already occurred. Instead, choosing to look

to renewable energy sources and energy conservation techniques offers the potential to improve the health of the planet. This belief concerning the future of renewable energy is voiced by author Melvin A. Benarde in his book, *Our Precarious Habitat*. "There are no instant cures, no ready-made solutions," Benarde writes. "This does not mean there is no hope for a future. On the contrary, there is a great deal; but it will take time and money — lots of money—and a willingness on the part of the people to see it through." [5]

Renewable Energy

Because energy is usable power, the form that the energy is in can be used up. When a combustion engine car runs out of gasoline, it loses its power and can no longer operate until more fuel is put into the system. If a power plant that generates electricity by burning coal runs out of coal, then it can no longer generate electricity until more coal is put into the power plant burners.

Renewable energy, on the other hand, is energy that is replaced at the same rate that it is used. Renewable energy is replaced through natural processes or through sound management practices, and so it is a source of power that does not run out. A perfect example of renewable energy is energy from the sun, which comes in an abundant supply every day.

Other examples of renewable sources of energy include the wind, the waves and tides, the gravitational pull of the earth, the heat at the earth's core (geothermal energy), landfill gases, and, to a limited degree, trees and plant material. Many of these renewable sources of energy can be used in their raw form. They are natural forces that create energy without the help of humans. All that is needed is for someone to decide how that energy can be used. Building a sail for a boat makes use of the wind. Building a waterwheel on a river makes use of the flowing water that is pulled downhill by the earth's gravity. Building a house out of glass—a greenhouse—traps the heat from sunlight inside, providing warmth and allowing plants to grow where they might not otherwise grow.

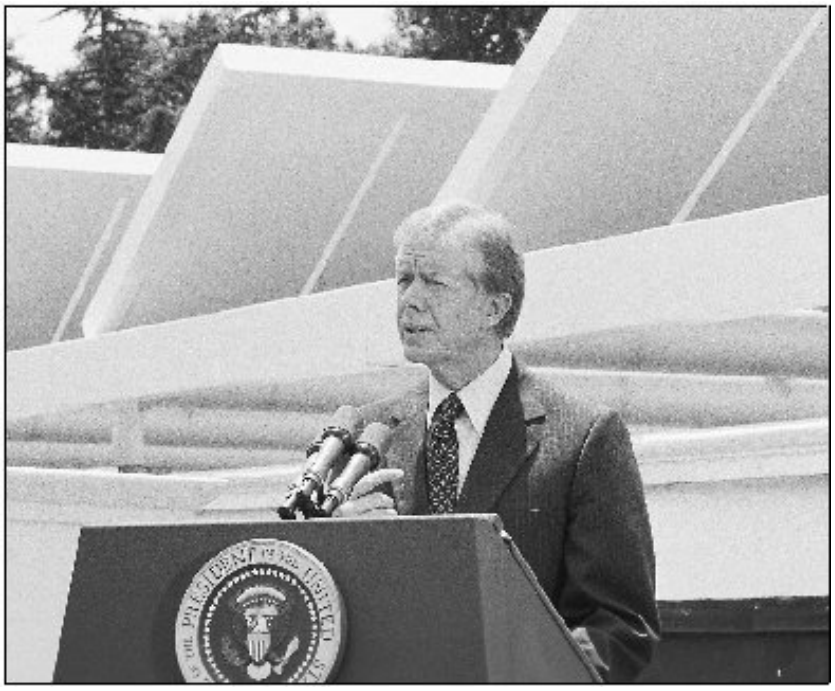
The Case for Renewable Energy

Renewable energy, also called "green energy," or "clean energy," does not deplete natural resources and creates little-to-no pollution when it is generated. Throughout history, renewable sources of energy have been used by various peoples to supply

power for their specific needs, but always on a small scale. The unique challenge of today is finding a way to supply renewable energy to entire populations. Large-scale energy production requires specialized equipment such as energy storage and transmission facilities. The technology for generating the power must also be efficient and cost-effective to produce and operate.

In the face of big-oil-company interests and the politics of government, it has taken a long time for renewable energy options to even be considered on a large scale. The scientific and technological development of solar power, for example, looked promising when in 1977 President Jimmy Carter initiated a plan to develop solar energy and other alternative fuels. His goal for the nation was to have 20 percent of its power coming from solar power generation by the year 2000, and he started by putting solar panels on the White House. By the late 1970s, however, big oil companies had bought up most of the patents for the solar technologies being developed. The Reagan administration took the solar panels off of the White House and spent billions of dollars on the military, foreign aid, and for research and production of atomic weapons instead of on renewable energy.

Since that time, government support for the research and development of renewable energy has not been easy to get, and the technology has been slow to come into its own. Despite these setbacks, independent companies are now making renewable energy products that, while still costly to purchase, offer cheap, clean, renewable energy to the consumer. In his book *Charging Ahead,* writer,



In 1977 President Jimmy Carter speaks about the importance of alternative energy sources during a dedication of a solar heating system installed on the White House.

teacher, and environmental science and policy consultant John J. Berger says of renewable energy sources that "modern science and engineering technology have of late made them much more efficient, convenient, and economical." [6] Steve Kretzmann, coordinator for the Greenpeace Global Warming Campaign, shares a similar point of view: "One of the greatest myths surrounding clean energy is that it is not ready to do the job. Renewables *are* ready—the technical barriers are almost entirely removed. The true barriers to energy reform are now, and always have been, political." [7]

Many experts agree that renewable energy would provide numerous benefits. Berger, for example, says that:

> Because renewables do not use fossil fuels (most are entirely fuel-free) they are largely immune to the threat of future oil or gas shortages and fossil fuel price hikes. For the same reason, because most renewable technologies require no combustion, they are far kinder to the environment than coal, oil, and natural gas. Smog and acid rain could be eliminated with renewables. The collective lungs of America could breathe a sigh of relief. [8]

In addition to being virtually nonpolluting, renewable energy is thought to be cheaper for producers and consumers. As reported in a book commissioned in 1992 by the United Nations Solar Energy Group on Environment and Development, "Given adequate support, renewable energy technologies can meet much of the growing demand at prices lower than those usually forecast for conventional energy." [9] As the human population continues to increase and the energy needs of the world climb, renewable energy is seen more and more as the only alternative.