

What is renewable energy?

The United States currently relies heavily on coal, oil, and natural gas for its energy. Fossil fuels are *nonrenewable*, that is, they draw on finite resources that will eventually dwindle, becoming too expensive or too environmentally damaging to retrieve. In contrast, *renewable energy* resources—such as wind and solar energy—are constantly replenished and will never run out.

Most renewable energy comes either directly or indirectly from the sun. Sunlight, or solar energy, can be used directly for heating and lighting homes and other buildings, for generating electricity, and for hot water heating, solar cooling, and a variety of commercial and industrial uses.

The sun's heat also drives the winds, whose energy is captured with wind turbines. Then, the winds and the sun's heat cause water to evaporate. When this water vapor turns into rain or snow and flows downhill into rivers or streams, its energy can be captured using hydroelectric power.

Along with the rain and snow, sunlight causes plants to grow. The organic matter that makes up those plants is known as biomass. Biomass can be used to produce electricity, transportation fuels, or chemicals. The use of biomass for any of these purposes is called biomass energy.

Hydrogen also can be found in many organic compounds, as well as water. It's the most abundant element on the Earth. But it doesn't occur naturally as a gas. It's always combined with other elements, such as with oxygen to make water. Once separated from another element, hydrogen can be burned as a fuel or converted into electricity.

Not all renewable energy resources come from the sun. Geothermal energy taps the Earth's internal heat for a variety of uses, including electric power production, and the heating and cooling of buildings. And the energy of the ocean's tides comes from the gravitational pull of the moon and the sun upon the Earth.

In fact, ocean energy comes from a number of sources. In addition to tidal energy, there's the energy of the ocean's waves, which are driven by both the tides and the winds. The sun also warms the surface of the ocean more than the ocean depths, creating a temperature difference that can be used as an energy source. All these forms of ocean energy can be used to produce electricity.

Why is renewable energy important?

Renewable energy is important because of the benefits it provides. The key benefits are:

Environmental benefits: Renewable energy technologies are clean sources of energy that have a much lower environmental impact than conventional energy technologies.

Energy for our children's children's children: Renewable energy will not run out. Ever. Other sources of energy are finite and will some day be depleted.

Jobs and the economy

Most renewable energy investments are spent on materials and workmanship to build and maintain the facilities, rather than on costly

energy imports. Renewable energy investments are usually spent within the United States, frequently in the same state, and often in the same town. This means your energy dollars stay home to create jobs and fuel local economies, rather than going overseas.

Meanwhile, renewable energy technologies developed and built in the United States are being sold overseas, providing a boost to the U.S. trade deficit.

Energy security

After the oil supply disruptions of the early

1970s, our nation has increased its dependence on foreign oil supplies instead of decreasing it.

This increased dependence impacts more than just our national energy policy.

Environmental benefits

Renewable energy technologies are a lot friendlier to the environment than conventional energy technologies, which rely on fossil fuels. Fossil fuels contribute significantly to many of the environmental problems we face today— greenhouse gases, air pollution, and water and soil contamination— while renewable energy sources contribute very little or not at all.

Greenhouse gases— carbon dioxide, methane, nitrous oxide, hydrocarbons, and chlorofluorocarbons— surround the Earth's atmosphere like a clear thermal blanket, allowing the sun's warming rays in and trapping the heat close to the Earth's surface. This natural greenhouse effect keeps the Earth's average surface temperature at about 60°F (33°C). But the increased use of fossil fuels has significantly increased greenhouse gas emissions, particularly carbon dioxide, creating an enhanced greenhouse effect known as global warming. According to the U.S. Environmental Protection Agency (EPA), carbon dioxide is responsible for one-half to two-thirds of our contribution to global warming. Renewable energy technologies, however, can produce heat and electricity with a very low or no amount of carbon dioxide emissions.

Energy use from fossil fuels is also a primary source of air, water, and soil pollution. Pollutants— such as carbon monoxide, sulfur dioxide, nitrogen dioxide, particulate matter, and lead— take a dramatic toll on our environment. On the other hand, most renewable energy technologies produce little or no pollution.

Both pollution and global warming pose major health risks to humans. According to the American Lung Association, air pollution contributes to lung disease – including asthma, lung cancer, and respiratory tract infections – and close to 335,000 people in the United States die from it every year. Meanwhile, the long-term effects associated with global warming may be even more devastating. Deaths due to extreme weather could increase, and diseases could have a greater potential to thrive as temperatures rise.

Ultimately, renewable energy technologies could help us break our conventional pattern of energy use to improve the quality of our environment.

The EPA has more information on [global warming](#) and on [pollution](#).



The U.S. Fish and Wildlife service uses a photovoltaic system to provide clean energy at the Farallon National Wildlife Refuge. *Credit: Farallon National Wildlife Refuge*

Energy for our children's children's children

What will the world's energy use be like in the future? Well, we can be pretty certain that electricity use will grow worldwide. The International Energy Agency projects that the world's electrical

generating capacity will increase to nearly 5.8 million megawatts by the year 2020, up from about 3.3 million in 2000. However, the world supplies of fossil fuels—our current main source of electricity—will start to run out from the years 2020 to 2060, according to the petroleum industry's best analysts. How will we meet those electricity needs? Our best answer could be renewable energy.

Shell International predicts that renewable energy will supply 60% of the world's energy by 2060. The World Bank estimates that the global market for solar electricity will reach \$4 trillion in about 30 years. Biomass fuels could also replace gasoline. It is estimated that the United States could produce 190 billion gallons per year of ethanol using available biomass resources in this country.

And unlike fossil fuels, renewable energy sources are sustainable. They will never run out. According to the World Commission on Environment and Development, sustainability is the concept of meeting "the needs of the present without compromising the ability of future generations to meet their own needs." That means our actions today to use renewable energy technologies will not only benefit us now, but will benefit many generations to come.

For more energy forecasts and data, see DOE's [Energy Information Administration](#).



This cornfield can be used to make ethanol—a fuel we won't run out of as long we grow corn and other comparable plants. *Credit: Warren Gretz*

Jobs and the economy

Many U.S. communities have to import fossil fuels, such as oil and natural gas, to provide electricity, heating, and fuel. The cost of these fossil fuels can add up to billions of dollars. And every dollar spent on energy imports is a dollar that the local economy loses. Renewable energy resources, however, are developed locally. The dollars spent on energy stay at home, creating more jobs and fostering economic growth.

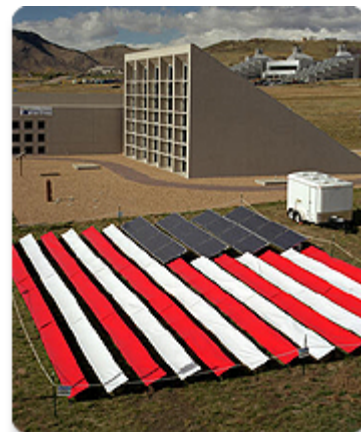
Renewable energy technologies are labor intensive. Jobs evolve directly from the manufacture, design, installation, servicing, and marketing of renewable energy products. Jobs even arise indirectly from businesses that supply renewable energy companies with raw materials, transportation, equipment, and professional services, such as accounting and clerical services.

In turn, the wages and salaries generated from these jobs provide additional income in the local economy. Renewable energy companies also contribute more tax revenue locally than conventional energy sources.

The economic advantages of renewable energy also extend far beyond the local economy. The whole country benefits. In 2001, the United States spent about \$103 billion dollars outside the country for oil. But as one of the world's leading manufacturers of renewable energy systems, we can bring in more money with the increased use of renewable energy sources around the world. Currently, for example, the United States manufactures about two-thirds of the world's photovoltaic (PV) systems. And it exports about 70% of these PV systems, mostly to developing nations, resulting in annual sales of more than \$300 million.



A certification test engineer, shown here measuring the noise from a wind turbine, is one of many careers available in the renewables industry. *Credit: Warren Gretz*



NREL's Solar Independence

Energy security

Exhibit featured a 4-kilowatt photovoltaic system that is used for mobile emergency power. *Credit: Warren Gretz*

Our nation's energy security continues to be threatened by our dependency on fossil fuels. These conventional energy sources are vulnerable to political instabilities, trade disputes, embargoes, and other disruptions.

U.S. domestic oil production has been declining since 1970. In 1973, the United States only imported about 34% of its oil. Today, our country imports more than 53%, and it is estimated that this could increase to 75% by 2010.

Most of the world's oil reserves are now in the Middle East. We have witnessed this shift in economic influence through the last three sharp increases in the world's oil prices: the Arab Oil Embargo in 1974, the Iranian Oil Embargo in 1979, and the Persian Gulf War in 1990. It has resulted in periods of negative economic growth and a rising trade deficit.

But with renewable energy, we can decrease our dependency on foreign oil imports. For example, the U.S. Department of Energy (DOE) estimates that if we displace 10% of our petroleum use for transportation with biofuels, which are produced from organic material, we could save about \$15 billion over 10 years. A 20% displacement could save us about \$50 billion. This would strengthen our energy security, as well as our economic and national security.

For more data, see the DOE Energy Information Administration's information on [energy supply security](#).

Why is energy efficiency important?

Energy efficiency means using less energy to accomplish the same task.

The more efficient use of energy throughout our country results in less money spent on energy by homeowners, schools, government agencies, businesses, and industries. The money that would have been spent on energy can instead be spent on consumer goods, education, services, and products. For more information, see the [American Council for an Energy-Efficient Economy](#) and the [Alliance to Save Energy](#).



State-of-the-art spray foam insulation can completely fill walls, ceilings, and floors in a building for greater energy efficiency. *Credit: Paul Norton*

An energy-efficient economy can grow without using more energy. From 1970 to 2000, U.S. energy consumption grew only 45 percent while the U.S. Gross Domestic Product (GDP) increased 160 percent. In other words, the amount of energy used per dollar of GDP decreased 44 percent from 1970 to 2000.

An economy that uses less energy also produces less pollution, because the two are closely tied. By 1999, greenhouse gas emissions from energy use had risen 13 percent above 1990 levels. During that period, energy use increased 14.9 percent.

For your home or small business, and for other buildings, energy efficiency means using less energy to heat, cool, and light the building. It also means buying energy-saving appliances, computers, and other building equipment. For the homeowner or business owner, using less energy saves money.

The U.S. Department of Energy (DOE) has available a number of resources for homeowners wanting to save energy. DOE's [Consumer Energy Information](#) will guide you to resources on saving energy, including [Energy Savers](#), and direct you to [energy experts](#) that can answer any questions. You might also try out the [Home Energy Saver](#), a do-it-yourself home energy audit, created by DOE's Lawrence Berkeley National Laboratory.

See NREL's [Center for Buildings and Thermal Systems](#) for a list of energy-efficiency projects that NREL research is currently supporting. For further information, see DOE's [Building Technologies Program](#).

For your car, and for other vehicles, energy efficiency means creating new drive trains and other vehicle technologies to help manufacturers achieve higher-mileage vehicles. Cars powered by hybrid gasoline-electric engines or by fuel cells are two examples of energy-efficient vehicles.

DOE and the U.S. Environmental Protection Agency have an online [fuel economy guide](#), which can help you find fuel-efficient cars, including hybrids, and provide you with gas mileage tips.

See NREL's [Center for Transportation Technologies and Systems](#) for information about energy-efficient vehicle technologies that NREL is developing. For further information, see DOE's [FreedomCAR & Vehicle Technologies Program](#).

For your power company, and other providers of electricity, energy efficiency often means helping customers like you save energy in their homes and businesses. But it also means delivering and storing electricity more efficiently. For further information, see DOE's list of [power topics](#) and links.

For local industry, energy efficiency means finding processes that achieve the same task with less energy. For instance, continuous casting in the steel industry is an energy-efficient improvement. Energy efficiency also means using more efficient motors, steam systems, compressed air systems, and other industrial equipment. For further information, see DOE's [Industrial Technologies Program](#).