

# Lesson 6.4: Off the Grid

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## Learning Objectives

After this lesson, students should be able to:

- Define renewable and non-renewable energy sources.
- Describe some advantages and disadvantages to using renewable energy sources to power a home.
- Explain what it means for a house to be "off the grid."

## Introduction

From where do most homes and businesses get their power? ("A power plant" will probably be the most common response.)

How does a power plant generate most of that power? (Answer: From the burning of fossil fuels [hydrocarbons], such as coal, oil and natural gas.)

Are there any other ways in which power can be generated? (Possible answers: From the sun, wind or water.)

Solar power, wind power and hydroelectric power are all ways in which energy-efficient homes and businesses can generate power. We call these renewable energy sources.

What is the difference between renewable energy sources and non-renewable energy sources?

**Renewable energy** sources are naturally replenished in a short period of time; think of solar, hydro and wind power. Renewable energy sources account for about 13% of the energy generated in the world (in 2004).

By contrast, **non-renewable energy sources** are all the sources for energy that are not replenished naturally in a short period of time; think of coal, oil (petroleum), natural gas, propane and nuclear power (uranium). We call coal, oil and natural gas "fossil fuels" because they are created from the remains of animals and plants that died millions of years ago (hydrocarbons). Most of the world's energy is generated through using non-renewable energy sources; in 2004, 87% of the world's energy was generated using non-renewable energy sources. Oil accounts for about 34%, gas accounts for 21%, and coal accounts for 25%.

**Pros:** Renewable energy sources offer many advantages to traditional (non-renewable) energy sources. The biggest one is that renewable energy sources do not derive power from the burning of fossil fuels. By not burning fossil fuels, less pollution and carbon dioxide is released into the Earth's atmosphere. Another advantage is that these energy sources do not run out; they provide us with an endless supply of power. And, they also do not require the costs to drill for oil and gas, or dig for coal.

**Cons:** Criticisms of renewable energy include being unreliable. While this is true to an extent (you cannot tap the sun's power if it is cloudy or dark), by designing for several renewable energy sources and storage options, you can minimize this limitation so that even if the wind is not blowing or the sun is not shining, you still have power. Many people criticize renewable energy technologies as being unsightly (solar panels, wind turbines, dams), which may be viewed as a matter of personal preference. Fossil fuel-burning power plants are not usually attractive either.

## **Lesson**

Renewable energy sources include solar, wind, hydro (water), biomass/biofuels, and geothermal. Non-renewable energy sources include oil/petroleum, natural gas, coal, and nuclear/uranium. See below for more information about each.

### ***Solar Power***

Using PV cells has several advantages over fossil fuels, primarily its minimal environmental impact because no water is required for cooling and no by-products result from the process. The only disadvantages to using solar power are that the amount of sunlight hitting the Earth's surface is dependent on time of day, time of year, location, and the weather conditions, and that the energy provided to any one place at any one time by the sun is so small that large areas are needed for any practical use of the sun's energy.

New Jersey by 2021, utilities must obtain at least 22.5% of their electricity from renewable sources; at least 4.1% of all electricity must be provided specifically by solar energy. The most advantageous locations for installing solar energy systems in the U.S. are typically in the Southwest.

### ***Wind Power***

Wind energy is preferred over fossil fuels because it produces no pollutants. The only complaints with wind power are its negative effect on bird populations and the sight of 20-story tall, 200 foot wide wind turbines in the middle of open space. Then again, some prefer the sight of wind farm over the alternative of fossil fuel-burning power plant smokestacks and pollution. And, newer wind turbines are less likely to kill birds because of their wider blades and slower spin speed. One other disadvantage is that the wind does not always blow, thus energy generation is not always possible, requiring supplementation with other energy sources until the wind picks up again.

Wind farms are particularly effective in locations with relatively flat, treeless terrains such as in the Great Plains and Texas. Another advantageous location for wind installations is offshore in shallow waters. This presents a larger engineering challenge, however, since building the foundations for turbines in water is more complex. Like solar energy, some countries have made great changes to their laws, requiring more wind power installations in an effort to be less reliant on non-renewable sources. In Denmark, for example, the government has begun an initiative to use only renewable energy sources by 2050, much of which will be generated by wind turbines.

### ***Hydro Power***

Engineers design turbines that are spun by the flow of the water, which then creates electricity using a generator. One method is to place the turbines in a swiftly-flowing river where the fast moving water has enough kinetic energy to transfer it to the turbines and spin them. Another approach is to place the turbines under a flow of falling water, taking advantage of the water's transformation of potential energy into kinetic energy and transferring the water's kinetic energy to the turbines.

To accomplish both of these methods, dams are often built. When energy demand increases, the dam releases more water to spin the turbines and thus generate more energy.

Hydropower is an efficient way to generate energy. It is a renewable source of energy because the Earth's water cycle continuously replenishes the water in the river the dam is blocking. Hydropower also does not pollute the water or the air. One criticism of the use of hydropower is that you must build a dam to generate the energy. By damming a river, we disturb the surrounding environment and animals' natural habitats. Engineers continually work to find solutions that minimize environmental problems caused by dams.

### ***Biomass/Biofuels***

The largest renewable source of energy found in the world is biomass or biofuels. Biomass is simply organic material made from plants and animals. It can be as simple as burning wood or dung for heat. Other forms of biomass include crops such as corn, waste and alcohol fuels.

They produce carbon dioxide but take the equivalent amount of carbon dioxide to produce.

Require a large amount of land.

### **Geothermal Energy**

Geothermal energy is a good alternative to fossil fuels because the direct use of geothermal energy has almost no negative impact on the environment and is continually available. A geothermal power plant releases almost no carbon dioxide pollution since fossil fuels are not being burned to produce the steam to turn the turbines.

### **Vocabulary/Definitions**

<i>biofuel:</i>	Fuel created using biomass.
<i>biomass:</i>	An energy source that consists of biological and organic materials.
<i>conservation of energy:</i>	A physical law stating that energy can neither be created nor destroyed.
<i>energy:</i>	The ability of an object to do work.
<i>energy transfer:</i>	The process through which energy is converted from one form to another.
<i>geothermal energy:</i>	Energy generated from the radioactive decay of particles found in the Earth's core.
<i>hydro energy:</i>	Energy generated from the movement or falling of water.
<i>joule:</i>	The unit of measure for energy and work. Equal to 1 N-m or 1 kg*m <sup>2</sup> /s <sup>2</sup> .
<i>kinetic energy:</i>	An object's energy due to its motion.
<i>non-renewable energy source:</i>	An energy source that is not replenished in a short period of time.
<i>photovoltaic cells:</i>	Circuits that convert the sun's light directly into electricity.
<i>potential energy:</i>	The energy stored in an object based on its position.
<i>power:</i>	The rate at which an object does work.
<i>renewable energy:</i>	Energy derived from a renewable source.
<i>renewable energy source:</i>	An energy source that is replenished naturally in a short period of time.
<i>solar energy:</i>	Energy that is generated from the sun's light.
<i>watt:</i>	The unit of measure for power. Equal to 1 joule/sec.
<i>wind energy:</i>	Energy generated from the blowing of the wind.
<i>work:</i>	The mechanical transfer of energy from one object to another.

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