What Powers the Earth?

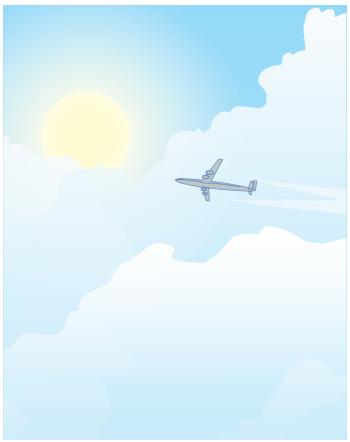
Energy and Solar Power

Energy is all around us. Nothing can happen without the presence of energy. Life needs energy, as do our machines, and computers. The Earth needs energy to circulate water and heat in weather cycles. Our sun in one way or another, directly or indirectly, powers these and other examples of energy in our lives.

Energy is simply the ability to do work. Work might include moving a mass or heating an object. Energy comes in two forms called kinetic and potential. Kinetic energy is the energy of moving things. Potential energy is energy waiting to be released – the energy an object has due to its position within a field like gravity or magnetism. The chemical energy in a battery, or energy stored in a compressed spring or a stretched rubber band are examples of potential energy. They can be released and turned into kinetic energy. Energy can be exchanged, but it cannot be created or destroyed. Energy can be concentrated and made more useful, or made so diffuse that it is unusable.

The human body gets its energy from chemical potential energy extracted from our food. All animals get energy by taking it from plants and other animals. Plants make chemical energy by harvesting energy from the sun. Plants are solar powered which makes you solar powered.

Energy can be measured in watts. A watt is a small unit of power roughly equal to the amount of energy needed to lift an apple 3 feet off the ground. How much energy do we use every day?



A human body consumes about 100 watts while resting – 10 times less than a toaster at about 1000 watts or 1 kilowatt. A house uses much more energy, around 6 to 15 kilowatts. Cars range from 40 to 200 kilowatts. Large ships need around 50 million watts or 50 megawatts. Jet planes need enormous amounts of power like 200 megawatts or more which is a little less than small electric power plants. Large electric power plants need over a thousand megawatts or 1 gigawatt of power. The largest power plants make over 10 gigawatts. All of human technological civilization requires about 16 trillion watts! These are continuous power requirements. At any given moment you need to supply 1000 watts to a toaster. If the toaster is left on for half an hour it uses 500 watt hours of power. Left on for an hour and you would have used 1000 watt hours of power or 1 kilowatt hour.

Using all that power costs a lot of money, and generating and storing that much energy is difficult and can be dangerous. The easiest way to reduce the harm caused by our appetite for energy is to use less. This can be done by buying more energy efficient products, turning off appliances when not in use, and turning thermostats lower in the winter and higher in the summer. We can also choose to use different sources of energy.

Most of energy used today is made by burning fossil fuels. Fossil fuels are the stored fossilized remains of ancient plant energy (which is just stored solar energy) exposed to heat and pressure. Fossil fuels include oil, coal, and natural gas. The energy is used in trains, planes and other moving machines. The heat is used in homes and businesses and is used to boil water into steam at power plants. The steam builds up pressure which is used to spin generators and make electricity. These electrical power facilities are complex and expensive, but the cost is managed by building huge centralized power stations that distribute the energy over high voltage lines to surrounding communities. Fossil fuels are relatively cheap since externalities are not included – this means costs that are a result of fossil fuels but not included in the price such as health impacts, climate change and habitat loss. Fossil fuels can also be stored cheaply. Unfortunately extracting these fuels has devastating effects on the local environment and the burning of fossil fuels pollutes the atmosphere and changes the climate.

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Biomass is energy from plants that have not fossilized. Wood, biodiesel oils, and corn ethanol are examples of biomass energy. Biomass can be burned to run engines, heat buildings and make steam for electricity generation and can be stored like fossil fuels. However, growing and harvesting biofuels has an impact on the environment, and carbon dioxide is released by the vehicles used on the farm to grow the plants and by the factories that produce artificial fertilizers.

Nuclear energy is not related to the sun at all. It is the energy released by the break up or combination of subatomic particles into atoms. Nuclear energy is used to make heat and steam electricity. It can be stored and is nonpolluting under most circumstances. However it can be incredibly damaging and harmful if radioactive fuel or waste is released into the environment. The sun itself is powered by nuclear energy being released in its core.

Hydropower is the kinetic energy in moving water. Water falling from high to low elevations can be used to spin a generator and make electricity. At one time it was also used to power machines directly. Hydropower is nonpolluting but can degrade rivers and destroy habitats. The sun powers the water cycle by heating the surface of the Earth leading to evaporation. Warm moist air at the surface is less dense than cold air so warm air rises until it cools, the water vapor condenses, and the water falls back to Earth. Rain collects in low lying areas turning into rivers which drain back to the sea.

Geothermal is the heat energy stored within the Earth. Miles below the surface, rocks are hot enough to make steam for heat and pressure for generators. The constant temperature of the soil a few feet below the surface can be used to heat or cool individual homes. This is a nonpolluting, reliable low impact power source. However it can be expensive to install due to the need to dig deep wells.

Wind power is the kinetic energy in moving air. Air moving from areas of high pressure to areas of low pressure create powerful winds that can be used to spin blades and make electricity – an energy source that is nonpolluting with minimal impact on the environment. The largest wind turbines can make up to 7 megawatts. Unfortunately wind as an energy source is unreliable and can't be stored easily. This energy source is ultimately powered by the sun because the sun heats the atmosphere unevenly, creating areas of warm, low density air, and areas of cold, high density air which generates wind as the air moves from high to low density areas.

Solar power can be an energy source in two main ways: through the capture of the heat energy in sunlight, or through conversion directly into electricity. The energy of the sun can be captured with lenses and mirrors and concentrated enough to heat buildings or even make steam pressure for electricity. Solar thermal can heat homes easily with inexpensive pipes on the roof and the heat can be easily stored. Solar energy can also be converted directly into electricity with photovoltaics (PV) as solar panels. Solar PV is low impact and becoming cheaper every day. While it is difficult to store the electrical energy produced by these panels, as a small scale distributed source of power it is one of the most cost effective.

Almost all other sources of energy are derived from the sun, solar is just the most direct way to use the sun's power. Each source of power has its own strengths and weaknesses. The safest, most reliable way to power human civilization will involve using a combination of different renewable, sustainable sources together.

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Name:_____

Energy is required to perform any kind of work. Moving machines, heating an oven, breathing and even thinking are just a few of the things that require energy. Sources of energy exist all around us and yet it comes in only two main forms: kinetic energy and potential energy. Kinetic energy is the energy possessed by a moving object like a spinning top or a falling stone. Potential energy is the stored energy of an object due to the object's position relative to others. A heavy object held in the air has gravitational potential energy. A battery has potential energy stored in chemical bond molecules inside it.

1. Circle examples of Kinetic energy. Underline examples of Potential energy.

A compressed spring

Coal burned in a stove

The spinning of our planet

A stretched rubber band

A falling rain drop

A ship coasting after the engines have stopped

A calorie rich food eaten by an animal

Vibrations in atoms that we feel as heat

Human civilization uses a lot of energy. Much of this energy comes from burning fossil fuels which are the fossilized remains of plants that have been under heat and pressure in the Earth's crust for over hundreds of millions of years. Plants capture energy from the sun and use it to make sugar molecules that store a lot of energy. Fossil fuels are concentrated forms of this very old plant energy. When we burn them we release pollutants like sulfur, mercury, soot, and carbon dioxide. Fossil fuels are nonrenewable sources of energy, meaning once they are burned they are gone.

2. Which sentence describes where the energy contained in fossil fuels came from?

____ As the remains of plants were buried and fossilized, the pressure of the rock around them squeezed energy into them.

____The heat of the sun became trapped in the leaves of plants. The heat from inside the Earth gave the plants even more energy as they fossilized.

____The energy in sunlight was used to make the sugar molecules in plants. These ancient plants were fossilized and exposed to heat and pressure, concentrating the energy over millions of years.

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Fossil fuels, and nuclear power from radioactive materials like uranium, are nonrenewable. Renewable energy sources are ones that are replaced as fast as we use them and include: biomass, geothermal, hydropower, wind, and solar. Biomass is energy from plant tissues that is burned for energy. Geothermal is the heat energy that comes from the hot interior of the Earth. Hydropower is the energy that we can capture from moving water. Wind power is energy captured from moving air and solar power is energy captured from sunlight.

3. Circle renewable energy sources, underline nonrenewable energy sources.

Sustainably harvested firewood

Coal mines

Natural Gas wells

Water from a hot spring

Oil wells

Solar electric panels

Sails on a windy day

Uranium deposits

Except for deep geothermal power, most of the renewable sources of energy are actually a kind of solar energy. Sunlight provides the energy that plants use to make sugar molecules that we use for biomass or fossil fuels. Sunlight also provides the energy to our atmosphere that leads to rain and hydropower. Sunlight heats the Earth in ways that generate wind. And of course sunlight is used directly in solar panels and solar water heaters. Sunlight can power the world, in fact it already does!

4. Which energy sources are not related to the sun at all.

____Wind

____Shallow Geothermal

____Nuclear

____Hydro

____Deep Geothermal

____Biomass

____Fossil fuels

5. Why are fossil fuels not considered a form of renewable energy? _____

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