Potential vs. Kinetic Energy Packet

Introduction to Energy

What Is Energy?

Energy does things for us. It moves cars along the road and boats on the water. It bakes a cake in the oven and keeps ice frozen in the freezer. It plays our favorite songs and lights our homes at night. Energy helps our bodies grow and our minds think. Energy is a changing, doing, moving, working thing.

Energy is defined as the ability to produce change or do work, and that work can be divided into several main tasks we easily recognize:

- Energy produces light.
- Energy produces heat.
- Energy produces motion.
- Energy produces sound.
- Energy produces growth.
- Energy powers technology.

Forms of Energy

There are many forms of energy, but they all fall into two categories–potential or kinetic.

POTENTIAL ENERGY

Potential energy is stored energy and the energy of position, or gravitational potential energy. There are several forms of potential energy, including:

- **Chemical energy** is energy stored in the bonds of **atoms** and **molecules**. It is the energy that holds these particles together. Foods we eat, biomass, petroleum, natural gas, and propane are examples of stored chemical energy.

  During photosynthesis, sunlight gives plants the energy they need to build complex chemical compounds. When these compounds are later broken down, the stored chemical energy is released as heat, light, motion, and sound.

- **Elastic energy** is energy stored in objects by the application of a force. Compressed springs and stretched rubber bands are examples of elastic energy.

- **Nuclear energy** is energy stored in the nucleus of an atom—the energy that binds the nucleus together. The energy can be released when the nuclei are combined or split apart. Nuclear power plants split the nuclei of uranium atoms in a process called **fission**. The sun combines the nuclei of hydrogen atoms into helium atoms in a process called **fusion**. In both fission and fusion, mass is converted into energy, according to Einstein's Theory, $E = mc^2$.

- **Gravitational potential energy** is the energy of position or place. A rock resting at the top of a hill contains gravitational potential energy because of its position. Hydropower, such as water in a reservoir behind a dam, is an example of gravitational potential energy.

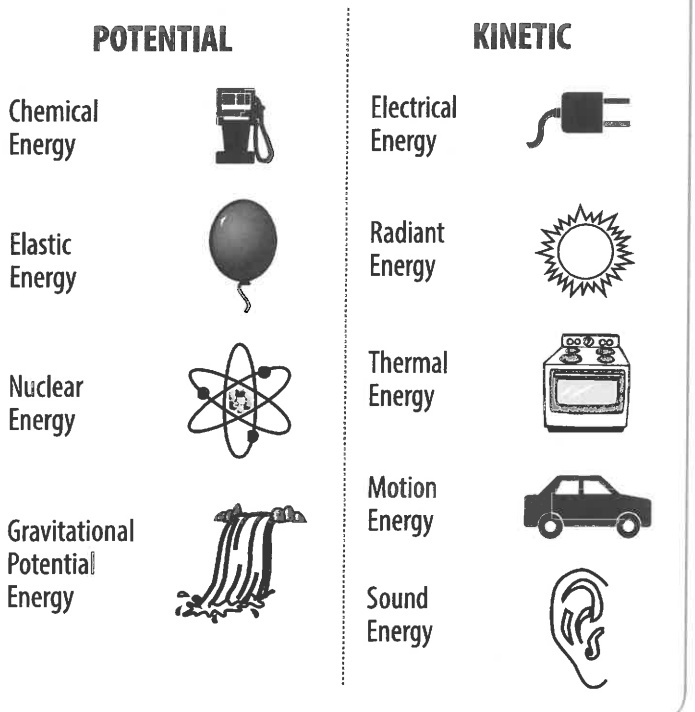
Energy at a Glance, 2016

	2015	2016
World Population	7,245,299,845	7,442,136,000
U.S. Population	321,418,820	323,127,573
World Energy Production	546.7 Q*	
U.S. Energy Production	88.024 Q	84.226 Q
• Renewables	9.466 Q	10.181 Q
• Nonrenewables	78.558 Q	74.045 Q
World Energy Consumption	542.49 Q*	
U.S. Energy Consumption	97.344 Q	97.410 Q
• Renewables	9.450 Q	10.113 Q
• Nonrenewables	87.667 Q	87.111 Q

Q = Quad (10^{15} Btu), see Measuring Energy on page 8.
* 2016 world energy figures not available at time of print.
Data: Energy Information Administration

**Totals may not equal sum of parts due to rounding of figures by EIA.

Forms of Energy



KINETIC ENERGY

Kinetic energy is motion—the motion of waves, **electrons**, atoms, molecules, substances, and objects.

- **Electrical energy** is the movement of electrons. Everything is made of tiny particles called atoms. Atoms are made of even smaller particles called electrons, protons, and neutrons. Applying a force can make some of the electrons move. Electrons moving through a wire are called **electricity**. Lightning is another example of electrical energy.
- **Radiant energy** is **electromagnetic** energy that travels in transverse waves. Radiant energy includes visible light, x-rays, gamma rays, and radio waves. Solar energy is an example of radiant energy.
- **Thermal energy**, which is often described as heat, is the internal energy in substances—the vibration and movement of atoms and molecules within substances. The faster molecules and atoms vibrate and move within a substance, the more energy they possess and the hotter they become. Geothermal energy is an example of thermal energy.
- **Motion energy** or mechanical energy is the movement of objects and substances from one place to another. According to **Newton's Laws of Motion**, objects and substances move when an unbalanced force is applied. Wind is an example of motion energy.
- **Sound energy** is the movement of energy through substances in longitudinal (compression/rarefaction) waves. Sound is produced when a force causes an object or substance to vibrate. The energy is transferred through the substance in a wave.

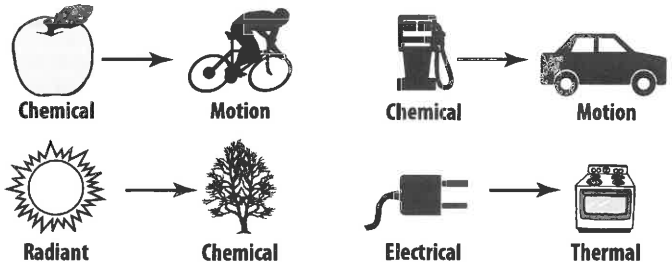
Conservation of Energy

Your parents may tell you to conserve energy. "Turn off the lights," they say. But to scientists, conservation of energy means something quite different. The **Law of Conservation of Energy** says energy is neither created nor destroyed.

When we use energy, we do not use it completely—we just change its form. That's really what we mean when we say we are using energy. We change one form of energy into another. A car engine burns gasoline, converting the chemical energy in the gasoline into motion energy that makes the car move. Old-fashioned windmills changed the kinetic energy of the wind into motion energy to grind grain. Solar cells change radiant energy into electrical energy.

Energy can change form, but the total quantity of energy in the universe remains the same. The only exception to this law is when a small amount of matter is converted into energy during nuclear fusion and fission.

Energy Transformations



Efficiency

Energy efficiency is the amount of useful energy you can get out of a system. In theory, a 100 percent energy efficient machine would change all of the energy put in it into useful work. Converting one form of energy into another form always involves a loss of usable energy, usually in the form of thermal energy.

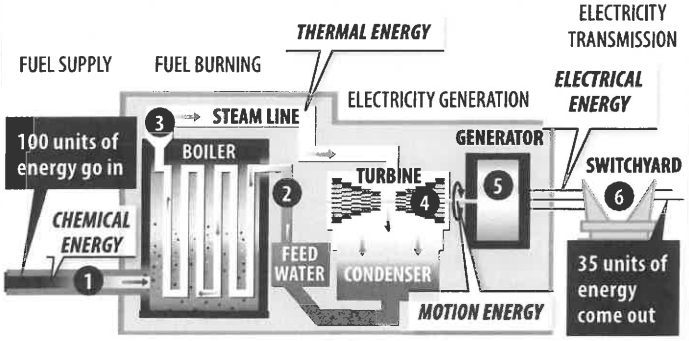
In fact, most energy transformations are not very efficient. The human body is no exception. Your body is like a machine, and the fuel for your "machine" is food. Food gives us the energy to move, breathe, and think. Your body is very inefficient at converting food into useful work. Most of the energy in your body is released as thermal energy.

A traditional incandescent light bulb isn't efficient either. This type of light bulb converts only ten percent of the electrical energy into light and the rest (90 percent) is converted into thermal energy. That's why these light bulbs are so hot to the touch. Their inefficiency is also why these bulbs are no longer sold for use in homes, and why many consumers use LEDs and CFLs for lighting.

Most electric **power plants** that use steam to spin turbines are about 35 percent efficient. Thus, it takes three units of fuel to make one unit of electricity. Most of the other energy is lost as waste heat. This heat dissipates into the environment where we can no longer use it as a practical source of energy.

Efficiency of a Thermal Power Plant

Most thermal power plants are about 35 percent efficient. Of the 100 units of energy that go into a plant, 65 units are lost as one form of energy is converted to other forms. The remaining 35 units of energy leave the plant to do usable work.

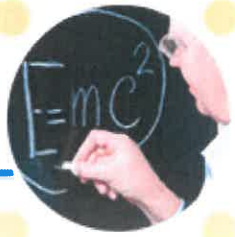


Fuel Sources

How a Thermal Power Plant Works

1. Fuel is fed into a boiler, where it is burned (except for uranium which is fissioned, not burned) to release thermal energy.
2. Water is piped into the boiler and heated, turning it into steam.
3. The steam travels at high pressure through a steam line.
4. The high pressure steam turns a turbine, which spins a shaft.
5. Inside the generator, the shaft spins a ring of magnets inside coils of copper wire. This creates an electric field, producing electricity.
6. Electricity is sent to a switchyard, where a transformer increases the voltage, allowing it to travel through the electric grid.

What Is Energy? *Explained*



Basics

Energy is the ability to do work

Energy comes in different forms:

- Heat (thermal)
- Light (radiant)
- Motion (kinetic)
- Electrical
- Chemical
- Nuclear energy
- Gravitational

People use energy for everything from walking to sending astronauts into space.

There are two types of energy:

- Stored (potential) energy
- Working (kinetic) energy

For example, the food a person eats contains chemical energy, and a person's body stores this energy until he or she uses it as kinetic energy during work or play.

Energy sources can be categorized as renewable or nonrenewable

When people use electricity in their homes, the electrical power is probably generated by burning coal or natural gas, by a nuclear reaction, or by a hydroelectric plant on a river, to name just a few sources. When people fill up a car's gasoline tank, the energy source is petroleum (gasoline) refined from crude oil and may include fuel ethanol made by growing and processing corn. Coal, natural gas, nuclear, hydropower, petroleum, and ethanol are called energy sources.

Energy sources are divided into two groups:

- Renewable (an energy source that can be easily replenished)
- Nonrenewable (an energy source that cannot be easily replenished)

Renewable and nonrenewable energy sources can be used as primary energy sources to produce useful energy such as heat or used to produce secondary energy sources such as electricity.

Renewable energy

There are five main renewable energy sources:

- Solar energy from the sun
- Geothermal energy from heat inside the earth
- Wind energy
- Biomass from plants
- Hydropower from flowing water

Nonrenewable energy

What is Energy?

Definition: A measurable quantity of heat, work or light

Types of Potential Energy

- Chemical
- Elastic
- Gravitational
- Nuclear

Types of Kinetic Energy

- Thermal
- Mechanical
- Electrical
- Magnetic

WISE
Workforce Instructions for Standards and Efficiency

Forms of Energy

All forms of energy fall under two categories:

POTENTIAL

Stored energy and the energy of position (gravitational).

CHEMICAL ENERGY is the energy stored in the bonds of atoms and molecules. Gasoline and a piece of pizza are examples.

NUCLEAR ENERGY is the energy stored in the nucleus of an atom – the energy that holds the nucleus together. The energy in the nucleus of a plutonium atom is an example.

ELASTIC ENERGY is energy stored in objects by the application of force. Compressed springs and stretched rubber bands are examples.

GRAVITATIONAL POTENTIAL ENERGY is the energy of place or position. A child at the top of a slide is an example.

KINETIC

The motion of waves, electrons, atoms, molecules, and substances.

RADIANT ENERGY is electromagnetic energy that travels in transverse waves. Light and x-rays are examples.

THERMAL ENERGY or heat is the internal energy in substances – the vibration or movement of atoms and molecules in substances. The heat from a fire is an example.

MOTION is the movement of a substance from one place to another. Wind and moving water are examples.

SOUND is the movement of energy through substances in longitudinal waves. Echoes and music are examples.

ELECTRICAL ENERGY is the movement of electrons. Lightning and electricity are examples.

Forms and Sources of Energy

In the United States we use a variety of resources to meet our energy needs. Use the information below to analyze how each energy source is stored and delivered.

1 Using the information from the *Forms of Energy* chart, and the graphic below, determine how energy is stored or delivered in each of the sources of energy. Remember, if the source of energy must be burned, the energy is stored as chemical energy.

NONRENEWABLE		RENEWABLE	
Petroleum	_____	Biomass	_____
Coal	_____	Hydropower	_____
Natural Gas	_____	Wind	_____
Uranium	_____	Solar	_____
Propane	_____	Geothermal	_____

2 Look at the U.S. Energy Consumption by Source graphic below and calculate the percentage of the nation's energy use that each form of energy provides.

What percentage of the nation's energy is provided by each form of energy?

Chemical ☐
Nuclear ☐
Motion ☐
Thermal _____
Radiant _____

What percentage of the nation's energy is provided by nonrenewables? _____

by renewables? _____

U.S. Energy Consumption by Source, 2013

NONRENEWABLE

PETROLEUM 35.2%
Uses: transportation, manufacturing

NATURAL GAS 26.6%
Uses: heating, manufacturing, electricity

COAL 18.5%
Uses: electricity, manufacturing

URANIUM 8.5%
Uses: electricity

PROPANE 1.7%
Uses: heating, manufacturing

RENEWABLE

BIOMASS 4.7%
Uses: heating, electricity, transportation

HYDROPOWER 2.6%
Uses: electricity

WIND 1.6%
Uses: electricity

SOLAR 0.3%
Uses: heating, electricity

GEOTHERMAL 0.2%
Uses: heating, electricity

*Total does not add to 100% due to independent rounding.
Data: Energy Information Administration