

Energy

Energy: 'en-ər-jě (noun), 1599

(a) the capacity for doing work

(b) usable power (as heat or electricity); also, the resources for producing such power

What is energy?

Energy is what allows us to move, to think, to grow. Every living thing, from the tiniest microbe to the largest mammal needs energy in order to survive. Living creatures get their energy from food. Non-living things need energy too; your computer and television get their energy from electricity, your car and skidoo from gas. In fact, everything which produces heat or moves needs energy.

If you go to school without eating breakfast, how do you feel by the middle of the morning?

The biggest animals need energy...



so do the smallest,



Defining energy is a little tricky. We can't see energy, but we can sometimes measure it. In fact, for scientists and engineers, energy is the measurable ability to do work. By using math, they can figure out how much energy it takes for a roller coaster to make it all the way around its track, or for a supply ship to travel from the south to northern communities.



Conservation of energy

More important than measuring energy is understanding that energy cannot be created or destroyed. Energy can be changed from one form of energy to another, like when the movement of water becomes electricity. It can also be moved from one object to another, like when one pool ball hits another. But, no matter how it changes or moves, in the end, we always have the same amount of energy. Scientists and engineers (and science teachers) call this phenomenon, conservation of energy. It means that all the energy we use today was here at the very beginning of time. So energy, like everything else, is a gift from the Creator which we need to use with respect and care.

*We can't create energy, but we sure use a lot of it.
Where does all the energy we use come from?*

Forms of energy

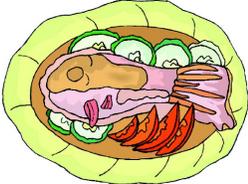
Light is a form of energy, so is sound. Energy can take many different forms.

Can you name any forms of energy?

Scientists and engineers classify all the forms of energy into two main groups - potential energy and kinetic energy.

Potential energy:

Potential energy is energy that isn't being used yet. It is stored energy. It is also the energy of position, sometimes called gravitational energy. There are different types of potential energy. They include:



Chemical energy

Chemical energy is stored in the bonds between atoms and molecules. When these bonds are broken they release energy as heat, light, motion and sound. Coal, oil and propane have stored chemical energy, so does food.

Stored mechanical energy

Stored mechanical energy is found in objects that want to bounce back into their natural shape when they are stretched or squished. There is stored mechanical energy in a drawn guitar string and in a compressed spring.



Nuclear energy

Nuclear energy is the energy which holds together the nucleus of an atom. It is released when atoms are split open (fission) or smashed together (fusion).

Gravitational energy

Gravitational energy is the energy stored in an object because of where it is placed. A roller coaster at the top of its rails has gravitational energy, so does water held behind in a dam's reservoir.



Kinetic energy:

Kinetic energy is energy which is being used. It is the energy of motion. It includes:



Electrical energy

Electrical energy is caused by the movement of electrons. Lightning is electrical energy, so is the electricity which comes into our houses.

Radiant energy

Radiant energy is energy that comes from the waves of the electromagnetic spectrum. Light is a type of radiant energy, so are x-rays.



Thermal energy

Thermal energy is heat. Heat is caused by the movement of atoms and molecules within a substance.

Motion energy

Motion energy is energy caused by objects or substances that are moving. Tides have motion energy, so does the wind.



Energy transformations

Energy can't be created or destroyed, but it can be changed or transformed from one form to another. For instance:

- the chemical potential energy stored in gasoline becomes thermal and motion kinetic energy when it is used by a car or truck.
- the radiant kinetic energy of the sun becomes potential chemical energy when it is photosynthesized by plants.

Can you identify the missing forms of energy in the energy transformation below?

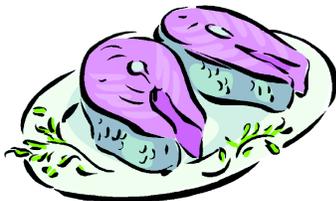


Electrical energy from the plug

is transformed into



_____ energy in the oven.

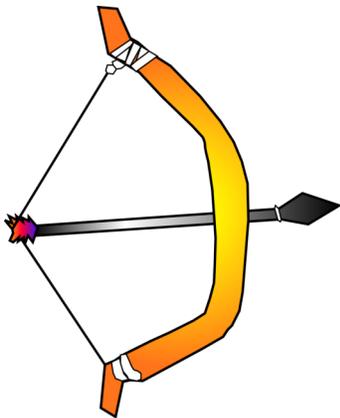


_____ energy from the fish

is transformed into



motion energy when you push your skateboard.



Stored mechanical energy from the bow

is transformed into



_____ energy when the arrow is released.

Energy chains

Because energy cannot be created or destroyed it is never transformed just once. Energy is transformed from one type to another to another and so on. When we follow these transformations we get an energy chain.

You can build energy chains for just about anything. The energy chain on this page shows how you get to school in the morning.

Why do you think orange juice is sometimes called liquid sunshine?

1. Radiant energy from the sun is transformed into chemical energy by the leaves of an orange tree.



2. This chemical energy is used to grow oranges which also store chemical energy.



3. Some one picks the oranges and makes orange juice with them. The orange juice contains all the chemical energy of the orange.



4. You drink the orange juice. The chemical energy from the orange becomes chemical energy in your body. You realize that because you took the time to drink the orange juice you are late for school.



5. You use the chemical energy from the orange juice as motion energy as you run to get to class. Some of the chemical energy is also transformed into heat, because you sweat as you run to school.



Eventually most energy transforms into either heat or light. While this energy still exists, it spreads out into the environment and is difficult to access.

Energy resources

Everyday we use energy to power lights, run cars, heat buildings and cook food. If you have been camping or hunting out on the land you know that you use energy even when you are away from your community. You have batteries in your flash light, radio or cell phone, you make a fire for cooking and warmth, you use gasoline to power a 4x4 or boat.

How different would your life be without easy access to energy?



Even though we use lots of energy everyday, it comes from very few sources. In Canada about 70% of the energy we use comes from fossil fuels (oil, natural gas and coal), world wide 85% of the energy used is obtained from fossil fuels. That's a problem because our reliance on fossil fuels can't last forever.

Do you know why?

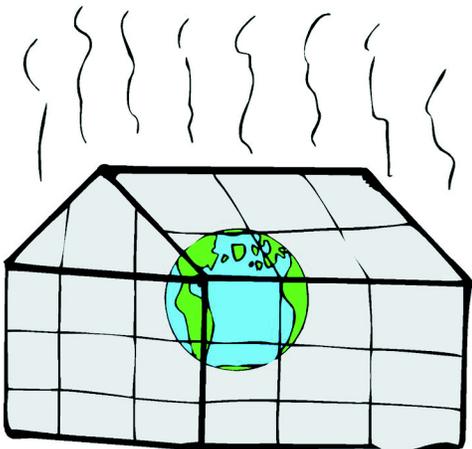
Nonrenewable energy sources

Fossil fuels are found underneath the Earth.

Why do you think they are called fossil fuels?

Fossil fuels are made from the decayed remains of plants and animals which became buried under the Earth. Over millions and millions of years, they were subjected to pressure and heat caused by earth movements and chemically changed into oil, natural gas and coal.

Fossil fuels are non-renewable resources. So is nuclear energy. Nonrenewable resources are those that cannot be replaced as they are used, and we are using up our stores of fossil fuels very quickly. This means that more and more we have to look for alternate, renewable sources of energy.



There's another reason for us to be looking for alternatives to fossil fuels. The main element in oil, coal and gas is carbon. The chemical reaction which takes place when we burn fossil fuels - by driving snow mobiles or heating our homes - releases carbon compounds such as carbon monoxide and carbon dioxide into the air. Carbon dioxide is one of the greenhouse gases which scientists believe is contributing to climate change on earth. Over the last 250 years the amount of carbon dioxide in the atmosphere has increased by 31%. As far as we can tell, the earth's atmosphere is now holding more carbon dioxide than it has at anytime in the past 420,000 years! Some scientists think the amount of carbon dioxide may be the highest it has been in 20 million years!

Do you know what event marked the beginning of this increase?

Renewable energy resources

Renewable energy sources are those which do not diminish over time or can be replaced in a relatively short amount of time. Some renewable energy sources emit carbon dioxide and other greenhouse gases, but for the most part they are less damaging to the atmosphere than fossil fuels.

Can you name any renewable energy sources?

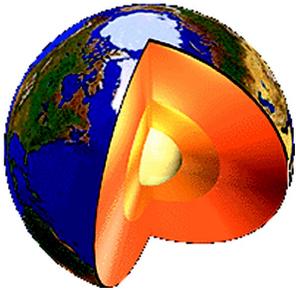
Biomass: Biomass energy is the energy source first used by humans. It includes things like wood, animal waste and seaweed. Biomass is essentially any organic matter that can be used to generate energy. There are four main groups of biomass energy sources.

Wood: Wood, wood chips and waste products from the lumber industry can be burned or used to produce electricity.

Solid waste: In many parts of the world animal waste is what people use to cook their food and warm their homes.

Garbage/landfill: Decaying garbage produces methane gas which can be used for heating or producing electricity.

Plants: Plants like corn and wheat are full of sugars and starches which can be fermented to produce ethanol. Ethanol can be mixed with regular gasoline to make cleaner burning fuels for cars.



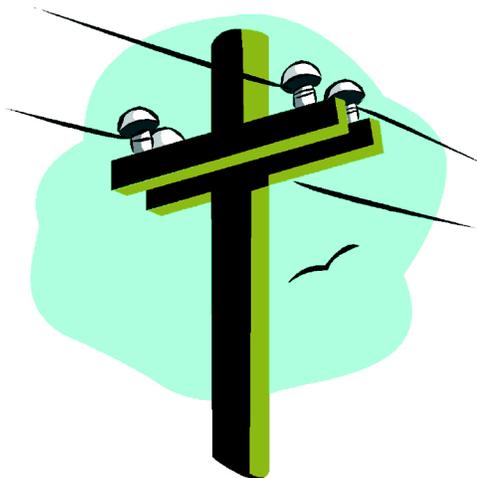
Geothermal energy: Geothermal energy is heat energy obtained from below the Earth's surface.

Solar energy: Solar energy is radiation energy produced by the sun. We can harness solar energy by using photovoltaic cells which transform solar energy into electricity.

Water energy: We get energy from water by harnessing the power of its movement. The movement of rivers, waves and tides can all be used to generate electricity.



Wind energy: Much like water, the power of the wind can be used to produce electricity. Harnessing wind power requires large areas full of windmills.



Electricity

A few renewable sources, like wood and animal waste, can be burned directly for heating and cooking, but most are used to produce electricity.

Is electricity a renewable or non-renewable energy source?

Electricity is neither renewable or non-renewable. It can only be generated through the transformation of other energy sources. Sometimes it is produced by non-renewable sources like coal or uranium (nuclear energy), and sometimes it is produced by renewable sources like water, wind or geothermal energy. Because electricity can only be produced through the transformation of other energy sources it is called a secondary source of energy.

Balancing energy needs with community needs

Canada is the world's largest producer of hydroelectricity - electricity generated by the power of water. Most power is produced by reservoir and dam systems in remote areas of northern Quebec, Manitoba and BC, areas where many Aboriginal people live. Canada also has one of only two tidal hydroelectricity plants in the world. It is found in the Bay of Fundy in Nova Scotia. The Bay of Fundy has the highest tides found on earth.

In order to make hydroelectric dams work well, rivers are often diverted to provide more water to reservoirs and large areas of land may be flooded. These activities have impacts on people, animals and the land. Animal habitats and migration routes are changed. Soil is eroded and lost. Forested areas are clear cut for transmission lines. Plants which rot under water increase mercury levels all the way up the food chain.

Harnessing energy of any kind has impacts on communities, plants, animals and the earth. Aboriginal communities are often on or close to areas with high concentrations of energy resources. Harnessing these resources therefore impacts Native people and towns in very concrete ways. This is one of the reasons Aboriginal communities need engineers who can help make decisions that balance the need for energy with the needs of the community and the Earth.



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Connecting to Math

1. You work for the local band council in the finance department. Your council has been looking at how much the people in your community pay for electricity compared with people in the rest of Canada. You have the information in Table 1. The band council has asked you to make a presentation which includes the following information:

a) A graph which shows how the price the people in your community pay for electricity compares with prices in other cities.

b) A table which shows how much more or less electricity costs in your community compared with other cities. The differences should be shown in cents and as percentages.

What do you present to the band council?

Table 1

City, Province	Residential electricity price cents/kilowatt-hour (¢/kWh)
Yellowknife, NT	49.30
Iqaluit, NU	37.12
Halifax, NS	10.96
Toronto, ON	10.38
Your community	10.26
Whitehorse, YK	10.16
St. John's, NF	9.95
Regina, SK	9.75
Ottawa, ON	8.09
Calgary, AB	7.27
Montreal, QC	7.27
Winnipeg, MB	7.56
Vancouver, BC	6.96

Table 2

Energy source	1997 Production petajoules
Hydro	1255
Tidal	0.1
Biomass	1066.5
Earth Energy Systems	1.5
Geothermal	0.003
Wind	1.2
Solar	0.21

Source: Natural Resources Canada
Energy in Canada 2000

2. Your class is studying renewable energy. Your teacher tells you that in 1997, more than 2000 petajoules of energy were produced by renewable energy sources in Canada. (1 petajoule = 1×10^{15} joules.) She shows you Table 2, a list of the sources and amounts of renewable energy. Then she asks the class to...

a) ...make a pie chart which shows how much of the total renewable energy was produced by each source.

b) "The pie chart may be a little hard to draw," she says, "some of the quantities are really small." You tell her the quantities only look small because 0.003 petajoules is 3,000,000,000,000 joules. She smiles and says you are right.

"But the quantities will still be hard to fit on the pie chart, because pie charts show how big one thing is in relation to all the other things we're looking at." She then asks the class how it would be easier to show the small quantities on the pie chart. What do you tell her?

c) Once everyone draws a pie chart, your teacher then tells you that renewable energy accounts for less than 20% of energy consumption in Canada. So, she asks you to figure out the approximate amount of energy consumption for 1997, in petajoules.