1

ENERGY, SOCIETY AND CONSERVATION PRINCIPLES

OBJECTIVES

At the end of this topic, students should be able to:

- identify the sources of energy; distinguish between renewable and non-renewable sources of energy;
- identify the various ways energy is used;
- explain the importance of energy in the development of the society;
- explain the impact/effect of energy use on the environment;
- identify energy sources that are environmentally friendly and those that are hazardous to the environment.

Energy and society

Every community needs energy in one form or another. No community will develop without efficient use of energy. Using energy wisely should be a part of any society that wants to develop. It means instead of wasting energy, it should be conserved. The sources of usable energy such as petroleum, radioactive elements and natural gases can be changed to other forms of energy that can serve the community better. ***The law of energy conservation states that energy is always conserved although, it can change from one form to another form.*** This does not mean that the sources of energy in any community cannot finish. The total energy is conserved, but when the energy source is changed to other forms of energy not useful to the community, it is used up and may soon finish.

The sources of energy we use to work and develop our community can be divided into two types: **non-renewable** and **renewable energy sources.**

The non-renewable energy sources:

Non-renewable energy sources are the sources of energy that are not easily replaced or renewed by nature when they finish.

Examples of non-renewable energy sources are:

1.Fossil fuels: Examples of fossil fuels are coal, crude oil and gas. The energy stored in fossil fuels is the Sunâ€™s energy trapped by plants and animals that died millions of years ago. The chemical energy stored in these fuels can be converted to heat energy when they burn in air (oxygen).

2.Nuclear fuel: Examples of nuclear fuels are Uranium-235, Radium and other radioactive elements. These nuclides release large amount of energy when they undergo fission reaction. The heat energy released can be changed to other useful forms of energy.

Fossil and nuclear fuels, no matter the quantity buried under the earth, will not last forever; it will one day be exhausted. This is why we must look for alternative sources of energy.

The renewable energy sources

Renewable energy sources are the sources of energy that are constantly being replaced or renewed by nature. Firewood is a renewable energy source. The source of firewood is dead plants. We can easily replace firewood by planting more trees. Other examples of renewable energy sources are the Sun, wind power, waves and tides, water falling from a height like in a dam, rushing water like flood, geothermal and biomass. All these energy sources are naturally replaced daily therefore, they cannot be exhausted.

a)Biomass fuel: The materials derived from living things and used directly as fuel are called biomass fuel. These include wood, charcoal and biogas.

b)Wind power: Energy from winds can be used to generate electricity as in aerogenerator or windmill. The largest wind turbines in the world can generate up to 6MW of power.

c)The Sun (solar energy): Energy from the Sun can be used directly to dry food and clothes. Solar energy can be concentrated at a spot using curved mirrors or solar panels to produce steam, which can be used to generate electricity. Solar cells are designed to change solar energy directly to electricity as it is used in calculators and wristwatches.

d)Hydropower or energy of falling water: Water at the top of a mountain has potential energy. If allowed to fall, the potential energy is changed to kinetic energy, which can turn large turbines to produce electricity.

e)Wave and tidal power: The energy of tides and waves along the seaside can be tapped and used to turn large turbines to generate electricity.

f)Geothermal energy: Temperature of rocks buried underground in the earthâ€™s crust can rise up to 200Â°C depending on how deep they are. Cold water can be pumped down to the rocks to produce steam which can be used to produce electricity.

Three Gorges Dam in China is the largest hydroelectric power station in the world

Modern windmills or aerogenerators are designed to convert the energy of the wind into electricity

A house powered by solar panels, the energy from the Sun is converted directly into a usable form of energy

The energy of tidal waves like this can be used to generate electricity

Petroleum refineries convert crude oil into useful petroleum products

Forest like this is a source of firewood. Forest should be preserved to serve as a source of future fuel

Figure 1.1: Different sources of energy

Differences between renewable and non-renewable energy sources

S/n	Renewable energy sources	Non-renewable energy sources
1.	Renewable energy sources are constantly replaced by nature.	Non-renewable energy sources are not easily replaced by nature. It takes very long time to replace.
2.	Some renewable energy technologies do not pollute the environment in the same ways and therefore can help contribute to a cleaner energy future for the world.	Use of some non-renewable energy sources like fossil fuels and nuclear fuels release some substances which pollute the environment.

Forms and uses of energy

Energy exists in different forms. These forms include chemical, mechanical, electrical, sound, light, heat (thermal), solar and nuclear energies. All these forms of energy come from nuclear reaction going on at the core of the Sun. The Sun directly or indirectly, is the source of all energies on Earth.

Energy is used for heating, transportation, power production and operating many devices and appliances used at home, in schools and in industries.

Heating

Firewood, fossil fuels (coal, petroleum and gas), nuclear fuels (uranium and hydrogen), electricity and Sun (solar), all release energy in the form of heat. The energy from these sources is used to warm the surroundings. Firewood and fossil fuels burn in air (oxygen) to produce heat. The heat energy produced is used in cooking. Stoves, gas cookers and lamps transform chemical energy of fossil fuels to heat and light. Electricity supplied to our homes is converted to heat by appliances like electric iron, electric cookers and electric converter heater. Heating is an important use of energy.

Transportation

Vehicles, ships, trains and aeroplanes are all means of transportation. They need energy to transport goods and people from one place to another. Cars use petrol, lorries and trains use diesel while aeroplanes use refined kerosene as sources of energy to move them. When these fuels are burnt in the engines, the chemical energy stored in them is transformed to heat, which is also changed to motion.

Power production

The energy stored in fossil fuels, nuclear fuels and solar energy from the Sun can be changed to heat. The heat energy from these sources is used to heat water and convert it to steam. The steam power is used to rotate powerful turbines to generate electricity. Electricity is important in developing a society. Industries, homes and offices depend on electricity supply to carry out their works. Many devices and appliances used in our various homes need electricity to operate. Solar panels can change solar energy to heat while photovoltaic cells convert solar energy direct to electricity.

Photosynthesis

Plants convert solar energy to chemical energy. This conversion takes place in a chemical reaction called photosynthesis.

The effects of energy use in the environment

Burning fossil fuels (coal, oil and gas) and firewood release some gases, which pollute the environment. For example, burning 1 kg of coal will introduce about 4 kg of carbon (iv) oxide gas in the environment. Carbon (iv) oxide (CO_2) and other greenhouse gases cause global warming. Burning coal also releases sulphur (iv) oxide (SO_2) gas into the environment. Sulphur (iv) oxide (SO_2) and other acidic gases dissolve in rainwater to form acids. Acid rain destroys plants, buildings and kills fishes in ponds and lakes.

Friendly and hazardous energy sources

Sources of energy that do not pollute the environment are said to be friendly. These sources include renewable energy sources like the Sun (solar energy), wind power, wave and tidal power, hydropower and geothermal. Electricity used in our homes for cooking do not pollute the environment; therefore, it is a friendly source of energy. Sources like fossil fuels and firewood that release gases that pollute the environment are called hazardous energy sources. Although, electricity used in our homes is a clean source of energy but at the power station where it is produced, fossil fuels are burnt. Large volume of carbon (iv) oxide gas and gases that pollute the environment are released into the air. The process of producing electricity pollutes the environment. The more electricity you use the more the environment is polluted therefore you must save energy by switching off all appliances when you are not using electricity.

Changing energy to other forms

Two important facts about energy conversion are:

1. Energy must first exist in one of the forms listed above.
2. Converting energy to other forms involves either heating (energy conversion heats up the system or causes a rise in temperature) or working (causing something to

move).

1.**Converting chemical energy to heat and light**

The devices that convert chemical energy to heat and light are stoves, gas cooker, torch, firewood, etc.

Firewood

Firewood burns in air to convert chemical energy to heat and light energy

Gas cooker converts chemical energy of gas to heat and light energy

Figure 1.2 Conversion of chemical energy

2.**Converting electrical energy to mechanical energy**

The devices that convert electrical energy to mechanical energy are electric motors, blenders, electronic appliances like DVD player and recorder, turntable, electric fans, etc. Although, the major energy conversion in these appliances is electrical to mechanical, other energy transformations also occur. For example, electric motor, apart from converting electrical to mechanical energies also produces heat and sound energies.

Blender converts electrical energy to mechanical, heat and sound energies

Electric ceiling fan

Electric motors and fans convert electrical energy to mechanical, heat and sound energies

Figure 1.3 : Conversion of electrical energy

3.**Converting mechanical energy to electrical energy**

Two forms of mechanical energy are potential and kinetic energies. The potential energy of water at the top of the dam is changed to kinetic energy as it falls. The kinetic energy of falling water (mechanical energy) is used to turn turbines to produce electrical energy. Turbines or generators convert mechanical energy to electrical energy.

4.**Conversion of sound energy to electrical energy and back to sound energy**

The device that convert sound energy to electrical energy and back to sound energy is telephone (both landline and mobile phones). Sound energy is picked up by the microphone and converted to electrical energy or electromagnetic waves in the case of mobile phones. Electrical energy is changed back to sound by the speaker at the earphone.

Telephones also called landline phones

Mobile phones popularly called GSM

Figure 1.4 : Conversion of sound energy

5.**Conversion of electrical energy to heat energy**

The devices that convert electrical energy to heat energy are electric stoves or hotplate, electric kettle or electric water boiler, electric pressing iron, etc. These devices have heating elements that convert electrical energy directly to heat energy

An electric pressing iron

Electric water boiler or electric water heater

6.**Conversion of electrical energy to light and sound**

The device that changes electrical energy to light and heat are televisions, DVD players and camcoder.

LCD television

DVD Player

Camcoder

Figure 1.6 : Conversion of electrical energy to light and sound

Other energy conversions
There are many different machines that convert one energy form into another:
Heat to electricity– (thermophotovoltaics, geothermal power, ocean thermal power)
Heat to mechanical energy (heat engines, such as the internal combustion engine used in cars, or the steam engine)
Gravitational potential energy to electricity (Hydroelectric dams)
Chemical energy to electricity (Fuel cells like batteries)
Nuclear energy to electricity (Nuclear reactor)
Light to electricity (Solar cells)
Mechanical energy to electricity (Wave power)
Wind energy to electricity or mechanical energy (Windmills)

Note that energy conversion is a complex process. In the examples above, we only list the major energy conversion. Other minor energy conversion also takes place. For example, the major energy conversion in a television is electrical to light and sound, however, heat energy is also produced.

Conservation of energy

When energy changes from one form to another form, total energy available at the beginning is the same as the total energy after the conversion. This is an important law in science. The law of conservation of energy states that the total energy of a system is always constant although, energy can change from one form to another form.

The effect of energy use on the environment

The use of energy can have adverse effect on the environment. Misuse of energy may lead to greenhouse effect and global warming. Spilling oil also can cause environment and water pollutions.

Greenhouse effect

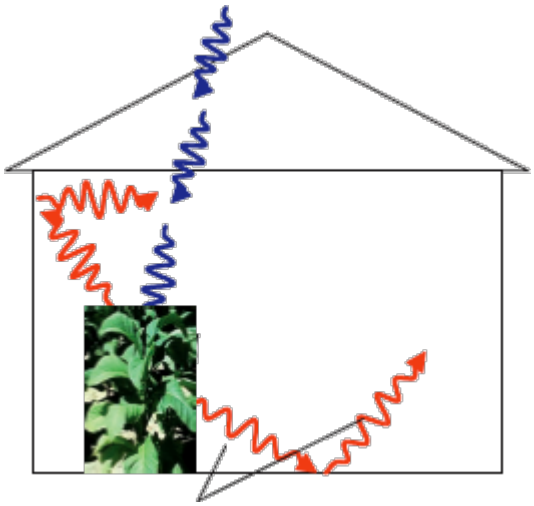
A greenhouse is a structure with glass walls and roof, designed to retain heat. The glass covers trap long wavelength infrared or heat radiations. Light and short wavelength infrared from the sun can pass through the glass in a greenhouse. These short wavelength radiations are absorbed by the soil and plants inside the greenhouse which in turn emits long wavelength infrared radiations which cannot escape from the greenhouse. The effect is that the temperature of the greenhouse rises. The greenhouse is therefore, a heat-trap, making the temperature inside to rise.

Figure 1.7 : A Solar greenhouse

Greenhouse gases

The earthâ€™s atmosphere contains gases. Some of these gases are water vapor, carbon (iv) oxide, methane, ozone, and nitrous oxide. They are called **â€œgreenhouse gases.â€** The greenhouse gases act like glasses in the earthâ€™s atmosphere allowing light and some short wavelength ultraviolet radiation from the Sun to pass through. The transmitted radiations are absorbed by the Earth, warming land, oceans, and atmosphere. The warmer Earth radiates long wavelength heat radiations. The greenhouse gases in our atmosphere act as glass trapping heat radiations like the glass walls of a greenhouse. This causes greenhouse effect raising the temperature in the environment slightly. The earthâ€™s â€œgreenhouse effectâ€ is what makes this planet suitable for life as we know it.

Light and short-wavelength U-V radiations penetrates the glass and are absorbed by plants



Long-wavelength infrared emissions from plants are reflected back increasing the temperature of the greenhouse.

Global warming

Global warming is the increase in the average measured temperature of the Earthâ€™s near-surface, air and oceans. Global surface temperature increased 0.74 Â± 0.18 Â°C in the past 100 years. This is sufficient to cause changes in the worldâ€™s climate. Scientists use temperature changes, patterns of precipitation and circulation of atmosphere to study global warming. Using their knowledge of these, scientists can predict how global warming will affect weather, glacial ice, sea levels, agriculture, wildlife, and human health. Weather forecast broadcast on T.V. and radio stations, is based on knowledge of global warming.

The effects of global warming

The warmer earth, as the result of the greenhouse effect will have the following effects:

1. Melting of ice at the polar regions and mountaintops. The effect of melting ice will cause oceans to expand and the overflowing water may cover islands and cities along the coastal areas.
2. Change in climate which may result to flooding in different parts of the world.
3. Animal and plant species at the cold polar regions will be in danger of extinction.
4. Storms will occur frequently because of global warming. Water will also evaporate more rapidly from the soil, causing it to dry out faster between rains.
5. Global warming of a few degrees may increase agricultural production, but not necessarily in the same places where crops are grown.
6. In a warmer world, scientists believe that more people will get sick or die from heat stress, not only due to hotter days, but more importantly, to warmer nights.
7. Diseases such as malaria will increase. Other tropical diseases may spread similarly, including dengue fever, yellow fever, and encephalitis.

Ozone, ozone layer and global warming

Ozone is an isotope of oxygen with three atoms in its molecule. The earthâ€™s atmosphere contains large quantity of ozone gas which forms what is known as the ozone layer. The ozone layer is important for life on earth as it absorbs harmful radiations from the sun like gamma rays,

X-rays and very short-wavelength ultraviolet radiations. These radiations can cause skin cancer and affect the growth of plants. Anything that destroys the ozone layer will affect life on earth. Recently, scientist alerted the world about the depletion of ozone layer and a hole in the ozone layer. Manâ€™s activities are also releasing some chemicals like aerosol and chlorofluorocarbons (CFCs). These chemicals which we use as insecticides and in refrigerators at the ground level are harmless but once they escape to the atmosphere, they quickly react with ultraviolet radiations released chlorine gas. Chlorine reacts with ozone to destroy ozone molecules in the upper atmosphere. This can break down, or deplete the ozone layer. Depletion of the ozone layer actually causes a slight cooling on earth and other harmful effects like increasing in skin cancer due to penetration of harmful radiations.

Other activities of man causing climatic changes include constant air travel, space exploration, bush burning, burning of fossil fuels in the industries, vehicles, motorcycles and deforestation (destruction of our forest by manâ€™s activities). These activities of man release gases into the earthâ€™s atmosphere causing climatic changes.

What you can do to control global warming

Two main causes of global warming are: (1) The burning of fossil fuels like oil, gas, and coal. The harmful gases released by these actions include carbon (II) oxide, methane, and nitrous oxides. (2) Deforestation or the destruction of the worldâ€™s forests. Our forests are fast being destroyed, leading to accumulation of carbon (iv) oxide in the atmosphere. You can do something today to help save the earth from destruction by:

Figure 1.8: Burning fossil fuels like this pollutes our environments

1.Saving our forests and replanting those trees that have been destroyed.
2.Cutting back on our use of fossil fuels, and
3.Making sure that when we burn fossil fuels, we take measures to prevent the gases listed above from escaping into the atmosphere.

Hazardous and friendly energies

Wood and fossil fuels (coal, oil and natural gas) are used for heating and lighting. They release carbon (II) oxide and other greenhouse gases into the atmosphere and also cause air pollution. These gases affect the environment adversely. Nuclear power plants do not release carbon (iv) oxide but produces harmful radioactive substances capable of destroying the environment. These energy sources are not friendly as their use release substances which have adverse effects on the environment.

Significant reductions in carbon (iv) oxide and radioactive emissions can be achieved by replacing fossils and nuclear fuel energy sources with friendly energy sources like solar power, wind power, hydropower, wave power and hydrogen fuel cells. Theses energy sources do not emit greenhouse gases. Other alternative friendly energy sources include fuels made from plants, such as biofuel made from vegetable oil and ethanol.

The effect of oil spills on the environment

Oil spill is a significant presence of large quantity or layers of crude or refined oil on soil or seawater.

Oil spill pollutes the environment (air, water and soil) and could lead to total destruction of the ecosystem, especially in the Niger Delta region of Nigeria where oil spill occurs constantly. Oil released on water spreads fast to other places polluting water, air and soil. The volatile component of oil evaporates and pollutes air while less volatile components dissolve in water to form emulsified water which affects aquatic life. Fish ponds are destroyed, fish eggs and larvae suffer high rate of mortality, including adult fish.

Oil spills degrade agricultural land and turn fertile land into wasteland. Oil spilled on the soil hinders proper soil aeration as oil film on the soil surface acts as a physical barrier between air and the soil.

Figure 1.9 : Oil spills destroys aquatic lives

Crops like pepper and tomatoes are affected due to blockage of stomata thereby inhibiting photosynthesis, transpiration and respiration. Oil spillage in Nigeria contaminates streams, lakes, underground water, oceans and leads to scarcity of potable drinking water.

Energy crisis

Energy crisis is a shortage or restricted access in the supply of energy. It is also rise in the cost of energy consumption because of insufficient supply of energy. It can be called energy shortage, oil or petroleum crisis or electricity shortage or crisis. Energy crisis occurs because our supply of energy is finite. The major source of energy in Nigeria is crude oil and natural gases. Another source of energy currently used in the interior is wood fuel obtained from plants. This energy sources are not renewable and will soon finish. Nigerias estimated reserve of natural gas reserve

is 124 trillion barrels, which would make it the nineth largest reserve in the world and oil reserve is estimated between 24 billion to 31.5 billion barrels. At the production rate of 2.2 million barrels per day (2002), Nigerian oil reserve may last only for 40 years. Pressure on the power sector means higher consumption of the limited oil and gas supply. Nigerian power production output is around 4 000 MW which in reality is very small. The electricity demand is close to 10 000 MW. Inadequate supply of electricity (electricity crisis) made many people and companies to supplement the electricity provided by the grid system with their own generators. This means more consumption of oil and gas and environmental pollution.

Our forests are fast being destroyed. Trees are cut down and burnt to produce energy for our homes. Using energy without replacing it and wasting it may lead to energy shortage in the future. We waste a lot of energy by not controlling the use of electricity in our homes and by indiscriminate use of fossil fuels.

Figure 1.10 : A solar panel like this can be a good source of energy in future

There is a need to look for an alternative energy for sustainable development before oil and gas are used up. Renewable energy sources are the solution to Nigeriaâ€™s energy crisis. The Energy Policy in Nigeria is to use other sources of energy to achieve stable energy supply by 2020.
The energy types include solar, biomass and wind and is expected that in the next 30 years, renewable energy sources will contribute at least 25 percent of the total energy requirements in Nigeria. We must learn the habit conserving energy by saving it. We can conserve energy by:

1. minimizing electricity consumption in our homes. Switch off when you are not using electricity at home.
2. stopping bush burning and deforestation,
3. not wasting gas and oil in our homes,
4. planting more trees to replace the ones cut down.

Summary

1. Greenhouse is a glass house with glass roof which allows light and short-wavelength radiations to enter the house but stops long-wavelength heat radiations from escaping which cause the temperature of the greenhouse to rise.

2. Global warming is the warming of the earthâ€™s environment because heat rays are trapped by the earthâ€™s atmosphere causing a slight rise in temperature. Gases that cause global warming are carbon (iv) oxide, water vapour, methane, nitrous oxide. They act like glass by stopping heat radiations from escaping from the earth.

3. Ozone layer absorbs harmful radiations from the Sun (gamma rays, X-rays and very short-wavelength ultraviolet radiations). These radiations can cause skin cancer and affects the growth of plants.

4. Spilling of oil destroys the environment and aquatic lives.

Questions

1. (a) Explain what is meant by greenhouse effect.
   (b) State three greenhouse gases and give two examples to show the activities of man to global warming.
   (c) Suggest two things you do to reduce the global warming.
2. (a) What is ozone layer? Explain why the ozone layer is important to living things on earth.
   (b) Name one chemical that can cause depletion of ozone layer.
3. (a) State two effects each of global warming and oil spillage on the environment.
   (b) What do you understand by *energy crisis?* Suggest two ways we can solve the energy crisis in the country.
4. (a) Explain why a person inside a car with windscreens rolled up feels hotter than a person outside.
   (b) What is meant by the term *â€œenergy friendlyâ€?* Give examples of energy sources that may be considered friendly to the environment.
5. (a) Name two energy sources that may be considered harmful to the environment.
   (b) State two ways man has contributed in the pollution of the environment.
   (c) Suggest ways to minimise environmental pollution.