NATIONAL OPEN UNIVERSITY OF NIGERIA

SCHOOL OF EDUCATION

COURSE CODE: SED 224

COURSE TITLE: ENERGY AND MATTER 1

COURSE GUIDE

SED 224
ENERGY AND MATTER I

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INTRODUCTION

SED 224 – This course ‘energy and matter’ will provide you with basic knowledge of the various forms of energy that can be generated from matter, and how these various forms of energy can be put to use.

WHAT YOU WILL LEARN FROM THIS COURSE

You will learn the definition of energy, how energy is measured, the energy cycle, the various sources of energy and their uses to man.

COURSE AIMS

The aim of this course is to provide you with the basic knowledge of the concept of energy and its importance to man.

COURSE OBJECTIVES

After doing a thorough study of the content of this course, you are expected to be able to among others:

- define energy;
- explain how energy is measured;
- list the various sources/forms of energy;
- explain how the various forms of energy are transformed from one form to another;
- describe the energy cycle;
- list the uses of the various forms of energy;
- write the energy equation;

WORKING THROUGH THE COURSE

In working through this course, you are expected to read the study units, and other relevant books and materials provided by the National Open University of Nigeria. Self assessment exercises are provided in the course and at certain points in the course, you are required to submit assignments for assessment purpose. This course is expected to last for a period of one semester after which there will be a final examination. The various components of the course are listed below. You are also provided with a guide on how you should allocate your time to each unit in order complete the course successfully and timely.

ASSIGNMENT FILE

There are thirteen (13) assignments in this course, covering all the units studied.
This file will be available at your study centre. You are expected to submit completed assignments in them. The marks you obtain for these assignments will count towards the final mark you obtain for this course. Further information on assignments will be found in the Assignment File itself and also in this Course Guide in the section on assessment.

THE COURSE MATERIALS

National Open University of Nigeria will provide you with the following:

The Course Guide
At the end of each unit, you also provided with list of books and other reference materials for further reading. Note that while you may not have access to all of them, it is important to strive to get some of them as supplements to the main course materials.

Tutor Marked Assignments are to be submitted at the appropriate time.

STUDY UNITS

The study units are:

Module 1 Energy: meaning, measurement and sources

Unit 1	Meaning of energy and matter
Unit 2	Measurement of energy
Unit 3	Physical sources of energy
Unit 4	Chemical sources of energy
Unit 5	Biological sources of energy
Unit 6	Gaseous sources of energy

Module 2 Energy Transformation and Consumption

Unit 1	Energy of the universe andEnergy cycle
Unit 2	Forms and uses of energy
Unit 3	Energy dissipation
Unit 4	Energy consumption
Unit 5	Energy equation

Module 1 presents the subject matter content in six units. This module focuses on the meaning, measurement and sources of energy.

Module 2 presents the subject matter content in 5 units focusing on Energy transformation and consumption.

ASSESSMENTS

Assessment is in three formats: self assessment exercises, tutor – marked assignments and the final examination. Be truthful to yourself in attending to the exercises. Ensure that you provide an in-depth information about the knowledge you have acquired in each unit. You are advised to adhere strictly to the deadlines indicated on your schedule in submitting your TMA.

TUTOR-MARKED ASSIGNMENT

Attempt all TMAs provided in this course. Ensure you consult widely on the subject matter content of this course. This will give you a wider knowledge of the course while at the same time provides you with a deeper understanding of the content. This will transform into a better performance in the examination. Ensure you meet up with all the deadlines for submission of assignments. In the event that you are unable to complete any work on time, contact your tutor before the deadline for the submission of the assignment to discuss the possibility of a concession. Except in exceptional circumstances, extensions may not be granted after the deadline.

FINAL EXAMINATION AND GRADING

The final examination carries 60% of the total mark. It will assess all areas covered in the course. The questions will normally follow the pattern of the self-testing, practice exercise and tutor marked assignments even though they may not necessarily be repeated.
You are advised to review your self assessment exercises, tutor marked assignments and comments on them before the examination.

COURSE MARKING SCHEME

All submitted works will count for 40% of your total course mark while the final examination will count for 60%.

HOW TO GET THE MOST FROM THIS COURSE

Distance learning students are assumed to be matured individuals who have the ability to organize themselves. You need to really plan your schedule to give room for adequate time for study within the scope of your daily engagements. Assign specific periods of your days for study.

Ensure that you go through the materials at your own pace but be mindful of deadlines.

Each of the study units follows a common format. You have the introduction to the subject matter of the unit, followed by a set of learning objectives. These objectives let you know what you should be able to do by the time you have completed the unit. The objectives are useful guides to the study.

When you have completed a unit, be sure you have achieved the objectives of that unit.

The following is a practical strategy for working through the course: Read this course guide thoroughly.

- Organize a study schedule. Refer to the 'Course Overview' for more details. Note the time you are expected to spend on each unit and how the assignments relate to the units. Important information, e.g. details of your tutorials, and the date of the first day of the semester, is available from the WebCT OLE. You need to gather together all this information in one place, such as your diary or a wall calendar. Whatever method you choose to use, you should decide on and write in your own dates for working on each unit.
- Once you have created your own study schedule, do everything you can to stick to it. The major reason for students' failure is that they get behind with their course work. If you get into difficulties with your schedule, please let your tutor know before it is too late for help.
- Turn to Unit I and read the introduction and the objectives for the unit.
- Assemble the study materials. Information about what you need for a unit is given in the 'Overview' at the beginning of each unit. You will almost always need both the study unit you are working on and one of your set books on your desk at the same time.
- Work through the unit. The content of the unit itself has been arranged to provide a sequence for you to follow. As you work through the unit you will be instructed to read sections from your set books or other articles. Use the unit to guide your reading.
- Keep an eye on the WebCT OLE. Up-to-date course information will be continuously posted here.
- Well before the relevant due dates (about 4 weeks before due dates), access the Assignment File on the WebCT OLE and download your next required assignment. Keep in mind that you will learn a lot by doing the assignments carefully. They have been designed to help you meet the objectives of the course and,

therefore, will help you pass the exam. Submit all assignments not later than the due date.

- Review the objectives for each study unit to confirm that you have achieved them. If you feel unsure about any of the objectives, review the study material or consult your tutor.
- When you are confident that you have achieved a unit's objectives, you can then start on the next unit. Proceed unit by unit through the course and try to pace your study so that you keep yourself on schedule.
- When you have submitted an assignment to the tutor for marking, do not wait for its return before starting on the next unit. Keep to your schedule. When the assignment is returned, pay particular attention to your tutor's comments, both on the tutor-marked assignment firm and also written on the assignment. Consult your tutor as soon as possible if you have any questions or problems.
- After completing the last unit, review the course and prepare yourself for the final examination. Check that you have achieved the unit objectives (listed at the beginning of each unit) and thecourse objectives (listed in this Course Guide).

TUTOR AND TUTORIALS

There will be specific time made available for tutorial sessions, in support of this course. You will be notified of the dates, time and location of these tutorials, together with the name and phone number of your tutor, as soon as you are allocated a tutorial group.

Your tutor will mark and comment on your assignments, keep a close watch on your progress and on any difficulties you might encounter and provide assistance to you during the course. You must mail your tutor marked assignments to your tutor well before the due date. They will be marked by your tutor and returned to you as soon as possible.

Do not hesitate to contact your tutor by telephone, e-mail or your discussion group (board) if you need help.

The following might be circumstances in which you would find help necessary. Contact your tutor if:

You do not understand any part of the study unit or the assigned readings.

You have difficulty with the self – tests or exercises.
You have a question or problem with an assignment, with your tutor’s comments on an assignment or with the grading of an assignment.

You should try your best to attend the tutorials. This is the only chance to have face-to-face contact with your tutor and to ask questions which are answered instantly. You can raise any problem encountered in the course of your study. To gain the maximum benefit from course tutorials, prepare a question list before attending them. You will learn a lot from participating in discussions actively.

SUMMARY

This course is designed to give to you some understanding of the concept of energy and matter that is required of you to be able to adequately teach the topic to students particularly within the framework of Basic Science. You should acquire the basic knowledge of the various forms of energy and their importance to man. A deeper understanding of the usefulness of energy to man and an appreciation of the beauty of nature.

We, therefore, sincerely wish you the best and that you enjoy the course.

MAIN CONTENT

CONTENTS **PAGES**

MODULE 1 ENERGY: MEANING, MEASUREMENT AND SOURCES

UNIT 1 MEANING OF ENERGY AND MATTER

CONTENTS

1.0 INTRODUCTION

One of the major challenges facing the human race is inadequate energy supply. Apart from the fact that energy (from food) is required for the proper functioning of our body system, we also require energy to live comfortable and decent life. Energy is needed to light up our homes, offices and streets, to power transportation engines, and to operate domestic electrical and electronic appliances. In fact, a substantial amount of our daily income is spent on procuring energy. However, energy is readily available in our environment. It is naturally available in various forms but we need to have a sound knowledge of its existence in matter for us to be able to make good use of it.

2.0 OBJECTIVES

At the end of this unit, you should to be able to:

- Define energy
- Define matter
- Explain the relationship between energy and matter

3.0 MAIN CONTENT

3.1 Energy- meaning of energy and matter

Energy could be defined as the property of matter that can be converted to work, heat or radiation. Energy can be utilized to move things or do work, produce heat. It can be converted to light and radiation. Energy is commonly defined as the ability to do work. Work often involves movement and energy is involved in moving things around.

Figure 1: little child swinging

Potential energy is energy stored in an object. Chemical, mechanical, nuclear, gravitational, and electrical are all stored energy. Kinetic energy does the work. Light, heat, motion, and sound are examples of kinetic energy.

For example, stretching a rubber band gives it the potential to fly. The tension created from the stretching is potential mechanical energy. When the rubber band is released, it flies through the air using motion (kinetic energy). The process of changing energy from one form into another is called energy transformation. The rubber band is transformed from potential energy into kinetic energy.

Anything that we can touch, see or sense is made up of matter. A piece of stone, a log of wood, a pencil, a biro, water, even the air we breathe, are all examples of matter. Matter is anything that has mass and occupies space. Hence there are two parts to matter. It must occupy space and it must have mass. The amount of space an object occupies is normally measured by volume. You can think of the volume unit in terms of how big something is. For instance, compare the size of an elephant with that of a dog.Mass is a measure of the amount of matter in an object. This is not the same as the size of the matter expressed as the volume. The unit for mass is grams. Mass differs from weight, even though we, incorrectly, use them interchangeably. When we talk of weight we talk of the gravitational pull exerted on an object.

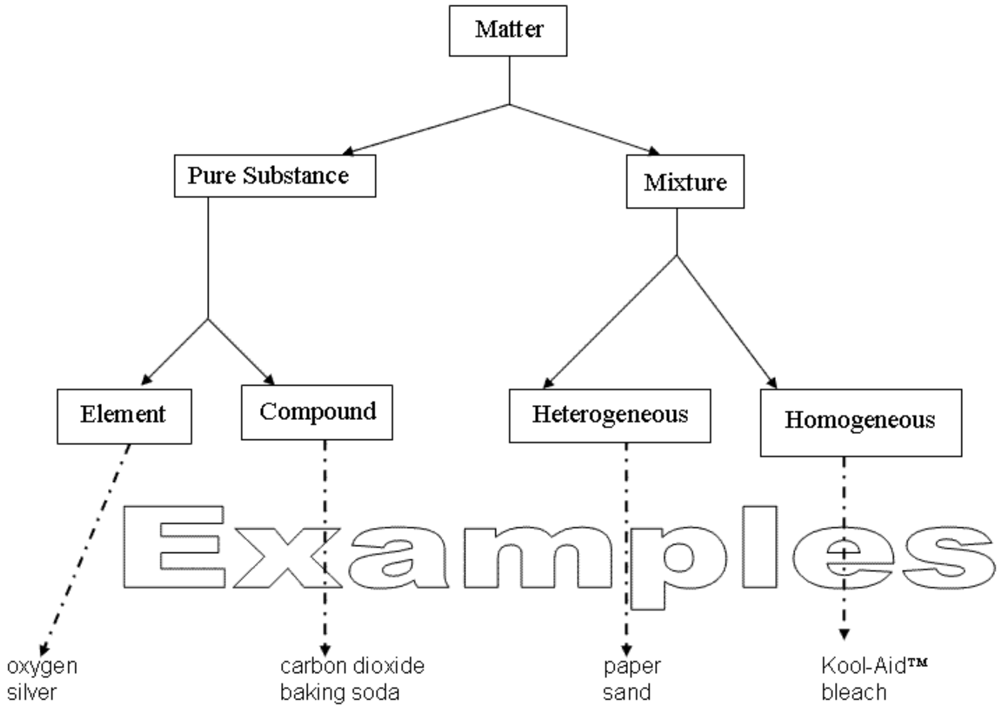

Figure 2: Classification of matter

3. 2 Relationshipbetween Energy and Matter

Even though energy is not the same as matter, the two are closely related. The fundamental relationship between energy and matter is the fact that all forms of energy are generated by changes in matter. Energy resides in matter. For instance, the human body is matter and it has energy residing in it. This is the energy we use to work and engage in our daily activities. Energy.

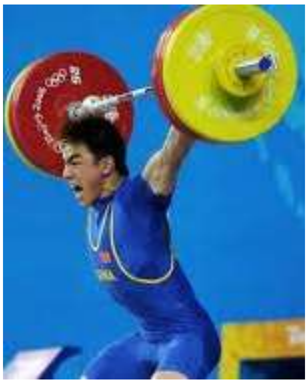

Figure 3: A weight lifter

Similarly, when wood is burnt, the energy in the wood is liberated and we can use this energy for cooking.
Matter is also converted into energy in nuclear reactors and nuclear bombs. Matter contains energy and energy makes its presence felt through matter. However, some forms of energy (e.g. light and radiant energy) can exist without contact with matter.

Figure 4: Burning firewood

4.0 CONCLUSION

Energy and matter are not the same but they are closely related. All forms of energy are generated by changes in matter.

5.0 SUMMARY

In this unit, we have learnt that:

- energy is the ability to do work.
- mater is anything that has mass and occupies a space.
- All forms of energy are generated by changes in matter.
- Energy in the stored form is called ***potential energy***, while energy in motion is called ***kinetic energy***

6.0 TUTOR-MARKED ASSIGNMENT

1. Give some examples of matter and how the potential energy in them can be transformed into kinetic energy.

7.0 REFERENCES/FURTHER READING

Zitzewitz, P. W. (1999): Principles and problems. Columbus OH: Glencoe/McGraw-Hill

Nelkon, M., &Parkeer, P. (1995). Advanced Level Physics (7th edition). Oxford: Heinemann Publishers.

UNIT 2 MEASUREMENT OF ENERGY

CONTENTS

1.0 INTRODUCTION

In the previous unit, you have learnt that energy could be stored. Energy can be produced and saved for later use. Energy is also a commodity and is available for sale. Just like any other commodity, energy can be quantified and priced. In this unit, you will learn the various ways in which energy is measured.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- List the various units of measuring energy
- Convert energy values from one unit to another

3.0 MAIN CONTENT

In the previous section, we developed the concept of energy. We now must be able to measure and quantify it, using a standard set of units. Worldwide, two systems of units of measurement are commonly used today: the Metric System (Systeme International) and the British System.

The units of energy described in these systems are derived from a technical definition of energy used by physicists. This definition suggests that energy can be represented by the following simple equation:

Work = Force x Distance

Workhas been defined as a force applied to some form of matter (object) multiplied by the distance that this object travels. Physicists commonly describe force with a unit of measurement known as a ***Newton*** (named after a famous physicist, Sir Isaac Newton). A Newton is equal to the force needed to move a mass weighting one kilogram one meter in one second within a vacuum with no friction. The work or energy required to move an object with the force of one Newton over a distance of one meter is called a ***Joule***.

Some other definitions for the energy measurement units are as follows:
Calorie- equals the amount of heat required to raise 1 gram of pure water from 14.5 to 15.5° **Celsius at standard atmospheric pressure**. 1 calorie is equal to 4.1855 joules. The abbreviation for calorie is cal. A kilocalorie, abbreviated kcal, is equal to a 1000 calories. 1 kilocalorie is equal to 4185 joules.

Btu - also called **British thermal unit** is the amount of energy required to raise the temperature of one pound of water one degree **Fahrenheit**.
Watt (**W/m**^{2} or **Wm**$^{-2}$) **-** a metric unit of measurement of the intensity of **radiation** in watts over a square meter surface. One watt is equal to one **joule** of work per second. A kilowatt (**kW**) is the same as 1000 watts.
Table 1 presents table different units for measuring energy, their definitions and conversions

Table 1: Units of energy

Unit	Definition	Used In	Equivalent to
British Thermal Unit BTU	A unit of energy equal to the amount of energy needed to raise the temperature of one pound of water by one degree Fahrenheit. It could be likened to the energy found in the tip of a match stick.	Heating and Cooling industries	1 BTU = 1055 Joules (J)
Calorie or small calorie (calorie)	The amount of energy needed to raise the temperature of one gram of water by one degree Centigrade (Celsius).	Science and Engineering	1 calorie = 0.003969 BTUs
Food Calorie, Kilocalorie or large calorie (Cal, kcal, Calorie)	The amount of energy needed to raise the temperature of one kilogram of water one degree Celsius. The food calorie is often used when measuring the energy content of food.	Nutrition	1 Cal = 1000 cal, 4,187 J or 3.969 BTUs

Joule (J)	It is a smaller quantity of energy than calorie and much smaller than a BTU.	Science and Engineering	1 Joule = 0.2388 calories and 0.0009481 BTUs
Kilowatt Hour (kWh)	An amount of energy from the steady production or consumption of one kilowatt of power for a period of one hour.	Electrical fields	1 kWh = 3,413 BTUs or 3,600,000 J
Therm	A unit describing the energy contained in natural gas.	Home heating appliances	1 therm = 100,000 BTUs

BTUs are often written in base 10 raised to a particular exponent. For example:

10,000 BTUs = 10^4 BTUs or 1 x 10^4 BTUs
50,000 BTUs = 5 x 10^4 BTUs
9,000,000 BTUs = 9 x 10^6 BTUs

4.0 CONCLUSION

Energy can be measured using several units. The units can be converted from one type to another and each type of unit is preferred by different fields of science.

5.0 SUMMARY

In this unit, we have learnt:

- The various units for measuring energy
- The relative values of these units and
- How the values of these units could be converted to other units

6.0 TUTOR MARKED ASSIGNMENT

Convert each of the following energy values to Joules

i. 450 BTUs
ii. 750 Calories
iii. 450 therms
iv. 670 kWh
v. 525 therms

7.0 REFERENCES/FURTHER READING

Pidwirny, M. (2006)."Measurement of Energy".*Fundamentals of PhysicalGeography*, *2nd Edition*.http://www.physicalgeography.net/fundamentals/6b.html

UNIT 3 PHYSICAL SOURCES OF ENERGY

CONTENTS

1.0 INTRODUCTION

Energy is available in physical, chemical, and biological forms. Three forms of physical energy: coal, hydroelectric and wind are discussed in this unit. He three forms of energy involve using physical quantities to generate energy.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- List three main sources of physical energy.
- Describe Coal as a source of physical energy
- Describe hydroelectric power as a source of physical energy.
- Describe wind as a source of physical energy

3.0 Main Content

Many sources of physical energy are used to provide humans with modern day conveniences such as light, heat, cooling and recreation. The demand for energy increases as the population of the earth increases. As many of the non-renewable resources of the earth deplete, there is an increasing demand for new and more efficient renewable resources for the production of energy.

Coal

Coal is one of the largest sources of physical energy in the world. More than one billion tons of coal is converted into energy per year within the United States, and more than two billion tons per year in China. Coal, a fossil-fuel, is turned into electric energy when it is burned at very high temperatures to boil water for steam. The steam spins a turbine which in turn operates a spinning generator. The generator distributes electricity into the power grid. It is important to know that coal is an efficient but not a particularly environmentally friendly source of energy.

Hydroelectric Power

Hydroelectricity is electricity generated by hydropower, i.e., the production of power through use of the gravitational force of falling or flowing water. It is the most widely used form of renewable energy. Hydroelectric power, also known as hydropower, is the use of water for the creation of electric energy. This source is considered a cleaner form of physical energy than fossil fuels because the power plants that produce hydroelectric power do not contribute greenhouse gases. Hydroelectric power is also inexpensive to produce as opposed to energy sources that come from non-renewable elements like coal. Typically, the water used to generate hydroelectric power is stored in reservoirs at a high elevation, with flow controlled by a man-made dam. The water flows quickly through a turbine which spins a generator that produces the electric energy. In spite of the merits of hydroelectric energy is in terms of efficiency and cleanliness, it alters the natural systems of rivers and adversely affects animals and plant life.

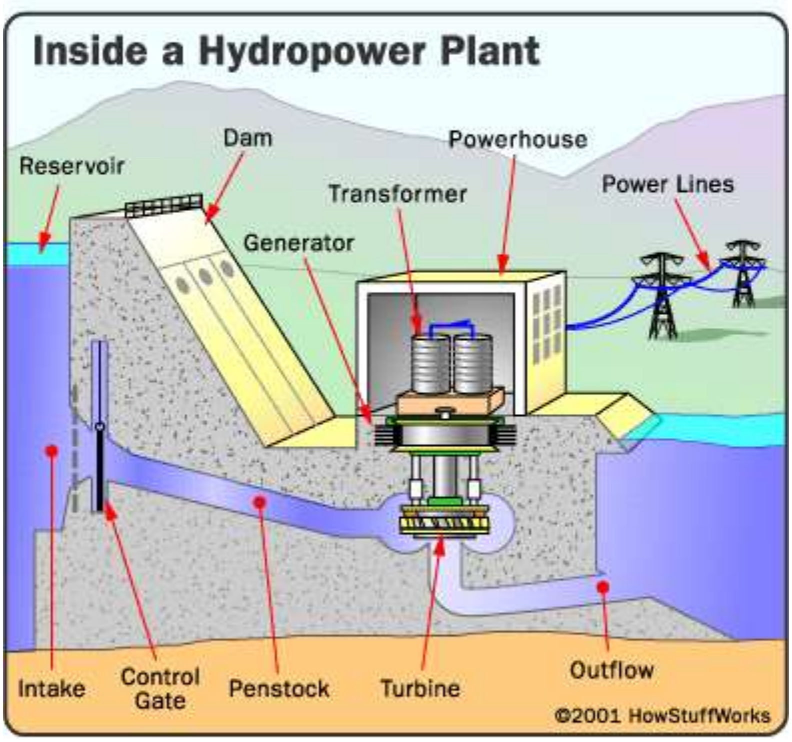

Figure 5: A typical hydropower plant

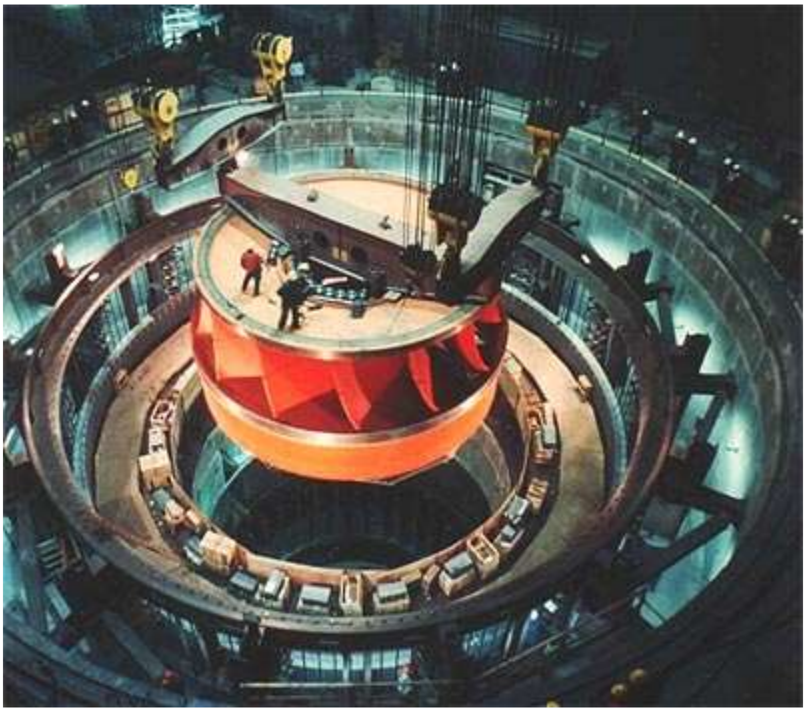

Figure 6: A hydroturbine

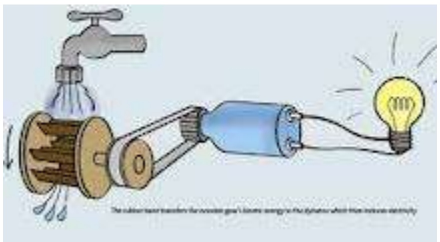

Figure 7: A waterwheel

Wind Energy

The energy generated by wind is normally converted into electrical energy using a wind mill/ turbine. Wind energy converted into electrical energy is a clean alternative to other energy sources such as nuclear power and fossil fuels. This source is environmentally friendly, as wind does not deplete supplies of any natural resources of the earth. A wind turbine is erected high to catch as much wind as possible. Wind turns a turbine, which is connected to magnetic generators to produce electricity. The electricity is then sent to the power grid.Wind power is clean, yet it is not the most efficient source of energy because the amount of wind cannot be controlled nor predicted. Choosing a source or a combination of sources of energy is often dependent on the environment of a given area.

Figure 8: A wind mill/turbine

Technologies are continually being developed and enhanced to improve energy sources. Not all energies are ready for mass consumption. To choose an appropriate energy source to use for a particular purposes, the following questions are advised:

- Is it a renewable or nonrenewable source?
- What are the capital and setup costs?
- What are the ongoing operating costs?
- What size of energy storage is required?
- How efficient is it to produce one unit of energy?
- Can it be produced on a large scale?
- What is the cost to the consumer?
- What impact will it have on the environment?

4.0 CONCLUSION

Coal, hydroelectric power and wind are physical sources of energy.

5.0 SUMMARY

In this unit, we have learnt that:

- Coal, hydroelectric power and wind are physical sources of energy
- Coal is one of the largest sources of physical energy in the world
- Coal is an efficient but not a particularly environmentally friendly source of energy.
- Hydroelectric power, also known as hydropower, is the use of water for the creation of electric energy.

- The energy generated by wind is normally converted into electrical energy using a wind mill/ turbine

6.0 TUTOR-MARKED ASSIGNMENT

Mention three locations in Nigeria where each of coal and hydropower are generated.

7.0 REFERENCES/FURTHER READING

Smith, D.Sources of physical energy.http://ehow.com/m/info_8221481_three-physical-sources-energy.html

UNIT 4 Chemical sources of energy

CONTENTS

1.0 Introduction

Chemical energy can be described as energy stored in the bonds between atoms in molecules. Chemical energy is embedded in certain chemicals that have the capability of undergoing combustion. When these chemicals burn, they generate heat.

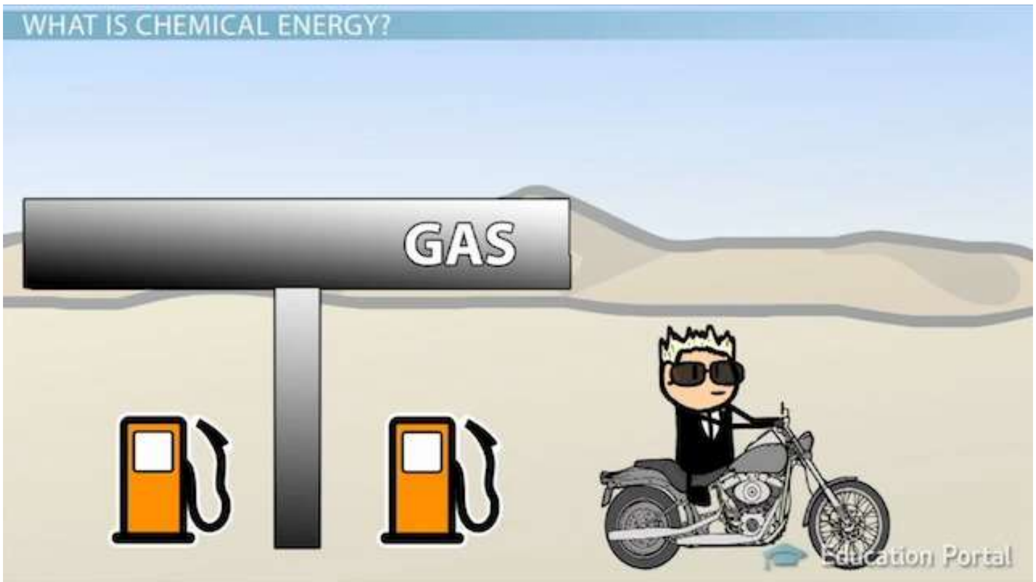

Figure 9: A gas filing station

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- Describe chemical energy.
- List examples of chemicals in which chemical energy is embedded.
- Describe how solar energy is converted to chemical energy in plants and animals.

3.0 MAIN CONTENT

A lot of energy used by man at home in forms of chemical energy. They are so referred because the energy is embedded within chemicals. These chemicals are normally called fuels. Fuels are used by burning them. They include wood, natural gas, gasoline, kerosene, diesel, coal etc. When these fuels are burnt, heat energy is liberated in a process called combustion. Some chemicals contain a great deal of energy that can be released all at once. These chemicals are called explosives. When some chemicals burn, they release a huge amount of energy at once. This leads to explosion. This can be observed when gasoline is burnt in a fairly enclosed container. The same thing happens when dynamite explodes. A combustible chemical possesses potential energy when it is not burning. However, when it burns, this potential energy is converted to kinetic energy.

The glucose (blood sugar) in the human body is said to have chemical energy because the glucose releases energy when chemically reacted (combusted) with oxygen during aerobic respiration in the muscles. The muscles use this energy to generate heat and mechanical force which manifests as shivering when we are cold.

Chemical energy is naturally present in crude oil from which several fuels could be isolated. Solar (radiant) energy is also converted to chemical energy during photosynthesis in green plants. Green plants take in radiant energy from sunlight. This solar energy is stored in carbohydrates produced by the plant. The stored energy in these carbohydrates is released when these compounds break down into simpler compounds when we eat and digest green plants. The energy produced from the metabolic processes in our body is used for our daily activities. Thus chemical energy in us is converted to mechanical energy.

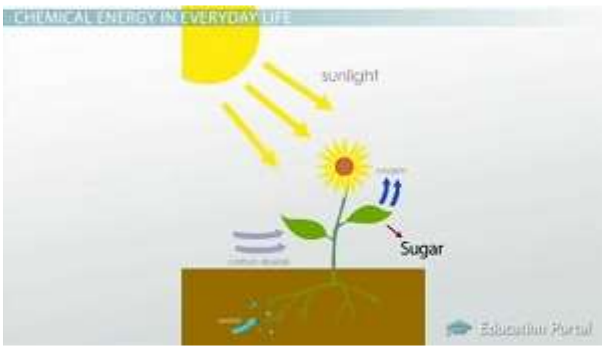

Figure 10: Photosynthesis

4.0 CONCLUSION

Chemical energy is the energy stored in the bonds between atoms in molecules. It is embedded in certain chemicals that have the capability of undergoing combustion. Combustible chemicals possess potential energy when they are not burning. When they burn, this potential energy is converted to kinetic energy.

5.0 SUMMARY

In this unit, we have:
1. Described chemical energy.
2. Given examples of chemicals in which chemical energy is embedded.
3. Described how solar energy is converted to chemical energy in plants and animals.

6.0 TUTOR-MARKED ASSIGNMENT

i. Give 5 examples of devises in which chemical energy is converted to mechanical energy.
ii. Described how solar energy is converted to chemical energy in plants.

7.0 REFERENCES/FURTHER READING

Chemical energy: http://education-portal.com/academy/lesson/what-is-chemical-energy-definition-examples.html

UNIT 5 BIOLOGICAL SOURCES OF ENERGY

CONTENTS

1.0 INTRODUCTION

Biological energy is the form of energy that is produced in **living organisms** when they use their metabolic capacities to transform other forms of energies into energy yielding molecules like hydrogen, methane, alcohols, ammonia and bioplastics. The reactions that lead to the production of these energy yielding chemicals are collectively referred to as *metabolism*.

2.0 OBJECTIVES

at the end of this unit, you should be able to:

- Explain what is meant by biological energy.
- How biological energy reduces the emissions of greenhouse which are toxic to the environment.
- The reasons for exploring biological energy.
- The various processes through which biological energy could be generated.

3.0 MAIN CONTENT

Biological energy is sustainable technology. Biological energy technology provides environmentally friendly alternatives to some industrial processes, thus reducing the emissions of greenhouse which are toxic to the environment. Industrial processes generate CO, CO_2 and other dangerous gases which contribute to global warming. The need to explore biological energy has been hinged on many reasons:

- Economic –It is anticipated that the world will eventually run out of crude oil which is a major source of energy.
- Political –Not all nations of the world are naturally endowed with crude oil, hence they rely on imports. If biological energy is

advanced, such nations will depend less on foreign imports of energy.

- National security - Famine induced instability in countries relying on nuclear energy because such countries face economic sanctions from super powers.
- Moral - people will starve/die as a result of the effects of global warming which results from the impacts of combustion.

Biological energy can be generated through:

a. Photosynthesis
b. Conversion of Biomass wastes into energy
c. Fuel production through microalgal CO_2 fixation

Biological energy comes from solar energy. Photosynthesis is a process through which green plants manufacture their food (carbohydrates) from carbon(IV) oxide and water in the presence of sunlight and chlorophyll. It is simply represented by the equation:

$6CO_2 + 6H_2O$ + light and chlorophyll $\rightarrow C_6H_{12}O_6 + 6O_2$

For every mole of CO_2 fixed during photosynthesis, approximately 114 kilocalories of free energy are stored in plant biomass. Photosynthesis occurs both in the terrestrial and aquatic habitats, hence, both terrestrial and aquatic plants could be used for biomassbiomass energy production.

One of the most serious environmental problems today is that of global warming, caused primarily by the heavy use of fossil fuels. The CO_2 generated by this process could potentially be recovered with relative ease through the use of established technologies like chemical absorption.

Photosynthetic microalgae could be potentiallyutilized for absorbing excessive amounts of CO_2, since when cultivated these organisms are capable of fixing CO_2 to produce energy and chemical compounds when exposed to sunlight. Biomass could be converted to modem gaseous and liquid fuels such as hydrogen, methane, ethanol, and oils which could serve as sources of energy.

Municipal wastes like manure, lumber, pulp mill wastes, and forest and agricultural residues constitute a large source of biomass. **Biological processes for the conversion of biomass to fuels include ethanol fermentation by yeast or bacteria, and methane production by microbes under anaerobic conditions.**

4.0 CONCLUSION

Biological energy is the form of energy that is produced in **living organisms** when they use their metabolic capacities to transform other forms of energies into energy yielding molecules like hydrogen, methane.

5.0 SUMMARY

In this unit, we have learnt:

- The definition of biological energy
- That biological energy is a sustainable technology that provides environmentally friendly alternatives to some industrial processes, thus reducing the emissions of greenhouse which are toxic to the environment.
- The reasons for exploring biological energy
- The various processes through which biological energy could be generated

6.0 TUTOR-MARKED ASSIGNMENT

Explain the path taken by solar energy to its conversion to biological energy in the human body.

7.0 REFERENCES/FURTHER READING

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UNIT 6 GASEOUS SOURCES OF ENERGY

CONTENTS

1.0 Introduction
2.0 Objectives
3.0 Main Content
4.0 Conclusion
5.0 Summary
6.0 Tutor Marked Assignment
7.0 References/Further Reading

1.0 INTRODUCTION

Natural Gas is a fossil fuel that exists in a gaseous state and is composed mainly of methane (CH4) and a small percentage of other hydrocarbons (e.g. ethane). Natural gas is very popular for commercial and industrial use, and electric power generation.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- Describe natural gas as a source of energy
- List the characteristics of natural gas.
- Itemise the advantages and disadvantages of the use of natural gas

3.0 MAIN CONTENT

Natural gas is found deep inside the earth and drilled in same way as crude oil. It is cheaper and cleaner than gasoline and produces less greenhouse emissions than its counterparts. It burns completely and can be safely stored. Natural gas can be used in the form of compressed natural gas (CNG) or liquified petroleum gas (LPG). Natural gas is widely used domestically especially in developing countries with poor supply of electricity. Hence, various schools, hospitals, hotels, motels, restaurants, office buildings also use natural gas for cooking.

Figure 11: Natural gas drilling

Advantages of Natural Gas

- It is less harmful than coal or oil: As compared to petroleum or coal, natural gas causes less damage to the environment. It is made up of methane and results in less carbon emissions. In
- It can be easily stored and transported: Natural gas is easier to preserve than other fuels. It can be stored and transported through pipelines, small storage units, cylinders or tankers on land and sea.
- Residential Use: Natural gas can be piped into houses for heating and cooking purposes and running a variety of appliances. Where there are no pipes, it can be supplied in small tanks.
- Vehicle Fuel: Natural gas can be used as a fuel for vehicles (cars, trucks, jet engines). It is a cleaner, cheaper fuel than diesel or gasoline.
- Burns Cleaner: Natural gas burns cleaner without leaving any smell, ash or smoke.
- Instant energy: Natural gas is an economic and instant fuel for heating water and large areas as well as cooking. It is ideal because it provides precise control and quick results. It helps in oven cooking as it does not require pre-heating.
- Precision in Kitchen: Natural gas is the best fuel to power kitchens because of its control, reliability and precision. A gas flame provides for precise temperature control and variety of heat settings allowing shift from hot to cold or vice versa, with the turning of the knob.

- Industrial use: Natural gas is used for producing hydrogen, ammonia for fertilizers and some paints and plastics.
- 9. It is abundant: It is relatively abundant compared to other fossil fuels, burns more cleanly and is easy to distribute.
- 10. It is Safer: It is lighter than air and tends to dissipate when there is a leakage unlike Propane, which being heavier than air, collects into explosive pockets.
- 11. It is very versatile: It can be used for heating, drying clothes, cooking, backing up generator power, and many other uses.
- 12. It is cheaper: Natural gas is cheaper than electricity. It is quicker when used for cooking and heating water and majority of gas appliances are cheaper than electric appliances.
- 13. It is neater: Gas appliances do not create electric fields which are unhealthy near your homes.
- 14. It is used to produce electricity

Disadvantages of Natural Gas

- It is toxic and flammable: Leaks of natural gas are tremendously dangerous. Such leaks may cause explosions or fire. When inhaled, the gas is highly toxic. The main danger is that it is odorless and leaks cannot be detected unless some odorant has been added to the gas. It is for this reason that LPG (residentially used gas) is suffused with odorants, that in the event of a leak, detection is easy and appropriate actions can be taken. In the case of an underground leak, we are helpless as odorant becomes weaker and the gas leak goes undetected.
- It could cause damage to environment: Burning of natural gas also releases carbon dioxide, carbon monoxide and other carbon compounds which are greenhouse gases that cause global warming and climate change. Even though it is cleaner than oil or coal as far as its by products are concerned, leakage of natural gas can be have serious consequences as methane is more toxic than carbon dioxide.
- Its processing is complex: For use as fuel, except for methane, all other constituents of natural gas have to be extracted. Processing results in many byproducts: hydrocarbons (propane, ethane etc.), sulfur, water, helium, nitrogen, and carbon dioxide.
- It is non-Renewable: Like all fossil fuels, natural gas though found in abundance is non-renewable and hence likely to be exhausted at some point of time. It is therefore not a long term solution to our energy problems.
- It is expensive to installation: The infrastructure for natural gas production and distribution is fairly expensive. This includes separate plumbing systems and specialized tanks.

- Inefficiency in Transportation: Natural gas when used as a fuel in vehicles provides less mileage than gasoline.

In spite of disadvantages, the entire process of producing, transporting and making use of natural gas provides an energy efficiency which is best among all fossil fuels. It proves to be less harmful to environment when it comes to pollution. It may not last forever but as of today it is the most popular energy source.

4.0 CONCLUSION

Natural gas is obtained from the earth like crude oil. It is a commonly used source of energy. It exists in the gaseous state. It is very cheap and is a clean source of energy. However, it is a non-renewable source of energy.

5.0 SUMMARY

In this unit, we have learnt that:

- Natural Gas is a fossil fuel that exists in a gaseous state.
- It is commonly used
- It is cheap
- It is obtained from beneath the earth like coal and crude oil
- The advantages of its use outweigh the disadvantages

6.0 TUTOR-MARKED ASSIGNMENT

Compare and contrast the uses of natural gas and gasoline.

7.0 REFERENCES/FURTHER READING

http://www.fueleconomy.gov/feg/bifueltech.shtml

http://wiki.answers.com/Q/What_are_the_advantages_and_disadvantages_of_natural_gas_for_our_planet

MODULE 2 Energy transformation and consumption

UNIT 1 ENERGY OF THE UNIVERSE AND ENERGY CYCLE

CONTENTS

1.0 INTRODUCTION

The relationship between matter and energy has been emphasised in previous units and we have seen that everything in the universe is actually made from energy. The total amount of energy in the universe does not change. The amount today is the same as the amount a million years ago. It cannot be destroyed but can be transformed from one form to another.This unit gives an insight into the total amount of energy scientists believe is available in the universe, and the explanation for it.

2.0 OBJECTIVES

At the end of the unit, you should be able to:

- Define energy of the universe
- Explain how the total energy of the universe is zero
- Explain the energy cycle

3.0 MAIN CONTENT

Energy of the universe
The energy in the universe never increases or decreases but it changes from one form to another through some natural processes like photosynthesis or through human activities like cooking. does move around a lot. Everything in the universe is made from energy.

Considering the amount of energy that we use on daily basis and in various forms, it may be rational to think the amount of energy available in the universe is huge. However, scientists have claimed that the total amount of energy in the universe is 0.The explanation given for this is that positive energy (light, matter and antimatter) are abundant in the universe but that that there is an equal amount of negative energy stored in the gravitational attraction that exists between all the positive energy particles. Physicists posit that the positive exactly balances the negative and hence, ultimately, there is no energy in the universe at all.

It has been stated that energy is neither created nor destroyed but is converted from one form to another. It has also been stated that energy in the universe neither increases nor decreases. The energy cycle shows how energy moves from its natural sources into the body of living things and is returned into the environment.

At any given moment, trillions of atoms and molecules are circulating between the living and the non-living world. Life processes like metabolism, growth, irritability and movement require a lot of energy and nutrients be introduced into the body. The sun begins the process through organisms like plants and other photosynthetic producers. There is a repeated process of higher organisms feeding on lower organisms. When living organism die, they decompose and their remains are returned into the cycle as inorganic molecules.

The sun is the primary source of the earth's energy. Sunlight is absorbed and used by the producers to create matter from smaller matter. Energy from the sun is used to drive the process of photosynthesis, constantly renewing the energy lost to the environment as heat from life's processes. The autotrophs, also known as the producers, include plants, many bacteria, plant-like protists and even some fungi photosynthesise and create the basic organic matter from inorganic matter using enzymes and chlorophyll. The producers (green plants and other autotrophs) break down some of the matter that they manufacture to produce energy.

Consumers (heterotrophy),feed on matter and digest it to form smaller pieces of matter which generate energy for their life processes. Scavengers and decomposers break down dead matter to return it to the soil for use by producers so that the cycle can begin again.

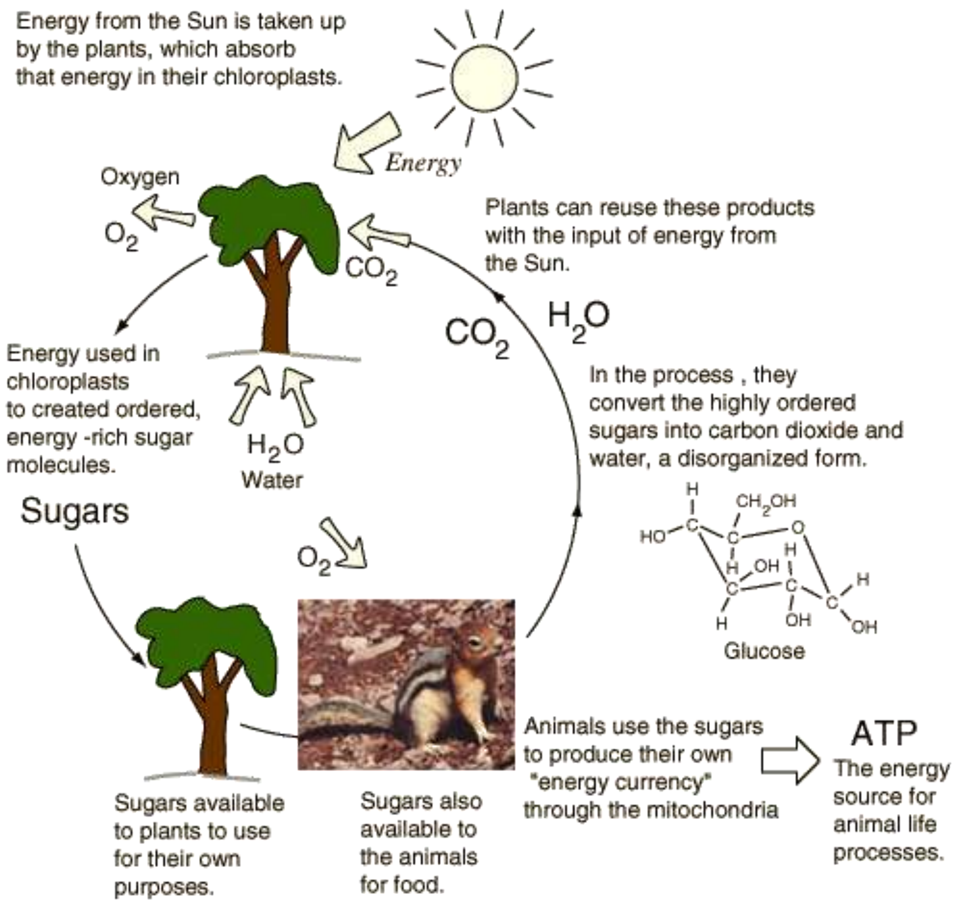

Figure 12:The energy cycle

4.0 CONCLUSION

The logical conclusion is that all the energy we see in the universe today must have always been here since the time it was created and energy just moves around in the ecosystem without increasing or decreasing in amount.

5. SUMMARY

In This Unit, We Have Learnt That:

- The Total Energy Of The Universe Is 0.
- Energy Can Neither Be Created Nor Destroyed.
- Energy Is Being Cycled Between The Environment And The Body Of Living Organisms.

6.0 TUTOR-MARKED ASSIGNMENT

i. Explain why is it that energy of the universe is zero?
ii. Make a diagramatic illustration of the energy cycle
iii. Explain the role of animals in the energy cycle.

7.0 REFERENCES/ FURTHER READING

Energy cycle: http://hyperphysics.phy-astr.gsu.edu/hbase/biology/enercyc.html

UNIT 2 FORMS AND USES OF ENERGY

CONTENTS

1.0 INTRODUCTION

Different forms of energy exist. In module 1, an insight into the various sources of energy has been discussed. In this unit, we discuss specifically the various forms of energy that exist. We have based our discussion on the law that energy cannot be created nor destroyed but can be transformed from one form to another.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- List the fundamental forms of energy
- Define and distinguish differences between energy and power
- Describe the various forms of energy

3.0 MAIN CONTENT

3.1 Forms of Energy

Six Basic Forms of Energy
Energy exists in a number of different forms, all of which measure the ability of an object or system to do work on another object or system. There are six basic forms in which we use energy in our day-to-day life,these are: **mechanical (kinetic and potential) energy, thermal, chemical, nuclear, electrical and Radiant (light) energy.**

Mechanical Energy (Kinetic).Energy that a body possesses by virtue of its motion. It is the energy associated with the motion and position of an object. Mechanical energy is the sum total of potential and kinetic energy. Mechanical energy is involved in moving people and good s around. It is the energy that a body possesses by virtue of its position relative to a reference point. Examples include a baseball player pitching a ball, a plough being pulled by a tractor, and a hammer that is being used to pound nails. A few examples of mechanical energy include a pendulum, a bow (archery), a spring, and a hammer that is raised in preparation to pound nails.

A book sitting on a piece of wood on a table is said to have **potential energy** because if it is nudged off the table, gravity will accelerate it, giving it**kinetic energy**. Because the Earth's gravity is necessary to create this kinetic energy, and because this gravity depends on the Earth being present, we say that the **Earth-wood system** is what really possesses this potential energy, and that this energy is converted into kinetic energy as the wood falls.

Chemical Energy

This is the energy locked in the bonds of molecules in the form of microscopic **potential energy**, which exists because of the electric and magnetic forces of attraction exerted between the different parts of each molecule. It is the same attractive force involved in thermal vibrations. The molecular parts get rearranged in the chemical reactions, releasing or adding to this Potential Energy.

Examples include a battery, burning wood, and glucose in the body. Fossil fuels such as coal, oil, and natural gas store energy in the form of chemical energy.When they are burnt, these fuels release energy in the form of heat.

An example of a biological substance that stores energy is glucose (blood sugar). Glucose releases energy when it reacts chemically with oxygen during aerobic respiration in animals. When this happens, muscles use this energy to generate mechanical force (work) and also heat.

Thermal (Heat) Energy

This is the energy that combines microscopic, kinetic and potential energy of the molecules. Some examples of this include a hot beverage and boiling water.Temperature is really a measure of how much thermal energy something has: The higher the temperature, the faster the molecules are moving around and/or vibrating, i.e., the more kinetic and potential energy the molecules have. Fuels are oftentimes burnt and converted to thermal or heat energy, which is then converted to motion in an automobile or electricity.

Thermal Energy

A hot cup of water is said to possess "thermal energy," or "heat energy," because it has a combination of kinetic energy due to itsvibrating molecules, and potential energybecause the molecules have a mutual attraction for one another.

Electrical Energy
Energy created through the movement of electrons among the atoms of matter. Although electricity is seldom used directly, it is one of the most useful and versatile forms of energy. Following are some examples.
When put into a toaster, it can be converted to heat;
When put into a stereo, it is converted into sound;
When put into an electric bulb, it converts into light;
When put into a motor it converts into motion or movement (mechanical energy).

Nuclear Energy
Energy produced when reactions occur in an atom, resulting in some type of structural change in the nuclei. This occurs in two ways:

Fusion occurs when two small nuclei join together to create one large nucleus or particle, and during this process, energy is released in the form of light and heat An example is in the Sun, hydrogen nuclei fuse (combine) together to make helium nuclei which releases energy.

Fission occurs when the nucleus of one big atom splits into two new atoms, and during this process, a tremendous amount of energy is released in the form of light and heat. An example is in a nuclear reactor or the interior of the earth, uranium nuclei split apart causing energy to be released.

In both fusion and fission, some of the matter making up the nuclei is converted into energy, represented by the famous equation by Albert Einstein:

$\mathbf{E = mc^2}$
Energy = Mass x (Speed or velocity of Light)^2
This formula indicates that energy intrinsically stored in matter at rest equals its mass times the speed of light squared. When matter is destroyed, the energy stored is released.

This equation suggests that an incredibly huge amount of energy is released when a small amount of matter is converted to energy.

Radiant energy (Radiation)
Energy radiated or transmitted in the form of rays, waves or particles. Some examples include: Visible light that can be seen by naked eye;
Infrared radiation;
Ultraviolet radiation (UV) that cannot be seen with the naked eye;

Long wave radiation, such as TV waves and radio waves;
Very short waves, such as x-rays and gamma rays.

Electromagnetic Radiation
Energy from the sun comes to the earth in the form of electromagnetic radiation, which is a type of energy that oscillates (side to side) and is coupled with electric and magnetic fields that travel freely through space.Electromagnetic radiation is composed of **photons** or particles of light, which are sometimes referred to as packets of energy.Photons, like all particles, have properties of waves.Photons make the world a brighter place.

E**nergy Conversion:** Energy can be converted from one form to another. For example, gasoline chemical in automobiles provides mechanical (kinetic) energy when the engine works. When electrical energy in our car is passed into our TV, it is converted to light and sound. This also lightens a bulb when passed into it.

Figure 13 shows some examples of energy conversions.

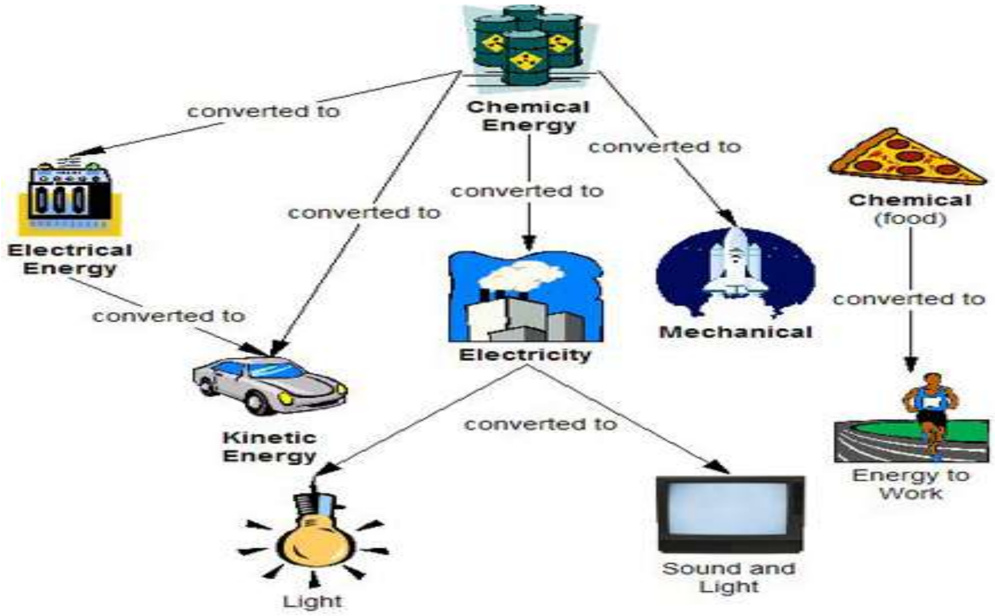

Figure 13: Energy conversions

4.0 CONCLUSION

Energy exists in various forms and it can be converted from one form to another.

5.0 SUMMARY

In this unit, we have learnt aboutmechanical (kinetic and potential) energy, thermal, chemical, nuclear, electrical and Radiant (light) energy and how they can be converted to each other.

6.0 TUTOR MARKED ASSIGNMENT

List and describe any four forms of energy.

7.0 REFERENCES/FURTHER READING

UNIT 3 ENERGY DISSIPATION

CONTENTS

1.0 INTRODUCTION

When a snooker ball is slid on the snooker board, it moves quickly and then slowly, the kinetic energy of the ball decreases and it gradually comes to a stop. Then kinetic energy of the ball has been **dissipated** through friction. **Energy Dissipation**: is defined as the process in which energy is used or lost without accomplishing useful work as friction causing loss of mechanical energy.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- define energy dissipation
- define energy dissipater
- explain energy conservation
- name and explain types of dissipaters
- enumerate the factor for selecting energy dissipater

3. 0 MAIN CONTENT

Energy dissipation is a physical process through which energy becomes unavailable and irrecoverable in any form. An example is the cooling of a body in an open air. When a hot object is exposed to an open air, it gradually lost heat to the environment. The lost heat is no longer available to the object. During energy dissipation, energy is transformed from some initial form to some final form making the capacity of the final form less than that of the initial.

It is necessary to artificially dissipate energy under certain circumstances. For instance, excess kinetic energy of flow must be dissipated downstream of the hydraulic structures specially built for the purpose of energy dissipation commonly known as energy dissipater in hydroelectric dams. This is because the excess kinetic energy of the stream causes flow distortion results in highly non-uniform velocity distribution and this makes it difficult to generate electricity from the dam. Hence, energy dissipaters are deployed to contain any excess energy of flow.

3.1 Energy Dissipation devices and types

In hydroelectric dams, hydraulic structures e.g spill ways, outlets, drops, regulators flow meter. It is extremely necessary that excess kinetic energy of flow must be dissipated downstream of the hydraulic structures specially built for the purpose of energy dissipation commonly known as energy dissipater.

There are several types of energy dissipaters used in dams. Selection of a particular type of energy dissipaters depends upon the amount of energy to be dissipated and erosion control required downstream of a structure.

- Hydraulic jump type stilling basin: is defined as a dissipater in which whole or part of a hydraulic jump is confined. In this type dissipater, the energy is dissipated by formation of hydraulic jump within the basin.
- Water cushion (plung pool type dissipater): in this type, the nappe impinges into the stilling water cushion below. There is no clear standing wave formation and the energy is dissipated by the turbulent diffusion as the high velocity jet enters the deep pool on the downstream.
- Sold roller bucket type dissipater: an upturn sold bucket is used when tail water depth is much in excess of sequent depth and in which dissipation of considerable portion of energy occurs as a result of formation of two complementary elliptical rollers, one in the bucket proper is called bucket roller, which is anti-clockwise (if the flow is to the right) and the other downstream of the bucket called ground roller which is clockwise.
- Slotted roller bucket type dissipater: an upturn bucket with teeth in it used when the tail water is much in excess of sequent depth and in which the dissipation of energy occurs by lateral spreading of jets passing through bucket slots in addition to the formation of two rollers as in solid roller bucket.
- Ski-ump (flop or trajectory bucket) type dissipater: an upturn solid bucket is used when the tail water depth is insufficient for the formation of hydraulic jump and the bed of the channel downstream comprises of sound rock which is capable of withstanding (without excessive scour), the impart of high velocity jet.

3.2 Factors for selecting energy dissipater

The following factors are considered while selecting the type of energy while selecting the type of energy dissipates

- Type of dam and its spillway
- Frequency and intensity of flood flows
- The degree of protection to be provided for high floods
- Proximity of power house, tail race and other structure
- Velocity and nature of flow
- Elevation of tail water at various discharges
- Natures of foundations
- Type and amount of bed material rolling on the spillway
- Safety of existing structure downstream
- Hydraulic approach conditions including specific discharge, energy head of approach flow, head loss and type of outlet.

4.0 CONCLUSION

Energy dissipation explain how mechanical energy (kinetic energy) is either used or lost without accomplishing useful work which is caused by friction.

5.0 SUMMARY

In this, unit, we have discussed:

- energy dissipation and what causes it
- energy dissipation devices, dissipaters and factors considered in their selection.

6.0 TUTOR MARKED ASSIGNMENT

i. Define energy dissipation
ii. What is energy dissipation device
iii. Mention and explain 5 types of dissipater
iv. Enumerate 10 factors responsible for selecting energy dissipater

7.0 REFERENCES/FURTHER READING

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Mazumder, S.K. &Naresh H.S.(1988) use of appurtenances for efficient design of jump type dissipaters having diverging slide walls for flumed canal falls “ the institute of engineer (India). Vol.68

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www.energysaving.org.uk

UNIT 4 ENERGY CONSUMPTION

CONTENTS

1.0 INTRODUCTION

We make use of energy every moment. Energy sustains our life and we use energy to run our lives. You wake up in the morning, stretched your muscle and jump into your bathroom, you use energy. You turn on the tap and warm water comes out from your water heater, and after your bath, you switch on your radio to listen to the news. Then, you land on your dining table to eat so that you can have energy for the day's work. You then enter your car and off you go to work. Your car is driven on chemical energy. Getting to your place of work, you enter an elevator, the elevator is powered by electricity and as soon as you enter your office, the first thing you do is to switch on the light, and then boot your computer………….. This illustration tells us how much of energy we consume in a day. In this unit we examine the concept of energy consumption to make us realize how important energy is to our daily survival.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- Discuss the four main categories of energy users
- List and explain the purposes for which energy is used in residential and commercial buildings
- List four major categories of energy-intensive industries
- State the reasons for the differences in energy consumption among countries

3.0 MAIN CONTENT

3.1 Energy Users

Energy users can be categorized into four categories:
1. Residential 2. Commercial 3. Industrial, and 4. Transportation

Residential and Commercial Use of Energy

We discuss these two categories together because the use to which energy is put in both instances aresimilar. Any place where people live is considered a residential building. Commercial buildings include offices, stores, hospitals, restaurants, and schools. Energy is used in residential and commercial buildings for **heating and cooling, lighting, heating water, and operating appliances.** In developed countries, electrical energy dominates the type of energy used for residential and commercial purposes. In Nigeria, however, power supply has remained a serious problem for decades. Hence, people have resorted to the use of generators at homes and offices. Artisans (eg. tailors, hairdressers, welders etc.) depend on electrical power for their work. Without this, they cannot work efficiently because the machines they use are driven by electrical power.

Heating and Cooling

In cold countries, rooms and offices have to be heated and in hot countries, air conditioners have to be used at home and offices to make life comfortable. It takes a lot of energy to heat rooms in winter and cool them in summer. In the United States for instance, it has been reported that fifty-six percent of the energy used in the average home is for heating and cooling rooms. The three fuels used most often for heating in the United States are natural gas, electricity, and heating oil. Today, more than half their homes use natural gas for heating followed by electricity. Electricity also provides almost all of the energy used for air conditioning.

Lighting

Homes and commercial buildings also use energy for lighting. In the developed world, electricity is the main source of power for lighting. However in developing countries e.g. Nigeria, most homes rely on chemical energy (kerosene) to produce light when it is dark. The invention of the fluorescent bulb has helped improve energy conservation. The incandescent bulbs that are still commonly used in developing countries (because they are cheaper to buy) are not efficient because about 90% of the energy that produces the light is lost as heat. Fluorescent lighting costs more to install, but it uses a lot less energy to produce the same amount of light.

Figure 14: A fluorescent bulb

Appliances

Advancements in science and technology have led to the production of many energy efficient appliances.Today, we use many more appliances than before and they have changed the way we spend our time at home. Chores that used to take hours can now be done in minutes by using electricity instead of human energy. Water heaters, refrigerators, clothes washers, and dryers all use much less energy today than they did 30 years ago.

Industrial

Countries that are highly industrialized use a lot of energy. Every industry uses energy, but four energy-intensive industries could be identified. They are:

- Petroleum refining industries
- Steel manufacturing industries
- Aluminum Manufacturing industries
- Chemical Manufacturing industries

Transportation

Automobile vehicles are major means of transportation. Modern automobile vehicles have been designed to consume less fuel. We are also learning to choose rightly when we want to buy automobiles. A major factor that people now consider in purchasing automobiles is fuel efficiency. Trucks, trains, and aircrafts also use fuel. Technologies are continually being advanced to produce automobiles that consume lesser amount of fuel.

The World's energy supply sources

The World's energy consumption for the year 2008 is shown in the figure 15

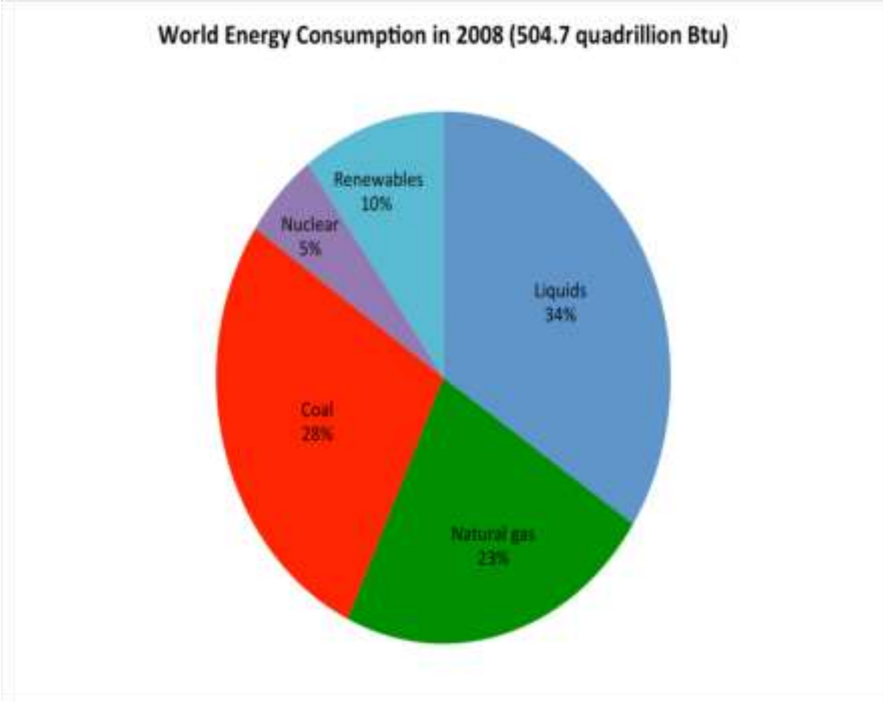

Figure 15: World energy consumption in 2008
Source: see references

Table 2: Three of the world's largest energy sources

Three of the world's largest energy sources		
Source	**Future Outlook**	**Advantages / Disadvantages**
Oil	It is the world's foremost source of primary energy consumption, and it is expected to remain in that position throughout the 2008 to 2035 period.	Robust growth in transportation energy use—overwhelmingly fueled by petroleum products—is expected to continue until 2035. As a result, oil is projected to retain its predominance in the global energy mix and meet 29% of the total primary energy consumption in 2035.

Natural Gas	Expected to remain an important supply source for new electric power generation in the future (23% of the total primary energy in 2035).	it is seen as the desired option for electric power, given its relative efficiency and environmental advantages in comparison with other fossil energy sources. Natural gas burns more cleanly than either coal or oil, making it a more attractive choice for countries seeking to reduce greenhouse gas emissions.
Coal	World coal use has been in a period of generally slow growth since the 1980s, and that trend is expected to continue through the projection period. Coal use will continue to dramatically increase in developing countries, but in developed or industrialized countries, it will not increase but may slightly decrease.	Coal use is projected to increase in all regions except for Western Europe, Eastern Europe and the former Soviet Union (excluding Russia), where coal is expected to be displaced by natural gas and, in the case of France, nuclear power, for electric power generation. Large increments in coal use are projected for developing Asia, especially in China and India. World coal consumption increased sharply from 2003 to 2004, largely because of a 17-percent increase in China and India. Coal remains a vital fuel for world's electricity markets and is expected to continue to dominate energy markets in developing Asia.

Energy Consumption Differences

The differences in energy consumption among countries are the result of:

- efficiency of industrial, transportation, commercial, and residential energy;
- climatic and geographical areas of a country;

- lifestyles (use of more gas guzzling cars and SUVs and bigger size houses);
- The nature of the products produced by the nations' industries.

4.0 CONCLUSION

We can see that we depend on energy consumption for everyday activities.

5.0 SUMMARY

In this unit, we have learnt that:

- Energy use is called energy consumption.
- **residential**, **commercial**, **industrial**, and **transportation**
- The differences in energy consumption among countries are the result of: efficiency of industrial, transportation, commercial, residential energy, climatic and geographical areas of a country, lifestyles.

6.0 TUTOR-MARKED ASSIGNMENT

List and explain three sectors that consume energy.

7.0 REFERENCES/FURTHER READING

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UNIT 5 ENERGY EQUATIONS

CONTENTS

1.0 INTRODUCTION

Energy is a quantitative phenomenon and it can be measured. In the study of the relationship between energy and matter, some mathematical relationships have been established between various parameters like mass, velocity, weight, height etc. These relationships have been mathematically established by scientists. In this unit three mathematical energy equations are considered.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- Write down the mathematical equations for rest energy as formulated by Albert Einstein
- Write down the mathematical equations for kinetic energy
- Write down the mathematical equations for potential energy
- Describe the relationship between the parameters involved in these equations.

3.0 MAIN CONTENT

Energy Mass Relationships

The law of conservation of energy states that energy can neither be created nor destroyed. What about mass can mass be created or destroyed?

The law of conservation of mass mass is neither created nor destroyed, and the total mass of substances involved in a physical or chemical change remains unchanged. For instance, if 4.032g of Hydrogen reacts with 31.9988g of Oxygen to produce 6.0308g of Water,The sum of the masses of the reactants is equal to the sum of the mass of the product, and hence mass is neither created nor destroyed.

In 1905, Albert Einstein concluded from his observations that mass and energy are related. He posited that mass, by its very nature is energy called rest energy which is represented by the famous equation.

$$\mathbf{E = mc^2}$$

where, E = Energy ,m = mass and c = velocity of light = 3 X 10^8 m/s. According to this relationship, if one gram of mass was completely converted to energy then 2.15 X 10^{13} calories of heat energy would be liberated. This amount of heat would raise the temperature of 215,000,000 kgs of water from 0 to 100°C! Similarly, according to this equation, a hot potato weighs more than a cold one, however, the change in mass may be too small to detect.

In ordinary chemical reactions, the energy changes involved are relatively small (in the order of 5 X 10^{-4} J or5 X 10^{-5}J) and the mass change is of the order of 2X10^{-9} to 2 X 10^{-8}gms, which is too small to be detected on most balances. In the reaction of hydrogen and oxygen to form water the loss of mass would amount to about 5.35 X $10^{\wedge-9}$gms. However, in nuclear reactions, the amount of mass converted to energy is quite significant and is great enough to be detected but we can still conclude that the law of conservation of mass is valid for ordinary chemical reactions. Hence, to be completely accurate, we must combine the Law of Conservation of mass with the Law of Conservation of Energy and state that **the total of the mass and energy can neither be created nor destroyed and this total is constant.**

When an object moves, the change in position of the object indicates that the object is moving. This energy of the object which results from this movement is called Kinetic energy. Kinetic energy (KE) of an object is normally expressed in terms of the mass of the object and its velocity because both mass and velocity are properties of the object. It is mathematically expressed as

$KE = 1/2mv^2$ Joule (J) = kg m^2 sec^2

Where m = mass in Kg and v= velocity in metre per second

Potential energy (PE) is energy possessed by an object at rest. However, potential energy is converted to Kinetic energy when the object moves. The potential energy of an object due to gravity is mathematically expressed as

PE = weight x height Joule (J) or kg m^2 sec^2.

4.0 CONCLUSION

The conclusion that can be drawn from this unit is that energy can be expressed mathematically in form of equations.

5.0 SUMMARY

In this unit, we have learnt the:

- Resting energy is expressed as $E=mc^2$
- Kinetic energy is expressed as $KE= 1/2mv^2$
- Potential energy due to gravity is PE = weight x height

6.0 TUTOR-MARKED ASSIGNMENT

Generate one problem each for the energy equations learnt in this unit and use the equations to solve the problems.