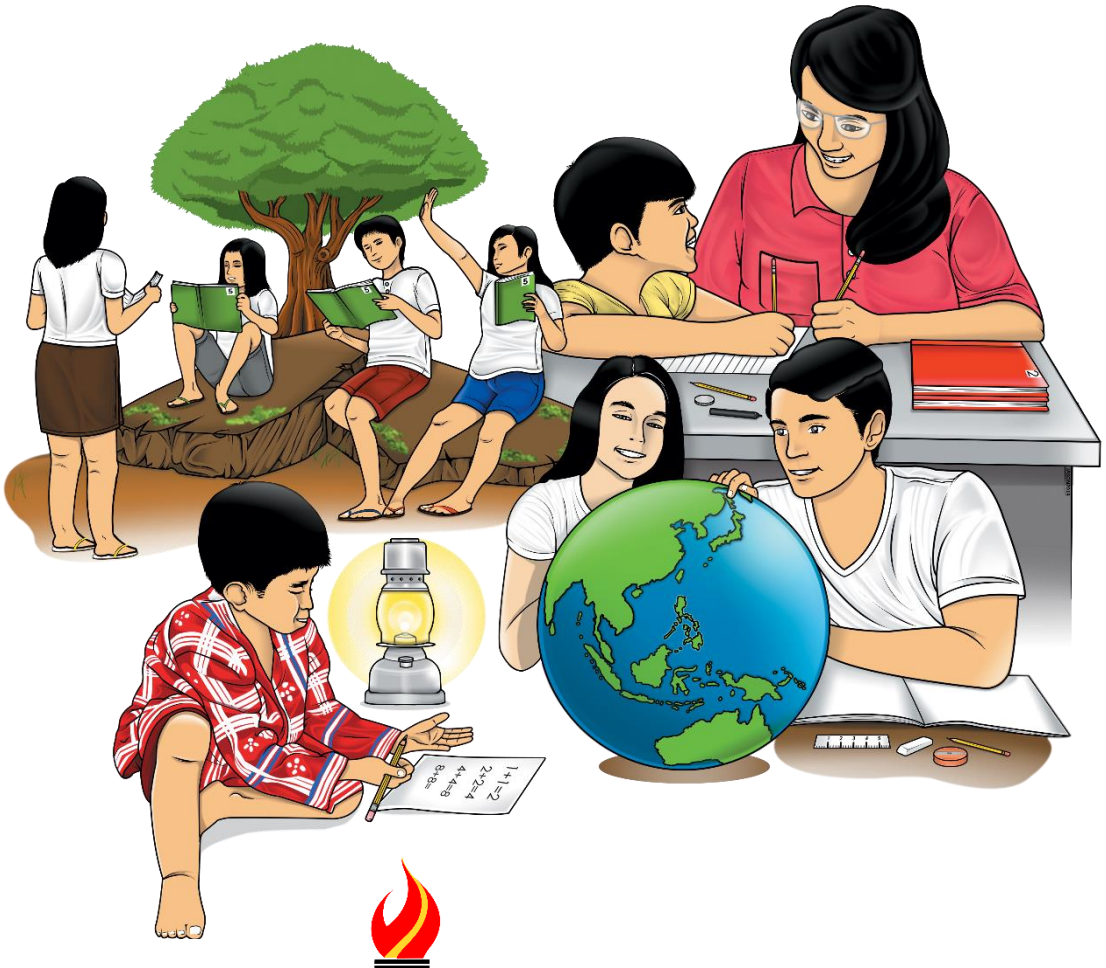
Senior High School

DepED
DEPARTMENT OF EDUCATION

Physical Science

Quarter 1 – Module 11:
How Energy is Produced and Managed



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Physical Science

Quarter 1 – Module 11:
How Energy is Produced and Managed

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Introductory Message

This Self-Learning Module (SLM) is prepared so that you, our dear learners, can continue your studies and learn while at home. Activities, questions, directions, exercises, and discussions are carefully stated for you to understand each lesson.

Each SLM is composed of different parts. Each part shall guide you step-by-step as you discover and understand the lesson prepared for you.

Pre-tests are provided to measure your prior knowledge on lessons in each SLM. This will tell you if you need to proceed on completing this module or if you need to ask your facilitator or your teacher's assistance for better understanding of the lesson. At the end of each module, you need to answer the post-test to self-check your learning. Answer keys are provided for each activity and test. We trust that you will be honest in using these.

In addition to the material in the main text, Notes to the Teacher are also provided to our facilitators and parents for strategies and reminders on how they can best help you on your home-based learning.

Please use this module with care. Do not put unnecessary marks on any part of this SLM. Use a separate sheet of paper in answering the exercises and tests. And read the instructions carefully before performing each task.

If you have any questions in using this SLM or any difficulty in answering the tasks in this module, do not hesitate to consult your teacher or facilitator.

Thank you.

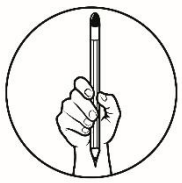
What I Need to Know

This module was designed and written with you in mind. It is here to help you master how energy is harnessed from different sources: fossil fuels, biogas, geothermal, hydrothermal, batteries, solar cells, and biomass. The scope of this module permits it to be used in many different learning situations. The language used recognizes the diverse vocabulary level of students. The lessons are arranged to follow the standard sequence of the course. But the order in which you read them can be changed to correspond with the textbook you are now using.

This module contains discussion about the different sources of energy, how they are generated and managed.

After going through this module, you are expected to:

1. describe the different sources of energy;
2. give a brief summary of how energy is produced from different sources;
3. differentiate between renewable and non-renewable sources of energy; and
4. outline the pros and cons of the different sources of energy.



What I Know

Multiple Choice. Read and analyze the given statements below. Write the chosen letter on a separate sheet of paper.

1. Which of the following is being described by this phrase, "It can be converted in form, but not created nor destroyed."
   A. Atom
   B. energy
   C. force
   D. matter

2. Energy that comes from sources that will run out or will not be replenished in our lifetimes—or even in many, many lifetimes.
   A. kinetic
   B. non-renewable
   C. potential
   D. renewable

3. It refers to the organic matter from plants and animals (microorganisms).
   A. battery
   B. biomass
   C. geothermal
   D. wind power

4. This form of energy includes hydrocarbons such as coal, oil, and natural gas that comes from organic remains of prehistoric organisms.
   A. batteries
   B. fossil fuels
   C. natural gas
   D. solar power

5. This source of energy is also known as "The People's Power" referring to the easy deployment of solar panels and the introduction of "community solar gardens" where energy is shared among owners.
   A. biofuel
   B. geothermal
   C. hydroelectric
   D. solar energy

6. This renewable energy utilizes moving water to turn turbines.
    A. biomass
    B. geothermal
    C. hydroelectric
    D. solar wind

7. This source of energy is less of an environmental hazard compared to fossil fuels.
    A. batteries
    B. biomass
    C. geothermal
    D. hydrothermal

8. The energy that comes from fossil fuels came from the sun through this process when the prehistoric plants were still alive.
    A. cytokinesis
    B. meiosis
    C. mitosis
    D. photosynthesis

9. Which of the following converts the kinetic energy of falling water into mechanical energy?
    A. generator
    B. steam
    C. turbine
    D. wind

10. Below are the operational geothermal power plants in the Philippines EXCEPT
    A. Balugbug
    B. Malibara
    C. Malikban
    D. Tiwi

11. Wind turbines are installed in strategic locations to harness what type of energy from wind?
    A. chemical
    B. kinetic
    C. mechanical
    D. potential

12. Which of the following operational solar power plants is found in Batangas?
    A. Cavite Economic Zone Solar Power Project
    B. Central Mall Biñan Solar Power Plant
    C. CW Home Depot Solar Power Project
    D. Lian Sola Power Project

13. Which of the following is used to create methane and alcohol which are fuels useful in energy production and in powering automobiles?
    A. biomass
    B. carbon
    C. coal
    D. oil

14. Which is an advantage of solar energy?
    A. abundant
    B. amount of space
    C. expensive
    D. rare metals

15. Which country has many potential sites where solar energy may be harnessed because of its location in the globe?
    A. Australia
    B. Philippines
    C. Saudi Arabia
    D. United Kingdom

Lesson 1 How is Energy Produced and Managed

Energy is defined as the ability to do work. When work is done, energy is transferred from one object to another. Energy exists from different forms such as electrical and chemical energy. Most forms of energy can be classified as kinetic energy and potential energy. *Kinetic energy* is the energy of moving matter. Things with kinetic energy can do work. Kinetic energy depends on the object's mass and velocity. *Potential energy* is the energy stored in an object because of its position or shape.

What's In

Activity 1.1 Word Pool

Direction: To get started, you have to choose the terms related to energy from the WORD POOL below. List down these words on the table on and write what you know about it on a separate sheet of paper.

potential	nutrition	stomach	electricity	geothermal
atom	rock	solar	typhoon	renewable
battery	volcano	biomass	redshift	respiration

Term	What I know about it?

Notes to the Teacher

Ask learners to name the different sources of energy and list examples on a separate sheet of paper.

What's New

Activity 1.2

The diagram shows the different sources of energy in the Philippines and the percentages of each source. Analyze the different sources of energy from the different regions in the Philippines based on Figure 1 Gross Power Generation by Fuel 2013. Then, answer the questions that follow.

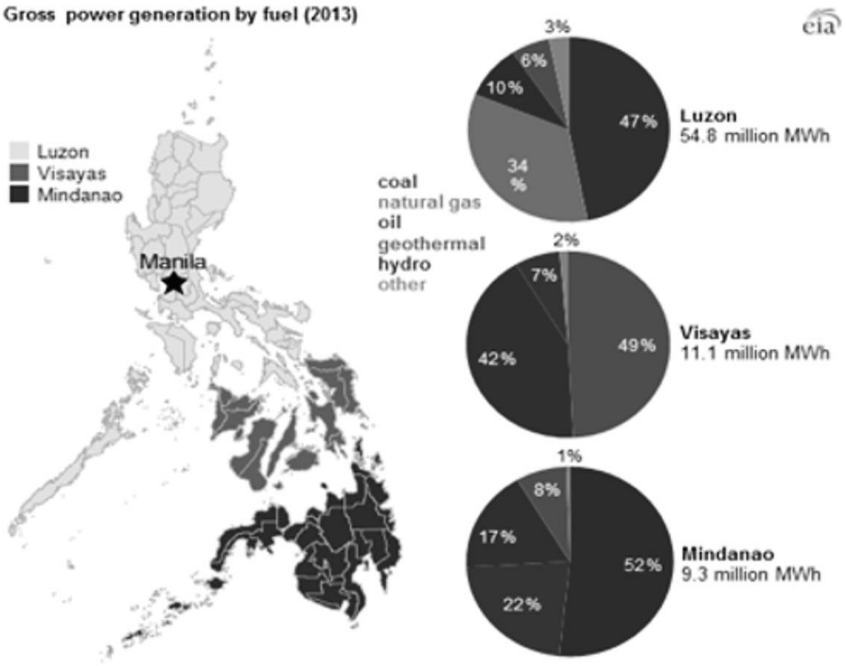


Figure1. Gross Power Generation by Fuel (2013), Retrieved July 17, 2020, http:// www.eia.gov/todayinenergy/images/2015.03.06/chart2.png).

Guide Questions:

1. What are the different sources of electricity in the Philippines?

2. Refer to the diagram above to complete the table below.

	Luzon	Visayas	Mindanao
Main source of electricity			
Percentage			
Second Source of Electricity			
Percentage			
Third Source of Electricity			
Percentage			

3. Based on the diagram, what can you say about the sources of energy from the different regions in the Philippines?

What is It

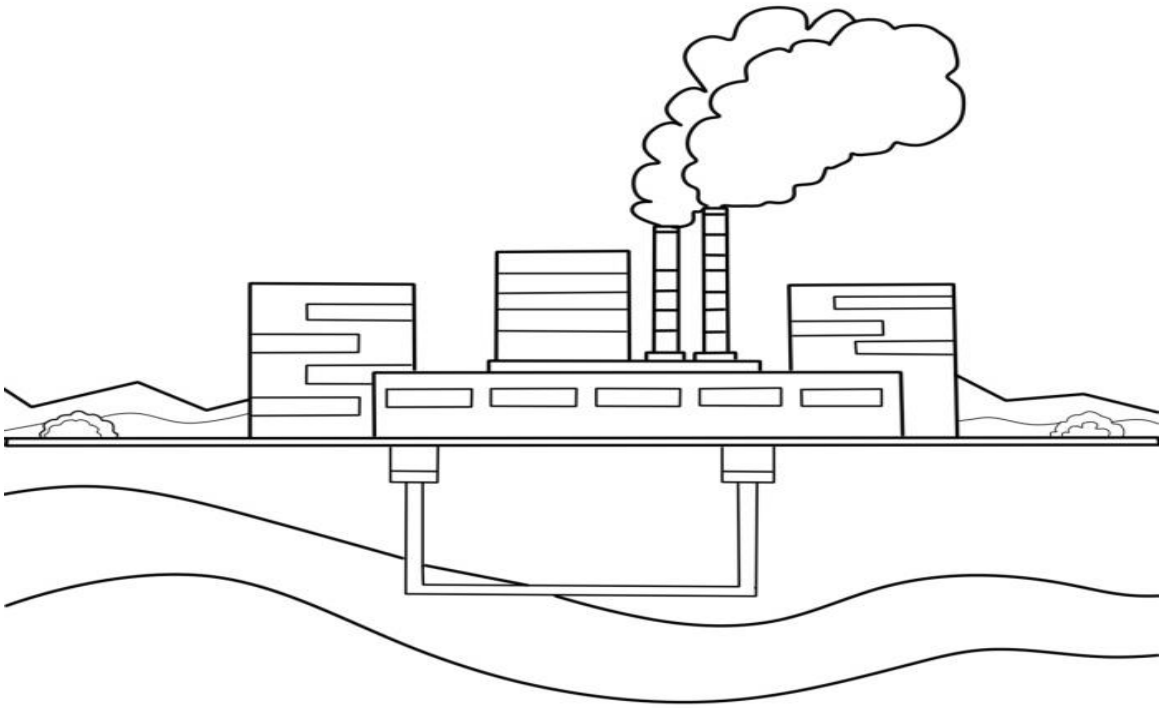
A *power plant* is an industrial facility that generates electricity from primary energy. Most power plants use one or more generators that convert mechanical energy into electrical energy in order to supply power to the electrical grid for society's electrical needs. The exception is solar power plants, which use photovoltaic cells (instead of a turbine) to generate this electricity.

The type of primary fuel or primary energy flow that provides a power plant its primary energy varies. The most common *fuels* are coal, natural gas, and uranium (nuclear power). A substantially used primary energy *flow* for electricity generation is hydroelectricity (water). Other flows that are used to generate electricity include wind, solar, geothermal and tidal.

Electrical sources can be broken down to two major groups: renewable and non-renewable sources. Renewable source is produced from sources that do not deplete or can be replenished within a human's life time. The most common examples include wind, solar, geothermal, biomass, and hydropower. This is in contrast to non-renewable source which is a natural resource that cannot be readily replaced by natural means at a quick enough pace to keep up with consumption.

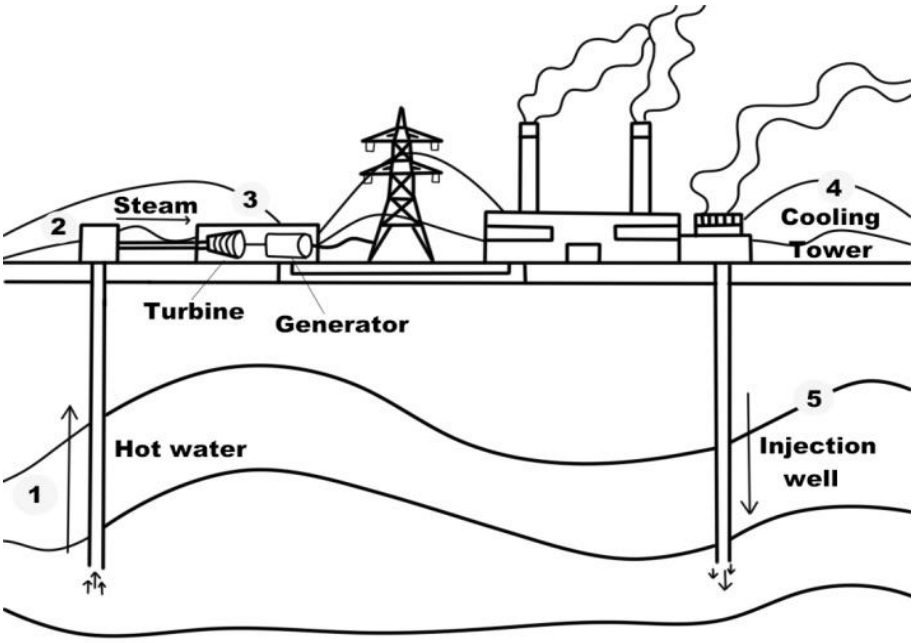
I. Renewable Sources

1. Geothermal



Geothermal power utilizes the heat energy from the earth's crust. This heat energy heats up rocks which, in turn, heats up nearby groundwater. The *Malitbog Geothermal Power Station* is a 232.5 MW geothermal power plant or an earth steam turbined electric generator--the world's largest geothermal power plant under one roof located in Malitbog, Kananga, Leyte, Philippines. The power plant is one of four operating in the Leyte Geothermal Production Field.

Geothermal energy is produced by the heat of Earth's molten interior. This energy is harnessed to generate electricity when water is injected deep underground and returns as steam (or hot water, which is later converted to steam) to drive a turbine on an electric power generator that produces electricity. Geothermal energy is less of an environmental hazard compared to fossil fuels though it still has some emissions of carbon dioxide, nitrous oxide, and sulfur dioxide.



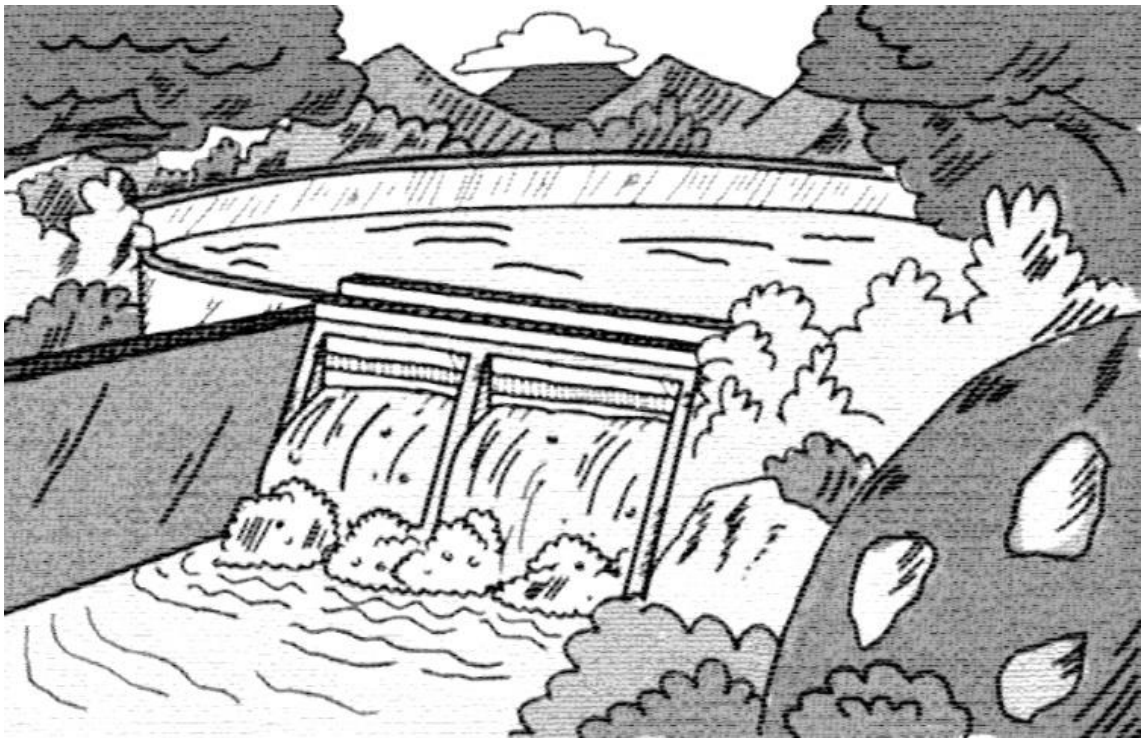
Some of the operational geothermal power plants in the Philippines are:

- Malibarara Geothermal Power Plant in Sto. Tomas, Batangas
- Makban Geothermal Power Plant and Makban Binary Geothermal Power Plant in Bay, Laguna
- Tiwi Geothermal Power Plant in Tiwi, Albay
- Bacon Manito Geothermal Power Plant in Sorosogon
- Unified Leyte Geothermal Power Plant Tongonan Geothermal Power Plant in Leyte
- Southern Negros Geothermal Production Field – Nasulo Geothermal Power Plant and Palinpinon Geothermal Power Plant in Valencia Negros Occidental

2. Hydroelectric

Hydroelectric power (hydropower) is derived from the energy of falling or moving water to generate electricity. Among other purposes, water is widely used to produce electricity. Hydropower is a proven, mature, predictable, and price competitive technology. A number of on- and off-grid hydropower plants have been built throughout the country, including impounding dams and run-of-river types. Impounding dams are able to supply energy during peak and off-peak hours while run-of-river types supply electricity whenever capable, depending on the volume of water that is discharged from the watersheds.

A turbine converts the kinetic energy of falling water into mechanical energy. Then a generator converts the mechanical energy from the turbine into electrical energy. The generator power is stepped up to a higher voltage from the substation, and then exported for transmission.



Some of the operational hydroelectric power plants in the Philippines are:

- Palakpakin Hydroelectric Power Plant in San Pablo, Laguna
- Balugbog Hydroelectric Power Plant in Narcarlan, Laguna
- Cantingas Hydroelectric Power Plant in San Fernando, Romblon

3. Wind power

While an electric fan uses electricity to produce wind, a wind turbine uses wind to produce electricity. A wind turbine can generate megawatts of power, depending on the weather conditions. In fact, an indicator for a potential wind farm site is the presence of flagging trees or trees that are bent like how a flag would look like due to strong winds. Because of the vast land area a wind farm occupies, unused areas can be co-located with agricultural crops or even a solar farm.

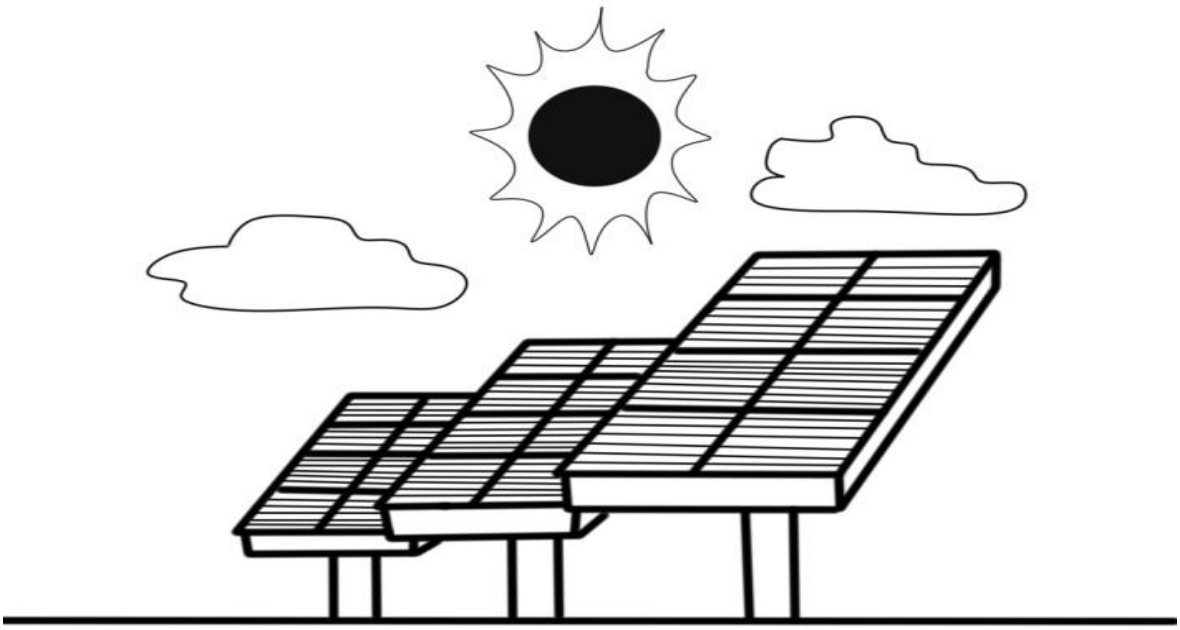
Wind has been used in centuries to move ships and pump water. Wind turbines are installed in strategic locations to harness the mechanical energy from wind. Some of the most recent developments are the Bangui Wind Farm, Burgos Wind Farm, and Caparispisan Wind Farm in Ilocos Norte, the Wind Energy Power System in Oriental Mindoro, San Lorenzo Wind Farm in Guimaras, Nabas Wind Farm in Aklan and Pililla Wind Farm in Rizal.

4. Solar Cells

If plants photosynthesize using sunlight, electric-powered technologies can also use sunlight for energy. Solar power is a variable energy source that is dependent on the cycle of the sun. The Philippines, being situated near the equator, has many potential sites where solar energy may be harnessed.

With recent technology, solar power systems can be both applied to on- and off-grid areas. Aggressive economic growth for the country is not far behind. As long as there is sunlight, solar power will always be available. Solar power technology may not generate energy at night but it is capable of supplying electricity to the grid at daytime.

A solar cell, or photovoltaic cell, is an electrical device that converts the energy of light directly into electricity by the photovoltaic effect, which is a physical and chemical phenomenon. It is a form of photoelectric cell, defined as a device whose electrical characteristics, such as current, voltage, or resistance, vary when exposed to light. Individual solar cell devices are often the electrical building blocks of photovoltaic modules, known colloquially as solar panels.



Some of the operational solar power plants in the Philippines are:

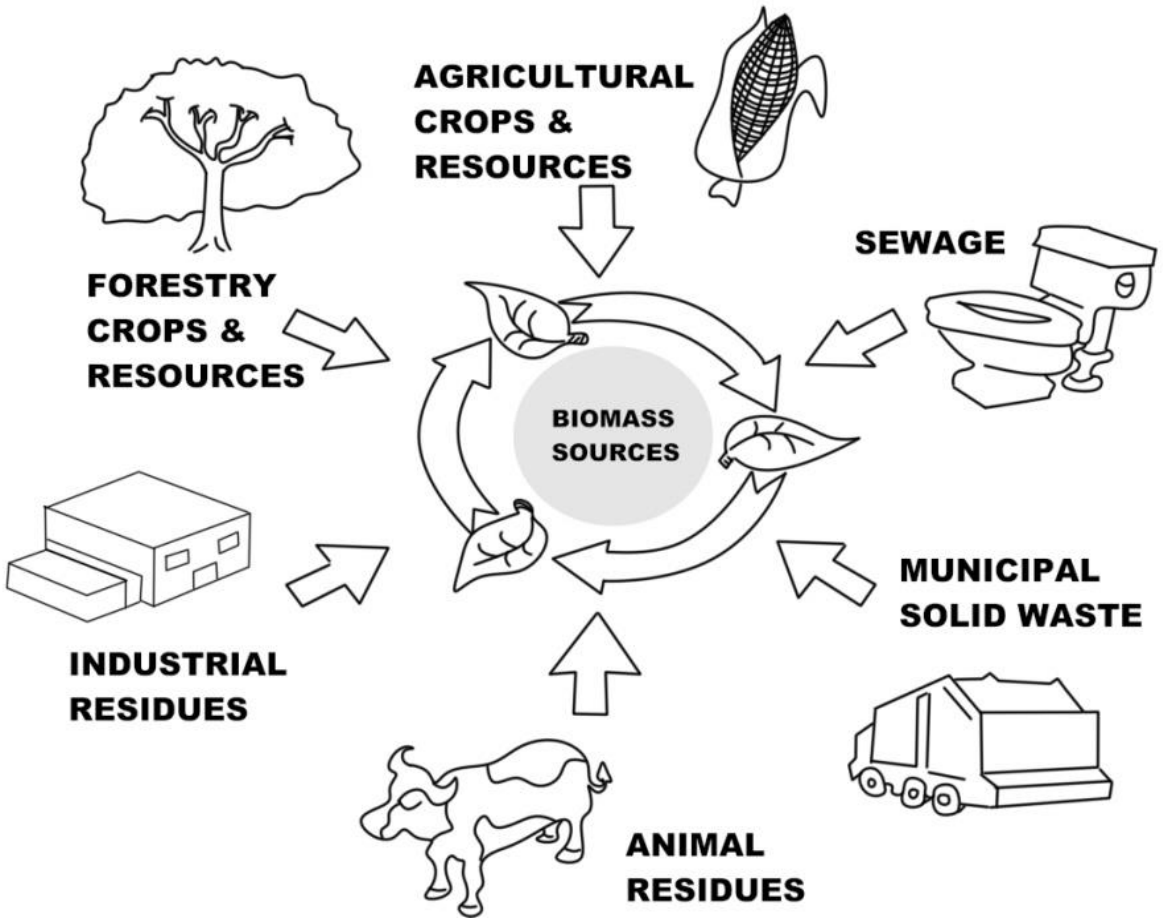
- Lian Sola Power Project and Calatagan Solar Power Project in Calatagan, Batangas
- Cavite Economic Zone Solar Power Project in Rosario and General Trias, Cavite
- CW Home Depot Solar Power Project and Central Mall Binan Solar Power Plant in Biñan City, Laguna

Solar energy is also known as “The People’s Power,” referring to the easy deployment of solar panels and the introduction of “community solar gardens” where energy is shared among owners.

- Solar energy is abundant, requires low maintenance, and is environmentally-friendly.
- Emissions associated with the manufacture of solar panels are present but very minimal compared to pollution caused by burning fossil fuels.
- Two of the harmful emissions from the manufacture of solar panels are nitrogen trifluoride and sulfur hexafluoride.
- Both are potent greenhouse gases.
- Some disadvantages of solar energy are: it is expensive, requires rare metals, and requires a good amount of space. Thankfully, the technology is continuously improving.

5. Biomass

Biomass refers to organic matter from plants and animals (microorganisms). Organic wastes such as crop remains, manure, and garbage usually left to rot, can be used for electricity generation. Rice husks and/or bagasse are burned as fuel to boil water. The steam from the boiling water is used to run steam turbines, which in turn drive generators to produce electricity.

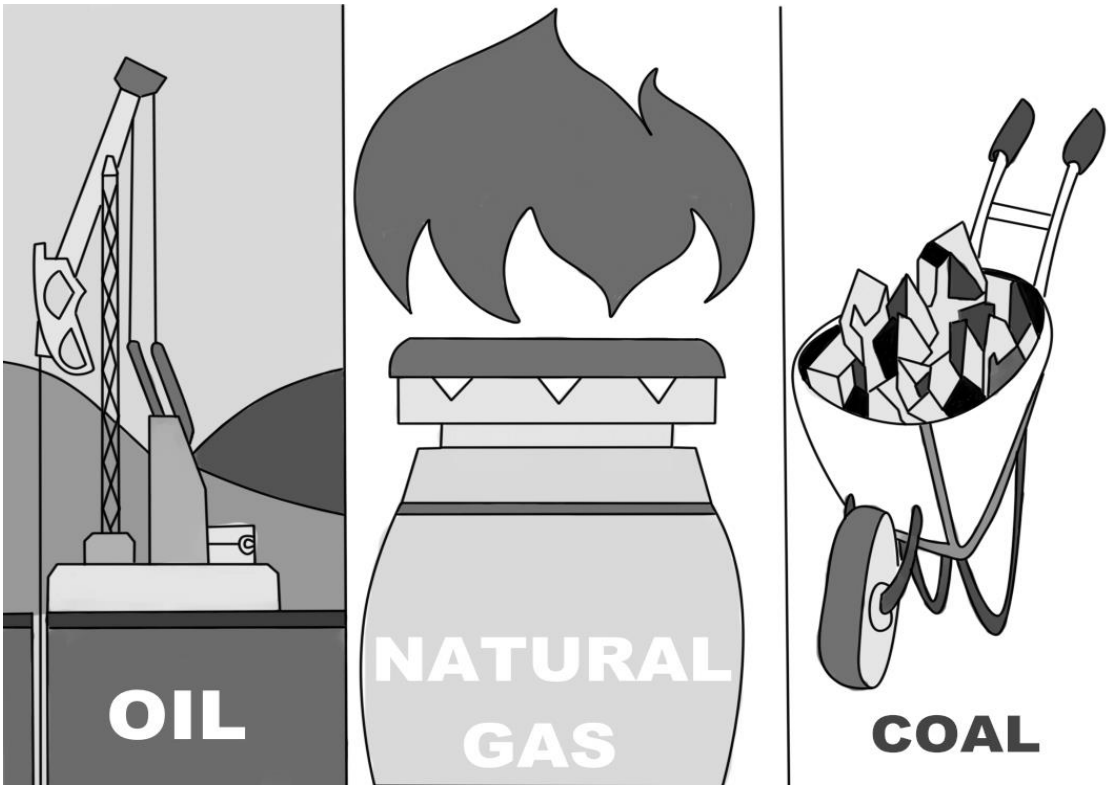


- Wood is also a biomass fuel.
- As long as we replenish the trees that we cut, biomass can be a sustainable energy source.
- Biomass is used to create methane and alcohol which are fuels useful in energy production and in powering automobiles.
- Production of biogas or biofuels involves the action of microorganisms that break down organic matter in a multi-step process.
- Technologies utilizing biomass are continuously evolving in order to improve efficiency.

II. Non-renewable Sources

1. Fossil fuels

Coal, oil and gas are fossil fuels, which have been formed over the last 600 million years. Coal is the fossilized remains of huge forests which covered many parts of the world in prehistoric times and hence contains biomass. As the trees and plants died, they were covered in layers of silt and sand and, under great pressure, gradually became formed into coal deposits.



- Coal is the world's most abundant fossil fuel. It is relatively inexpensive and is readily available.
- The formation of fossil fuels is due to a series of geologic processes where the remains of organic life are accumulated in the ocean bottom and are buried to eventually become part of the geosphere.
- They are buried to depths having high temperature and pressure where they are converted to oil, natural gas, or coal.
- In the Philippines, around 69% of our electricity is derived from fossil fuels (coal, oil, natural gas, biomass).
- In the world, around 75% of our energy is generated by combustion of fossil fuels.

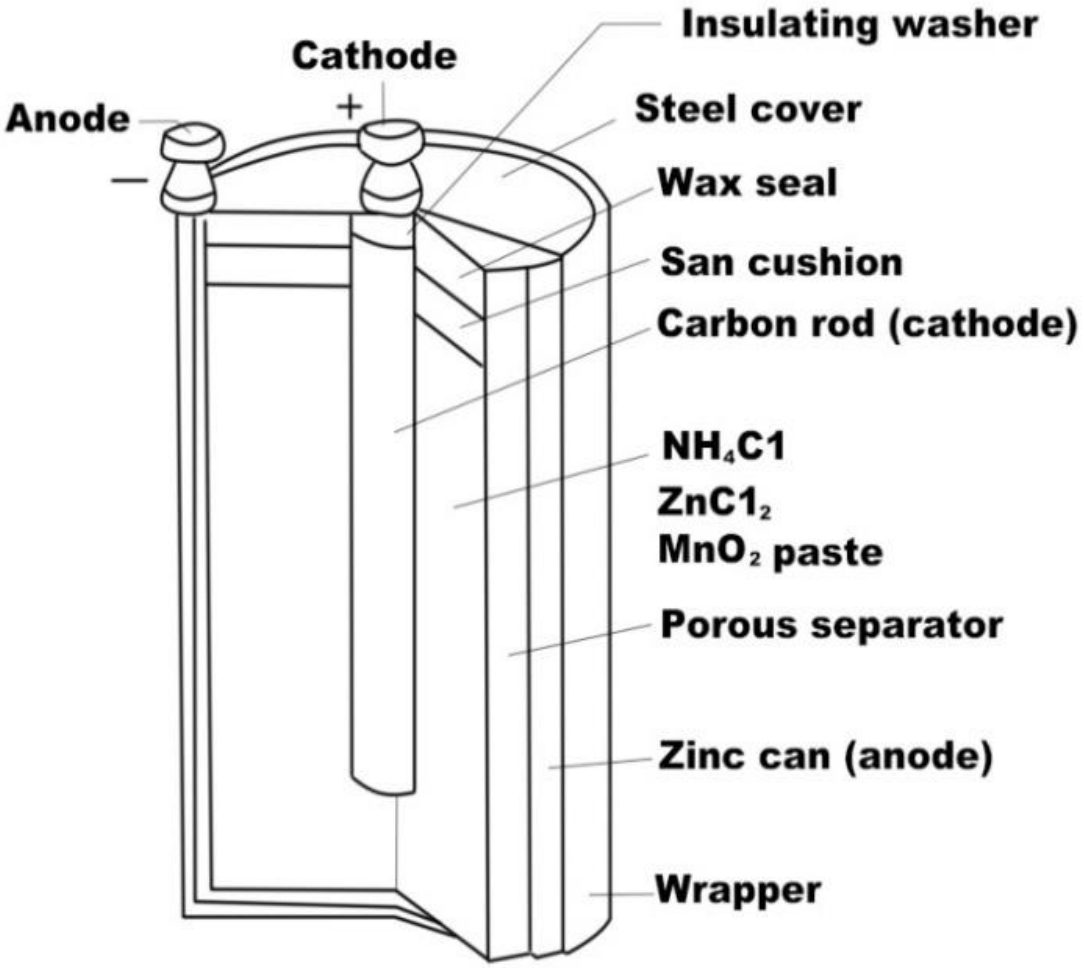
- Power plants burn fossil fuels and the heat generated during this process is used to turn water into steam and this turns the turbines.

2. Electrochemical (batteries)

A battery is a device that stores chemical energy and converts it to electrical energy. The chemical reactions in a battery involve the flow of electrons from one material (electrode) to another, through an external circuit. The flow of electrons provides an electric current that can be used to do work.

There are three main components of a battery: two terminals made of different chemicals (typically metals), the anode and the cathode; and the electrolyte, which separates these terminals. The electrolyte is a chemical medium that allows the flow of electrical charge between the cathode and anode.

Batteries, compared to other sources, have low intensity but they are commonly used since they are portable and efficient.



What's More

Activity 1.3 Table Summary

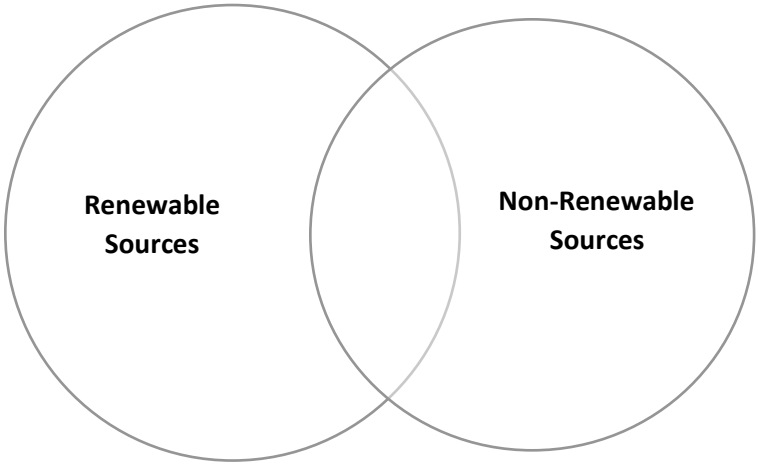
Direction: Summarize your understanding about the different sources of energy by filling out the table below. Use a separate sheet of paper for your answer.

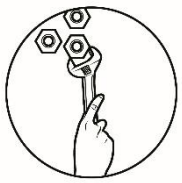
	Type of Electrical Source	**Example**
Fossil Fuel		
Electrochemical		
Geothermal		
Hydroelectric		
Wind		
Biomass		

What I Have Learned

Activity 1.4 Construct a Venn Diagram

Direction: Point out the similarities and differences between renewable and non-renewable sources of energy by using a Venn diagram on a separate sheet of paper.





What I Can Do

Activity 1.5 Create an Acrostic Poem

Direction: Now that you have the knowledge about the different sources of energy, create an acrostic poem using the word ENERGY.

Rubrics

Criteria	Excellent (4pts)	Merit (3pts)	Achieved (2pts)	Needs Improvement (1pt)	Score
Content	Information are clearly presented and ordered in such a way that it brings a full picture of the material	Information are clearly presented and ordered	Information is clear Order of information does not clearly show	Information is unclear and written in random order	
Creativity	It is visually inviting and easy to read	Visually inviting and easy to read	Visually pleasing and readable	Readable	
Spelling and Grammar	All spelling and grammar are correct	Some spelling and grammar error	Some spelling and grammar error	Notable spelling and grammar error	
Punctuality	Submitted on time	Submitted on time	Submitted on time	Submitted after the deadline	
				TOTAL	

Highest possible score: (4x4)/4= 4 components

Sample Score Sheet

Adjectival Rating	Rating Range	Grade Range
Excellent	3.4-4.0	95-100
Merit	2.6-3.3	88-94
Achieved	1.8-2.5	81.87
Needs Improvement	1-1.7	75-80

Criteria	Score
Content	3
Creativity	3
Spelling and Grammar	3
Punctuality	4
TOTAL	**13**

13pts/4categories= **3.25**

Learner is within the Merit range and the teacher may choose a grade within this range.

Assessment

Modified True or False. Read each statement carefully. Write **True** if the statement is correct; if the statement is **FALSE**, change the italicized word to make it true. Write your answer on a separate sheet of paper.

_____1. *Biomass* is used to create methane and alcohol which are fuels useful in energy production and in powering automobiles.

_____2. Electrical sources can be broken down into *three* major groups.

_____3. *Hydroelectric power* utilizes the heat energy from the earth's crust.

_____4. *Solar* energy is abundant, requires low maintenance, and is environmentally-friendly.

_____5. *Wind turbines* are installed in strategic locations to harness the mechanical energy from wind.

_____6. The *cushion* is a chemical medium that allows the flow of electrical charge between the cathode and anode.

_____7. The world's most abundant fossil fuel is *natural gas*.

_____8. The most common *fuels* are coal, natural gas, and uranium (nuclear power).

_____9. A *generator* converts the kinetic energy of falling water into mechanical energy.

_____10. Batteries have *high* intensity but they are commonly used since they are portable and efficient.

_____11. *Geothermal* energy is less of an environmental hazard compared to fossil fuels.

_____12. Wastes such as crop remains, manure, and garbage are good sources of *biomass*.

_____13. *Nonrenewable* source is produced from sources that do not deplete or can be replenished within a human's life time.

_____14. An electric fan uses electricity to produce *wind*.

_____15. *Water* is widely used to produce electricity.

Additional Activities

Activity 1.6

Direction: Make either a poster, a flyer, or a brochure on a product (such as fuels, household, or personal care products) indicating its uses, properties, mode of action, and precautions.

Answer Key

What I Have Learned

Answers may vary.

Assessment

1. True
2. two
3. Geothermal
4. True
5. True
6. electrolyte
7. coal
8. True
9. turbine
10. low
11. True
12. True
13. Renewable source
14. True
15. True

Additional Activities

Answers may vary.

What I Can Do

Answers may vary.

What's More

Answers may vary on third column.

	Type of Electrical Source	Example
Fossil Fuel	non-renewable	coal
Electrochemical	non-renewable	batteries
Geothermal	renewable	*Maitibog Geothermal Power Station*
Hydroelectric	renewable	Pulangi IV Hydroelectric Power Plant
Wind	renewable	Bangui Wind Farm
Biomass	renewable	manure

What I Know

1. B
2. B
3. B
4. B
5. D
6. C
7. C
8. D
9. C
10. A
11. C
12. D
13. A
14. A
15. B

What's In

1. potential
2. electricity
3. geothermal
4. solar
5. renewable
6. battery
7. biomass

What's New

1. The different sources of energy in the Philippines are coal, natural gas, oil, geothermal, hydroelectric and others.

2.

	Luzon	Visayas	Mindanao
Main source of electricity	Coal	Geothermal	Hydroelectric
Percentage	47%	49%	52%
Second Source of Electricity	Natural gas	Coal	Oil
Percentage	34%	42%	22%
Third Source of Electricity	Hydroelectric	Oil	Coal
Percentage	10%	7%	17%

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