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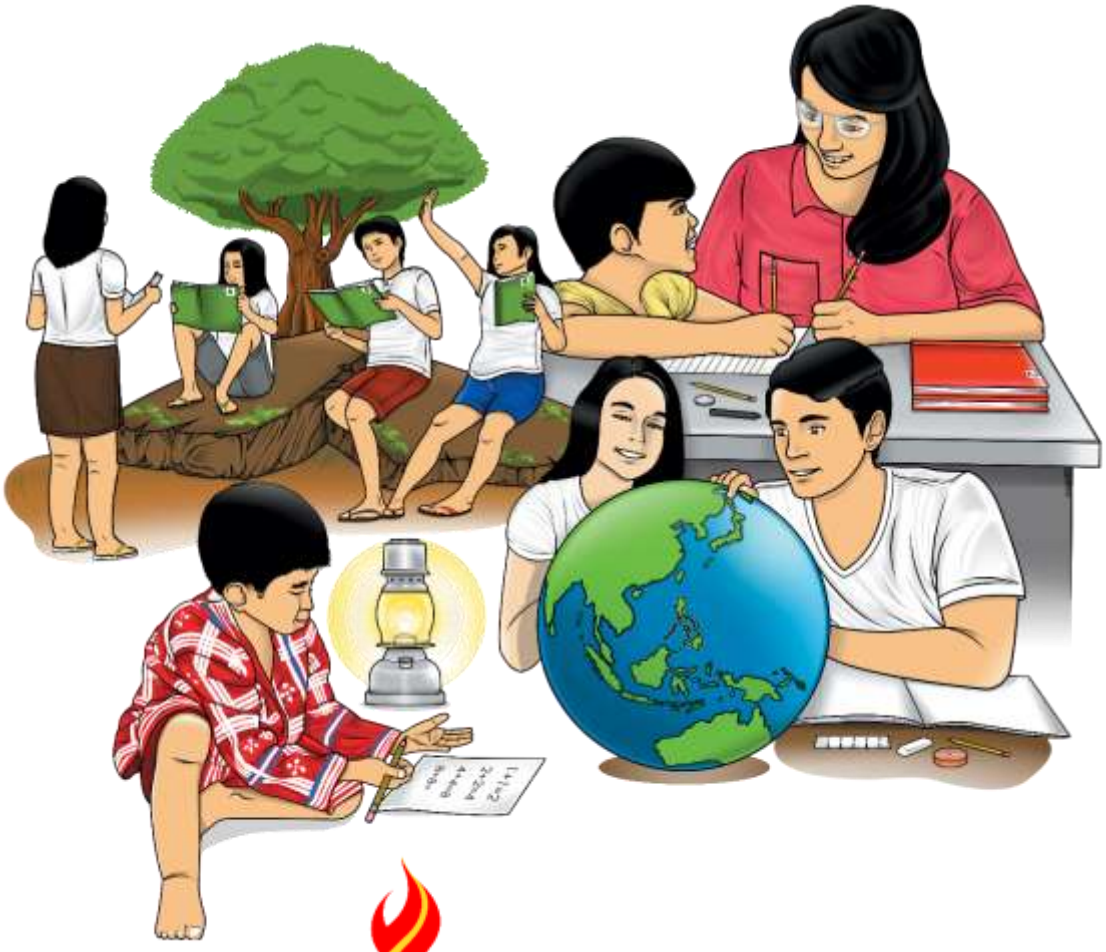
DEPARTMENT OF EDUCATION

Science

Quarter 3 – EARTH & SPACE

Module 3: Geothermal Energy



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Science

Quarter 3 – EARTH & SPACE

Module 3: Geothermal Energy

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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 the sources and type of energy from the volcano. 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.

The module focuses on achieving this learning competency:

Illustrate how energy from volcanoes may be tapped for human use- (S9ES-IIIc-d-29).

After going through this module, you are expected to:

1. describe the formation of energy from volcanoes;
2. explain how a geothermal energy is transformed into electrical energy;
3. create a concept map showing production of geothermal energy from Earth's interior;
4. identify types of volcanoes which can be good sources of geothermal energy;
5. identify the volcanoes in the Philippines which are sources of geothermal energy;
6. enumerate the uses of energy from volcanoes to human; and,
7. identify the advantages and disadvantages of using geothermal energy.

What I Know

Direction: Choose the letter of the best answer. Write the chosen letter on a separate sheet of paper.

1. Which geothermal plant is located at Albay province?
   A. Tiwi Geothermal Plant
   B. Ampiro Geothermal Power Project
   C. Maibarara Geothermal Power Plant
   D. Montelago Power Plant

2. What is being harnessed from the interior of the Earth that is used by geothermal power plants?
   A. heat
   B. mineral
   C. electricity
   D. solar power

3. What form of energy is generated using hot water steam from deep in the earth?
   A. Geothermal
   B. Hydropower
   C. Solar power
   D. Dendrothermal

4. What do dry steam, flash steam, and binary cycle geothermal plants have in common that they used to generate electricity?
   A. Solar turbines
   B. Nuclear turbines
   C. Steam turbines
   D. Water turbines

5. Which is being used to lead hot water or steam from the reservoirs into the power plants?
   A. Injection wells
   B. Rock catchers
   C. Heating boilers
   D. Production wells

6. Which draws the water up from the production wells and returns to the geothermal reservoir where it regains the thermal energy for electricity generation?
   A. Injection wells
   B. Rock catchers
   C. Heating boilers
   D. Production wells

7. What does “sustainable” energy source imply?
   A. It is limited in supply
   B. It will not be used up
   C. It may cause global warming
   D. It can be replenished within a human lifetime.

8. What is the negative effect of building geothermal energy?
    A. Cost
    B. Pollution
    C. Nuclear Fallout
    D. Global warming

9. Which method of converting energy is used by the Geothermal plant?
    A. Heat from the sun is used to generate electricity.
    B. Water from the dam is used to turn the turbine to generate electricity.
    C. Radiation from the radioactive substance is used to produce electricity.
    D. Heat inside the Earth is used to produce steam to generate electricity.

10. Which among these natural hazards has potential effect on geothermal power plants?
    A. Earthquakes
    B. Forest fires
    C. Hurricanes
    D. All of the above

11. What is the advantage of a geothermal power plant?
    A. renewable resources
    B. high temperature is required
    C. can cause surface instability
    D. suited only in particular region

12. Which of the following volcanoes is a source of Negros Oriental called EDC's Southern Negros Geothermal Production Field?
    A. Mount Taal
    B. Mount Talinis
    C. Mount Kanlaon
    D. Mount Pinatubo

13. What are the two volcanoes that run the Mak-ban Geothermal Power Plant?
    A. Mt. Bulalo and Mt. Olilia
    B. Mt. Taal and Mt. Bulusan
    C. Mt. Kanlaon and Mt. Olilia
    D. Mt. Kanlaon and Mt. Bulusan

14. Which pair of geothermal power plants and location is **INCORRECT?**
    A. Tiwi Geothermal Power Plant : Albay
    B. Mak - Ban : Laguna
    C. Mindanao Geothermal Production Field : Zamboanga
    D. Bac-Man : Sorsogon

15. Philippines is one of the world's top producers of this type of energy due to its location along the Pacific Ring of Fire. What type of energy source is being referred to?
    A. Dendrothermal
    B. Geothermal
    C. Hydropower
    D. Solar power

Lesson 1

Earth and Space: Geothermal Energy

In Modules 1 and 2, you have learned the different types of volcanoes and volcanic eruption. You can now explain what happens when a volcano erupts. In this module, you will be dealing with how the energy coming from volcanoes differ from other energy sources, identify the type of volcanoes which can be a good source of geothermal energy, create a diagrammatic representation of geothermal energy flow in a geothermal power plant, explain how geothermal energy is transformed into electric energy, and identify the advantages and disadvantages of using geothermal energy.

Here are some key questions for you to ponder after finishing this module:

1. What are the volcanoes in the Philippines that is a good source of geothermal energy?
2. How is geothermal energy transformed into electrical energy?
3. How can energy from volcanoes be tapped for human use?
4. What are the advantages and disadvantages of using geothermal energy?

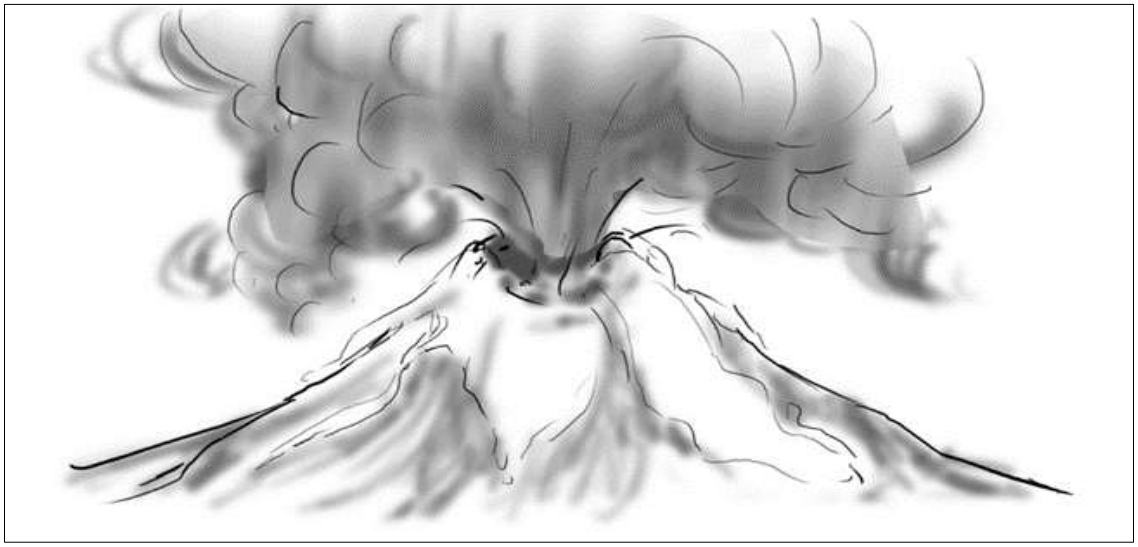
What's In

Let us recall your understanding about volcanic eruption by answering the given questions. Write your answer on a separate sheet of paper.

1. Describe two ways that volcanoes can change the surrounding environment rapidly.
2. Describe two ways that the surrounding environment of a volcano can change over many years.

Illustrated by Ellissa Christie Kaye L. Murillo

What's New



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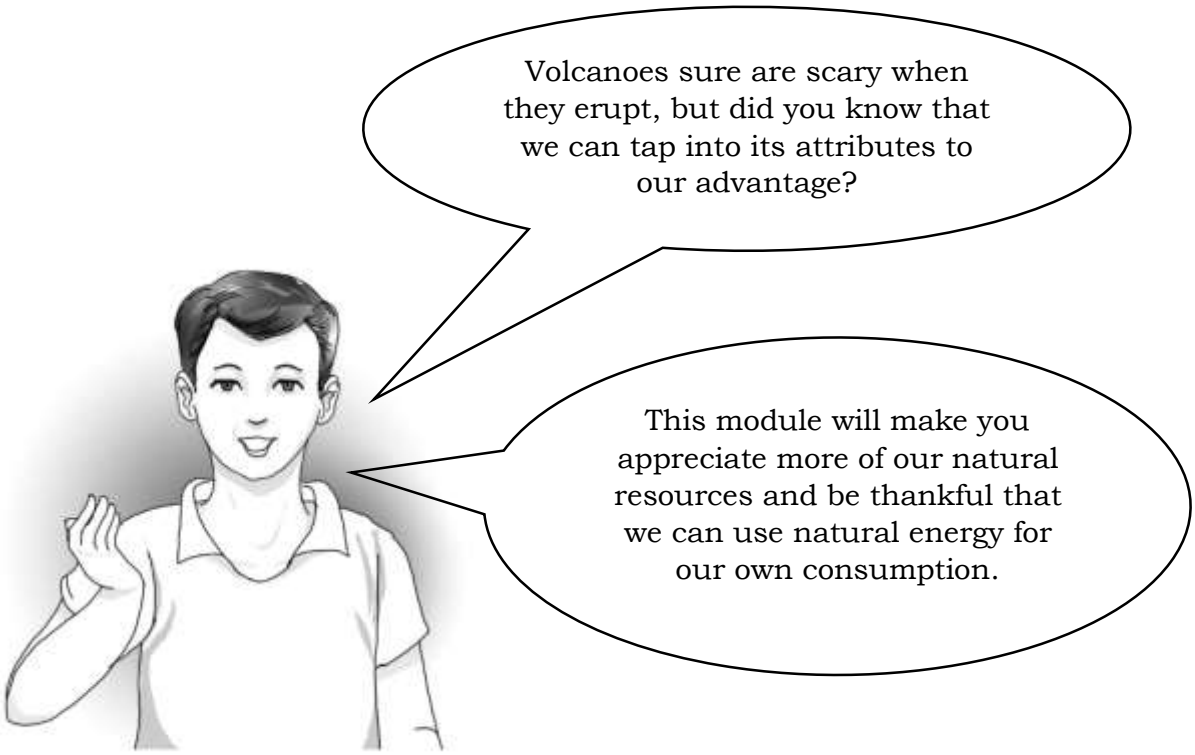


Source: *DepEd BLR Illustrations*

Have you ever seen a geothermal power plant?
How does it function as an alternative source of energy?

What is It

Energy from the Volcano

Since our country is a home to more than a hundred volcanoes, energy has been tapped from the depths of the Earth. Actually, the Philippines ranks second in the world's production of geothermal energy. According to the Department of Energy, 14.4% of the country's total power of generation is produced from the geothermal energy. The production of electricity from geothermal energy is cheaper than the electricity production using natural gas, coal, and hydropower.

What is Geothermal Energy?

The Earth is believed to be extremely hot from within. This heat from the Earth's interior is a source of energy called geothermal energy. The heat of the Earth warms up water which is trapped in rock formations beneath its surface.

There are two Geothermal Systems;

a. Conventional Geothermal System utilizes steam from natural resources such as geysers or by drawing water from the hot, high-pressure depths of Earth; and
b. Supercritical Geothermal System a naturally occurring hot water or steams flows heated by magma and circulating through permeable rock. In volcanic geothermal energy, the heat comes from supercritical. The energy from supercritical water is much higher than conventional steam.

How is geothermal energy generated?

Geothermal energy is generated in two ways: geothermal power plants and geothermal heat pumps. They differ in the depth of heat source to produce energy.

In geothermal power plants, the heat from deep inside the Earth is used to produce steam to generate electricity. In comparison with geothermal heat pumps, it uses the heat coming from close to the Earth's surface to heat water or provide heat for buildings.

In the Philippines, geothermal power plants are used to generate electricity in Tiwi (Albay), Kidapawan (North Cotabato), Calaca (Laguna), Tongonan (Leyte), Bago City (Negros Occidental), Valencia (Negros Oriental), and Bacon (Sorsogon).

Power Plant	Volcano	Location
Tiwi Goeothermal Power Plant	Mt. Malinao	Tiwi, Albay
Mindanao Geothermal Production Field	Mt. Apo	Kidapawan, Cotabato

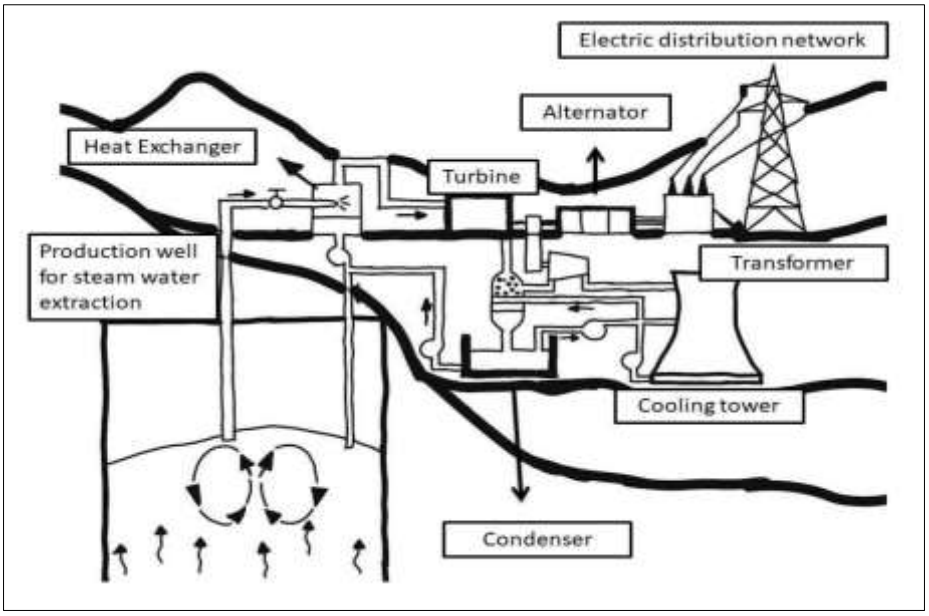
Makiling-Banahaw (Mak-Ban) Geothermal Power Plant	Mt. Bulalo and Mt. Olilia	Laguna
Leyte Geothermal Power Plants (Malitbog, Upper Mahiao, Mahanagdong, Tongonan)	Various Mountains	Leyte
Negros Occidental Power Plants (Northern Negros, Palinpinon, Nasulo)	Various Mountains, Northern – Mt. Kanlaon Southern – Mt. Talinis	Negros Occidental
BacMan Geothermal Power Stations 1 and 2	Pocdol Mountains	Sorsogon

The Geothermal Power Plant

Power plants are built in an area where it is particularly hot just below the surface or near a group of geysers, hot springs, or volcanic activity.

The following steps are followed to generate electricity in a geothermal power plant:

1. Wells are drilled deep into the earth to pump steam or hot water to the surface.
2. When the water reaches the surface, the drop in pressure causes the water to turn into steam.
3. The steam spins a turbine, which is connected to a generator that produces electricity.
4. Cooling tower cools the steam and condenses it back to water.
5. The cooled water is pumped back into the earth to begin the process again.



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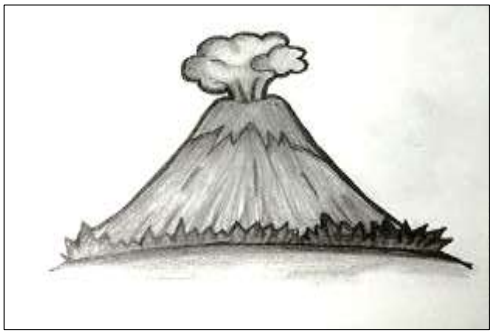
More stuff about Volcanoes!

A **VOLCANO** is an opening in the Earth's crust in which molten rock and fragments came out.



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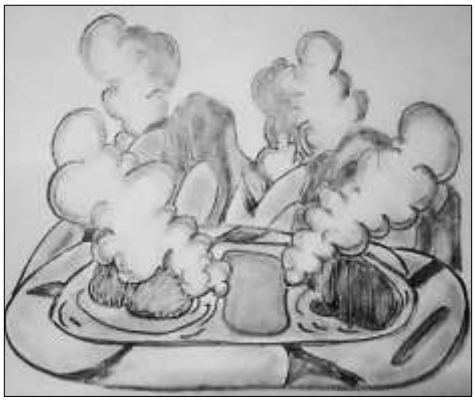

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A **HOT SPRING** is a source of water which flows out with a temperature higher than the average temperature of the neighboring areas.

Fumarole releases steam

A **FUMAROLE** is usually found in volcanic regions. It is a hole in the grounds where vapors and gases come out.

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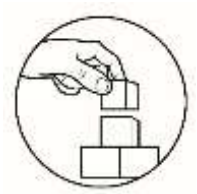
A **GEYSER** is a spring that occasionally shoots out hot water and steam.



What's More

ACTIVITY 1: THUMBS UP OR THUMBS DOWN

Read the statements below and mark it 👍 (thumbs up) if the statement is true or correct and 👎 (thumbs down) if the statement is false or incorrect. Write your answers on a separate sheet of paper.

_____1. High temperature inside the Earth turns different materials in the mantle to partially melt and can be used as source of energy.

_____2. Energy that comes from the heat inside the Earth is called Geothermal energy.

_____3. Geothermal energy converts heat to electricity using conventional and supercritical system.

_____4. Conventional Geothermal energy uses steam/heat produced from molten materials and water from the underground.

_____5. Supercritical system utilizes steam from geysers and hot-pressure depths of the Earth.

ACTIVITY 2: IDENTIFICATION

Identify the volcano and choose the answer on the table. Use a separate sheet of paper for your answers.

Mayon Volcano	Mount Pinatubo	Canlaon Volcano
Malinao Volcano	Taal Volcano	Mount Kratakoa

_____1. One of the most active volcanoes in the Philippines which located in Albay, Camarines Sur

_____2. An active stratovolcano situated in Central Negros Island

_____3. An active stratovolcano that can be found in the Zambales mountains

_____4. One of the most active and complex volcano located in Batangas

_____5. A potentially active volcano also known as Buhi or Takit situated between Albay and Camarines Sur.

ACTIVITY 3: FILL IN THE PROCESS

Arrange the step by step process of converting geothermal energy to electrical energy. Choose your answers below and write the corresponding letter to the numbered boxes, write your answer on a separate sheet.

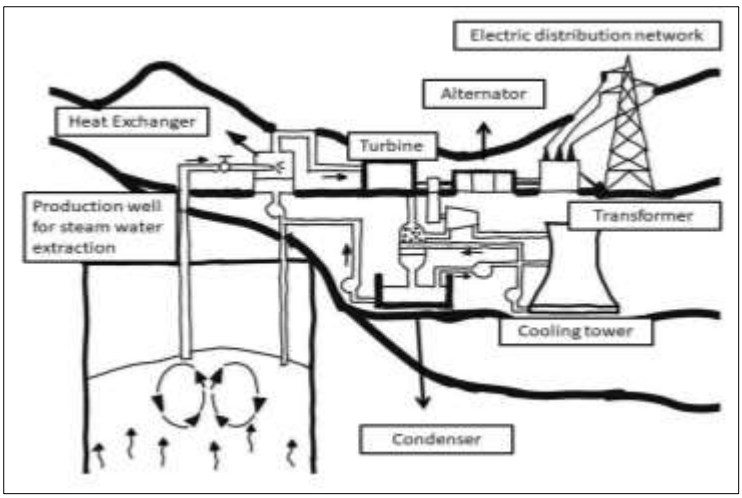
1.	2.	3.

4.	5.

A. The steam cools off in a cooling tower and condenses back to water.
B. When the water reaches the surface, the pressure is dropped, which causes the water to turn into steam.
C. The cooled water is pumped back into the Earth to begin the process again.
D. Hot water is pumped from deep underground through a well high pressure.
E. The steam spins the turbine, which is connected to the generator that produces electricity.

ACTIVITY 4: EXPLAIN...EXPLAIN

Explain how geothermal energy flows in a geothermal power plant using the diagram below. Use a separate sheet of paper for your answers.



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_____

_____

_____.

ACTIVITY 5: MY TOP 5!

List five activities that make use of geothermal energy. Use a separate sheet of paper for your answers.

MY TOP 5 ACTIVITIES

1.

2.

3.

4.

5.

What I Have Learned

Determine the word that correctly completes the statement. You may choose your answer from the words inside the box. Write your answer on a separate sheet of paper.

Geothermal energy	electricity	Earth's surface
Conventional	heat	Volcanic
more	steam	water
turbines	vapors	supercritical water
higher	gas	pressure

(1)_____uses the (2)_____ trapped beneath the (3)_____ to generate (4)_____. (5)_____geothermal energy utilizes (6)_____ from natural sources such as geysers, or by drawing (7)_____ from the hot, high-pressure depths of the Earth. The hot (8)_____ are then used to drive electric (9)_____.

In the case of (10)_____geothermal energy, the heat comes from (11)_____. The researchers explained that energy from so called supercritical water is much (12)_____ than conventional geothermal steam. When molten rock and water meet, the extreme heat and (13)_____ bring water to a "supercritical" state, where it is neither liquid or nor (14)_____. In this form, the water can carry (15)_____ energy than normal steam, which could create up to 10 times the power output of other geothermal sources.

What I Can Do

ADVANTAGE VS. DISADVANTAGE

Read and answer the questions below and give its advantages and disadvantages on the following; Social, Environmental and Renewable resources?

What is Geothermal Energy?

_____

Social		**Environmental**	
Advantages	Disadvantages	Advantages	Disadvantages
Renewable			
Advantages		Disadvantages	

Assessment

Direction: Choose the letter of the best answer. Write the chosen letter on a separate sheet of paper.

1. Heat from the volcano can be utilized as energy source. Which energy comes from the volcano?
   A. Biomass
   B. Dendrothermal
   C. Geothermal
   D. Hydroelectric

2. Which locations can be good sources of geothermal energy?
   A. Ocean, river, sea
   B. Geyser, ocean, river
   C. Geyser, hot spring, ocean
   D. Geyser, hot spring, steam vents

3. Where is the first geothermal power plant located in our country?
   A. Albay
   B. Batangas
   C. Leyte
   D. Negros

4. Which statement is TRUE about geothermal energy?
   A. Its supply is limited
   B. It causes global warming
   C. It generates greenhouse gases
   D. It is a sustainable energy source

5. Which shows the correct sequence of the flow of energy in a Geothermal Power Plant?
   A. electricity ⟶ steam ⟶ generator ⟶ turbine ⟶ hot water
   B. hot water ⟶ generator ⟶ turbine ⟶ steam ⟶ electricity
   C. generator ⟶ turbine ⟶ steam ⟶ hot water ⟶ electricity
   D. hot water ⟶ steam ⟶ turbine ⟶ generator ⟶ electricity

6. Heat energy can be trapped and used for our daily activities. What are the two ways in doing this?
   A. through the use of fossil fuels
   B. through Geothermal heat pumps
   C. through Geothermal power plant
   D. Both B and C

7. How is geothermal energy harnessed as source of electricity?
   A. Wells are drilled on Earth's surface to pump steam or hot water
   B. The steam from hot water spins the turbine to produce electricity
   C. The turbines are connected to generators that generates electricity
   D. All of the above

8. What is the positive effect of building a geothermal powerplant?
   A. Lesser cost
   B. Lesser Pollution
   C. Nuclear Fallout
   D. Global Warming

9. Which problem may occur as a result of building a geothermal energy facility?
   A. The burning of fossil fuel.
   B. Water pollution from the chemicals.
   C. Toxic gases can be released when drilling.
   D. All the above

10. Geothermal Power Plants is susceptible to trigger this natural calamity?
   A. Earthquakes
   B. Forest Fire
   C. Hurricanes
   D. All the above

11. Which of these are considered as the disadvantages of using geothermal energy?
   I. Low carbon footprints energy source
   II. Reservoirs are not permanent
   III. Harmful gases maybe released into the atmosphere
   IV. High cost of constructing the system
   A. I and II
   B. II and III
   C. I, III and IV
   D. II, III and IV

12. What is/are the advantages of using geothermal energy?
   I. The production cost is cheaper
   II. The main source of energy is the sun
   III. Safe and friendly to the environment
   IV. It is available everywhere on Earth
   A. I and II
   B. I and III
   C. III only
   D. IV only

13. Arrange the following sequence of conversion of geothermal energy into electrical energy in a geothermal power plant.
   I. Steam is used to turn the turbine
   II. Cool water is injected to the ground
   III. Generator converts mechanical to electrical energy
   IV. Hot water is pumped up and steam is produced
   A. I, II, III, IV
   B. II, III, I, IV
   C. II, IV, I, III
   D. IV, I, III, II

14. Which volcano is located on the northwest slopes of North Cotabato and Davao Provinces?
    A. Mt. Bulusan
    B. Mt. Apo
    C. Mt. Olilia
    D. Mt. Taal

15. Why is the Philippines the best place to build geothermal power plants?
    A. Because Philippines is a rich country.
    B. Because the temperature in the Philippines is too hot.
    C. Because the Philippines is in the of Pacific Ring of Fire.
    D. Because there is lesser chance that an earthquake might happen.

Additional Activities

Directions: Each letter has a number. To unlock the code, copy the letter that goes with the number. Write your answer on a separate sheet of paper.

1	2	3	4	5	6	7	8	9	10
A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**
11	12	13	14	15	16	17	18	19	20
K	**L**	**M**	**N**	**O**	**P**	**Q**	**R**	**S**	**T**
21	22	23	24	25	26	CODE BOX			
U	**V**	**W**	**X**	**Y**	**Z**				

20	8	5	18	13	1	12

5	14	5	18	7	25

9	14

20	8	5

18	15	3	11

1	14	4

6	12	21	9	4

20	8	1	20

6	9	12	12	19

6	18	1	3	20	21	18	5	19

1	14	4

16	15	18	5	19

23	9	20	8	9	14

20	8	5

18	15	3	11

9	14

20	8	5

5	1	18	20	8	19

3	18	12	19	20

Answer Key

Activity 2	Activity 1	What I Know
1. Mayon Volcano 2. Mount Canlaon 3. Mount Pinatubo 4. Taal Volcano Malinao Volcano	1. Thumbs Up 2. Thumbs Up 3. Thumbs Up 4. Thumbs down **5.** Thumbs down	1. A 6. A 11. A 2. A 7. D 12. B 3. A 8. A 13. A 4. C 9. D 14. C 5. D 10. A 15. B

Activity 3

1. D. Hot water is pumped from deep underground through a well high pressure.	**2. B.** When the water reaches the surface, the pressure is dropped. Which causes the water to turn into steam..	**3. E.** The steam spins a turbine, which is connected into a generator that produces electricity.
4. A. The steam cools off into a cooling tower and condenses back to water.		**5. C.** The cooled water is pumped back into Earth to begin the process again.

Activity 4

- Wells are drilled deep into the earth to pump stream or hot water to the surface.
- When the water reaches the surface, the drop in pressure causes the water to turn into steam.
- The steam spins a turbine, which is connected to a generator, that produces electricity.
- Cooling tower cools the steams which it condenses back to water.
- The cooled water is pumped back into Earth to begin the process again.

Activity 5

Answers may vary.

What I have Learned

1. Geothermal Energy	6. steam	11. supercritical water
2. heat	7. water	12. higher
3. Earth's surface	8. vapors	13. pressure
4. electricity	9. turbines	14. gas
5. conventional	10. volcanic	15. more

Additional Activity

THERMAL ENERGY IN THE ROCK AND FLUID THAT FILLS FRACTURES AND PORES WITHIN THE ROCK IN THE EARTH'S CRUST.

Assessment

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

What I Can Do

What is Geothermal Energy?

Geothermal Energy is a renewable resource derived from the earth's internal heat. Contained in the rocks and fluids beneath the earth's crust.

Social		Environmental	
Advantages	**Disadvantages**	**Advantages**	**Disadvantages**
Geothermal energy can be beneficial, as you can achieve saving of up to 80% over conventional energy usage.	One of its disadvantage is having a high initial cost for individual households. The need for drilling and installing quite a complex system into one's home makes the price climb quite high. Also, having a piece of land next to the house is required in order to be able to install one.	Geothermal energy is extracted from the earth without burning fossil fuels, and geothermal fields produce practically no emissions.	The extraction of geothermal energy from the grounds leads to a release of greenhouse gases like hydrogen sulfide, carbon dioxide, methane and ammonia. However, the amount of gas released is significantly lower than in the case of fossil fuels.
Renewable			
Advantages		**Disadvantages**	
Geothermal energy has many advantages when compared to other renewable sources like solar, wind or biomass. It is an exceptionally constant source of energy, meaning that it is not dependent on neither wind nor sun, and available all year long.		Despite being considered as sustainable and renewable energy, the chances are that specific locations might cool down after time, making it impossible to harvest more geothermal energy in future. The only non-depletable option is sourcing geothermal energy right from magma but the technology for doing so is still in the process of development.	

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