GEOTHERMAL POWER PLANT

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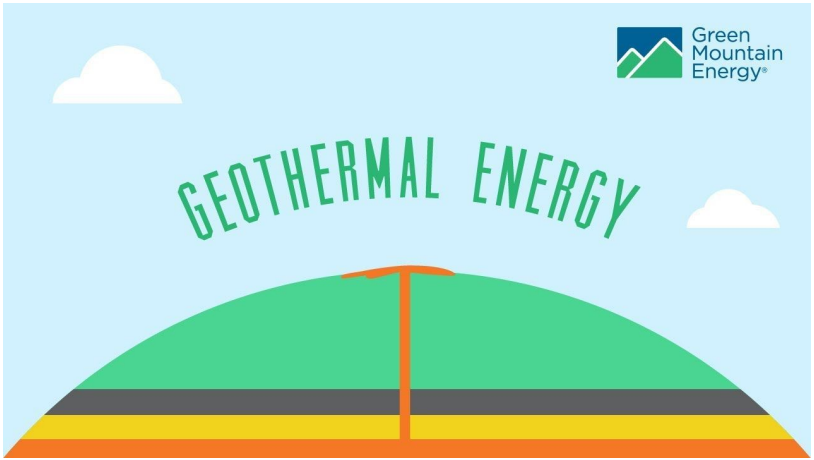
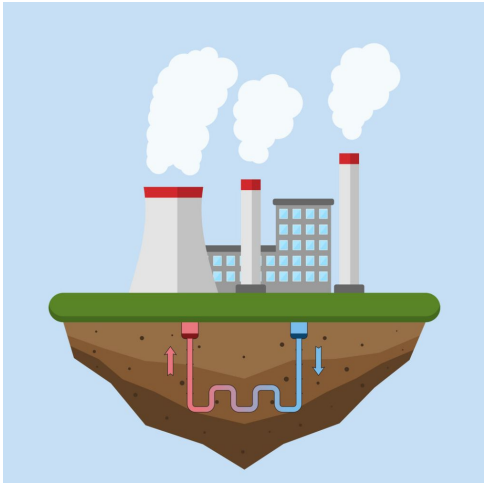
- Background
- Types of Geothermal Power plant
- Equipment and Process Flow
- Advantages and Disadvantages
- Conclusion and Recommendation

1

Background

Geothermal Energy
&
Geothermal Power Plant



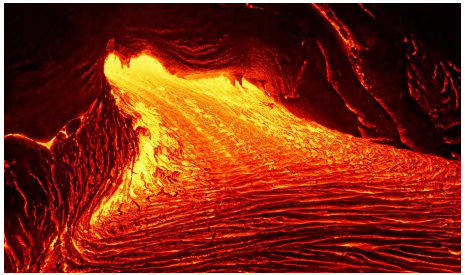


- It is the thermal energy stored in the Earth
- It is a clean, sustainable, and renewable energy source that has varying potential
- Can usually be found a few miles below the Earth's surface (can be 3-5 miles or even shallower)
- Shallow ground of up to 10 feet can also have areas where steam heated from magma streams are present, which can be used by simple applications of temperature control for buildings

SOURCES

★ **Magma**

Is able to produce “supercritical water” when water is mixed with molten rock which is around 427 °C, which carries more energy compared to conventional geothermal steam.



★ **Underground Hot Springs**

By drilling from the surface to the water, steam is directed to turbines to generate electricity

★ **Shallow Ground**

Ground around 10 feet from the surface of the earth, similar to a cave maintains constant temperature around 10-16 °C and is warmer than the air during winter and colder during summer.

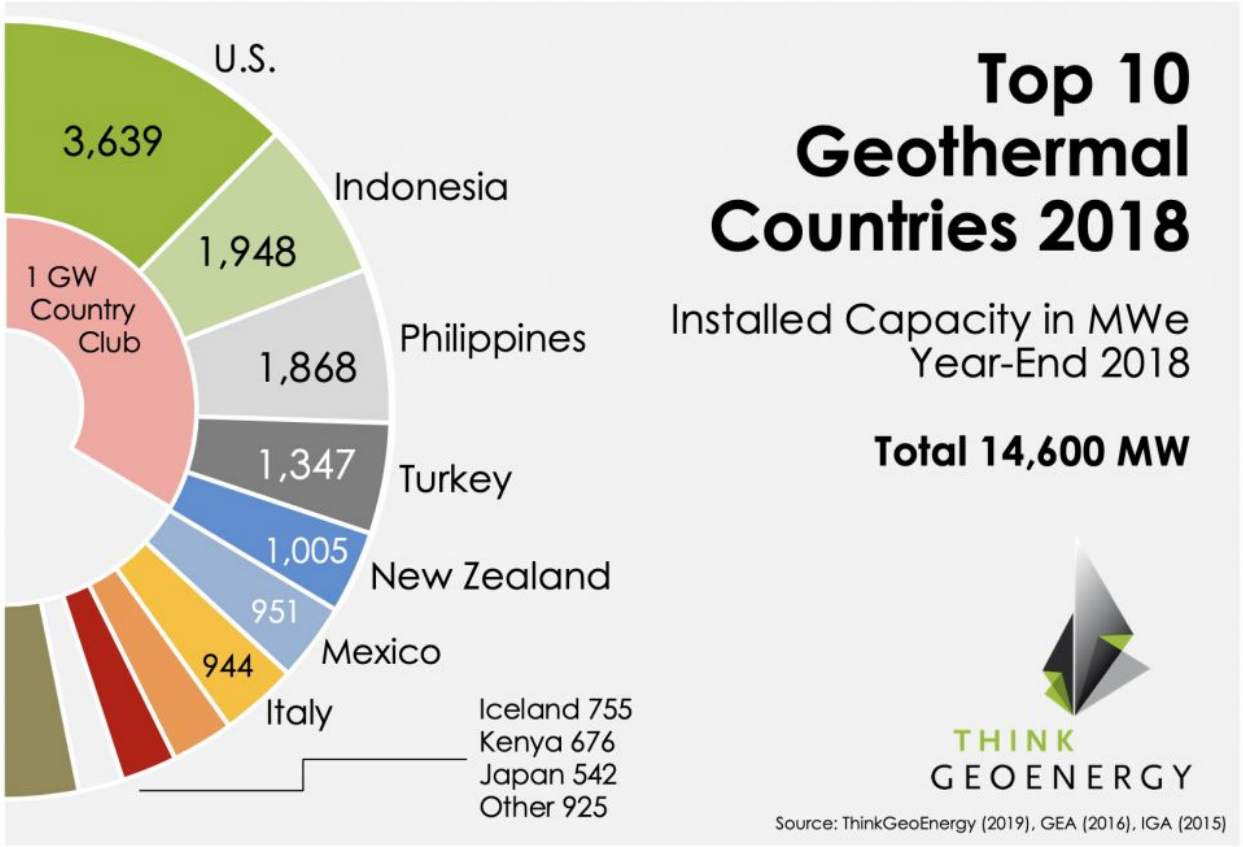
- Geothermal power plants are used in order to generate electricity by the use of geothermal energy (the Earth's internal thermal energy).
- They essentially work the same as a coal or nuclear power plant, the main difference being the heat source.
- Geothermal power plants require high-temperature (300°F to 700°F) hydrothermal resources that come from either dry steam wells or from hot water wells.

GEOTHERMAL HOTSPOTS

Salazar, S. et al (2017) Analysis of geothermal energy as an alternative source for electricity in Colombia. Retrieved from https://link.springer.com/article/10.1186/s40517-017-0084-x

Philippines is the third largest producer of Geothermal energy in the World.

GEOTHERMAL POWER PLANT



Richter, A. (2019). The Top 10 Geothermal Countries 2018. Retrieved from http://www.thinkgeoenergy.com/the-top-10-geothermal-countries-2018-based-on-installed-generation-capacity-mwe/

Philippine Setting

https://www.doe.gov.ph/geothermal-statistics

OPERATIONAL POWER PLANT

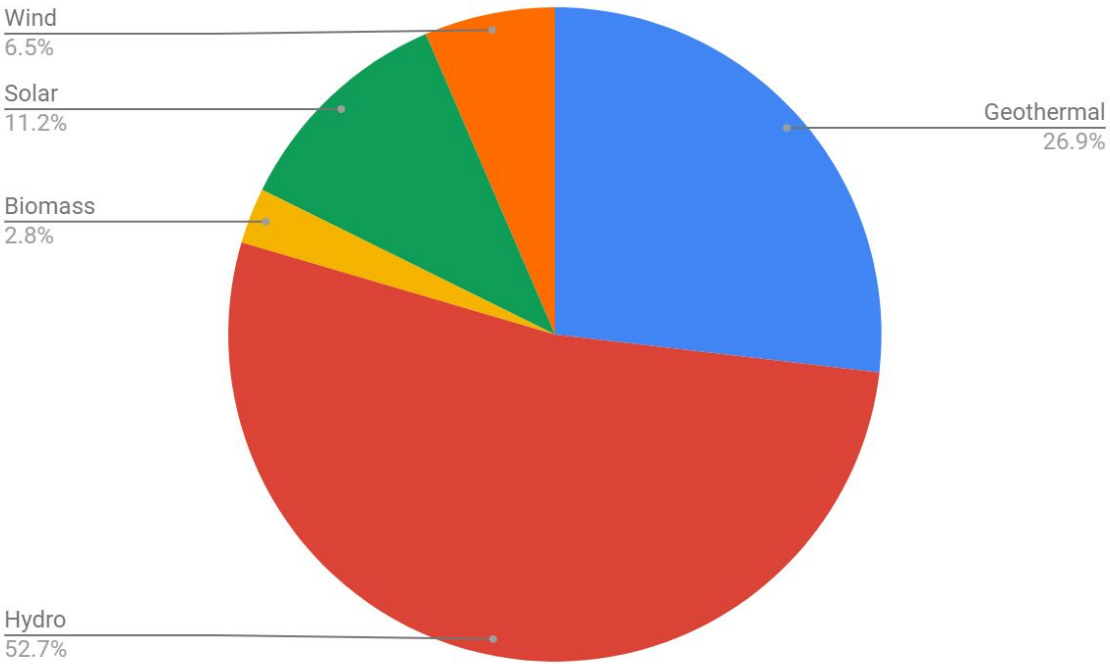
Station	Capacity (MW)	Commissioned
Bacman 1 & 2 Geothermal Power Station	120	1993
Malitbog Geothermal Power Station	20	1995
Upper Mahiao Geothermal Power Station	125	1996
Mahanagdong Geothermal Power Station	180	1997
Leyte Optimization Geothermal Power Station	50.9	1997
Tongonan Geothermal Power Plant	112.5	1982
Mindanao 1 & 2 Geothermal Power Plant	52 & 54	1997 & 1999
Palinpinon 1 & 2 Geothermal Power Plant	112.5 & 60	1983-1995
Nasulo Geothermal Power Plant	49.4	2015
Tiwi Geothermal Power Plant	275	1979
Maibarara Geothermal Power Plant	20	2014
Makiling-Banahaw Geothermal Power Plant	480	1979-1996

2018 Installed and Dependable Capacity, MW

Fuel Type	Installed		Dependable	
	2017	2018	2017	2018
Coal	**8,049**	**8,844**	**7,674**	**8,368**
Oil Based	**4,154**	**4,292**	**3,287**	**2,995**
Natural Gas	**3,447**	**3,453**	**3,291**	**3,286**
Renewable Energy	**7,080**	**7,227**	**6,263**	**6,592**
Geothermal	1,916	*1,944*	1,752	*1,770*
Hydro	3,627	*3,701*	3,268	*3,473*
Biomass	224	*258*	160	*182*
Solar	886	*896*	700	*740*
Wind	427	*427*	383	*427*
TOTAL	**22,730**	**23,815**	**20,515**	**21,241**

2018 Philippine Electricity Demand-Supply Snapshot. Department of Energy

Renewable energy



2018 Philippine Electricity Demand-Supply Snapshot. Department of Energy

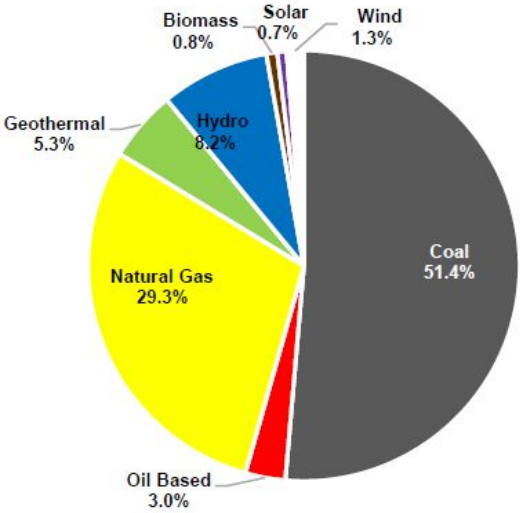


Figure 7. 2018 Gross Generation, Luzon

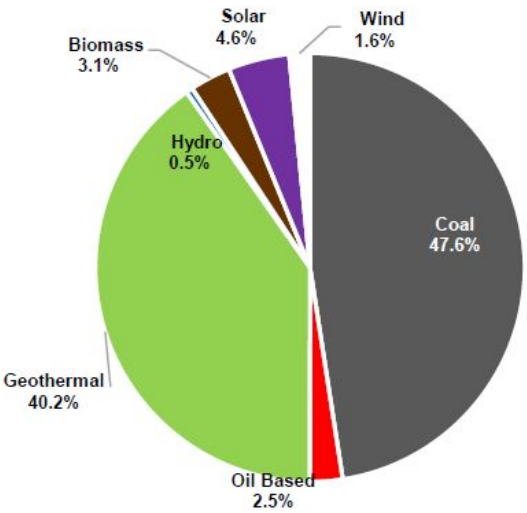


Figure 10. 2018 Gross Generation, Visayas

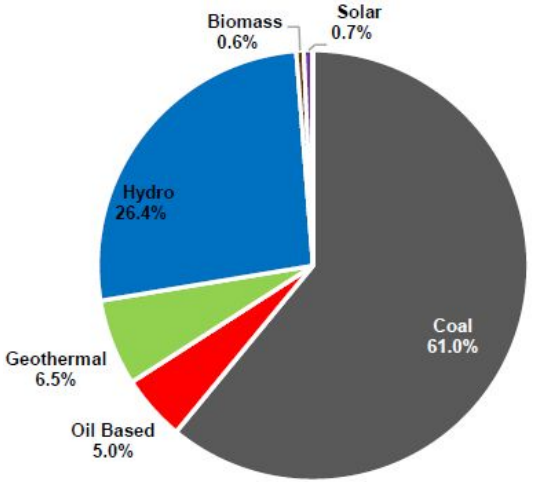


Figure 13. 2018 Gross Generation, Mindanao

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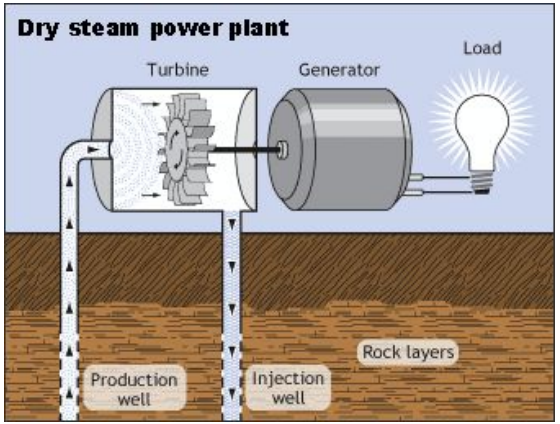
Types of Geothermal Powerplant

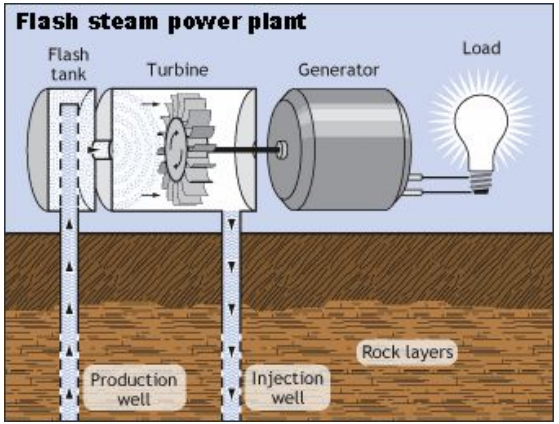
DRY STEAM



Least common

Steam directly from reservoir is used to drive the turbine

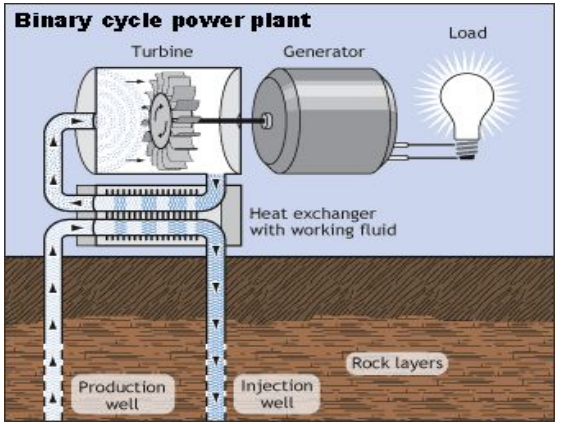
FLASH STEAM



Most common

Hot water from the reservoir rises and be converted to steam

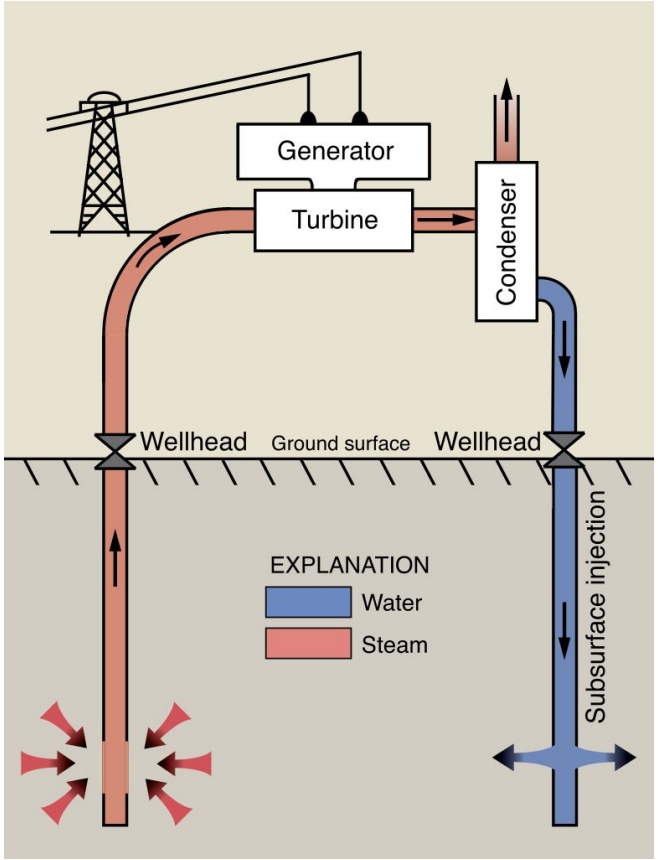
BINARY CYCLE



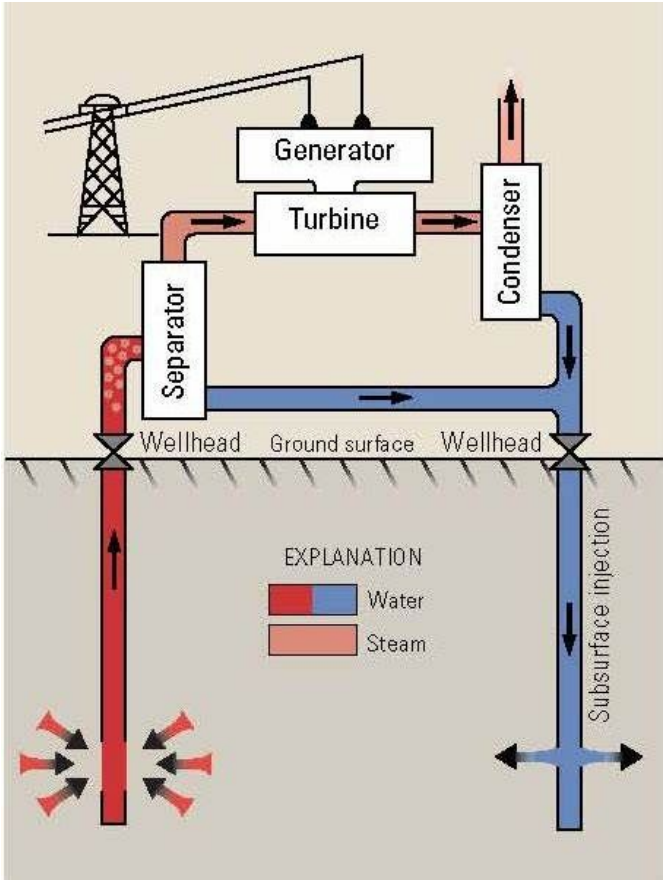
Two liquids are used - heat causes the second liquid to turn to steam

The oldest type of Geothermal power plant, the Dry Steam power plant utilizes geothermal steam reservoirs. These reservoirs are rare compared to water reservoirs which are utilized by Flash Steam cycles.

Steam extracted is at least 150℃

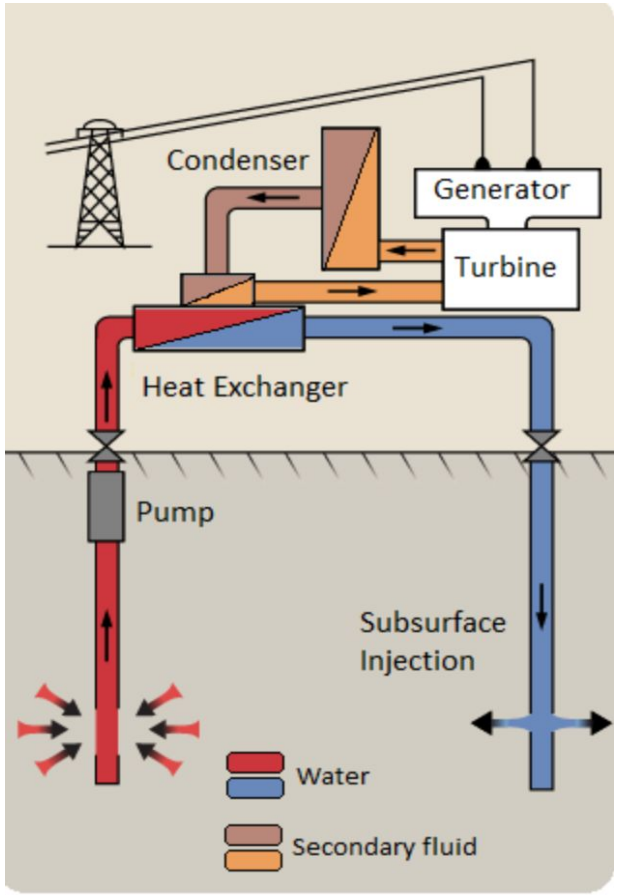


The most common type of geothermal power plant, this type pumps high pressure and high temperature water which is then vaporized by being diffused into a flash tank. The resultant steam is then used to generate electricity.



The Binary Cycle is a type of geothermal power plant which can utilize reservoirs with water temperatures lower than boiling point.

This cycle makes up for its lack of efficiency (around 10-13%) by allowing use of low temperature reservoirs without the need to heat the liquid from other means.



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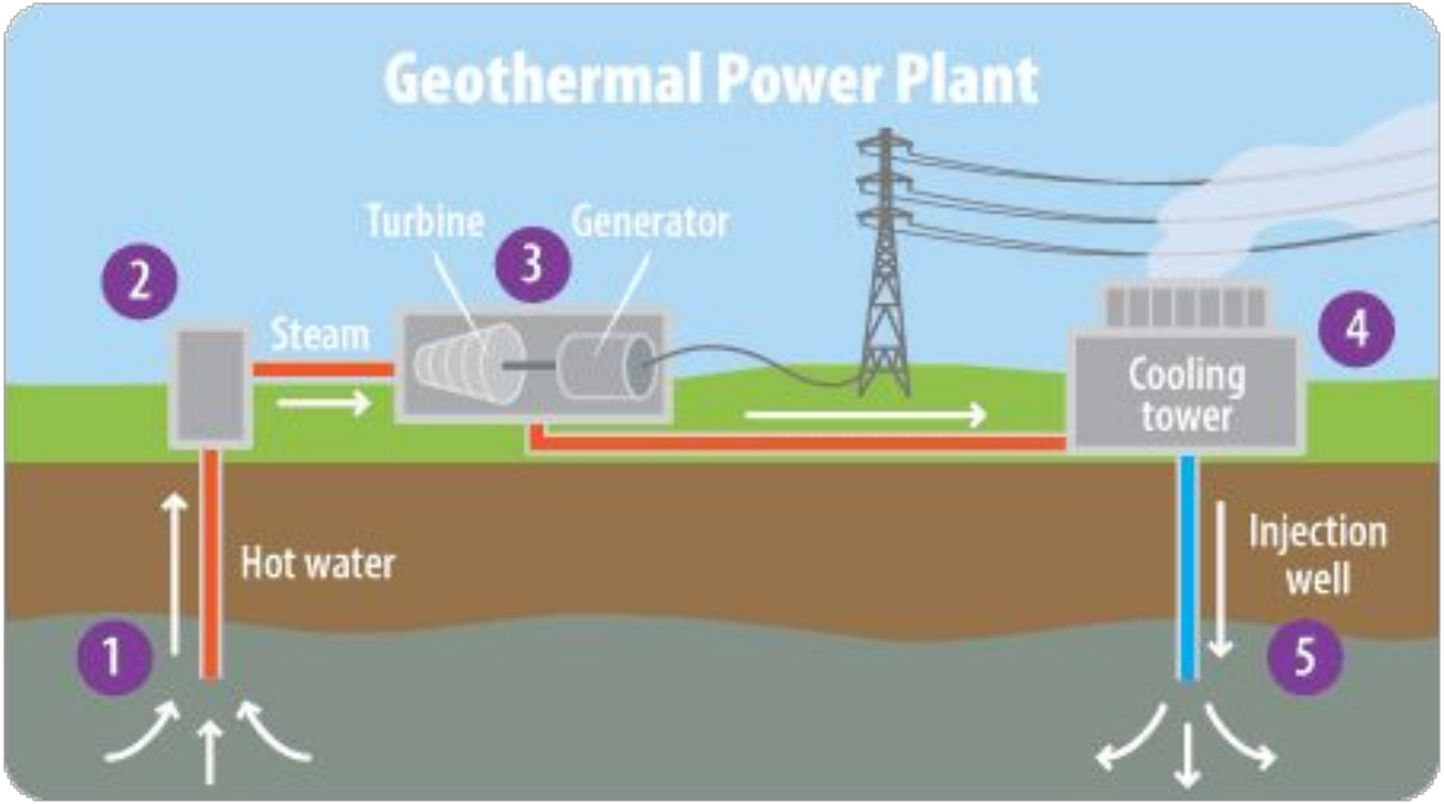
Equipment and Process Flow

Geothermal Power Plant


Geothermal Power Plant
Turbine
Generator
3
2
Steam
4
Cooling tower
Hot water
Injection well
1
5

Production Well - used to lead hot water/steam from the reservoirs into the power plant

Rock Catchers - are put in place to make sure that only hot fluid is sent to the turbine

Steam Turbine - extracts energy from the steam

Injection Well - is used to return the water that has been drawn up back to the geothermal reservoir where it regains energy

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Advantages and Disadvantages

Geothermal Power Plant

Advantages

- Can be extracted without burning a fossil fuel such as coal, gas, or oil
- Renewable source
- Accessibility
- Environment friendly

Disadvantages

- Location specific
- Release of hydrogen sulfide
- Disposal of some geothermal fluids

5

Conclusion and Recommendation

Geothermal Power Plant

With the modern day problems involving scarcity of fossil fuels and its negative impact on the environment, Geothermal energy arises as a great source of energy due to its ease of extraction and non-detrimental environmental impact.

Although the Philippines is already the 3rd largest country in terms of geothermal energy production, there are a lot of problems that the country faces brought by the lack of ethics of government officials such as irresponsible cost cutting and irresponsible waste management which would be a big problem especially with the disposal of waste fluids and the management of the release of hydrogen sulfide of geothermal plants. We recommend that the standards of safety be properly implemented and officials to have more accountability with geothermal plants.

LET’S PLAY A GAME!

What is the result of constant geothermal energy activity?

a.) Global Warming
b.) Earth Pollution
c.) Geothermal hotspots
d.) Stress of human beings

What is the average temperature of a shallow ground?

a.) 16-20 °C
b.) 10-16 °C
c.) 5-10 °C
d.) 20-27 °C

_____ is the fifth largest producer of Geothermal energy in the World.

a.) New Zealand
b.) U.S.
c.) Philippines
d.) Japan

Which of the following is the most common type of geothermal powerplant?

a.) Flash Steam
b.) Binary
c.) Dry Steam
d.) wasn't discussed

How does the binary cycle makes up for its lack of efficiency (around 10-13%)?

a.) by allowing use of high temperature reservoirs with the need to heat the liquid from other means.

b.) by allowing use of high temperature reservoirs without the need to heat the liquid from other means.

c.) by allowing use of low temperature reservoirs with the need to heat the liquid from other means.

d.) by allowing use of low temperature reservoirs without the need to heat the liquid from other means.

VIDEO

https://www.youtube.com/watch?v=mCRDf7QxjDk

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