"Productivity Improvement and Optimization of the World Geothermal Synergy"

Chemical Engineering

SEKOLAH TINGGI MANAJEMEN INDUSTRI KEMENPERIN RI

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History

Geothermal is a natural gift that is residual heat from the nuclear reactions that have occurred at the beginning of the formation of the earth and the universe. Nuclear reactions still occur naturally in the universe at the moment is a nuclear fusion reaction that occurs in the sun and also in the stars that are scattered in the universe. The natural nuclear fusion reaction produces heat of the order of millions of degrees Celsius.

The surface of the earth in the beginning also has a tremendous heat, but with the passage of time (in the order of billion years) the Earth's surface temperature begins to decrease and eventually live earth are still hot in the form of magma and that is the source of geothermal energy.Geothermal energy used by humans since about 2000 BC in the form of hot springs for treatment until today still many people do, especially hot springs that contain lots of salt and sulfur.While geothermal energy is used as a power plant started in Italy in 1904. Since then, geothermal energy began to be considered commercially for power generation

- Hot springs have been used for bathing at least since paleolithic times The oldest known spa is a stone pool on China's Lisan mountain built in the Qin Dynasty in the 3rd century BC, at the same site where the Huaqing Chi palace was later built. In the first century AD, Romans conquered *Aquae Sulis*, now Bath, Somerset, England, and used the hot springs there to feedpublic baths and underfloor heating. The admission fees for these baths probably represent the first commercial use of geothermal power. The world's oldest geothermal district heating system in Chaudes-Aigues, France, has been operating since the 14th century.
- The earliest industrial exploitation began in 1827 with the use of geyser steam to extract boric acidfrom volcanic mud in Larderello, Italy.
- In 1892, America's first district heating system in Boise, Idaho was powered directly by geothermal energy, and was copied inKlamath Falls, Oregon in 1900. A deep geothermal well was used to heat greenhouses in Boise in 1926, and geysers were used to heat greenhouses in Iceland and Tuscany at about the same time.[
- Charlie Lieb developed the first downhole heat exchangerin 1930 to heat his house. Steam and hot water from geysers began heating homes in Iceland starting in 1943.
- Global geothermal electric capacity. Upper red line is installed capacity;[lower green line is realized production.
- In the 20th century, demand for electricity led to the consideration of geothermal power as a generating source. Prince Piero Ginori Conti tested the first geothermal power generator on 4 July 1904, at the same Larderello dry steam field where geothermal acid extraction began. It successfully lit four light bulbs.
- Later, in 1911, the world's first commercial geothermal power plant was built there. It was the world's only industrial producer of geothermal electricity until New Zealand built a plant in 1958. In 2012, it produced some 594 megawatts.

- Lord Kelvin invented the heat pump in 1852, and Heinrich Zoelly had patented the idea of using it to draw heat from the ground in 1912.
- But it was not until the late 1940s that the geothermal heat pump was successfully implemented. The earliest one was probably Robert C. Webber's home-made 2.2 kW direct-exchange system, but sources disagree as to the exact timeline of his invention.
- J. Donald Kroeker designed the first commercial geothermal heat pump to heat the Commonwealth Building (Portland, Oregon) and demonstrated it in 1946. Professor Carl Nielsen of Ohio State University built the first residential open loop version in his home in 1948.[
- The technology became popular in Sweden as a result of the 1973 oil crisis, and has been growing slowly in worldwide acceptance since then. The 1979 development of polybutylene pipe greatly augmented the heat pump's economic viability.
- In 1960, Pacific Gas and Electric began operation of the first successful geothermal electric power plant in the United States at The Geysers in California.The original turbine lasted for more than 30 years and produced 11 MW net power.
- The binary cycle power plant was first demonstrated in 1967 in the USSR and later introduced to the US in 1981.[
- This technology allows the generation of electricity from much lower temperature resources than previously. In 2006, a binary cycle plant in Chena Hot Springs, Alaska came on-line, producing electricity from a record low fluid temperature of 57 °C (135 °F).

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Introduce Geothermal Energy

Geothermal is a source of heat energy contained in the hot water, steam, and associated minerals and rocks along with other gases that are genetically everything can not be separated in a system.Geothermal energy is environmentally friendly energy which CO2 emissions geothermal power plants is very low when compared with oil and coal, geothermal energy also endless as renewable. Geothermal energy is including primary energy

Primary energy in Indonesia is available in small quantities (limited) compared with the world's primary energy reserves. As an illustration, or at least limited energy is based on the data in Table I

Table 1 World primary energy reserves.

Oil Reserves	Indonesia 1,1 %	Middle East 70 %
Natural Gas Reserves	Indonesia 1-2 %	Rusia 25 %
Coal Reserves	Indonesia 3,1 %	North America 25 %

Preliminary Survey

- The event, which includes the collection, analysis, and presentation of data related to information geological, geophysical, geochemical, to estimate the location and existence of geothermal resources as well as the Work Area.

Geothermal Systems

Geothermal systems:

1).Heat Sources

2).Reservoir and Clay Cap

3). The existence of Hydrology System

Heat Sources

- The potential sources associated with volcanic pathways, which are generally high and the air enthalpy can be developed commercially for power generation. A small portion is associated with a geothermal source of non-volcanic system, typically has a relatively low temperature reservoir. Geothermal systems based on general geological structure can be divided into five types: single strato volcano, complex volcanic caldera, graben -kerucut volcanic and non-volcanic. Types of geothermal systems reflects the magnitude of its potential: the complex type of volcano, the caldera and graben-volcanic cone generally have the potential energy is much larger than the other types.

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Reservoir and Clay Cap

- **Introduction**

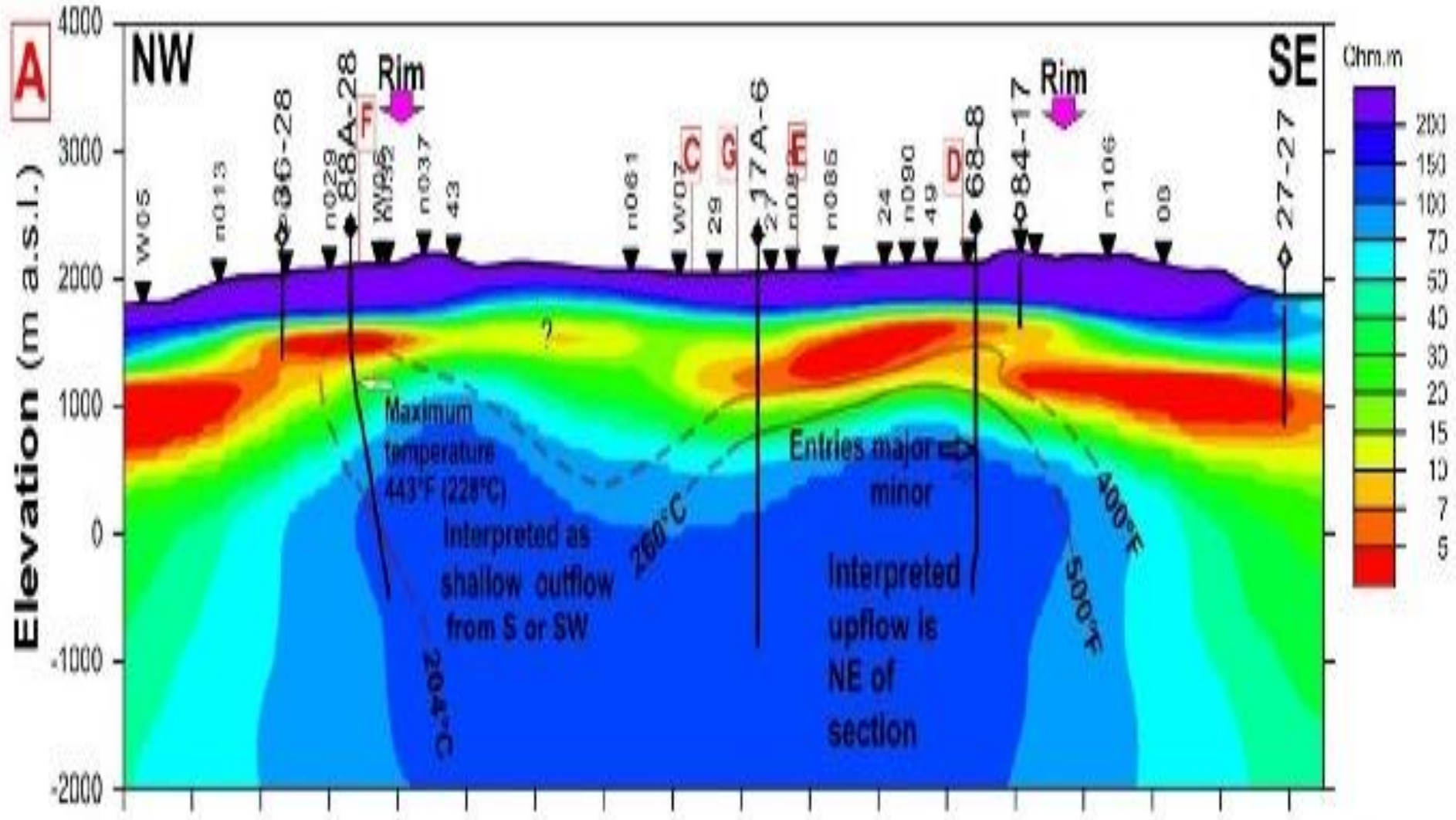
Magneto' refers to magnetic fields and 'telluric' refers to electric currents in the subsurface, derived from tellus (Latin for 'earth'). The fundamentals of magnetotellurics (MT) for a 1D structure were established by Tikhonov, Cagniard and Rikitake and the first papers were published on MT theory in the early 1950's. The term magnetotellurics was coined by Louis Cagniard in 1953.

Use in Geothermal Exploration

- Magnetotellurics is a classical technique applied toward geothermal exploration due to its sensitivity to signatures of geothermal systems and its superior depth of investigation relative to other geophysical techniques.

- The MT method is capable of resolving the low resistivity signature associated with the clay cap developed due to hydrothermal alteration resulting from fluid circulation within a geothermal system. This clay cap has a low permeability and acts as a trap over high temperature geothermal reservoirs. The type of clay mineral formed due to hydrothermal alteration largely depends on the temperature of the fluid (see Electrical Techniques: Use in Geothermal Exploration).

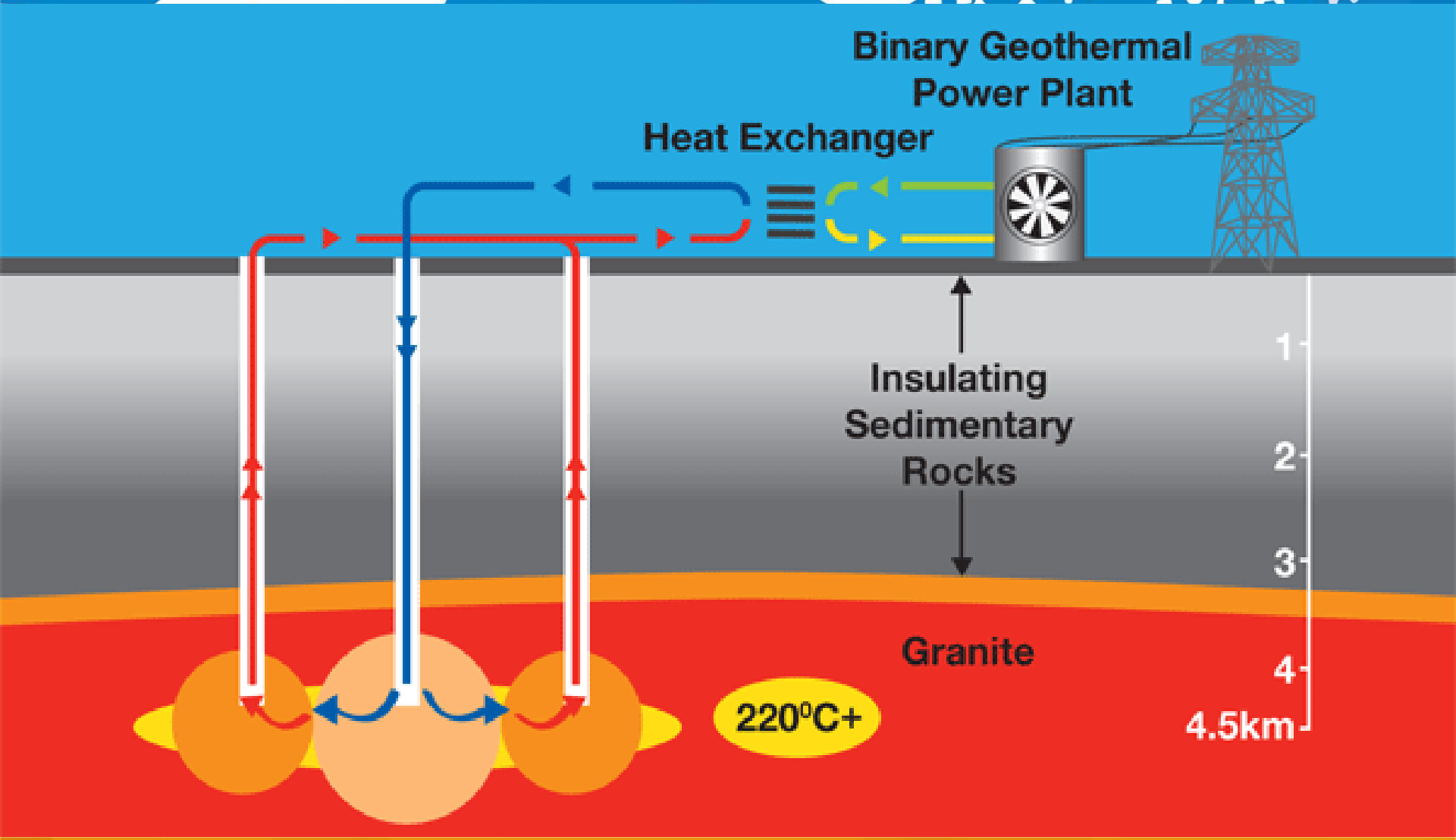
- The resistivity profile with depth as given in an MT sounding can assist in detecting the geometry and depth of the clay cap, and also in determining the boundary between the alteration zone and the geothermal reservoir. The clay cap composition typically consists of a conductive clay from the smectite group. At the temperature transition at the base of the smectite clay cap, the more electrically resistive illite and chloride are present, indicating the top of the permeable geothermal reservoir. Thus the MT method is capable of providing information on the depth to the potential reservoir, the thickness of the clay cap and the geometry of the reservoir based on electrical resistivity modeling.


A
NW
SE
Rim
Rim
Elevation (m a.s.l.)
4000
3000
2000
1000
0
-1000
-2000
Ohm.m
200
150
100
70
50
40
30
20
15
10
7
5
W05
n013
36-28
n029
88A-28
F
n037
43
n081
W07
C
29
G
17A-6
E
n085
24
n090
49
D
68-8
84-17
n106
09
27-27
?
Maximum temperature 443°F (228°C)
Interpreted as shallow outflow from S or SW
260°C
204°C
Entries major minor
Interpreted upflow is NE of section
400°F
500°F

The Existence of Hydrology System

- Is the residual magma hydrothermal solution that is "aqueous“ as a result of differentiation magma.Hidrotherma rich line of metals are relatively mild, and is the largest source (90%) of the process of formation of ore deposits.Hydrothermal process that hot water rises due to magmatic processes or from other processes such as meteoric water or liberated in a metamorphic process.
- The hot water can dissolve metals from rocks in its path, then deposited in a place at lower temperatures, most of the mineral deposits derived from this process.Hydrothermal circulation in the most general sense is the circulation of hot water, while the Greek which means water and "thermos" means hydros 'hot'.

- Hydrothermal circulation occurs most often around a source of heat in the earth's crust. This generally occurs near volcanic activity, but can occur in the crust related to the intrusion of granite, or as a result of orogeny or metamorphism.Moreover, it can also produce changes in rocks in alirinya. Hydrothermal solution plays an important role in the formation of valuable mineral deposits, forming veins and alteration of rocks.Valuable mineral deposits result hydrothermal solution is more common than the other types. The main composition of the hydrothermal solution is water.The water always contains salts, sodium chloride, potassium chloride, calcium sulfate, and calcium chloride. Soluble salt levels are highly variable, ranging from sea water salinity is 3.5% by weight to dozens of time. The solution is very "salty" (barin, high salinity) can dissolve a little insoluble minerals such as gold, chalcopyrite, galena and sphalerite.Hydrothermal solution occurs in several ways.One of them melting occurs by partial magma cools and crystallizes wet, the water which causes partial melting of wet released. But not as pure water, but it contains all the elements that can dissolve contained in magma like NaCl and chemical elements: gold, silver, copper, lead, zinc, mercury and molybdenum, which are not bound quartz, feldspar, and other minerals by ion substitution . High temperatures increase the effectiveness of a very salty solution is to form a hydrothermal mineral deposits.



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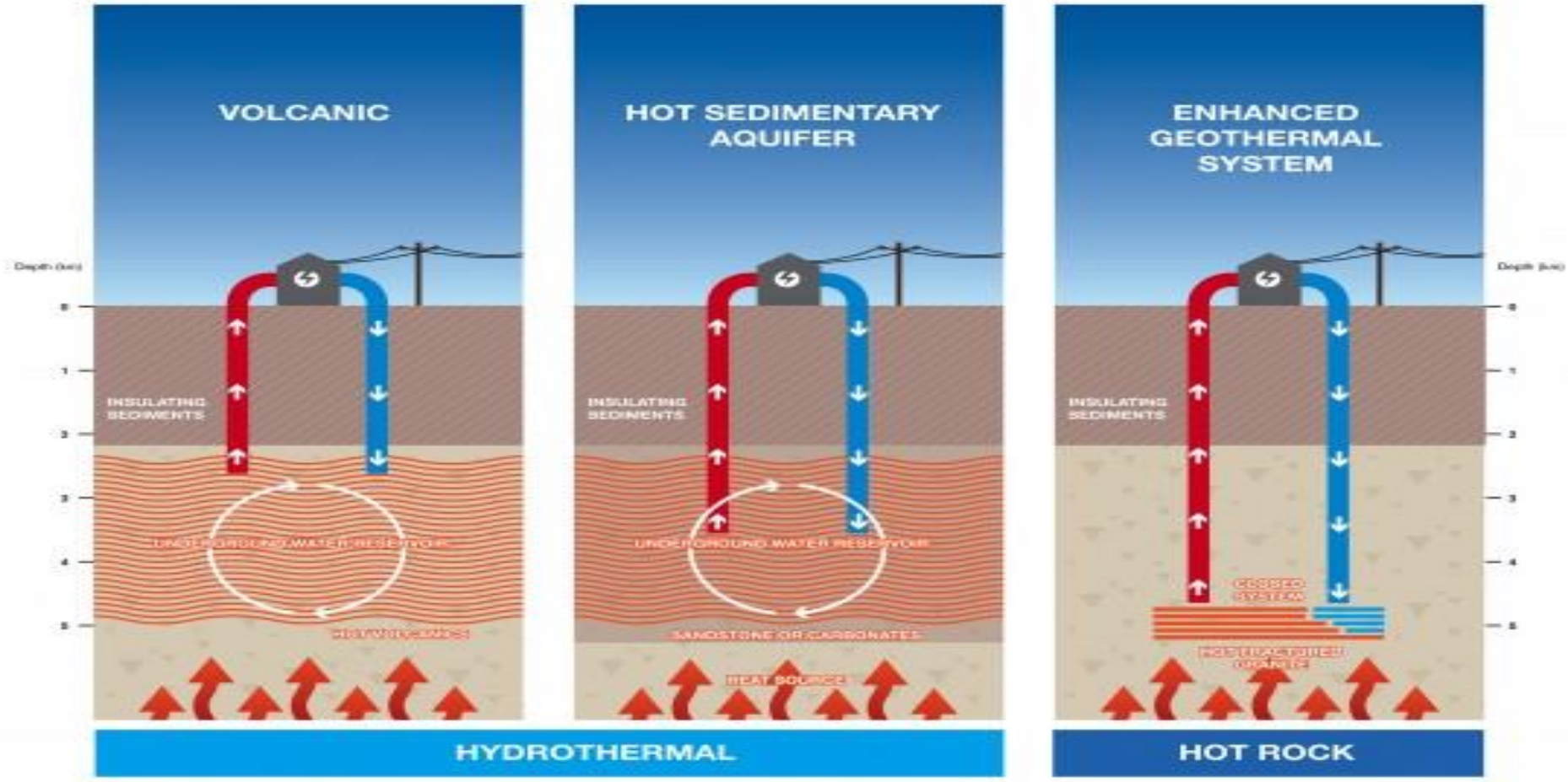
Differences in Process

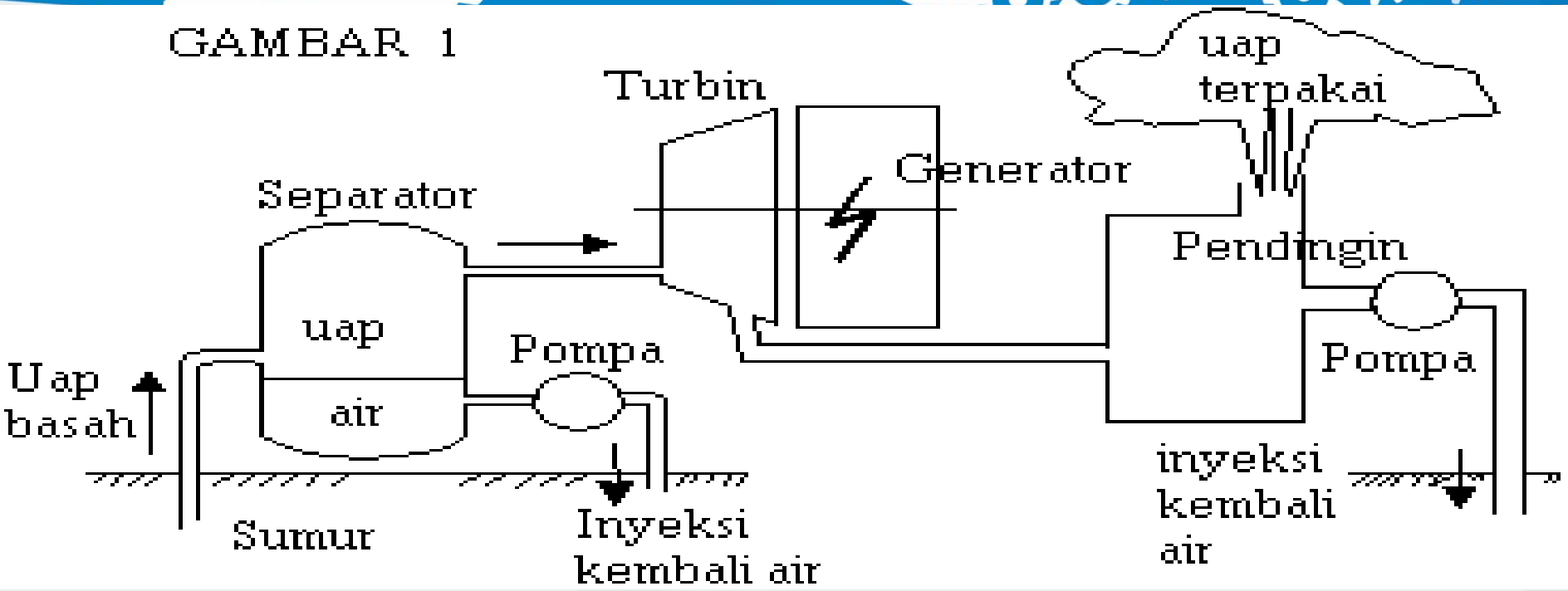


Grouping Geothermal

1. Geothermal Energy "wet steam"

- Utilization of geothermal energy geothermal ideal is when coming out of the bowels of the earth in the form of dry steam, so it can be used directly to drive a turbine electric generator. However, such a dry steam is rarely found, including in Indonesia and in general the steam that comes out of the wet steam containing an amount of water that must be separated before use to drive a turbine

GAMBAR 1

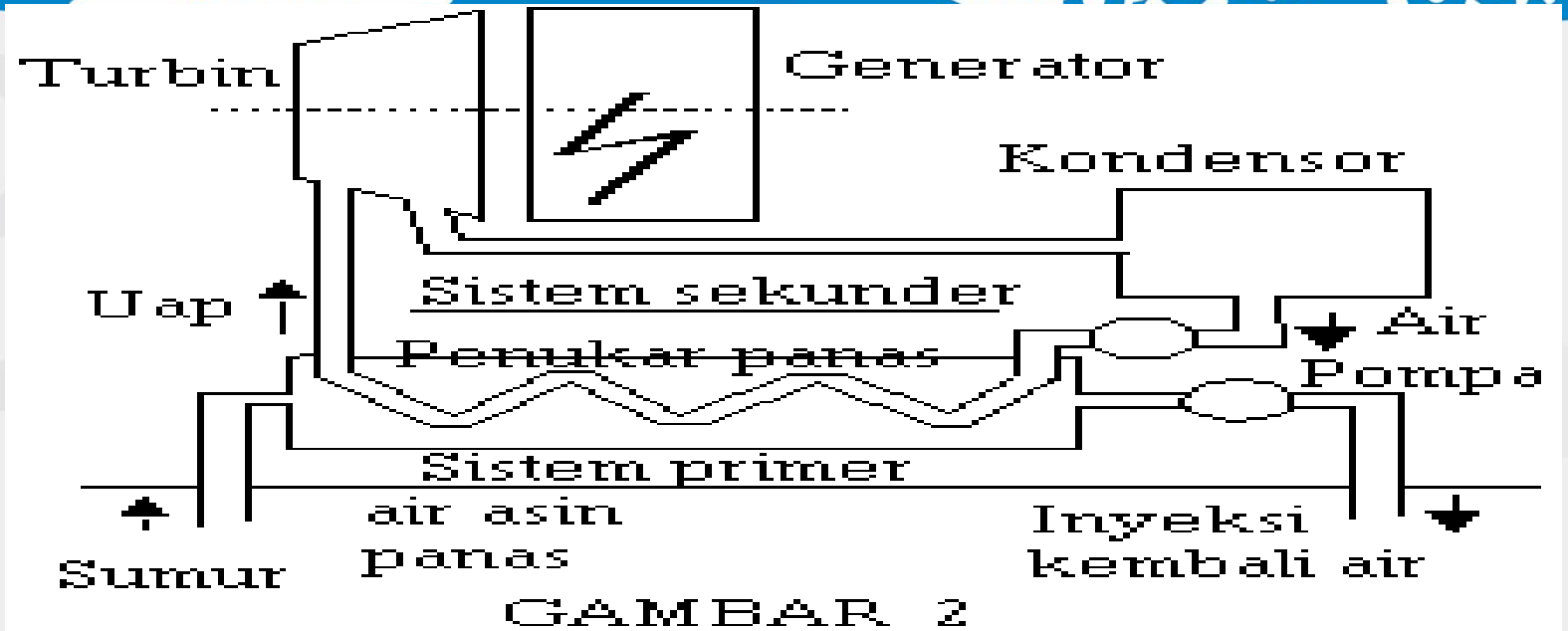


- Uap Basah : wet steam
- Sumur : Well
- Injeksi kembali air :Water re-injection
- Pendingin :Refrigerant
- Pompa :Pump

- Wet steam coming out of the ground at first in the form of hot water high pressure on the eve of the earth's surface is separated into approximately 20% and 80% water vapor. On this basis it is to be able to take advantage of this type of wet steam required separator for separating between steam and water. Steam that has been separated from the water is passed to the turbine to drive an electric generator, while the water is injected back into the earth to maintain water balance in the soil. Power generation schemes on the basis of utilization of geothermal energy "wet steam" can be seen in Figure 1.

2. Geothermal Energy "Hot Water"

- Hot water coming out of the ground is generally a hot salty water called "brine" and contains many minerals. Due to the large content of this mineral, the hot water can not be used directly because it can cause blockages in pipes electric power generation systems.
- To take advantage of this type of geothermal energy, use a binary system (two main systems) is a container of hot water as primemya system and secondary system in the form of heat exchanger (heat exchanger) which will produce steam to drive a turbine.Geothermal energy "steam" is corrosive, so the initial cost is greater utilization of geothermal energy compared with other types. Scheme geothermal power generation "hot" binary system can be seen in Figure 2.

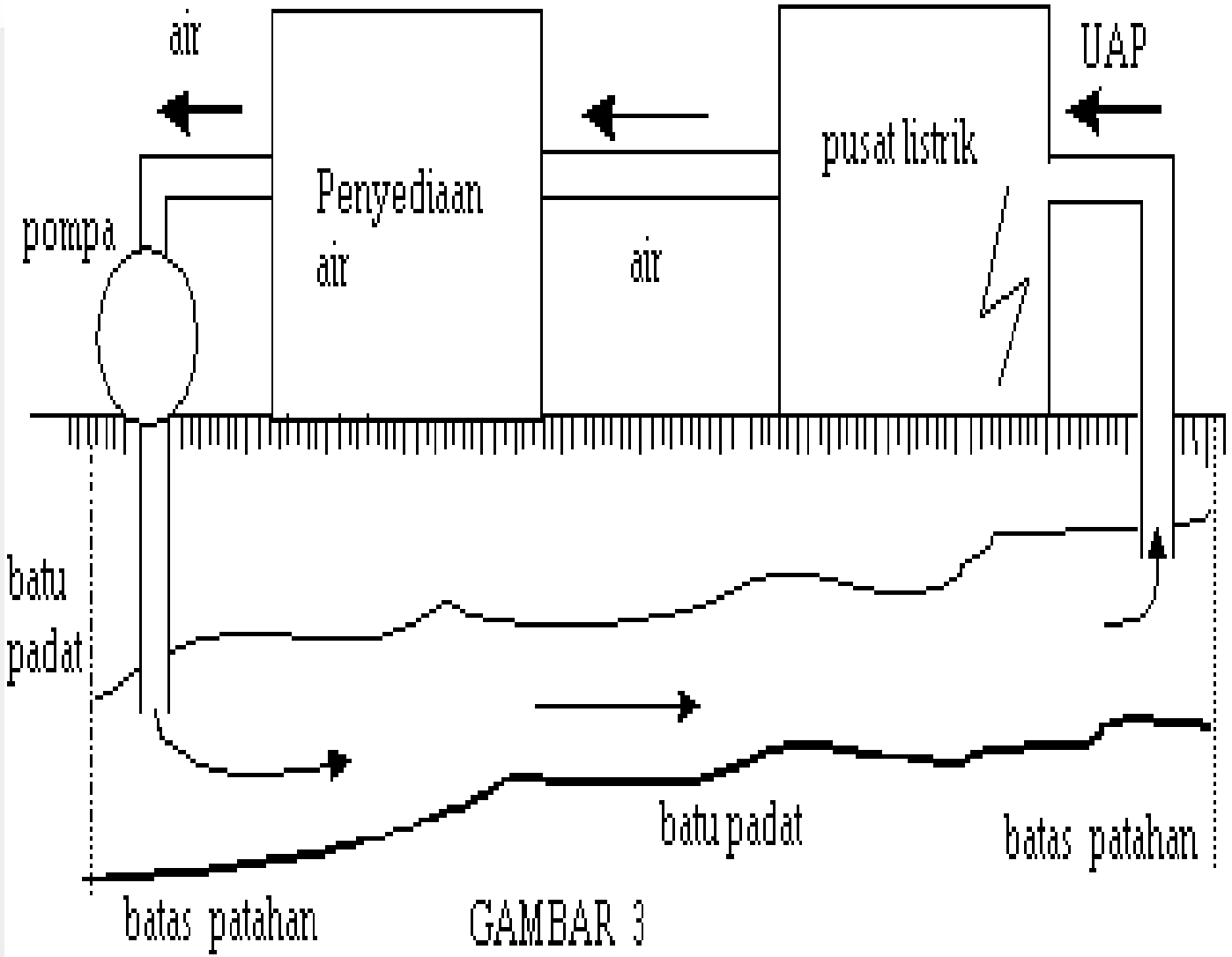


GAMBAR 2

- **Sumur : Well**
- **Injeksi kembali air :Water re-injection**
- **Pompa :Pump**
- **Kondensor :Condenser**
- **Uap :Steam**
- **Generator :Generator**
- **Turbin :Turbine**
- **Sistem Primer :Primary system**
- **Air Panas Asin :Hot salty water**
- **Sistem Sekunder Penukar Panas :Secondary heat exchanger system**

3. Geothermal energy "hot rocks"

- This type of geothermal energy in the form of hot rock in the bowels of the earth as a result of contact with the geothermal source (magma). Geothermal energy is to be taken personally by injecting water into the hot rock and allowed to steam, then sought to be recovered, as steam to drive a turbine. Source of hot rock in general is located deep in the bowels of the earth, so to use it need special drilling technique that requires a fairly high cost. Scheme power generation geothermal energy "hot rocks" can be seen in Figure 3.



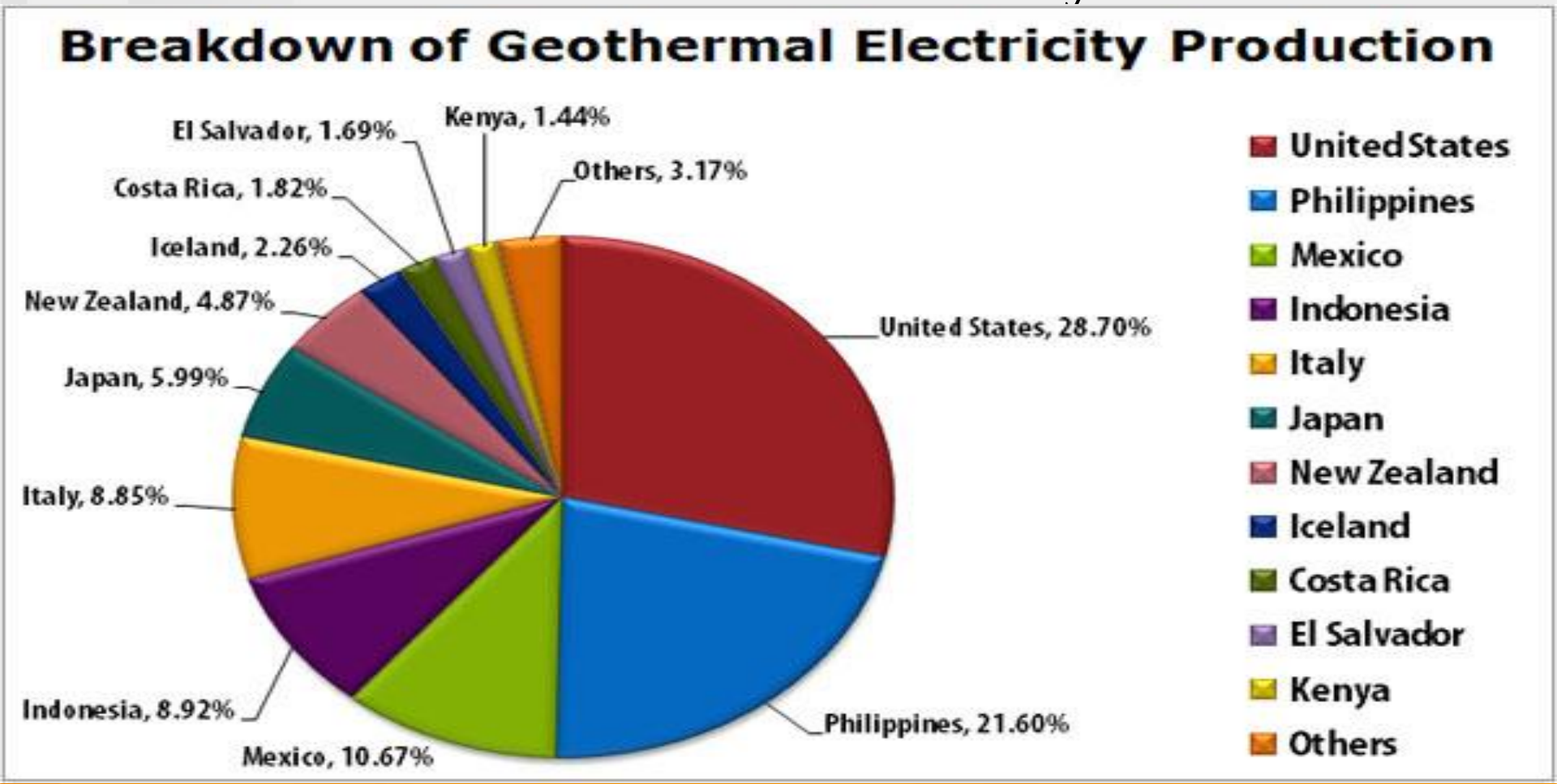
GAMBAR 3

- Batu padat :Solid rock
- Pompa :Pump
- Air :Water
- Penyediaan Air :Water supply
- Batas patahan :Boundary fault
- Uap :Steam
- Pusat listrik :Electrical center

Optimizing Geothermal Resources

Efforts to use other fossil fuels are relatively inexpensive, such as gas and coal reserves of the world, adding to the community's dependence on fixed harness the energy source.Competitive electricity prices do not become less attractive to investors in investing.There have been many government policies that have been developed to increase the utilization of sustainable energy sources. However, to build new plants or even increase the installed capacity in the Work Area Mining (WKP) which has existed just steps still halting.The main obstacle seems today is the lack of integration between national energy policy with the implementation of government and stakeholders to do. It is time for the government to think far ahead, to improve the quality of life of the world to use it, through the heat of the earth as a supplier of electricity.

Breakdown of Geothermal Electricity Production



- Leyte Geothermal FieldLocation: Leyte,
- PhilippinesCurrent capacity: 708.5 megawatts
- Planned capacity: 708.5 megawatts
- The jumble of tectonic plates underneath the Philippines has created the perfect situation for tapping geothermal power, particularly at the five-plant array of sites near Leyte. Geothermal development has gone so well that a major energy producer swore off coal in January of this year, choosing to buy into the government-run geothermal company, Energy Development Corporation, instead.
- Geothermal power has already had marked success in the developing world, as can be seen in the chart. That's because, when the geological conditions are right, geothermal can be downright cheap. (Chart: Marin Katusa, Chief Investment Strategist, Casey Research Group)