Geothermal Power

Chandra Prakash Jangir
B.Tech Scholar
Department of Mechanical Engineering
B.K. Birla Institute of Engineering and Technology, Pilani, India

Abstract— This paper gives the overview of geothermal energy, design of geothermal power plants. Moreover touches upon some of the advantages and future scope of geothermal power. This paper deals with the use of geothermal resources for production of electricity energy. Next is technologies of changes geothermal energy into electrical energy, future of geothermal energy and advantages and disadvantages of geothermal energy.

Key words: Geothermal Energy, Electricity, Themax, Provinces

I. INTRODUCTION

The word Geothermal comes from two Greek letter "thermal" means „heat" and "geo" which means "earth". The heat inside the earth is the source of geothermal power; this heat is so intense that it creates molten magma. It's the thermal energy which is generated and stored in the earth. By the original formation of planet (20%) and radioactive decay of minerals (80%) this Earth's crust geothermal energy originates. Geothermal energy is renewable energy-source and is based on the internal heat of the earth. During the first half of the twentieth century while geothermal electricity production, and large-scale direct use, thermal springs have been used for bathing; washing and cooking for thousands of years. Today in more than 50 countries geothermal energy is utilized [1].

To heat and cool buildings geothermal heat pumps can tap into the resource. An air delivery system and a heat exchanger-a system of pipes buried in the shallow ground near the building these are the system of geothermal heat pump. The heat removes from the heat exchanger by the heat pump in the winter and pumps it into the indoor air delivery system. The process is reversed, in the summer. The heat moves from the indoor air into the heat exchanger by the heat pump in the summer. During the summer the heat removed from the indoor air can also be used to provide a free source of hot water. [1]

II. GEOTHERMAL POWER

For electricity generation with conventional technologies (steam turbines, binary turbines) the geothermal potential of high temperature resources is spread rather irregularly and depends on the volcanic zones. By the year 2015 this number is expected to increase to 35. United States (3.1GW) are the main producers of geothermal energy.

The United States has roughly 3000 more MWe of geothermal energy available than the Russian Federation, which ranks tenth shown on the table 1.

In India coal and oil are the major sources of commercial energy. To take up the renewable energy programmes in a systematic manner in India, international cooperation for the Purposes of survey, formulation, installation, monitoring & evaluation is called.

Sr. No.	Country	Power
1	United states	3153.0 MW
2	Philippines	2195.3 MW
3	Indonesia	1132.0 MW
4	Mexico	965.0 MW
5	Italy	810.0 MW
6	New Zealand	577.0 MW
7	Japan	535.0 MW
8	Kenya	169.0 MW
9	Turkey	83.0 MW
10	Russian Federation	81.0MW

Table 1: Geothermal Power

III. GEOTHERMAL ENERGY

The oldest and largest geothermal power plant in the world, with the capacity of 2000MW is Geysers steam power plant of California. The major source of geothermal power in the world is hot-water plants and they have been developed more recently [3]. Heat pumps used in geothermal reduce the consumption of electricity by using heat exchangers and the constant temperature of the earth several feet under the ground to heat or cool indoor air but they do not generate electricity [4-5].

In the Iceland where renewable energy resources comprise 70% of the primary energy resources and 30% is coming from fossil fuels has the highest share of the use of renewable energy resources. Geothermal energy have the largest technical potential of the renewable energy sources on the worldwide basis. Compared to all other energy sources the production price of geothermal energy is favorable [6]. For India the resource map has been grouped into six geothermal provinces [7].

1) Himalayan Province: Tertiary Orogenic belt with Tertiary magmatism.
2) Areas of Faulted blocks: Aravalli belt, Naga-Lushi, West coast regions and Son-Narmada lineament.
3) Volcanic arc: Andaman and Nicobar arc.
4) Deep sedimentary basin of Tertiary age such as Cambay basin in Gujarat.
5) Radioactive Province: Surajkund, Hazaribagh, Jharkhand.
6) Cratonic province – Peninsular India.

India has about 340 hot springs spread over the country. Of this, 62 are distributed along the northwest Himalaya, in the States of Jammu and Kashmir, Himachal Pradesh and Uttarakhand. India identified six most promising geothermal sites for the development of geothermal energy in a December 2011 report. These are, in decreasing order of potential:

– Tattapani in Chhattisgarh

All rights reserved by www.ijsrd.com

- Puga in Jammu & Kashmir
- Cambay Graben in Gujarat
- Manikaran in Himachal Pradesh
- Surajkund in Jharkhand
- Chhumathang in Jammu & Kashmir.

In Jammu and Kashmir at puga, India plans to set up its first geothermal power plant, with capacity of 2–5 MW [8].

The potential geothermal provinces can produce 10,600 MW of power therefore can say India has reasonably good potential for geothermal. There is no operational geothermal plants in India at present although India has been one of the earliest countries to begin geothermal projects way back in the 1970s.

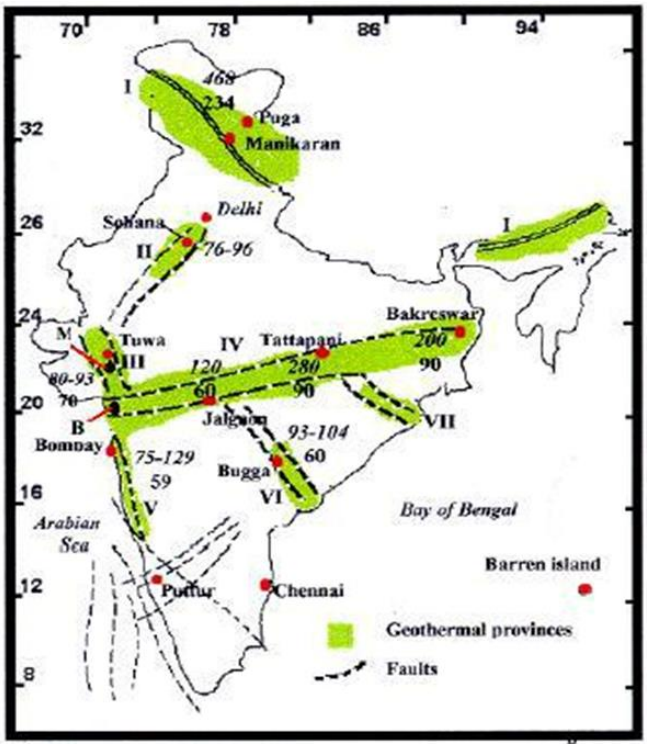

Fig. 1: Geothermal energy in India.[18]

Province	Surface Temp. degree	Reservoir Temp degree C	Heat Flow	Thermal Gradient
Himalaya	>90	260	468	100
Cambay	40-90	150-175	80-93	70
West Coast	46-72	102-137	75-129	47-59
Sonata	60-95	105-217	120-290	60-90
Godavari	50-60	175-215	93-104	60

Table 2: Potential Sources/Regions [9].

Thermax a capital goods manufacturer based in Pune is planning to set up a 3 MW pilot project. To promote geothermal energy India's Gujarat state is drafting a policy [9]. Potential Geothermal regions/sources in India with India's geothermal power potential of 10,600 MW, the following are the potential sources/ regions where geothermal energy can be harnessed in India shown in table 2.

By drilling wells geothermal electricity generation is possible and to bring to the surface these superheated fluids or steam to drive turbines.

IV. GEOTHERMAL RESOURCES

An understanding of the source of this energy - the earth's internal heat begins the understanding of geothermal energy. As go down to the Earth's depth temperature increases, with the temperature at the center reaching more than 4200 °C (7600 °F) [10].

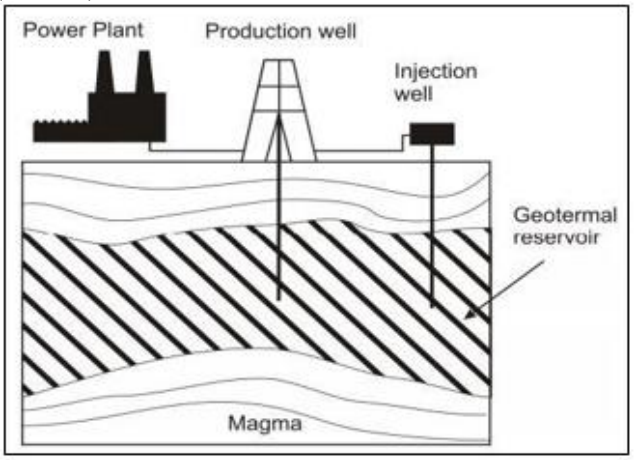

Fig. 2: Schematic of geothermal power plant production and injection wells [10]

Naturally the heat moves from hotter to cooler regions therefore earth's heat flows from its interior toward the surface and is fed back into the transmission grid. The Earth's crust has been broken into 12 huge plates that move apart or push together at a rate of millimeters per year, the geologic processes known as plate tectonics [10].

A. Power Plant Technology

1) Dry steam power plant
2) Flash steam power plant
3) Binary-cycle power plant

By absorbing heat from the rock and transport it to the earth's surface, geothermal power projects convert the energy contained in hot rock into electricity by using water and through turbine-generators it converted to electrical energy. Heat is converted to mechanical energy by passing steam through low-pressure steam turbines when water from high-temperature (>240 °C) reservoirs is partially flashed to steam. By using a heat exchanger and secondary working fluid to drive the turbine a small fraction of geothermal generation is generated worldwide. Production wells, scrubber, separator, turbine, cooling tower and condenser are the parts of geothermal process. Brine is injected back into the reservoir after being separated from steam. In the cooling towers condensed steam is used, where roughly 80% evaporates and the remainder is injected back into the reservoir.

All rights reserved by *www.ijsrd.com*

1) Dry Steam

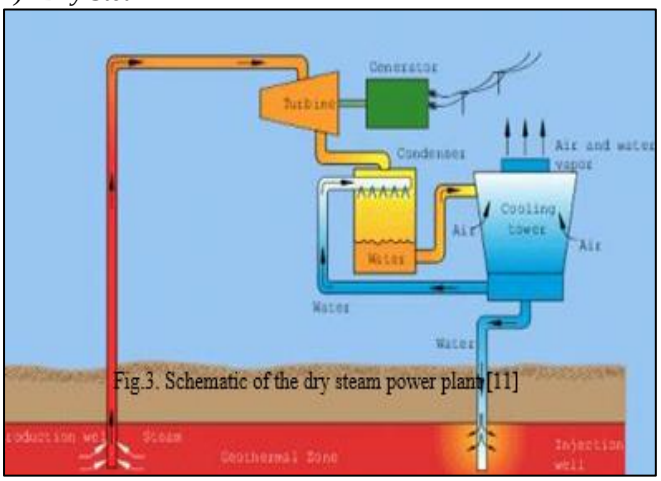

Fig. 3: Schematic of the dry steam power plant [11]

It is the oldest method, and the simplest design, known as dry steam, the steam goes directly through the turbine, then into a condenser where the steam is condensed into water. The first type of geothermal power generation plant using dry steam systems is shown in figure. They use steam from the geothermal reservoir as it comes from wells and route it directly through turbine/generator units to produce electricity.

Geysers Region in northern California is an example of a dry steam generation operation [11].

Temperature range for resource from about 320°C to some 230°C

2) Flash Steam

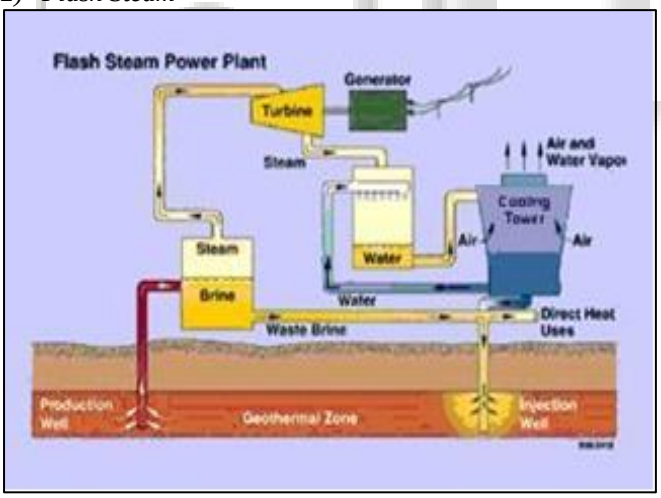

Fig. 4: Schematic of the Flash steam power plant [11].

The most common type of geothermal power generation plants in operation today are flash steam plants. The water used by them is at temperatures greater than 360°F (182°C) that is pumped under high pressure to the generation equipment at the surface. The pressure gets suddenly reduced, upon reaching the generation equipment, allowing some of the hot water to convert or "flash" into steam. To power the turbine/generator units to produce electricity this steam is used. The remaining hot water not flashed into steam, and the water condensed from the steam are pumped back into the reservoir. The Cal Energy Navy I flash geothermal power plant at the Coso geothermal field [11] is an example of an area using the flash steam operation.

3) Binary Cycle

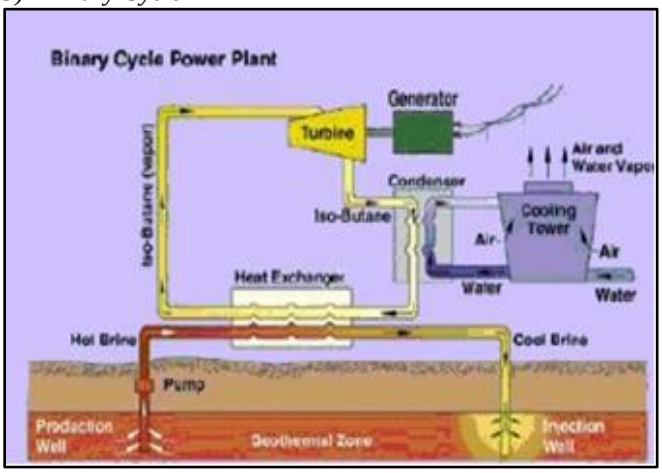

Fig. 5: Schematic of the Due steam power plant [11].

Since the water or steam from the geothermal reservoir never comes in contact with the turbine/generator units therefore Binary cycle geothermal power generation plants differ from dry steam and flash steam systems. For heating another "working fluid," (a pressurized gas or liquid) the water from the geothermal reservoir is used which is vaporized and also it is used to turn the turbine/generator units in the binary system. The "working fluid", geothermal water and the both are confined in separate circulating systems or "closed loops" so that they never come in contact with each other. The binary cycle plant can operate with lower temperature waters (225°F to 360°F) by using working fluids that have an even lower boiling point than water which adds to its advantage. No air emissions are produced by them. The Mammoth Pacific binary geothermal power plants at the Casa Diablo geothermal field [11] is an example of an area which uses a binary cycle power generation system.

V. APPLICATION OF GEOTHERMAL ENERGY

Electricity generation requires relatively hot fields and specialized heat cycles in order to produce more energy than the pumps consume. Its capacity factor can be quite large – up to 96% has been demonstrated because geothermal power does not rely on variable sources of energy for example, wind or solar. In 2005 the global average was 73%.

Low temperature means temperatures of 300 °F (149 °C) or less in the geothermal industry. In applications of direct-use, such as mineral recovery, district heating, greenhouse, fisheries, and industrial process heating low-temperature geothermal resources are typically used. From co-generation heat may come via geothermal electrical plant or from smaller wells or heat exchangers buried in shallow ground. Therefore geothermal heating is economic, at many sites than geothermal electricity generation. The heated water can be piped directly into radiators where natural hot springs are available. Earth tubes or downhole heat exchangers can collect the heat if the ground is hot but dry. Many applications supports by geothermal heat. To melt snow water spent from the district heating system is piped below pavement and sidewalks in Reykjavík, Iceland. Geothermal desalination has been demonstrated [12].

All rights reserved by *www.ijsrd.com*

VI. FUTURE OF GEOTHERMAL ENERGY

A small part of the geothermal resource are steam and hot water reservoirs. As soon as we develop a technology to use earth's magma and hot dry rock, it will be easy to provide cheap, clean and almost unlimited energy. Geothermal energy power source will start to enjoy more growth because it is reliable and renewable. Geothermal energy is being used in some places like California, Iceland, Hawaii and Japan due to earthquakes and the underground volcanic activity [14]. It is one of the few renewable energy technologies that can supply continuous, base load power additionally, binary geothermal plants can be used a flexible source of energy to balance the variable supply of renewable resources such as wind and solar which is different from coal and nuclear plants [15].

The levelized cost of energy (LCOE) for new geothermal plants (coming online in 2019) will be less than 5 cents per kilowatt hour (kWh), as opposed to more than 6 cents for new natural gas plants and more than 9 cents for new conventional coal is projected by the U.S. Energy Information Administration (EIA) [15]. Geothermal resources has a bright future that they can directly be used as a heating source for homes and businesses in any location.

VII. BENEFITS AND LIMITATIONS BENEFITS

Our dependence on fossil fuels have started to increase, therefore digging out the heat stored inside the earth is the new source of power generation and seen as geothermal energy. Very soon it will turn out to be the cheapest source of power generation due to factors such as location and high costs but in the years to come when fossil fuels would start to diminish. Geothermal energy has its own benefits and limitations.

1) Geothermal energy does not create significant amount of pollution and is generally considered environmentally friendly.
1) Geothermal reservoirs are renewable because they are naturally replenished (exhaustion of resources are not possible).
2) The base load energy demand meeting can be done excellently (as wind and solar are opposed).
3) For small households it is very good and great for heating and cooling.
4) Any kind of fuels are not involved in harnessing geothermal energy, which means less cost fluctuations and stable electricity prices.
5) Available of geothermal energy is everywhere, although only some resources are profitably exploitable.
6) Recent technological advancements (e.g. enhanced geothermal systems) have made more resources exploitable and lowered costs.
7) It does not depend on the weather conditions unlike solar energy.
8) Maintenance cost of geothermal energy is very less.
9) It can help in protecting natural environment because its plant don't occupy too much space.

VIII. LIMITATIONS OF GEOTHERMAL ENERGY

1) There are only few sites which have the potential of Geothermal Energy.
2) Production of geothermal energy are far from markets or cities, most of the sites, where geothermal energy is produced, where it needs to be consumed.
3) Production of geothermal energy are far from markets or cities, most of the sites, where geothermal energy is produced, where it needs to be consumed.
4) Generation is too small of total potential of this source.
5) Eruptions of volcano always cause a danger.
6) Steam power plant‟s installation cost is very high.
7) The amount of energy which is produced has no guarantee that it will justify the capital expenditure and operations costs.
8) Some harmful and poisonous gases release that can escape through the holes drilled during construction [16].

IX. CONCLUSION

There is a significant scope for developing geothermal energy resources in India to provide sufficient electricity and to meet all of India‟s domestic electricity requirements. By implemented the project on geothermal based energy the government has plan many incentives to the development to support the green technology programmed. The energy can encourage the energy sectors of economy in this country by improvement of developing the geothermal energy. According to the study there are still have a limit that are could be improved for further study. To enhance renewable energy development, there are several recommendations that can be performed. First need to, analyze widely about the potential of other renewable energy such as hydro, geothermal and etc. so that there will be a lot of data and information would be gathered for the future used. Finally, latest policies and funding mechanisms will be required to sustain and promote renewable energy investment.

REFERENCES

[1] International Journal of Advances in Engineering & Technology, Sept 2012.
[2] GreenChipStocks, http://www.greenchipstocks.com/articles/renewable - energy-capacities-by- country/765
[3] “Geothermal technologies today and tomorrow,” U.S. Dept. Of Energy, 1998.
[4] L. Lamarre, “Heating and cooling,” EPRI J., pp. 24–31, May/June, 1998.
[5] STANLEY R. BULL, “Renewable Energy Today and Tomorrow”, Proceedings of the IEEE, VOL. 89, NO. 8, AUGUST 2001, p.p-1216-1226.
[6] Valgardur Stefansson, Reykjavik, Iceland, “Global Perpective on Geothermal Energy”, IEEE-2011.
[7] "Geothermal fields of India". Geological Survey of India 2001, http://www.portal.gsi.gov.in/portal/page?_pageid=127,699645&_d ad=portal&_schema=PORTAL.
[8] "Development of 3.75 MW Durgaduani Mini Tidal Power Project, Sunderbans, West Bengal". NHPC Limited – A Government of India Enterprise. December 2011,

All rights reserved by *www.ijsrd.com*

http://www.nhpc.gov.in/english/Scripts/RDgeothermal.a spx
[9] Indian Power Sector: http://indianpowersector.com/renewable-energy/geothermal/
[10] REPP Mission: http://www.repp.org/geothermal/geothermal_brief_geothermal_resources.html 2010
[11] INL Biofuels and Renewable Energy: https://inlportal.inl.gov/portal/server.pt/community/geothermal/422/what_is_geothermal_energy , 2010
[12] http://indianpowersector.com/home/renewable-energy/geothermal/
[13] U.S. Department of Energy, Energy Efficiency and Renewable Energy, Geothermal Technologies Program, http://www1.eere.energy.gov/geothermal/powerplants html; accessed 03/22/2006
[14] http://www.eai.in/ref/ae/geo/geo.html, India energy portal http://www.indiaenergyportal.org/subthemes_link.php?text=geothermal &themeid=13
[15] http://www.ucsusa.org/clean_energy/ourenergy choices/renewableenergy/how-geothermal-energy-works.html#.VLwYOdKUchE
[16] http://energyinformative.org/geothermal-energy-pros-and-cons/,
[17] http://www.ianswer4u.com/2012/02/geothermal-energyadvantages- and.html#axzz3PC2X39NO
[18] http://www.geni.org/globalenergy/library/renewable-energy-resources/world/asia/geo-asia/geo-india.shtml

All rights reserved by *www.ijsrd.com*