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A Review on the Prospect of Geothermal Energy in Bangladesh

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Abstract:- Geothermal energy has been developed for the multipurpose application of direct heat use and electricity power generation for more than a decade. The application of geothermal heat resources depends on the current temperature. Typically, the power plant generates electricity using high-temperature steam that is extracted from the reservoir. On the other hand, low to medium geothermal heat is primarily employed for direct industrial, domestic, and agricultural use. Since conventional technologies were developed to exploit the heat source from this specific type of geological location, developed geothermal energy resources are primarily found in volcanic regions, while more advanced technologies and planning are currently being developed to utilize geothermal in various geological regions. The goal of this research project is to delve deeper into the potential energy resource that can be derived from geothermal energy, the technology to exploit the resource, and the ways in which the resource can supply various types of energy for the society's problems. A list of critical points about the use and acceptability of geothermal energy to replace fossil fuels is one of the expected outcomes of this research project.

Keywords:- *Electricity Generation, Geothermal Energy, Heat Resources, Steam.*

I. INTRODUCTION

Less than 60 years are predicted to be left for the world to exploit fossil fuels due to the issue of depleting confirmed reserves of fossil-based energy fuels, particularly oil and gas, assuming no new significant successful discoveries of proved reserves of oil and gas occur soon. [1] On the other hand, there is still a sizeable proven coal reserve in the world, and with that reserve, coal production is still possible for up to 350 years [2]. Renewable energy sources are now being developed for widespread use and application for the two reasons listed above. Even with the uncertainty surrounding the production source and the lag between the peak of production and consumption times, the majority of renewable energy sources, including solar, wind, and hydroelectric power, continue to face significant challenges. The availability of geothermal energy is, however, rather consistent throughout the year and is unaffected by the seasons [3]. The global potential for geothermal energy is enormous; according to one estimate, 50 times as much energy may be produced from geothermal resources as can be obtained from all of the world's oil and gas reserves [4].

II. PROBLEM STATEMENT

Since the phase of exploration and discovering is out of sync with the usage and needs, the reserve of fossil fuels is currently declining while the world's energy needs soar. To achieve the sustainable objective development and Paris agreement, western and industrialized countries, particularly the OECD group nations and the majority of EU members, are working to raise the amount of renewable-based energy and partially decrease the role of fossil fuels.

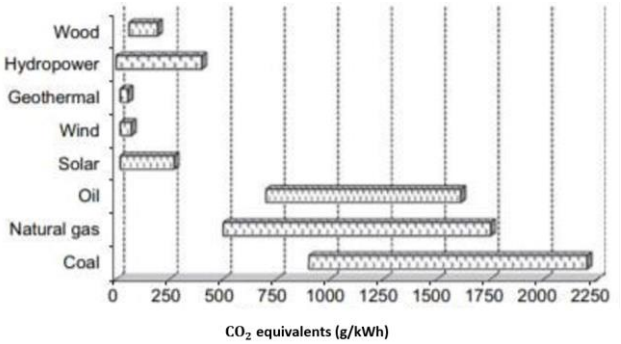

Fig 1: CO_2 Emissions of energy Sources [3]

According to figure 1, geothermal energy produces relatively fewer emissions than other conventional and renewable energy sources.

Since a geothermal resource's energy can be simply defined as a reservoir within the earth's subsurface from which heat can be economically extracted and used for generating electricity power plants or other heating industrial as well as domestic purposes in the near future [5], making the energy accessible with current technology is one of the biggest challenges to extracting the energy.

III. RESEARCH GOALS AND RESEARCH QUESTIONS

The purpose of this study is to advance our understanding of geothermal energy's ability to meet society's energy needs. This objective will be pursued by:

a. describing the most recent developments in geothermal energy theory.

b. The author chose the Bangladesh as the location to investigate while looking at the potential resource, technology to extract, and uses of geothermal energy that may be employed for the society.

➢ *Research Question*

What is geothermal energy, where and how can it be applied and what is its potential to become an alternative for fossil-based energy?

Sub-questions
Sub-questions 1: What is the current status, technologies, applications, resources of geothermal energy in the world?
Sub-questions 2: What are the main problems of current geothermal energy applications in term of physical, technical, and social?

IV. RESEARCH METHOD

With the aid of desk research and secondary data sources, this study aims to evaluate the potential of the resources, applications, and technologies to make use of the resource and the energy that geothermal energy could be able to give in terms of replacing fossil fuels in the Bangladesh. The researcher will also describe the physical, technological, and social issues involved while analyzing the existing use and state of the geothermal resource in the Bangladesh as an example of its potential. The writer has reviewed secondary data from documents, books, and reputable media sources as the last part of the data gathering process before analyzing the data in order to address the research questions raised earlier and completing the process with conclusions and suggestions.

V. RESEARCH FRAMEWORK

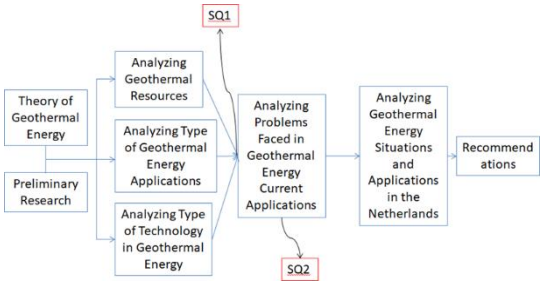

Fig 2: Geothermal Energy Systems and Models

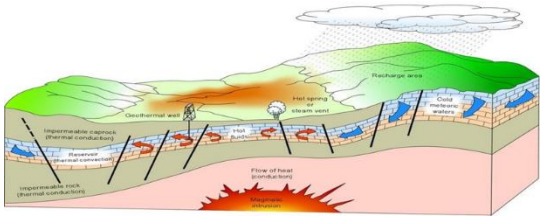

Fig 3: Ideal Geothermal Energy System (IGA, 2004)

From the above figure 3, the geothermal system can be explained methodically by heating the water with thermal energy from the earth's upper crust in a constrained area, then transferring that energy from the thermal source to the heat sink in the earth's free surface [6]. The geothermal system typically consists of three main components: a heat source, a reservoir, and a fluid that carries the heat and serves as a heat medium from the subsurface to the surface.

Additionally, as seen in Figure 3, the geothermal energy system's heat source is magma. Heat application to the heat exchanger is a possibility when the temperature is below 30°C. The application can be utilized for agricultural and home air conditioning. Since the effectiveness of these reservoirs is solely dependent on the underlying thermal inertia under typical geothermal gradient circumstances, they can be found wherever [7].

VI. ENERGIES FROM GEOTHERMAL

Since the ground contains a wide range of possible energy sources from shallow to deep subsurface and horizontal surface, geothermal energy likewise holds a variety of energy possibilities and sources from various earth layers.

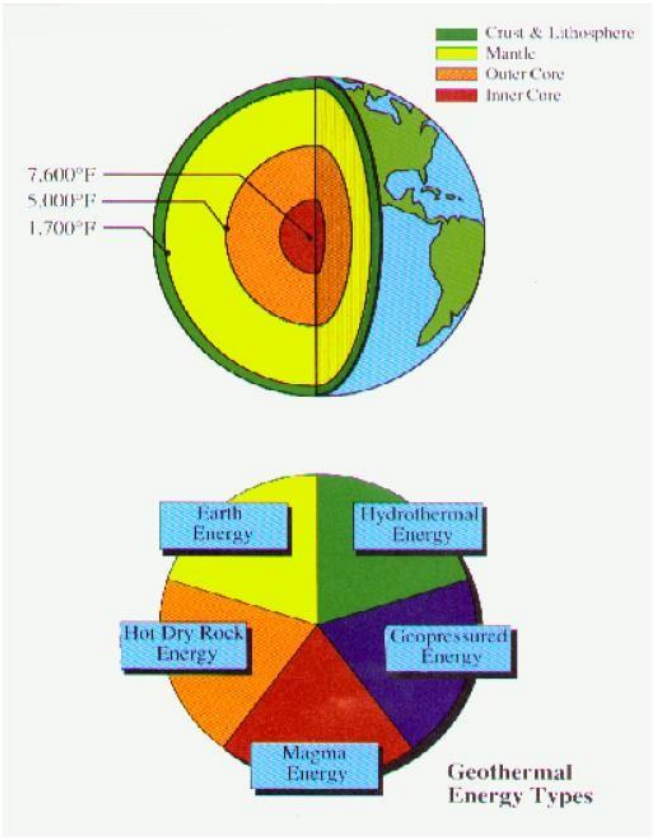

Fig 4: Geothermal Energy Types [8]

Geothermal energy was distinguished and categorized in Figure 4. Earth energy, hydrothermal energy, hot dry rock energy, magma energy, and geopressured energy are the five different subtypes of geothermal energy. The different layers of the earth, from the crust and lithosphere to the ultra-deep inner core with its associated ultra-high temperature, are used to categorize the geothermal energy seen in the above graphic.

VII. GENERAL APPLICATIONS OF GEOTHERMAL ENERGY

Geothermal energy uses are primarily categorized by their direct and indirect (power generating) uses. Both categories typically distinguish themselves based on needs, geothermal potential, and climate.

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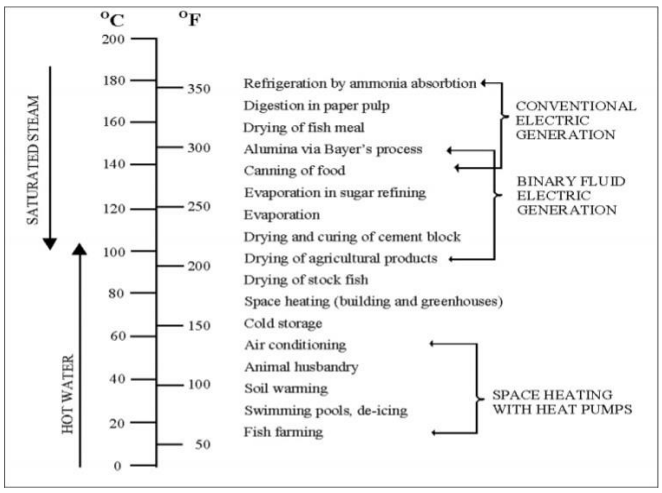

Fig 5: Lindal Diagram [9]

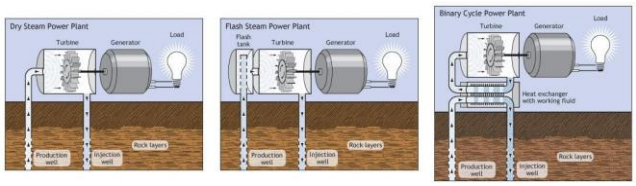

Fig 6: Type of Geothermal Power Plant [10]

There are three primary systems of geothermal power plants, as shown in the kind of geothermal power plant picture above:

1. Dry Steam Power Plant: Of all the geothermal power plants, this one is the most straightforward. The minimal amount of fluid and steam was injected again after the heat produced into the generator. The heat steam produced from production well entered the turbine and powered the electricity generator.
2. Binary Cycle Power Plant: The subsurface fluid used in this type of power plant must typically be around 200ºC or must be heated to a sufficient temperature. The fluid from the subsurface was used to heat the organic fluid that powers the electrical turbine, and after the heating of the organic fluid was complete, the subsurface fluid was injected once more. On the other words, the binary cycle power plant work as a heat exchanger machine [8]

VIII. WORLD STATUS OF GEOTHERMAL GENERATOR

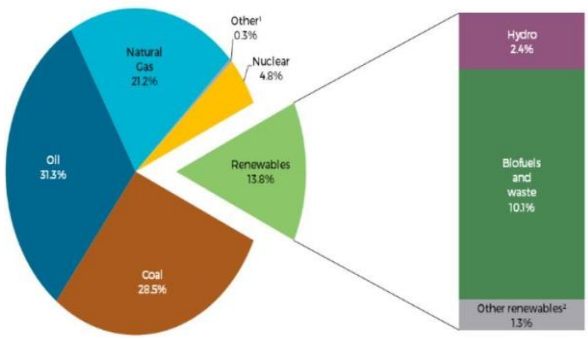

Fig 7: World Primary Energy Supply Mix [11]

Figure 7 shows that the majority of the world's primary energy source still relies on fossil fuels. While a combination of natural gas, oil, and coal continues to be the primary source of energy supply and generation, hydropower and biofuels continue to dominate the renewable energy sector, placing it in second position.

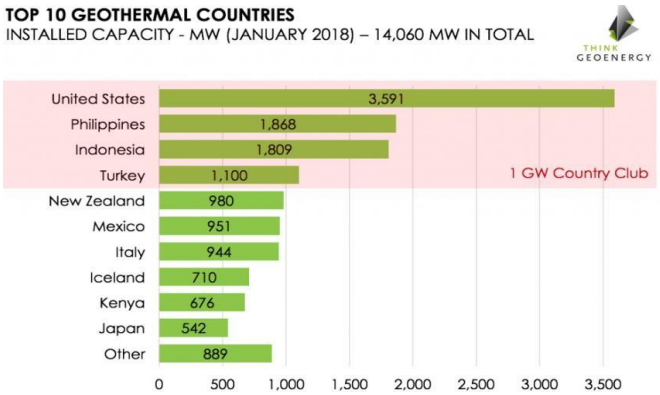

Fig 8: World Geothermal Generator Ranking [12]

IX. GEOTHERMAL ENERGY RESOURCES

Geothermal energy is a vast resource that is primarily found underneath the earth's surface. The geothermal energy's primary source of heat is often transferred into the reservoir fluids inside the matrix pore. Since the utilization of geothermal energy should not exceed a certain point of economic limit, which typically refers to conventional energy sources like oil and coal-based power plants, the subsurface heat located in shallow or even deep reservoirs should be extracted in a proper economical manner.

X. GEOTHERMAL ENERGY SURFACE MANIFESTATION RESOURCES

There are many other ways that surface manifestations can show up, as "Hot or Warm Spring" will illustrate. This particular type of surface manifestation is one of the signs that a certain place has the ability to produce geothermal energy. The thermal fluids from the subsurface that flowed from the stone matrix into the surface area created the hot or warm spring. The "Fumarole" is another. The fumarole is a tiny hole in the earth with either dry or wet steam coming from it. Furthermore, the steam-dominated hydrothermal reservoir system frequently included fumaroles that flowed high-speed steam. This steam could also contain SO_2 who can only being stabilize at more than 500ºC or can be classified as ultra-high temperature.

XI. GEOTHERMAL ENERGY APPLICATIONS ELECTRICITY GENERATIONS

As previously said, mountainous and volcanically active regions are where geothermal energy applications (mostly hydrothermal energy) that are sufficient to provide the quantity of heat needed to operate the power plant are most frequently found. The heat from the subsurface well is transferred directly by pipe to the power generator, which will generate electricity using either dry steam or wet steam, or

both. Additionally, the residual water and chemicals from the subsurface are injected once again using the injection well after the heat from the steam has been removed.

➢ *Direct Heating*

The simplest things that geothermal energy can be used for are direct heating applications. Direct heating can be used for a variety of purposes, from drying and heating in homes to heating and drying in large sectors. Additionally, the most typical direct applications for geothermal heat are covered. Results show that the use of low temperature geothermal resources may greatly benefit from the use of binary organic ranking cycle power plants [17].

➢ *Heat Pumps and Space Heating*

Geothermal heat pumps, which can also be utilized for building and space heating, account for the majority of the dominance in geothermal utilizations for direct heating. 10.74 percent of the total global share is used specifically for space heating, while approximately 70.95 percent of the geothermal heat pump capacity is used for multiple purposes (mostly for building).

➢ *Agriculture and Aquaculture Use*

These applications in the direct use of geothermal energy are less common than the other uses. Agriculture drying and aquaculture pond heating are now not very widespread and popular to be used, with a global total share of less than 4%.

➢ *Industrial Uses*

With less than 3% of the global capacity used for direct geothermal energy consumption (both with and without heat pumps), industrial uses are last in line (even in the with heat pumps total percentage, it counted less than 1 percent). Many industrial operations, including process heating, industrial space air conditioning, food and fish drying, pulp and paper processing, textile washing, even fuel manufacturing and oil upgrading, can be used with this application.

➢ *Exploration Geothermal Energy Technologies*

The majority of the geothermal exploration technology has been adopted from oil and gas exploration techniques. Geochemistry, drilling, remote sensing, geology/stress analysis and modeling, prospective field geophysics, and seismic activity are the five phases of the exploration of the thermal potentials. Geology and geophysics (GnG) operations make up the majority of the exploratory activities in the quest for geothermal energy potentials [13].

➢ *Production and Utilizations Technologies*

Geothermal energy production systems can be divided into two categories: direct uses and uses in electric power plants. As previously said, direct uses are the most common, and geothermal energy potential in some areas isn't as great as what's needed for power plants.

Fig 9: Map of the World's Geothermal Energy Power Plants, [14]

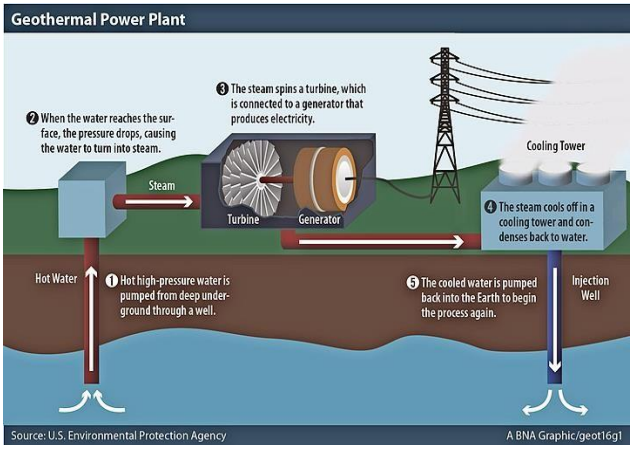

Fig 10: Geothermal Electricity Power Plant [15]

Figure 10 above essentially explains the geothermal electricity generating plant. This sort of geothermal energy is thermally extracted from the steam passing through the production well. In addition to being environmentally beneficial, ground-source heat pumps (GSHP) can lower emissions by 66 percent when compared to conventional thermal systems that are powered by fossil fuels.

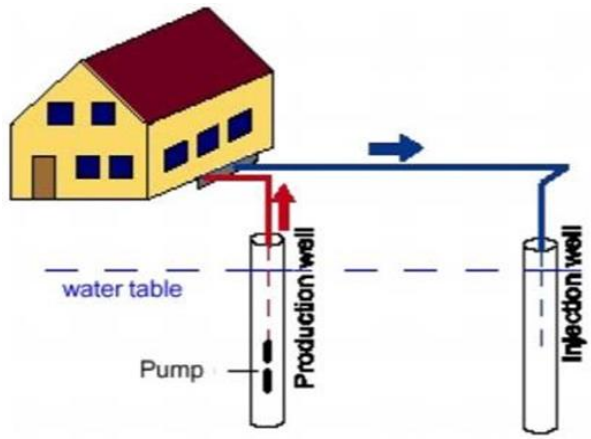

Fig 11: Open Loop Groundwater Heat Pump Doubleted

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XII. PHYSICAL PROBLEMS OF GEOTHERMAL ENERGY

Since geothermal energy is located beneath the earth's surface and is being exploited during the exploration process, there is a high probability that it will negatively impact the environment in the proposed locations as well as the area around them. This poses one of the biggest challenges for geothermal development. The main concerns that geothermal energy production is currently facing in terms of physical difficulties are those related to natural hazards, the atmosphere, land, freshwater, and forests.

- *Natural Hazards*

Seismicity induction, landslides, and hydrothermal eruption are negative effects that could result from the development of geothermal energy. The likelihood of these adverse effects is most likely to occur during the geothermal discovery phase, while there is a small chance of an accident occurring during the exploitation phase.

- *Atmosphere*

Additionally, air pollution brought on by geothermal exploration and extraction activities is categorized as atmospheric issues. The actions may release H2S pollutants, greenhouse gas emissions, and other harmful gas emissions.

- *Land*

There are some issues with the land impact of geothermal energy development and utilization such as habitat loss, soil compaction, and also conflicts with other land uses, even though some other renewable energy sources such as solar panel and wind energy claim that the use of geothermal energy only requires a small amount of space or land.

- *Fresh Water*

One of the important topics now being discussed in many scientific and governmental forums is the availability of fresh water. In comparison to other types of fossil and nuclear power plants, geothermal power plants may need more water. In the instance of the Imperial Valley geothermal power plant, it is predicted that the plant will require more than 300.000-acre feet of water to maintain the production of 5.500 MW of energy [16].

- *Forests*

When the development of this thermal energy could create such a complex issue as deforestation and ecosystem loss while creating the energy, geothermal energy utilization can still save forests and its biodiversity by replacing traditional biomass.

XIII. TECHNICAL PROBLEMS

Since technical perfectionism would lead a geothermal energy project into a specific goal of success while poor engineering performance could follow the project into technical failures that also lead into other problems in physical and social dimensions, the technical problem of geothermal energy is primarily based on the aspect of technology and engineering.

First off, poor waste management in the generation of geothermal energy may contaminate the environment, which may spread the issue to other areas. As was indicated in the section on physical issues, subsurface steam may contain hazardous chemicals and corrosive gases that could damage the local people who reside close to the geothermal project site as well as the surrounding environment.

Second, as the majority of geothermal projects are anticipated to last for a considerable amount of time, the hydrothermal reservoir component needs to be carefully maintained and tracked, since the loss of pressure in the geothermal reservoir could affect the efficiency of electricity production.

Thirdly, the turbines themselves play a major role in the use of steam to generate energy. One of the most expensive initial investments in the development of geothermal energy is made by steam turbines, which turn steam into electricity. The dilemma of choosing the right options between concerning on capital efficiency or focusing on maximizing the engineering design who will directly affect the performance of the power station for an extensive period, since focusing on the reducing geothermal operation capital and initial cost is currently the issues that faced in the plan of development geothermal energy.

XIV. GEOTHERMAL PROSPECTS IN BANGLADESH

Bangladesh ranks among the nations with the lowest per-capita energy use in the world. The nation may be struggling with an energy shortage and relied heavily on fossil fuels and imported fuel for the production of power, industries, transportation, and other things. Despite having enormous fossil fuel resources, Bangladesh has scant oil and coal reserves. Fossil fuels typically account for the majority of industrial energy use (about 70%), followed by oil, hydropower, and coal. The primary source of energy for the majority of the nation's economic operations is electricity. Bangladesh installed more than ten GW of electricity generation capacity.

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XV. GEOTHERMAL ACTIVITIES IN BANGLADESH

So far, there is no major work in this country with regard to geothermal energy.

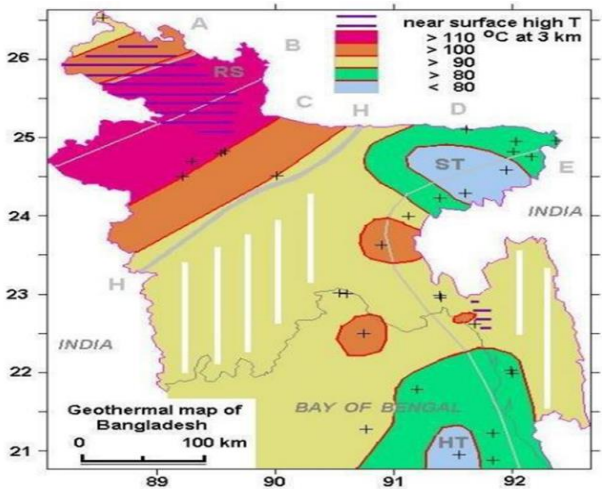

Fig 12: The geothermal gradient of Bangladesh at 3 km depth (modified from Guha. 2010).

They examined fifty more abandoned wells in an Asian nation and offered advice on how to use these wells to generate thermal energy. Dhaka University's Dr. Badrul Mohammedan in the end, it was suggested that at least one of the three wells (Singra, Shalbanhat, and Sitakund wells) undergo a pilot study that would reopen the abandoned wells, but it never happened. Drilling program (GDH-65/11) was administered by Earth Science Survey of Asian nation within Thakurgaon district. Drilling came to an end at a depth of 586 m, with a temperature reading of 47 °C, which is about typical of Asian countries.

XVI. ADVANTAGES OF GEOTHERMAL ENEGRY

1. Environmentally Friendly

Compared to conventional fuels like coal and other fossil fuels, geothermal energy is more environmentally benign. Additionally, a geothermal power plant has a little carbon footprint. While geothermal energy does produce some pollution, it is much less than that produced by fossil fuels.

2. Renewable

Geothermal energy is a renewable resource that will be available until the sun destroys the Earth in about 5 billion years. Because the Earth's heated reserves are refilled naturally, it is both renewable and sustainable.

3. Huge Potential

Around 15 terawatts of energy are currently consumed globally, which is a small fraction of the total energy that may be obtained from geothermal sources. Although most reservoirs cannot now be used, there is hope that as industrial research and development continue, the number of geothermal resources that can be used will rise. Geothermal power facilities are thought to be capable of producing between 0.0035 and 2 terawatts of energy.

4. Sustainable / Stable

Compared to other renewable energy sources like wind and solar power, geothermal energy offers a consistent stream of energy. This is so that, unlike with wind or solar energy, the resource is always available to be used.

5. Heating and Cooling

Water must be over 150°C in order for turbines to be driven by geothermal energy effectively. Alternately, the differential in temperature between a ground source and the surface might be utilized. Just two meters below the surface, a geothermal heat pump can operate as a heat sink/source since the ground is more resistant to seasonal heat variations than the air.

6. Reliable

Since it does not fluctuate as much as energy from other sources, like solar and wind, it is simple to compute the amount of energy produced by this resource. This implies that we can make highly accurate predictions about a geothermal plant's power output.

7. No Fuel Required

Unlike fossil fuels, which are a limited resource that must be mined or otherwise extracted from the earth, geothermal energy is a naturally existing resource, hence no fuel is needed.

In future we can a huge amount of electricity by geothermal energy. Because there are so many places in Bangladesh where can produce this. Sylhet, Mymensingh are those places where geothermal energy can produce easily. Another important factor is that by producing geothermal energy we can reduce earthquake in those areas. So, it will be more reliable for our national electricity grid.

XVII. DISADVANTAGES OF GEOTHERMAL ENERGY

1. The fact that geothermal energy is location-specific is its biggest drawback. Because geothermal plants must be constructed where the energy is available, some regions cannot utilize this resource.
2. Although greenhouse gases are not normally released by geothermal energy, many of them are stored beneath the Earth's surface and are released into the atmosphere when excavation takes place. Although these gases are also naturally emitted into the environment, the rate rises in the vicinity of geothermal facilities.
3. Earthquakes could potentially be sparked by geothermal energy. This is because digging has changed the structure of the Earth.
4. It costs between $2 and $7 million to build a plant with a 1-megawatt capacity, making geothermal energy a pricy resource to use. However, where the initial investment is substantial, it can be recovered over time by other investments.

It is important for industry to assess the geothermal energy pros and cons in order to take account of the advantages while mitigating against any potential problems.

XVIII. CHALLENGES ON GEOTHERMAL DEVELOPMENT

Geothermal energy development does not solely rely on its benefits. The fundamental problems with the contradictory nature of geothermal development itself present the greatest hurdles for projects including its use. In actuality, the difficulties in harnessing geothermal energy are not just constrained by the physical difficulty. One of the issues with building hydrothermal systems could be the challenges of geothermal development, which can include economic, technological, and social challenges.

XIX. CONCLUSIONS

In order to acknowledge the primary study topic and the other two sub-questions, let's wrap up. Geothermal energy is any heat or energy that travels from the earth's surface to its interior. It is divided into five categories: earth energy, hydrothermal energy, hot dry rock energy, geopressured energy, and magma energy. Hydrothermal energy is the most common type of geothermal energy. Geothermal energy resources can be further broken down into two categories: surface resource and subsurface resource. The subsurface resources are the heat sources that are placed below the ground, such as heat reservoirs, magmas, etc. The surface resource may be known as geothermal subsurface manifestations that are caused by the heat conduction from the heat source below the ground or possibly transferred by a rock's friction. Geothermal energy is mostly employed nowadays for two purposes: producing electricity and direct heating. While geothermal energy requires a high temperature steam to generate turbines that permit producing electricity, direct heating applications are a utilization that employ a constant or/and greater temperature compared from the surface in shallow or deep beneath. Three alternative classifications could be used to distinguish the issues with geothermal energy. First, because H_2S gas is dangerous and has the potential to jeopardize the lives of nearby residents and possibly entire communities, it is one of the primary physical issues with geothermal energy. Since electricity is essential to daily living in every society and high temperature reservoirs are required for the production of electricity, the second technological challenge with geothermal energy is how to generate enough heat to deliver both heat and power simultaneously. The development of geothermal energy in these kinds of regions may interrupt local people's everyday activities or perhaps dispense with the local indigenous land and their traditional way of life. This is because most of the vast geothermal energy reserves are found in remote areas with indigenous society. Even if geothermal energy cannot completely replace fossil-based energy, it would be a good replacement for the generation of electricity and heat. Geothermal energy contains very big potentials to be employed in the middle to long term for several uses in different regions across the world. Only three countries out of all the geothermal generator nations have installed capacities of at least 1 GW, with the USA being the largest player in the world with 3.5 GW capacities. The most common form of geothermal energy used is hydrothermal energy with subsurface hot aquifer reservoir resources. Since electricity is the most valuable energy that geothermal energy can create and it cannot be used universally everywhere, the study concluded that in the short to medium term, geothermal energy would not be able to completely replace fossil fuels.

In the end, during the development and utilization of geothermal energy there are three most problems that currently faced all over the world: social, technical and physical problems. The social aspect of this problem mostly tackled with the complex resolutions, since the conflict of different interest by multi stakeholders usually happened during the development of geothermal energy especially in the electricity power plant areas, while the technical and physical problems only need an advance engineering solution to be neglected.

Both the power crisis and the country's population are growing daily in Bangladesh. Therefore, it is imperative that Bangladesh investigate renewable energy sources. The most promising renewable energy sources in Bangladesh are geothermal energy. Gases and pure water can lower the cost of agriculture and drinking water for the nation since they prevent the additional expense of building new chemical and water plants. As a result, this geothermal process will benefit three distinct areas of the country at a far lower overall cost than the cost of the three areas separately. Similar to typical fuel power plants, geothermal power plants emit very little pollution.

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