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Current and future prospects of geothermal energy in Bangladesh

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***Abstract*— In this modern era, geothermal energy is vastly used for producing electricity and it is also a very interesting choice for Bangladesh for the sake of producing electricity. The paper mainly focuses on the production of electricity by using an efficient technique. Applying this process, the cost of producing electrical energy is comparatively low for longer-term purpose. Moreover, mineral water and germicide components can also be produced after a few refining processes. This paper analyses and discusses the promising aspects that can be utilized by geothermal energy for Bangladesh. The technical and economic feasibility has also been analyzed in this research.**

Keywords*— *Geothermal heat; steam turbine; lower cost; germicide; mineral water; electricity.

I. Introduction

Geothermal energy has been considered as a blessing in many countries all over the world due to its renewability and sustainability. By this process, the heat is generated in a natural way with millions of years [1]. Fig.1 shows the potential scenery of the geothermal energy of the whole world [2]. In the last few years, geothermal concepts really become a reliable system for improvement and development in power energy. The most important feature of this process is that it doesn't emit any carbon while running. It can deliver continuous load-power for around 24 hours. On the other hand, the solar systems, water, wind and fuel systems are able for a particular time in a day or night [3].

In the present condition, geothermal energy is used not only for electricity but also in industry, residential, commercial and other issues. In Fig.2, the energy consumption of the whole world in 2007 is represented [4]. Fig.2 shows that over the world, the electricity and heat generation from geothermal energy resources is about 91%, residential 5%, commercial 2%, industrial 1% and others 1%. So, it clears that most of the geothermal energy is absorbed by electricity and heat generation. Here Table 1 shows the geothermal power generation around the end of the twentieth century [2].

Geothermal energy is now very popular. An analytic observation between 1955 and 2015 indicates the popularity of that process. Fig.3 shows the result of that plant installation capacity as popularity [5]. Geothermal plants have also some criteria of enthalpy range for different types of geothermal plants, where single flash plant operates at a range of about 800 to 2800 kJ/kg, double flash range of about 750 to 1900 kJ/kg and the binary plant is about 300 to 150 kJ/kg [6]. Fig.4 shows the results.

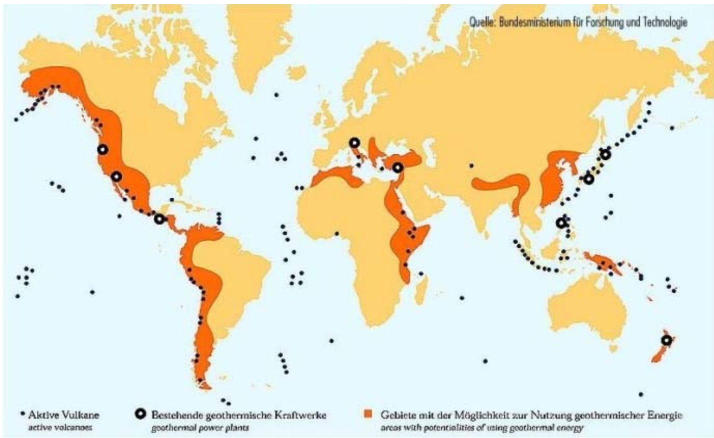

Fig.1: Global geothermal sites.

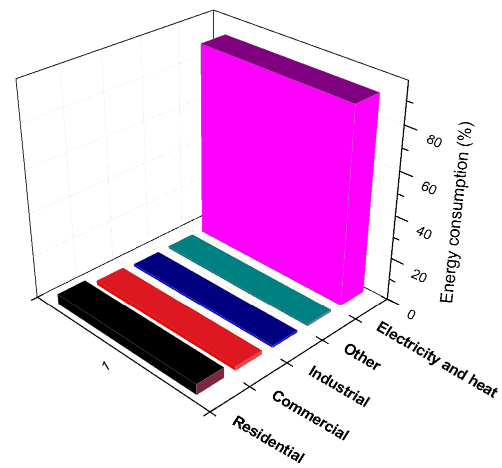

Fig.2: World geothermal energy consumption, by sector, 2007 [15].

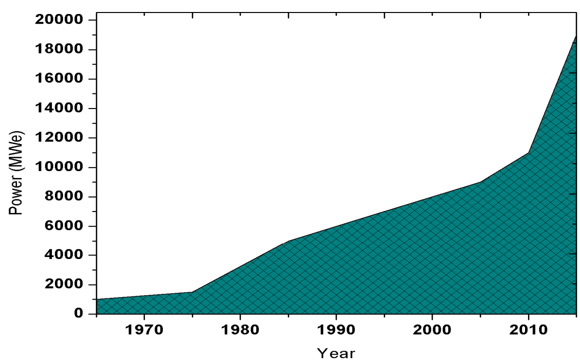

Fig 3: World geothermal power plant installed capacity (MWe vs Years) [5].

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Table 1: Geothermal power generation around the end of the twentieth century.

Nation	*1995 (MW)*	*2000(MW)*	*2005(MW)*
Argentina	0.67	0	N/A
Australia	0.17	0.17	N/A
China	28.78	29.17	N/A
Costa Rica	55.0	142.5	161.5
El Salvador	105.0	161	200
Ethiopia	0	8.52	8.52
France	4.2	4.2	20
Guatemala	0	33.4	33.4
Iceland	50.0	170	186
Indonesia	309.75	589.5	1987.5
Italy	631.7	785	946
Japan	413.7	546.9	566.9
Kenya	45.0	45	173
Mexico	753.0	755	1080
New Zealand	286.0	437	437
Nicaragua	70.0	70	145
Philippines	1227.0	1909	2673
Portugal	5.0	16	45
Russia	11.0	23	125
Thailand	0.3	0.3	0.3
Turkey	20.4	20.4	250
USA	2816.7	2228	2376
Total	**6833**	**7974**	**11414**

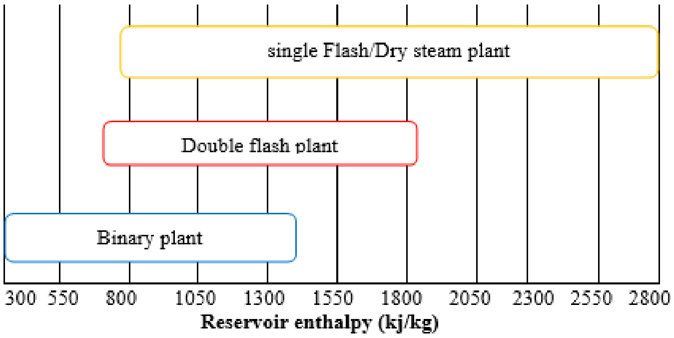

Fig 4: Geothermal power plant operating enthalpy range based on current.

II. Geographic Location And Current Scenery

Bangladesh is a country of South Asia and according to the condition of Fig.1, Bangladesh stands in a potential area. The area of Madhyapara, western Rangpur, Boropukuria, Thakurgaon, Madhupur, Singra, Kuchma, Chittagong-Tripura and Bogra zone of Bangladesh has powerful potential for geothermal energy. Fig.5 shows the probable zone of geothermal areas and their temperature at 3 km [7]. The observation says that the north Bengal and East Bengal have a great opportunity. The underground temperature of the country varies from area to area and it has an increasing temperature per kilometers. Table 2 indicates the range of temperature per kilometers [8].

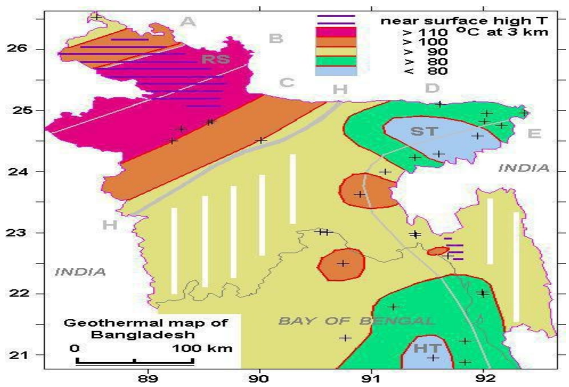

Fig.5: Geothermal map of Bangladesh showing the temperatures at 3 km depth [7].

Table 2: Geothermal gradients for the deep wells along the Bengal for the deep region.

Sl/No	Well name	˚c/km	Sl/No	Well name	˚c/km
1	ARCO AL	26.1	13	Kailashtila 1	19.8
2	Atgram 1	20.1	14	Kamta 1	23.5
3	Bakhrabad 1	23.9	15	Kutubdia 1	26.4
4	Beani Bazar1	19.8	16	Muladi 1	26
5	Begumganj 1	25.4	17	Muladi 2	24.4
6	BINA 1	25.2	`18	Patharia 5	20.4
7	BODC 1	25	19	Rashidpur 1	21.7
8	Chattak 1	21.1	20	Saldanadi 1	27.2
9	Cox's Bazar	25.6	21	Semutang 1	27
10	Fenchuganj 2	20.7	22	Shabajpur 1	29.5
11	Feni 1	23.8	23	Sitakund 5	24.7
12	Feni 2	23.5	24	Sylhet 7	19.9

III. Methodology

In this paper, methodology deals with a simple divided process. Bangladesh has the great potentiality of having geothermal energy. Thus, overheated liquid water and steam can be collected from underground. According to ideal gas law, increasing temperature increases the steam velocity. From Graham's Law [12],

$$C = \sqrt{(3RT/M)} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(i)}$$

Here, C = RMS value or velocity (m/s), R = Ideal gas constant, T = Temperature (K), M = Atomic Mass (kg/mol). From this law, the velocity of the atom of underground hot liquid is always increasing. As a result, the natural temperature of the underground is always in a higher value. And due to the geological location, the temperature varies. For geothermal energy, the necessary temperature is a minimum of 700 OC. Table.2 describes the possibilities for Bangladesh having 700 ˚c to 1300˚c in underground liquid. water and steam can be separated geothermal liquid. Now the velocity of steam rotates the turbine for mechanical energy and the mechanical energy is converted into electrical energy by the generator. After some refining processes, the steam can be used for drinking water. The other part of this process gives hot liquid water which can be condensed and sent to the ground again for renewal.Fig.6 represents the whole process simple.

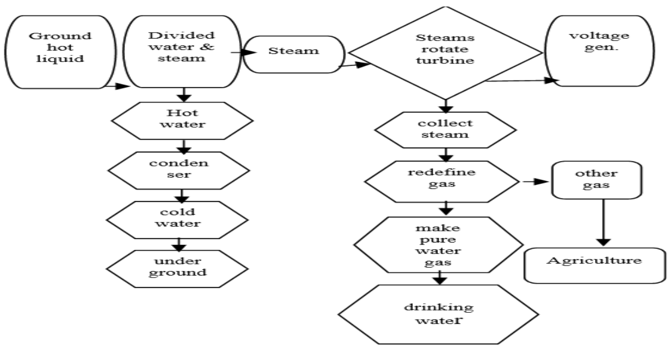

Fig.6 Flow chart for the proposed methodology.

IV. Calculation of Electricity

The analysis takes into account the usual acceleration in well productivity decline due to increases in plant capacity. Fig.7 shows the electricity production with the cost (€/kwh) after 30 years & 50 years plan life. After 50 years the cost becomes less. The capacity for electricity production will also decrease due to the maintenance issue. Fig.8 compares power cost vs plant capacity. The constant initial annual harmonic decline rate is 5% irrespective of capacity. Fig.8 shows that if productivity decline rate were insensitive to plant capacity, power cost would decline with plant capacity much more rapidly than in the usual case, the minimum power cost being only 2.8 €/kWh (for a 150 MW plant). However, a stand-alone project of capacity larger than 100 MW is a rarity in the geothermal industry [9]. The existing fields with a generation level greater than 100 MW typically rely on multiple, independent units of up to 100 MW each.

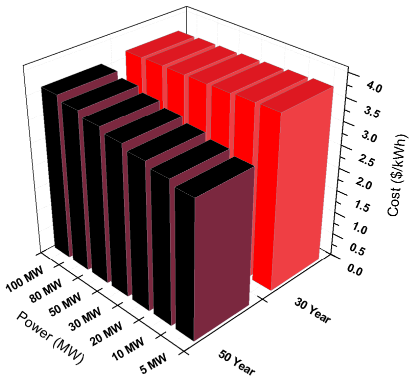

Fig.7: 30 years plant life with a 30 years amortization vs 50 years plan a life with a 50 years amortization.

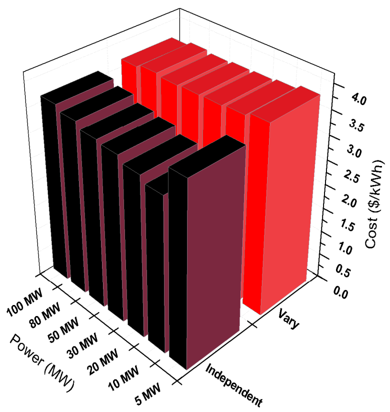

Fig.8: power cost vs plant capacity(for 20 years of making up drilling).

V. Geothermal Plant Cost

The initial cost of a geothermal plant according to the USA are higher because of well drilling, pipeline construction and design of the actual plant. The initial cost for the field and power plant is around $2500 per installed KW. Operating and maintenance costs range from $0.01 to $0.03 per kWh. Most geothermal power plants can run at greater than 90% availability but running at 97% or 98% can increase maintenance costs [10, 11]. Geothermal power plants are generally considered one of the power production means with the highest capacity factor because the power can be generated throughout the whole year. Though investment costs for geothermal power plants are higher than other types of the power plant, maintenance costs are low because no fuel or external energy source is needed to run this plant. This is the main reason which has made this economical. Typical costs for different power plants are shown in Table 3.

Table 3: Effect of plant life on power cost (20 years of making up well drilling.

Plant	Investment cost MUSD/MWh	Annual operational and maintenance cost		Typical load factor
		Fixed USD/MWh	Variable USD/MWh Gross	Nominal
Geothermal steam	3.60	43000	4.3	90-95
Geothermal, binary	5.30	43000	1.0	85-90
Large wind	2.00	35000	2.0	35-40
Nuclear	4.05	90000	15.0	80-90
Gas Turbines	0.80	12000	90.0	50-60
Coal	2.10	70000	60.0	70-80
Diesel	1.50	60000	120.0	30-40

VI. Conclusion

The population of Bangladesh is increasing day by day as well as the power crisis. So, it is high time to explore renewable energy sources in Bangladesh. Geothermal energy is the most promising renewable energy sources in Bangladesh. Gasses and pure water which can reduce the agricultural and drinking water cost for the country because it saves the extra cost of installing new chemical and water plants. So, this geothermal process will cover three sectors of the country and the whole cost will far less than the three-individual cost. Again, the geothermal power plant emits a very little amount of pollutant compared to traditional fuel power plants. So, it may play a vital role in reducing the greenhouse effect.

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