PROSPECT OF GEOTHERMAL ENERGY RESOURCES IN BANGLADESH

Asif Bin Karim, Sakib S. Avro, Saquib Shahriar*
Department of Mechatronics Engineering, Rajshahi University of Engineering & Technology,
Rajshahi-6204, Bangladesh
e-mail: asif.mte.148004@gmail.com

ABSTRACT
In today's world, many countries are using geothermal resources mainly to produce electricity. Furthermore, it can be a very effective and fruitful choice for Bangladesh. This paper mainly deals with techniques of converting electrical energy from geothermal heat in comparatively efficient ways. 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; Germicide; Mineral Water; Electricity

1. 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 (Kabir et al., 2018). Fig.1 shows the potential scenery of the geothermal energy of the whole world (Mallik & Hasan, 2018). In the last few years, geothermal concepts really become a reliable system for improvement and development in the 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 around 24 hours. On the other hand, the solar systems, water, wind and fuel systems are able for particular time in a day or night (Arefin & Mallik, 2018). Kinetic energy resource in tidal streams or marine currents, driven by gravitational effects, and the resources in wind-driven waves, derived ultimately from solar energy was considered as sources of energy in (Bahaj, 2011). Inauspiciously, the ocean atmosphere is very harsh (Hossain et al., 2015 & 2017) which poses a barrier to the process of using this energy. However, 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 whole world in 2007 is represented (Mallik et al., 2017). 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 twentieth century (Mallik & Hasan, 2018).

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 (Nahian & Islam, 2016). 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 binary plant is about 300 to 150 kJ/kg (Moya et al., 2018). Fig.4 shows the results. In this article a total overview of geothermal energy has been represented which has not yet done in any other researches on recent times. Of all renewable energy sources, geothermal energy is the most efficient energy source in Bangladesh. There is a vast opportunity to search for investment for geothermal energy in power sector of Bangladesh because of power crisis and lack of scope of producing electricity from any renewable energy sources. In this paper we intend a procedure to produce renewable energy from the ground water by generating voltage and use it to generate electricity.

2. CURRENT STATUS: GEO-THERMAL ENERGY FOR BANGLADESH

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 have powerful potential for geothermal energy. Fig.5 shows the probable zone of geothermal areas and their temperature at 3 km (Momin et al., 2018). The observation says that the north Bengal and east Bengal have a great opportunity. The under-ground 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 (Mondal et al., 2018).

3. METHODOLOGY

In this paper methodology deals with a simple divided process. Bangladesh has great potentiality of having geothermal energy. Thus, over heated liquid water and steam can be collected from under-ground. According to ideal gas law, increasing temperature increases the steam velocity. From the Graham's Law (Property of Gases/ Physical and Theoretical Chemistry Textbook),

$$C = \sqrt{(3RT/M)}$$

Here, C = rms value or velocity (m/s), R = Universal ideal gas constant, T = Temperature (K), M = Atomic Mass (kg/mol). From this law, velocity of the atom of underground hot liquid is always increasing. As a result, the natural temperature of underground is always in a higher value. And due to geological location, the temperature varies. For geothermal energy the necessary temperature is minimum 700 ˚C. Table.1 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 kinetic energy and the kinetic energy is formed into electrical energy by the mechanism of 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 simply.

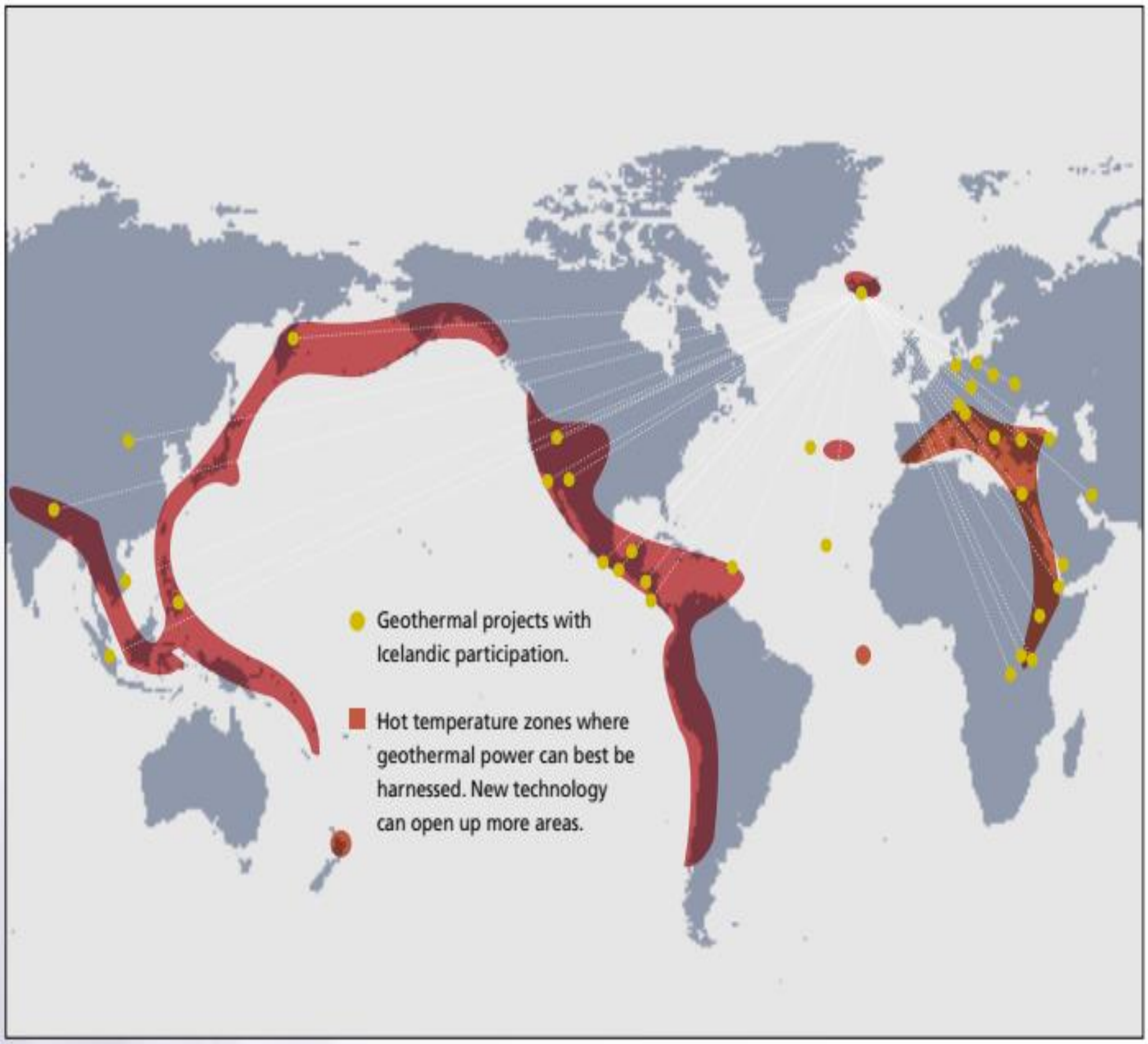

Fig.1 Global geothermal sites (Tigue et al. 2018 and Salehi et al. 2018)

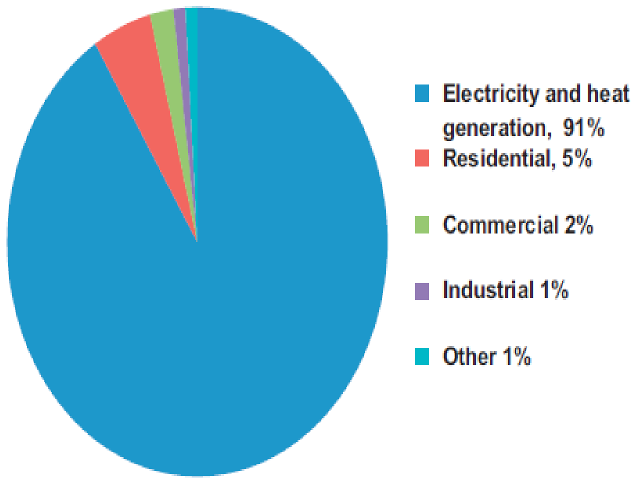

Fig.2: World geothermal energy consumption, by sector, 2007 (Tigue et al., 2018).

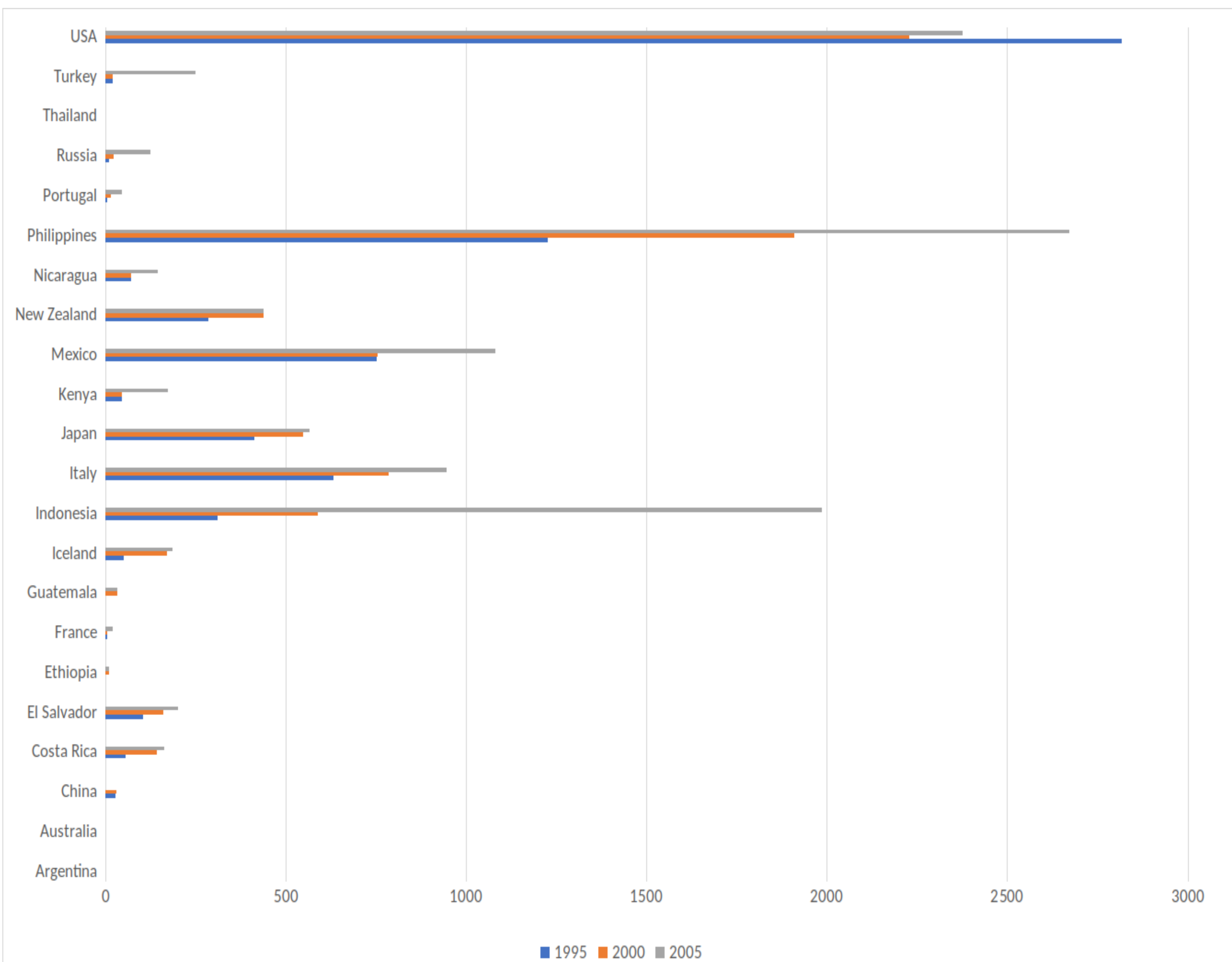

Fig.3: Geothermal power generation around the end of twentieth century.

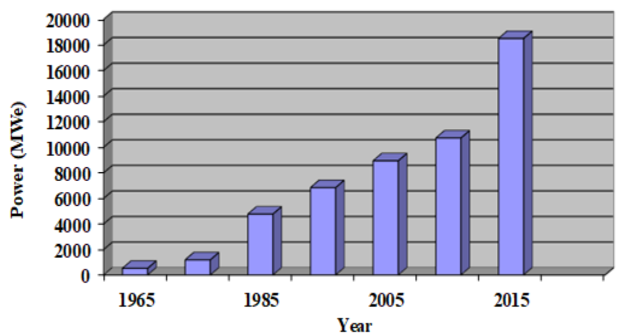

Fig. 4: World geothermal power plant installed capacity (MWe vs Years)

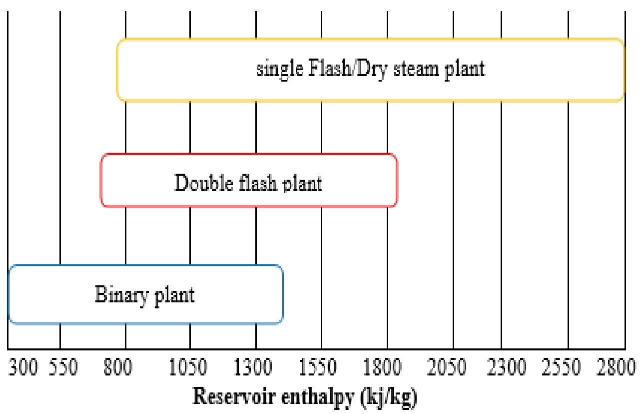

Fig.5: Geothermal power plant operating enthalpy range based on current plant.

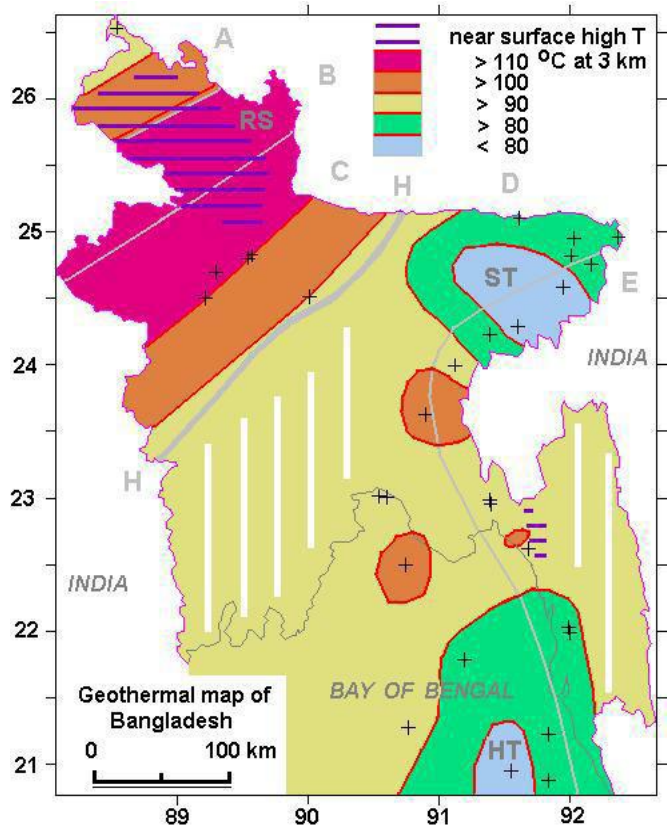

Fig.6: Geothermal map of Bangladesh showing the temperatures at 3 km depth (Momin et al., 2018).

Table 1: Geothermal gradients for the deep wells along the Bengal for deep region.

Sl/No	Name	˚C/km	Sl/No	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

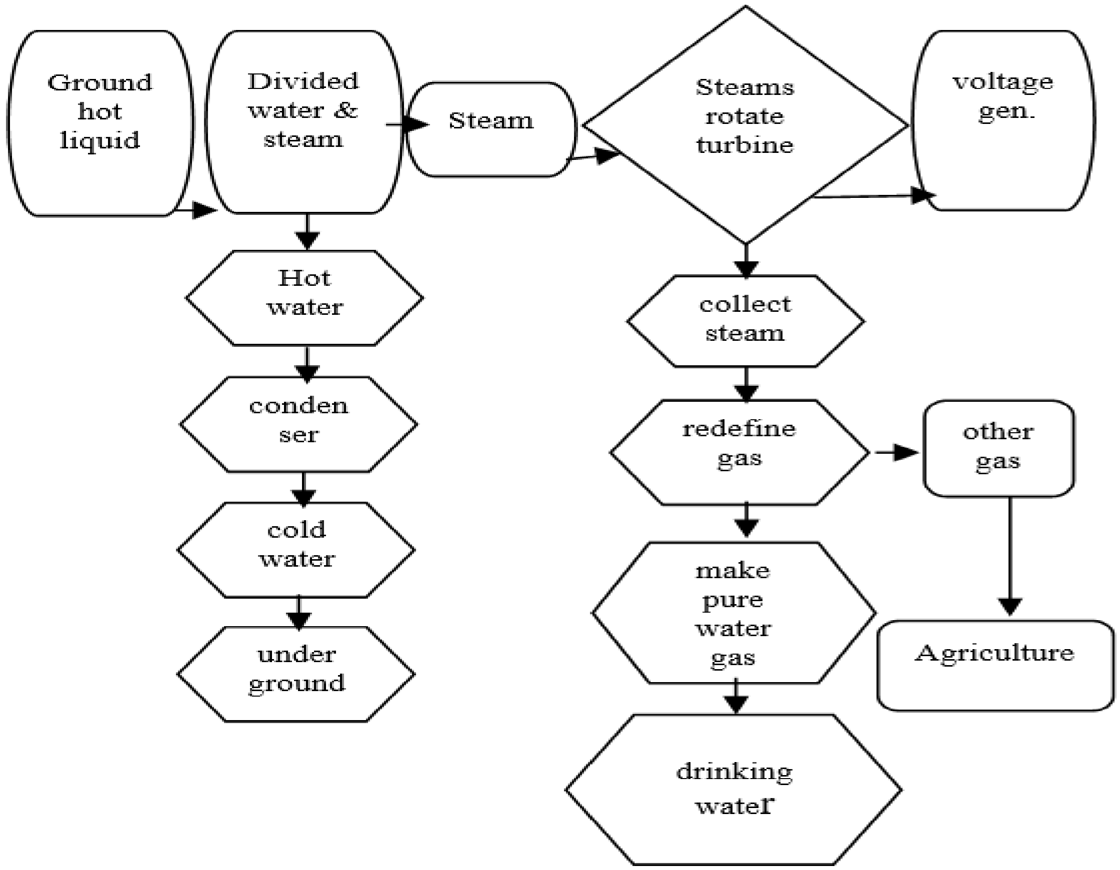

Fig.7: Flow chart for the proposed methodology.

4. RESULTS REGARDING ELECTRICITY PRODUCTION

This analysis is about a numerical value which is suitable for any plant, but it declines when there is an increase in plant capacity. Fig.7 shows that power is produced in relation to cost (€/kwh) after the 30-year and 50-year plant life. The cost tends to reduce after 50 years. The capacity of electricity production will also decrease, given maintenance issue. Fig.8 represents cost for power production with the plant capacity. The constant initial annual harmonic decay rate is 5%, regardless of capacity. Fig.8 shows that if productivity decay rate is insensitive to the plant capacity. The minimum power cost being only 2.8 €/kWh (for a 150 MW plant). However, a stand-alone project of a larger-than-100 MW capacity is rare in the geothermal industry (Karimi & Mansouri, 2018). The existing fields with a generation level greater than 100 MW typically count on different, independent units of up to 100 MW each.

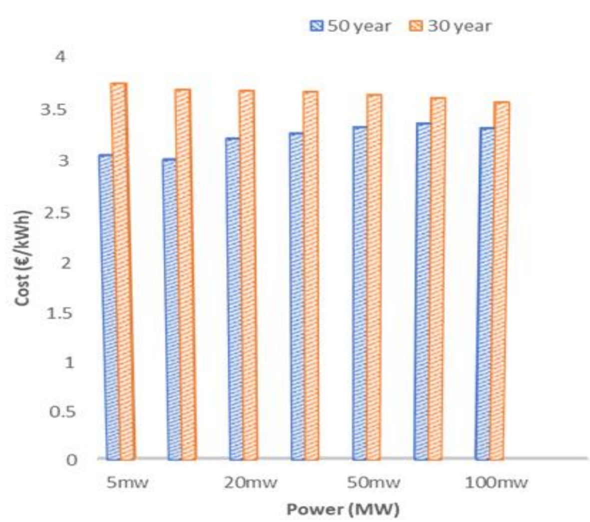

Fig.8: Plant life with a 30 years' amortization vs 50 years plant life with a 50 years' amortization.

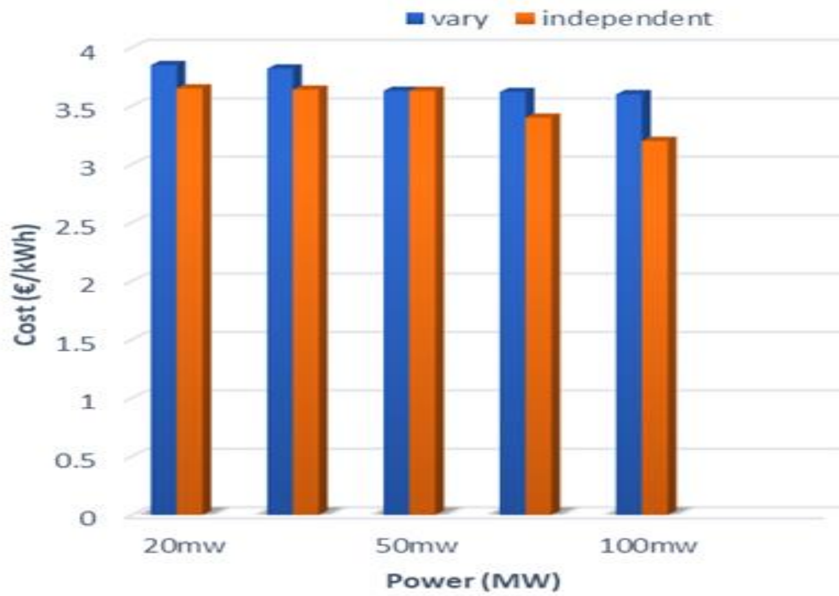

Fig.9: Power cost vs plant capacity (for 20 years of the build of the drilling)

5. FEASIBILITY OF GEOTHERMAL PLANT

The initial cost of a geothermal plant according to 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 (Saheli et al., 2018; Tigue et al., 2018). Geothermal power plants are generally considered one of the power production means with the highest capacity factor because the power can be generated through the whole year. Though investment costs for geothermal powerplants are higher than other types of power plant, but maintenance costs are low because no fuel or external energy source is needed to run this plant. This is the main reason which have made this economical. Typical costs for different power plants are shown in Table 3.

Table 2: Lifetime cost estimation of plant life on power cost

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

6. 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 whole cost will far less than the three-individual cost. Again, 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 greenhouse effect.

ACKNOWLEDGEMENTS

Publishing of this journal is supported by the Matrix Engineering Research Centre and the authors are thankful to Mr. Avijit Mallik, Mr. Md. Arman Arefin and Mr. S. M. Asif Hossain for their support and help. The authors would also like to acknowledge Prof. Dr. Mhia Md. Zaglul Shahadat (HOD, Dept. of Materials Science & Engineering, RUET) for his kind support and appreciation.

REFERENCES

Arefin, M. A., A. Mallik (2018) Numerical investigation of solar and wind energy assisted plugged in hybridized engine driven auto-rickshaw/three-wheeler, AIMS Energy, 6(2), 358-375.

Bahaj, A. S. (2011). Generating electricity from the oceans. Renewable and Sustainable Energy Reviews, 15(7), 3399-3416.

Hossain, S.A., Anower, M.S., & Halder, A. (2015). A cross-correlation based signal processing approach to determine number and distance of objects in the sea using CHIRP signal. IEEE conference in Electrical & Electronic Engineering (ICEEE), 177-180

Hossain, S.A., Mallik, A., & Arefin, M. (2017). A Signal Processing Approach to Estimate Underwater Network Cardinalities with Lower Complexity. Journal of Electrical and Computer Engineering Innovations, 5(2), 131-138.

Kabir, E., P. Kumar, S. Kumar, A.A. Adelodun, and K. H. Kim (2018) Solar energy: Potential and future prospects. Renewable and Sustainable Energy Reviews 82, 894-900.

Karimi, S. and Mansouri, S., (2018). A comparative profitability study of geothermal electricity production in developed and developing countries: Exergoeconomic analysis and optimization of different ORC configurations. Renewable Energy, 115, 600-619.

Mallik, A., Arefin, M.A., Rashid, F. and Asfaquzzaman, M. (2017) Solar Based Plugged-in Hybrid Engine Driven rickshaw (Auto-Rickshaw) & its Feasibility Analysis for Bangladesh. In: Proceedings of the international conference on mechanical, industrial and materials engineering RUET, 2017, http://icmime-ruet.ac.bd/2017/DIR/Contents/Technical%20Papers/Energy%20Technology/ET-253.pdf.

Mallik, A., M. Hasan (2018) PV/T Systems for Renewable Energy Storage: A Review. World Scientific News 96, 83-95.

Momin, M.S.A., Morshed, A., Hossain, F. and Setu, R.S., (2018) Present Conventional & Non-Conventional Energy Scenario in Bangladesh and Its Future Aspects. International Journal of Modern Research in Engineering & Management 1(6), 29-40.

Mondal, M.A.H., Rosegrant, M., Ringler, C., Pradesha, A. and Valmonte-Santos, R. (2018) The Philippines energy future and low-carbon development strategies. Energy, 147, 142-154.

Moya, D., Aldás, C. and Kaparaju, P. (2018) Geothermal energy: Power plant technology and direct heat applications. Renewable and Sustainable Energy Reviews, 94, 889-901.

Nahian, M.R., M.N. Islam (2016) Prospects and potential of biogas technology in Bangladesh. In Innovations in Science, Engineering and Technology (ICISET), International Conference on, pp. 1-4. IEEE, 2016.

Property of gases, Retrieved From: https://chem.libretexts.org/Textbook_Maps/Physical_and_Theoretical_Chemistry_Textbook_Maps/Map%3A_Physical_Chemistry_for_the_Biosciences_(Chang)/02%3A_Properties_of_Gases/2.9%3A_Graham's_Laws_of_Diffusion_and_Effusion

Salehi, S., Mahmoudi, S.M.S., Yari, M., Rosen, M.A., 2018. Multi-objective optimization of two double-flash geothermal power plants integrated with absorption heat transformation and water desalination. Journal of Cleaner Production, 195, 796-809.

Tigue, J.D.M, Castro, J., Mungas, G., Kramer, N., King, J., Turchi, C. and Zhu, G (2018). Hybridizing a geothermal power plant with concentrating solar power and thermal storage to increase power generation and dispatchability. Applied energy, 228, pp.1837-1852.