# An Introduction and Prospect of Geothermal Energy in power Sector of Bangladesh

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Abstract— Power crisis is a major problem for a developing country like Bangladesh. To improve our power system situation geothermal energy can be a viable and useful alternative. Geothermal energy has vast global potential and its development can contribute significantly towards meeting the growing global renewable energy demand in both developed and developing countries. This paper proposes the prospects of geothermal energy in power sector of Bangladesh. The main agenda of this paper is to discuss about the significance and a detailed feasibility study of practical implementation of geothermal power plant in Bangladesh. This paper also emphasis the technological resource in conjunction with the ways in which geothermal energy is converted into electrical energy.

**Index Terms**— Renewable energy; Geothermal system; Electrical energy; Geothermal technology; Geothermal gradient.

## 1 INTRODUCTION

GEOTHERMAL is named comes from two Greek letter "thermal" that means 'heat' and "geo" have means 'earth'. Renewable energies are provided by natural resources (sunlight, wind, water, and geothermal heat) through the use of engineering technologies able to collect the energy and to convert it in a more usable form. Geothermal power is extracted from heat stored in the earth. This geothermal energy originates from the original formation of the planet, from radioactive decay of minerals, and from solar energy absorbed at the surface [1].

Geothermal (meaning "earth heat") energy involves using the high temperatures produced beneath the earth to generate electricity from heated water, as well as for various direct uses (such as hot springs spas, lumber drying or aquaculture). The term geothermal is also applied to the temperatures of the earth near the surface which are used as a source of consistent temperatures for heating and cooling of buildings. Geothermal applications that involve water heated within the earth are also called hydrothermal processes [2].

The thermal energy which is generated and stored inside the earth surface is called geo thermal energy. It is very much cost effective and environmentally friendly. With this technology, we can use the steam and hot water produced inside the earth surface to generate electricity. Geothermal energy is generated about 4,000 miles below the surface, in the earth's core .the process takes place due to the slow decay of radioactive particles, the high temperature produced inside the earth and it happens in all rocks . About 10,715 megawatts (mw) of geothermal energy is generated in 24 countries worldwide [3]. The northern districts of Bangladesh show the prospect to explore the geothermal resources. The demand of electricity in urban as well as in the rural areas are increasing, but our production on of electricity is not increasing . The rural demand for electricity can be covered by the production of electricity through geothermal energy. The electricity demand of urban areas can be met then by this saved electricity which is supposed to be provided in the rural areas. Geothermal energy can balance the electricity consumption in these two areas [2], [3].

## 2 GEOTHERMAL ENERGY

Geothermal energy is a kind of "heat-embedded" energy, and can be used directly without conversion, better than other types of renewable energy in some extent. In certain cases, geothermal energy is more convenient to use, and would become an effective "compliment" energy for other types of energy. When renewable energy sources are used, the demand for fossil fuels is reduced [1] ,[2].

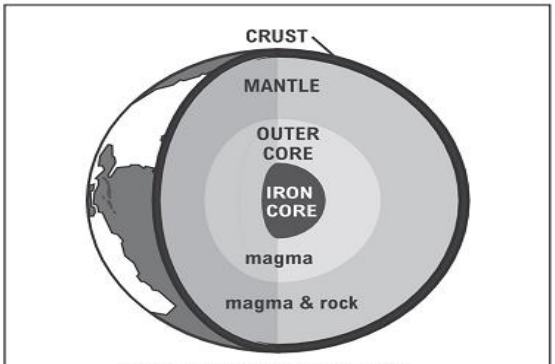


Fig. 1. the earth's interior

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Geothermal energy is the energy contained in the heated rocks and fluid that fills the fractures andpores within the earth's crust. It originates from radioactive decay deep within the earth and can exist as hot water, steam, or hot dry rocks [1].

## 3 Background Of Geothermal Energy

Geothermal energy is a well established renewable energy subsector. In 2008, geothermal power production exceeded three times that of solar photovoltaics. Current growth is steady, but rather slow. While wind and solar photovoltaic are going through periods of accelerating growth, geothermal power is developing rather linearly. So far, its deployment has relied mainly on hydrothermal resources (hot rock and water) located in special geological settings [1]. There are two main utilization categories: Power generation and direct use. Direct use of geothermal energy means that the thermal energy from underground is used directly as heat (or cold), rather than being used to generate electricity. There are significant advantages to geothermal energy. Geothermal energy is available around the clock, independent of the time of day and night, or of the current climatic conditions. When used to generate electricity, this means that geothermal energy is base-load, suited to producing energy at a constant level, in contrast to the variable output of wind and solar power, and the peaking output of hydropower and some bio-power [1].

## 4 Geographical Analysis Of Geothermal Power Plant In Bangladesh

Bangladesh located at the head of the bay of Bengal, is formed by the successive delta systems developed by the two great rivers of the ganges (padma) and the Brahmaputra (jamuna). The Himalayan mountain ranges were uplifted as a result of the collision with the northward drifting Indian plate after the break-up of the gondwana continent starting in upper Jurassic / lower cretaceous time [2].

The geothermal energy resource should be given emphasis now, as geothermal energy is green, local and continuously available, independent of wind and sun variations. The high cost of drilling a well can be reduced by using the existing abandoned on-shore dry wells where the geothermal gradient is sufficiently high (like over 30 k/ km) and where porous and permeable reservoir sandstones are penetrated. The study of geothermal conditions in Bangladesh has now resulted in clearer patterns for the geothermal energy potential [2] [4] , related to the major tectonic-structural regions, illustrated in figure2.

## 5 echnological Overview Of Geothermal Power Plant

The capacity of geothermal power plants in the world totals approximately 9 gw, with an annual electricity generation of about 60 twh, equivalent to less than 1% of the global electricity demand. Geothermal heating plants have a global capacity of approximately 18,000 mw and produce some 63 twh per year. In general, technologies for the exploitation of what is called 'conventional and shallow' geothermal energy resources are commercially available . These technologies include [2].

- Dry steam plants.
- Flash plants.
- Binary plants.
- Combined-cycle or hybrid plants.
- Combined heat and power based on geothermal
- Energy.
- Heating based on geothermal energy.

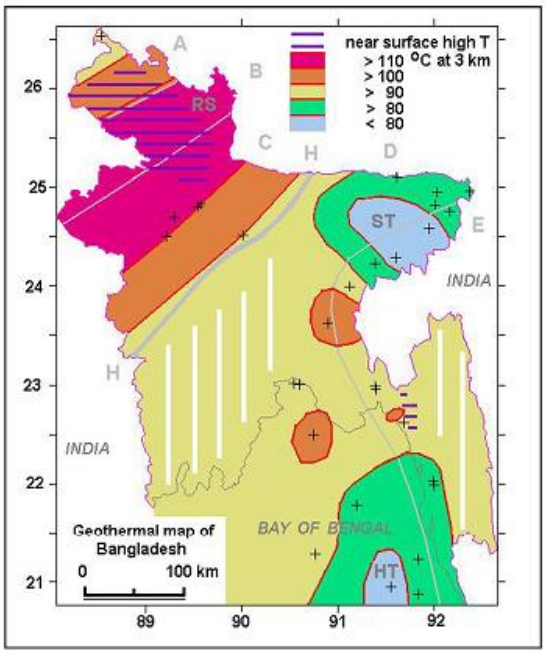


Fig. 2. geographical map of Bangladesh

## 6 Components Of Geothermal Systems

Geothermal systems are made up of four main components: a heat source, a reservoir, a fluid (the carrier that transfers the heat) and a recharge area [2].

The basic forms of geothermal energy are [2]:

- Hydrothermal fluids.
- Hot dry rock.
- Geo-pressured brines magma.
- Ambient ground heat.

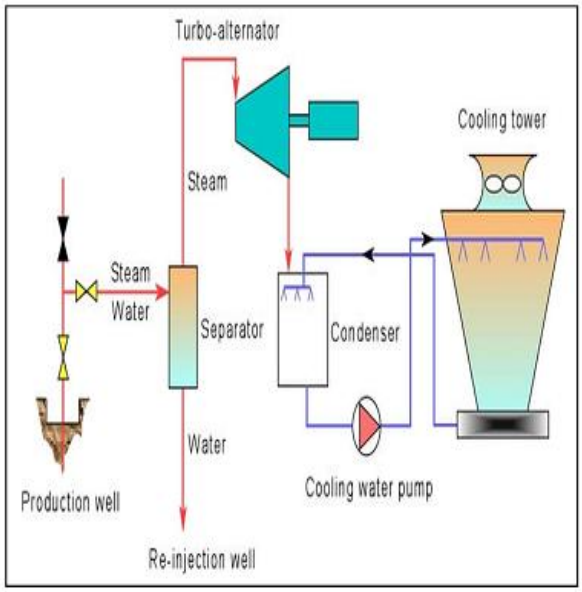


Fig. 3. a schematic diagram of geothermal binary plant

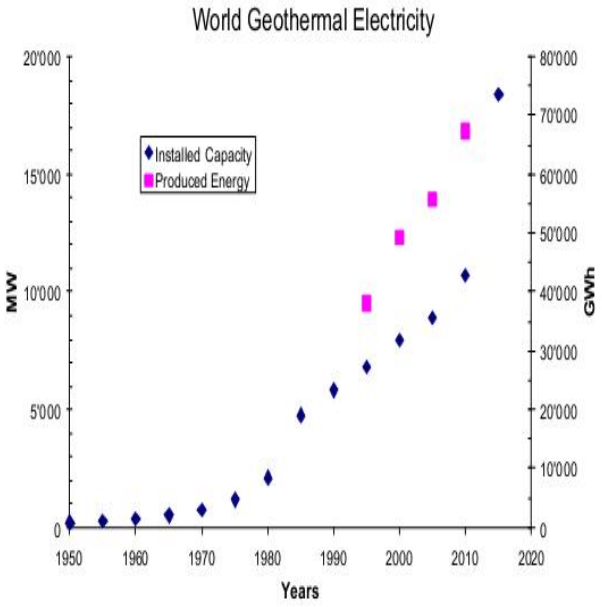


Fig. 4. installed capacity from 1950 up to 2015, (left ,mw) and produced electricity (right, gwh).

## 7 Sizes Of Geothermal Power Plant

Geothermal power plants come in small (300 kw to 10 mw), medium (10 mw to 50 mw), and large (50 mw to 100 mw and higher) capacities. A geothermal power plant usually consists of two or more turbine-generator "modules" in one plant. Extra modules can be added as more power is needed. Binary plants are especially versatile because they use relatively low reservoir temperatures. Small binary modules can be built quickly and transported easily [2] [5].

TABLE 1
TOTAL INSTALLED CAPACITY FROM 1950 TO 2015 AND SHORT TERM FORECASTING

| Year | Installed capacity (mw) | Produced energy (gwh) |
|---|---|---|
| 1950 | 200 | |
| 1955 | 270 | |
| 1960 | 36 | |
| 1965 | 520 | |
| 1970 | 720 | |
| 1975 | 1,180 | |
| 1980 | 2,110 | |
| 1985 | 4,764 | |
| 1990 | 5,834 | |
| 1995 | 6,833 | 38,035 |
| 2000 | 7,972 | 49,261 |
| 2005 | 8,933 | 55,709 |
| 2010 | 10,715 | 67,246 |
| 2015 | 18,500 | |

## 8 Geothermal Energy Resources

Geothermal resources include dry steam, hot water, hot dry rock, magma, and ambient ground heat. Steam and water resources have been developed commercially for power generation and ambient ground heat is used commercially in geothermal heat pumps; methods of tapping the other resources are being studied. Research centers on lowering costs, improving methods for finding and characterizing reservoirs, and tapping broader resources [6],[7].

Geothermal energy resources:

There are four major types of geothermal energy resources.

- Hydrothermal
- Geopressurised brines
- Hot dry rocks
- Magma

## 9 Electricity From Geothermal

Geothermal power projects convert the energy contained in hot rock into electricity by using water to absorb heat from the rock and transport it to the earth's surface, where it is converted to electrical energy through turbine-generators [8], [9]. Water from high-temperature (>240 °c) reservoirs is partially flashed to steam, and heat is converted to mechanical energy by passing steam through low-pressure steam turbines. A small fraction of geothermal generation worldwide is generated using a heat exchanger and secondary working fluid to drive the turbine [1] [2].

## 10 GEOTHERMAL GRADIENT OF BANGLADESH

The geothermal gradient of Bangladesh is mostly controlled by the tectono-stratigraphic setup of the Bengal basin. It is, therefore, necessary to evaluate the geothermal gradient of Bangladesh in order to understand individual tectonic elements with respect to the regional tectonic history. Geothermal gradients were calculated from corrected bht (bottom hole temperature) using horner´s plot or by simply adding 10°c to the maximum recorded bhts. Surface temperature is assumed to be 24°c (75°f) for onshore wells, and 15°c (59°f) for offshore wells. Geothermal gradients were computed on the assumption of a linear increase in temperature with depth [4].

With this assumption, the temperature of any depth can be expressed by the following equation:

$$T_z = t_0 + t_g z / 100 \quad (1)$$

$T_z$ = the wellbore temperature (°c) at depth z (m).
$T_0$ =the mean surface temperature (°c).
$T_g$ =the geothermal gradient in (°c / km).

## 11 POSITIVE ATTRIBUTES OF GEOTHERMAL ENERGY

- Geothermal power plants have no smoky emissions. Binary power plants have virtually no polluting emissions [2].
- Geothermal power plants use very little land compared to conventional energy resources and can share the land with wildlife or grazing herds of cattle. They operate successfully and safely in sensitive habitats, in the middle of crops, and in forested recreation areas [2].
- Geothermal wells are sealed with steel casing cemented to the sides of the well along their length. The casing protects shallow, cold groundwater aquifers from mixing with geothermal reservoir waters. This way the cold groundwater does not get into the hot geothermal reservoir and the geothermal water does not mix with potential sources of drinking water [2] [6].
- Geothermal power plants provide very reliable base load electricity. Some plants can increase production to supply peaking power. But geothermal plants cannot be used solely as peaking plants [2].
- Geothermal energy is "homegrown." This will create jobs, a better global trading position and less reliance on oil producing countries [6].
- In large plants the cost is 4-8 cents per kilowatt hour. This cost is almost competitive with conventional energy sources [6].
- Geothermal electric plants production in 13.380 g of carbon dioxide per kwh, whereas the $co_2$ emissions are 453 g / kwh for natural gas, 906g g / kwh for oil and 1042 g / kwh for coal [6].

## 12 ENVIRONMENTAL IMPACT

Geothermal energy produces no air emissions other than steam, and the water used in the conventional hydrothermal process often is injected back into the source reservoir. Because available water can be depleted, as can the heat, if too much cooler water is injected, there has been some discussion as to whether geothermal is truly "renewable"[7].

## 13 FUTURE OF GEOTHERMAL ENERGY

Because geothermal energy is reliable and renewable, this alternative power source will start to enjoy more growth. However, just remember that geothermal energy will not necessarily be available in many areas due to its volatile needs. Areas like California, Iceland, Hawaii and Japan are just a few places where geothermal energy is being used, many due to earthquakes and the underground volcanic activity. From the long-term perspective, it is necessary for Japan to start studying electricity generation with enhanced geothermal systems , which the united states and Australia have already started researching. In the end, there are high expectations that geothermal energy will again come into the spotlight [10], [11], [12].

## 14 CONCLUSIONS

Renewable energy technologies offer the promise of clean, abundant energy gathered from self-renewing resources such as the sun, wind, earth, and plants. Each of the renewable energy technologies is in a different stage of research, development, and commercialization and all have differences in current and future expected costs, current industrial base, resource availability, and potential impact on greenhouse gas emissions. At present, the scale of geothermal power industry is small because of the limitation of easily exploitable high temperature geothermal resources, therefore, the development of geothermal resources have to be primarily focused on utilization of ground source heat pumps which can make good use of the enormous low temperature geothermal resources.

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