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A Study on New Green Methods of Generating Electricity

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ABSTRACT: *In this paper, a new method of electricity generation, namely geothermal technique based on carbon dioxide (CO_2), is proposed as a partial solution to the power generation needs of Bangladesh. This geothermal technique is an environmentally friendly and safe method of electricity generation compared to some other methods of power generation. Although the cost of the overall system is high, especially for storage of liquid CO_2 this high cost can be reduced by using multiple sub-systems of power generation. Every brick field can set up a CO_2 trap including a liquefied conversion unit. The pros and cons of the newly proposed method have been discussed extensively with some specific points related to environmental and technical issues. The overall results show that the new method can be useful in Bangladesh to generate an adequate supply of electricity to meet demand.*

KEYWORDS: *geothermal, renewable energy, CO_2 emissions, CO_2 conversion.*

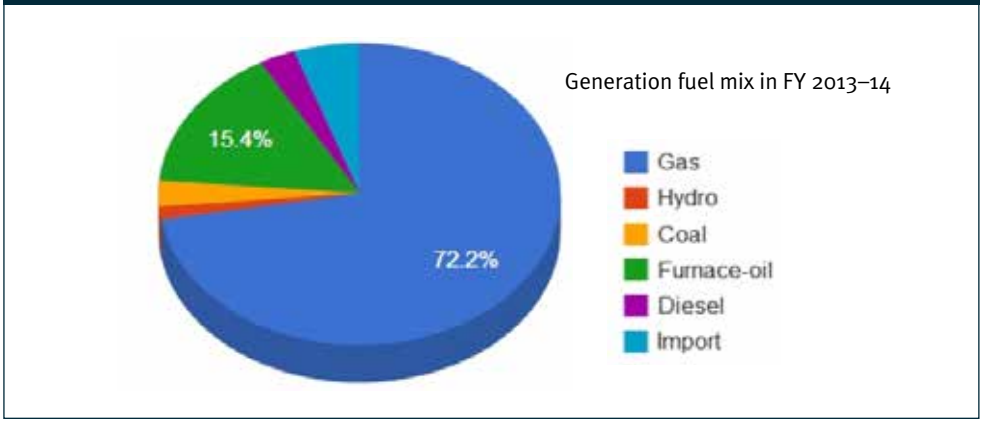
Introduction

BANGLADESH IS IN GREAT NEED of more electricity generation capacity for its economic growth. The country has small reserves of oil and coal, and very large natural gas resources. In Bangladesh the primary source of commercial energy is natural gas (72%), followed by oil, hydro power, and coal. Natural gas comprises around 82% of the energy source for electricity generated (IEA 2008; Rifatand Islam 2014; Flavin and Aeck 2005). At present, the Government of Bangladesh and private firms are trying to develop fossil fuel power stations, nuclear power stations, renewable energy systems, and so on. However, fossil fuel power stations inevitably cause environmental pollution. The renewable systems do not generate greenhouse gases, but they create other problems. Typically they have higher generating costs per MWh of electricity. Many renewable technologies are intermittent and pose problems of storage if they are to generate base power.

While Bangladesh has considerable gas reserves, this is a finite resource and annual consumption is rising rapidly (Ullah, Hoque and Hasib 2012, 618-627). At present, 53% of the total electricity generation of Bangladesh comes from power plants under the public sector and 47% is added from the private sector (Nasrin 2013). Despite a tripling of maximum generation capacity from 2100 MW in 1995–1996 to 6200 MW in 2011, there remains a power crisis in the country (Anam et al. 2011, 13; Government of Bangladesh 2011, 1-2). Because of the shortage of gas supply, some power plants are unable to produce power at their rated generation capacity. The power crisis has other aspects: exhaustion of fossil fuel reserves, deforestation, and environmental pollution (Anam and Al-Bustam 2011).

Geothermal technology uses deep-earth heat to generate electricity. Currently, geothermal plants rely on locations where hot water is trapped under the surface, and can be pumped out to drive turbines. This method of generating electricity limits the feasible locations (Lepisto 2007).

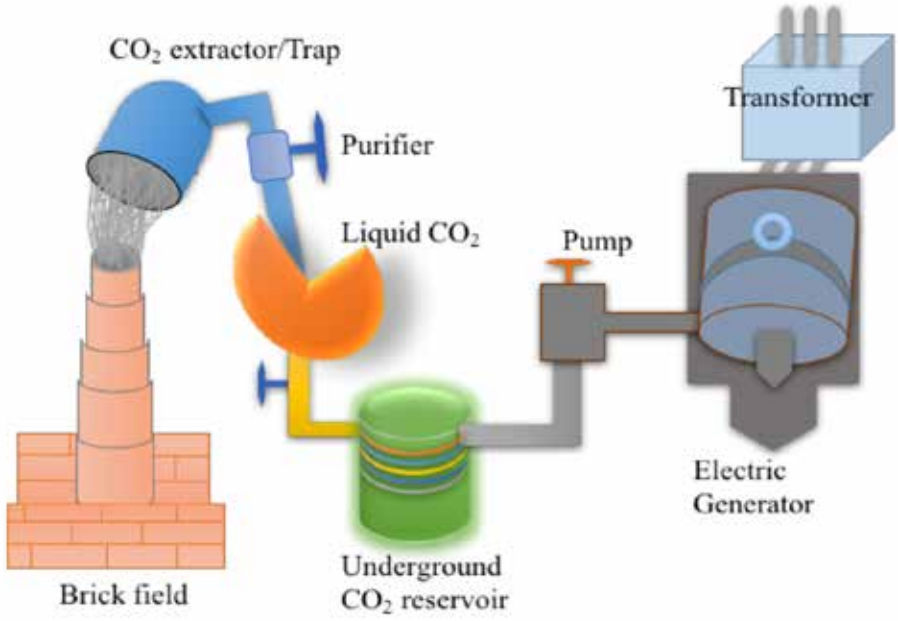
Figure 1: Net Energy Generation (%) by Different Resources (Renewable Energy in Bangladesh)



This paper presents a new method of environmentally friendly electricity generation. In Bangladesh, there are uncounted brick fields that generate huge amounts of carbon dioxide (CO_2) every day. This new method collects the CO_2 from the chimneys of brick fields and stores CO_2 inside the earth surface. The storage CO_2 drives turbines to generate electricity. Figure 2 shows a schematic diagram of electricity generation using CO_2 emissions.

Figure 2: Schematic View of Generating Electricity Using Carbon Dioxide of Brick Fields

Carbon dioxide (CO_2) is captured at the source from fossil fuel burning brick fields. The collected CO_2 is liquefied and stored efficiently in a reservoir. In order to use this CO_2, a pump feeds into the generators. The whole procedure is called a carbon dioxide storage and electricity generation system (CSEGS). Carbon dioxide flows through the porous rock bed deep in the earth more quickly than water. Moreover, the CO_2 expands more significantly than water when it is heated, thus the pressure differential between the CO_2 pumped into the ground and this heated CO_2 is much greater than the pressure differential of the water for the same procedure.



Feasibility of New Method in Bangladesh

Bricks are one of the basic building components in Bangladesh. From the brick fields, CO_2 can be collected easily, and can be used instead of water for geothermal electricity generation. Simultaneously, CO_2 emissions can be reduced and the power crisis relieved. The cost of collection and storage of CO_2 and the cost of a geothermal turbine remain to be calculated.

According to studies, the cost of a new geothermal power plant is higher than that of a comparable natural gas facility. While the construction costs of a natural gas plant are lower than for a geothermal plant, operating costs of a natural gas facility are higher than for a geothermal plant. The levelized cost per MWh of geothermal power are in the range of Tk. 8,000 per MWh. While this is higher than the levelized cost per MWh of natural gas, it is similar to that of other renewable and nuclear power costs (Geothermal Energy Association 2016).

An advantage of CO_2 over water-based geothermal power is that the CO_2 expands so much that the pressure alone can carry the heated CO_2 back to the surface. (This effect is referred to as the thermo-siphon.) The thermo-siphon makes the use of pumps for recovering the hot CO_2 unnecessary (Lepisto 2007). For instance, the California Energy Commission (CEC) undertook cost estimation for a 50 MW geothermal binary plant and 50 MW dual flash geothermal power plants. The CEC found that the levelized cost per MWh of a geothermal binary plant would be Tk. 7360 and of a dual flash geothermal plant Tk. 7040. These estimates imply that the plants could be competitive with various other technologies, including natural gas technology.

According to the CEC report, the cost per megawatt hour for a 500 MW combined cycle natural gas plant is Tk. 8080. The capital cost per megawatt for a 100 MW simple cycle plant is Tk. 46880. According to a 2006 report, the capital cost estimate for a new geothermal plant (together with the production tax credit) ranged from Tk. 48000 to Tk. 64000 per MW. However, it should be recognized that the cost for a geothermal project can vary significantly based upon factors such as local, regional, national, and global availability of commodities and that costs change over time with economic conditions (Geothermal Energy Association 2016).

Table 1 sets out the amount of electricity generated in Bangladesh from 1995 to 2011 (Anam et al. 2011, 13; Rahman 2011, 9).

Maximum Electricity Generation Capacity (MW)	
1995–1996	2087
1996–1997	2114
2001–2002	3218
2002–2003	3458
2003–2004	3622
2004–2005	3751
2005–2006	3812
2006–2007	3718
2007–2008	4230
2008–2009	4037
2009–2010	4606
2010–2011	4699

Advantages and Disadvantages

In our country, water is abundant, and water-based geothermal power generation is perfectly feasible here. However, to reduce the excessive carbon dioxide emissions from the brick fields, the carbon dioxide geothermal process can play a vital role.

Environment Friendliness

Compared with power generation systems that use coal, natural gas, or other fuels, the footprint of geothermal power plants is smaller. The surface area occupied by a reservoir, pump house, heat exchanger, turbine hall, is much less than the area occupied by typical power generating plants. Unlike other power plants, a geothermal plant does not require miles of gas or fuel pipe lines. This kind of power plant requires only proper geothermal hot water, which is usually available at the site.

If the gases, extracted from the brick houses in Bangladesh, can be converted to liquid and piped at the injection pit to magma below the earth's surface, this will purify the air. Some geothermal resources may be near forested regions, and the combined brick house and geothermal power station setup may deforest the region. But other types of power stations also would do so. A geothermal power plant is more reliable than conventional power plants.

While producing electricity, geothermal power plants, unlike other power plants, do not generate greenhouse gases. Hydrogen sulfide emitted from the geothermal power plant can be eliminated by a scrubber system. According to the Nevada Geothermal Council, almost 4.5 million tons of oil and 2.25 million tons of carbon dioxide are saved merely by 300 MW of geothermal power (Geothermal Energy Association 2012, 4).

Renewable

Currently, Bangladesh is in great need of more electricity for its growing population. To meet this additional demand in the context of "defossilization" of the world economy, the country needs plans for renewable electricity generation. As a riverine country, geothermal power generation may be the best renewable technology in practice. In the geothermal process, water is superheated by magma beneath the earth, and vapour from this hot water is used to turn turbines and generate electricity. Having passed through the turbine, condensed water is returned to magma rock level.

Solar power is a renewable technology. However, solar energy is not available at night or in dark or cloudy weather unless the energy has been saved in a storage device. The absence of large-scale storage remains a major obstacle to use of solar power for base load. With geothermal processes, there is no such difficulty, as hot water is always available.

Nuclear energy has contributed to non-fossil fuel power generation, but it creates difficulty in management of radioactive spent fuel (Nuclear Energy 2014).

Reliability and Simplicity

Geothermal power generation is the simplest power generating process, compared with other non-fossil fuel power generating technologies. It is the most feasible and most stable means of generating base load power. Once a geothermal power plant is set up, it is stable unless a heavy earthquake occurs.

Raw Material Availability

In a CO_2 geothermal process, the only raw material is CO_2, which can be collected from brick fields throughout the country and preserved in liquid form in drums or underground store rooms. Furthermore, the geothermal process is free from the transportation cost of coal or natural gas.

Sustainability and Cost of the System

If geothermal resources are used for power generation, Bangladesh fossil fuel resources will be preserved for other purposes. The major drawback to geothermal power is its high cost of plant construction. To date, the cost of geothermal capacity has been in the range of Tk. 160 million to Tk. 560 million per megawatt of capacity (Maehlum 2012). This is a cost well above most conventional power sources. However, as discussed above, the levelized cost per MWh is similar to other non-fossil fuel technologies such as nuclear. Carbon dioxide geothermal is obviously associated with hydrocarbon combustion and hence is associated with some activity generating greenhouse gases.

Noise, Hydrogen Sulphide and Loss of Forest

There is also the problem of noisy drilling processes, creating an inconvenience for religious practices, as well as and hydrogen sulfide gas emissions. In order to extract the hot water 4,000 meters below the earth surface, a production pit is created by means of drilling, which creates enormous noise pollution in the region of the geothermal power plant. This is an inconvenience for the dwellers and worshippers (Fridleifsson et al. 2008, 20-25). Hydrogen sulfide gas, from the superheated geothermal water, is released into the atmosphere when it turns into steam, which causes environmental hazards (Zorpette 1992, 49).

Despite all the controversies, it is clearly established that, except for the enormous capital construction cost, the geothermal process is a viable renewable power generation process in our country and can help meet our extreme need for electricity.

Conclusion

This article proposes a new method of generating electricity. The carbon dioxide storage and electricity generation system (CSEGS) could simultaneously supply more electricity for Bangladesh and help save the environment.

This method can be used in all industries where CO_2 is produced in large quantities. Storing liquefied CO_2 below ground is increasingly seen as a solution to generation of electricity as well as a means of reducing greenhouse gas emissions that contribute to global warming. In addition, CSEGS can be used in many locations around the country, unlike conventional geothermal electric plants.

CSEGS has advantages compared with other renewable energy systems that generate electricity from the sun or the wind. Energy generated from these sources is often wasted when demand does not equal supply. In contrast, CSEGS generation of electricity can be varied continuously.

This new geothermal process of electricity generation is under research and evaluation to verify its cost-effectiveness in Bangladesh.

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