

## **Study on the Electricity Generation from Municipal Solid Waste of Dhaka city**

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**Abstract:-** With a population of 170 million Bangladesh is considered as the new growing economic force in the queue of world trade whereas organic solid waste has been increasing on same scale as the population poses promising use for it as renewable energy resource. This increasing waste is becoming an issue not only for the lack of space but also due to it being the cause of illness, pollution, destruction of natural beauty of the city. This research aims to evaluate and estimates the biogas productions from the municipal solid waste (MSW) through anaerobic digestion processes. Both Biogas production and power generation from MSW can lead the economy to prosperity. The estimated potentiality to generate electricity from biogas is 207, 873 and 2878 MW/day, in years 2020, 2025 and 2050 respectively, could help to meet the increasing demand of electricity in urban Bangladesh.

**Keywords:-** Municipal solid waste, Biogas, anaerobic digestion, Electricity generation, Bangladesh

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### **I. INTRODUCTION**

Electrical energy is generated from the natural resources in the form of fossil fuels which are the raw materials and the day to day life of the people of today's world is primarily driven by electrical energy [1]. Scientist claims the reserve of natural gases would soon be depleted as their usages increases daily. In developing countries like Bangladesh with fast paced population growth, meeting the daily energy demand is a major challenge. The need to switch to sustainable source is evident [2]. The waste materials can be a good source of energy as the amount of waste is increasing every day, and can help in meeting the electrical energy not only in Bangladesh but also in the world.

In Bangladesh, wastes are disposed of only by land filling, while there is optimal opportunity of producing energy like biogas as well as electricity [3]. In 2009, the installed electricity generation capacity was approximately 4.7GW, only 30% people of the population of Bangladesh has access to electricity and frequent load shedding disrupts the whole uses [4].

Biomass is a well-known as a renewable fuel energy resource and biogas production from municipal wastage has received a significant attention as an alternative energy source in the recent years. Biogas is the by-product of the process which is referred to as anaerobic digestion. The main constituents of biogas approximately are 50-60% methane (CH<sub>4</sub>) and 30-40% carbon-dioxide (CO<sub>2</sub>) 5-10% hydrogen 1-2% nitrogen and 0.3% water vapour [5]. Thus, the production of biogas can be made on a large scale by the anaerobic digester. Moreover, the resulting methane can be contributed to the electrical energy generation, lighting, heating and cooking gas as we face the energy shortage crisis. Biogas is composed of methane (CH<sub>4</sub>) and carbon dioxide (CO<sub>2</sub>) gas. When the methane content is more than 50% in the biogas, it burns very readily and therefore can be used as an alternative fuel for power generation.

### **II. SCOPE OF THE PROBLEM**

In the Dhaka city there are about eighteen million people [7], which have an area of 344 km<sup>2</sup>. Estimates for solid waste generated in Dhaka city 3500 tons per day back in 1995 [6] and the disposal of solid waste require 110 hectares of land per year. The total waste generated in Dhaka city could reach straggling amount of 8000 tons per day in 2015. It will require 292 hectares of land for disposal per year. Bangladesh, a land scarce country, does not have physical space.

The indiscriminate disposal of solid waste in public places causes serious environmental hazards and health risks. Uncontrolled and open dumping also clogs the urban drainage system, causes water stagnant and threatens the contamination of water supply. There is a crucial demand of electricity for consuming in

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households, factories, industries and public institutions. Therefore, using the waste of city to produce electricity by means of generating biogas, can contribute considerably to resolve the problem.

### III. METHODOLOGY

Secondary data were collected from the city corporation office, reports and studies by ADB, JICA, BBS and World Bank as well as from field observation. The data also have been extracted through pursuing different report of corporation, web materials, various articles, journals and books. By using this data we analysed statistically and draw inference about the total amount of electricity in Dhaka city for various years.

### IV. POWER GENERATION AND DEMAND IN BANGLADESH

The rate at which our Metro-Politan cities are booming these days in terms of population, the more the difficulties to meet the power demand is spiralling. If we just only take into an account of the capital city, Dhaka-which is one of the tenth largest city in the world, with a population of 18 million [7], we can have an idea about the rate of migration of the people from village to cities. So, Bangladesh often faces a great challenge to meet the power needs. According to the Bangladesh Power Development Board, BPDB, the maximum demand (generation end) is 7590 MW and the day peak (generation end) is 6206 MW as per 12th July, 2015 report [8] . The following table would illustrate the current scenarios of power demand and load shedding In Bangladesh.

Zone	Demand in MW	Supply in MW	Load Shed in MW	Zone	Demand in MW	Supply in MW	Load Shed in MW
Dhaka	2836	2836	0	Mymensingh	503	503	0
Chittagong	752	752	0	Sylhet	292	292	0
Khulna	704	704	0	Barisal	171	171	0
Rajshahi	789	789	0	Rangpur	462	462	0
Comilla	588	588	0	Total	7097	7097	0

**Table 1: Zone Wise Demand and Load Shed at Evening Peak (Sub-station end) [2]**

So from the above mentioned data we can easily perceive that the generation is less than the demand. Although the table shows that, currently the demand and supply are both equal which results in negligible load shedding, but in reality, the scenario is different. We still have power cuts to balance the need in different localities of a particular zone. So, to eliminate this problem, power generation from solid waste can prove to be a good alternative.

Three types of waste are mostly generated in Dhaka city which includes residential, commercial and industrial areas waste. Each of the sectors produces different amount of waste. A table in the below can depict the percentage of different type of waste in Dhaka City.[9]

**Table 2: Solid waste in Dhaka City in terms of percentages Sources: World Bank,1998**

Component	Commercial Waste weight in percentage (%)	Industrial Waste weight in percentage (%)	Residential Waste weight in percentage (%)	Average (%)
Cloth	18.93	46.20	-	21.71
Food and vegetable waste	62.05	26.37	59.91	49.44
Glass and ceramics	0.37	-	-	0.12
Garden wastes and trees	2.86	4.32	8.76	5.31
Paper products	6.28	7.59	11.21	8.36
Plastics , rubber and leather	4.62	6.01	17.67	9.43
Metals	0.28	-	15	5.09
Moisture Content	54	60	50	54.67
Rocks, dirt and others	4.62	9.49	2.3	5.47

From the table, it can be easily deduced that food and vegetable waste and the moisture content contributes to the maximum generation of waste in Dhaka City. These elements are also considered to be the best components to produce biogas which contains up to 50-70% of methane (CH<sub>4</sub>) gas [10].

### V. ELECTRICITY GENERATION PROCESS

In electricity generation process, a very strong waste management system is needed. Electricity is mainly generated from bio gas and in order to do this waste should be sorted out according to the highest contributors of methane gas. The compostable nature of waste is very important and needs to be sort out at first. The bio degradable waste is then collected and biogas is produced by anaerobic process. This biogas is used as fuel in generator and helps in electricity generation. The process is shown below by a block diagram. Efficiency can be increased by inserting a gas filter between the biogas generation step and gas generation step. We may produce organic fertilizer from the digester step and that may act as an economic backup [11]. The block diagram is shown in the following:



Fig.1: Electricity generation process from solid waste [12]

### VI. ANALYSIS AND TECHNICAL POSSIBILITIES:

Table 3: Parametric analysis of generation

Item	Parameter
Estimated Generation (2015)	11200 tons per day
Generation rate	0.56 kg per person per day
Average Caloric Value	600-900 kilo calorie per kg

Table 4: Calorific values for different waste type

Component	Calorific Value (MJ/kg)
Vegetable/food waste	19.70
Paper	16.80
Plastic package	40.00
Garden and tree waste	10.70
Other waste for incineration	18.00
Glass and ceramics	10.70
Metal package	40.00

**Table 5: Calorific value calculation from the waste generated in Dhaka city**

Calorific value	Amount	Percentage
Residential waste	9 MJ/kg	58%
Industrial waste	6 MJ/kg	20%
Commercial waste	7 MJ/kg	22%

Calorific value of the waste generated in the Dhaka city –  
 $(9 \times 58\%) + (6 \times 20\%) + (7 \times 22\%) = 7.96 \text{ MJ/kg}$  (around 8 MJ/kg)

Here we have to keep in mind that as the amount of moisture in the waste in this region is higher than other areas, it will require extra fuel such as natural gas to burn it down to produce electricity.

## VII. ENERGY POTENTIAL

The figure of daily waste generation in Dhaka city is about 11200 tons per day.

Total waste generation in a year is nearly about 4088000 tons.

Calorific value of waste = 8 MJ/kg = 8000MJ/ton = 2222.22 kWh/ton.

Conversion efficiency 25%=0.25  $\times$  2222.22=555.56 kWh/ton.

Potential of electric power plant capacity from the waste in Dhaka city  
=  $(4088000 \times 555.56) / 8000 \text{ kW} = 283891.16 \text{ kW} = 283.90 \text{ MW}$ .

## VIII. COST ANALYSIS

From the analysis of different studies it is found that the price for producing per unit electricity from municipal solid waste by incineration would be between taka 9.50-10.50 (USD 0.136-0.150/unit) [13].

In Bangladesh, it is found that the electricity production cost for each unit of electricity from wind based power plant could be around taka 10.00-12.00 (USD 0.142-0.171/unit), from diesel fired power plants is taka 8.00-14.00 (USD 0.114-0.200/unit) and Taka 8.00 (USD 0.114/unit) from furnace fired power units [14, 15]

## IX. CONCLUSION

The use of non-renewable source of energy for energy production might not be feasible due to its harmful impact on the environment and its issues with its long term sustainability. The mentioned reason calls for the use of renewable sources of energy. Energy derived from solid municipal waste could be used to meet the demand of energy for the general population of Bangladesh. Bangladesh, a land scarce country, does not have physical space to accommodate the disposal of the ever increasing wastages. But by using the waste to produce electricity, the waste amount that is to be disposed could be significantly reduced and thus reducing the area of land required for waste disposal. The further scope of the project would include field testing, proper site selection and developing an analytical or simulative model. Keeping all the above points in mind the government should start intense research on improving the ways and technologies to use municipal waste as source of energy.

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