ICMIEE18-194

Economic Viability of Biomass Power plant in Bangladesh

Tamal Chowdhury [a*], *Hemal Chowdhury* [b], *Piyal Chowdhury* [c], *Pranta Barua* [a], *Monirul Islam Miskat* [a]
[aa*]Department of Electrical &Electronic Engineering, Chittagong University of Engineering & Technology, Chittagong, BANGLADESH
[b] Department of Mechanical Engineering, Chittagong University of Engineering & Technology, Chittagong, BANGLADESH
[c] Chittagong Collegiate School& College

ABSTRACT
Combustion of fossil fuels results in high emission of green house gas. Besides it also results in shortage of fossil fuels So, it is necessary to look for alternate solution. Biomass is a renewable source which is abundant in nature. Combustion of biomass produces gas which can be used to generate electricity. In this study, a simulation has been done by RETScreen software to find out the economic viability of 3MW biomass based power plant in Chittagong**.** From simulation it is found that electricity export to grid from plant is 23,915 MWh and revenue earned by selling electricity is $2,391 480.It was also observed that the proposed system reduces 13000 tonne CO2 annually.

Keywords: Renewable energy, Organic waste, Solid waste, RETScreen.

1. Introduction
Approximately 80% people of Bangladesh live in rural area and 40% of people have access to electricity. The biggest portion of her energy demand is met up by fossil fuels such as natural gas, coal etc. As her population is increasing, the demand for electricity is increasing continuously. As a result, fossil fuels consumption is also increasing. According to World Bank, fossil fuel energy consumption (% of total) in Bangladesh was reported at 73.77% in 2014. Combustion of fossil fuels to produce electricity emits various dangerous gases. These gases are harmful for environment. It is also estimated that because of high cost grid connection, dispersed population 44% of the world population do not have access to grid electricity [1]. The only solution for this problem is to utilize renewable energy as they are environment friendly. Biomass which is abundant in nature can play an effective role here. They can be burned to produce steam or gas. This gas can drive turbine which will generate electricity.

In this study an attempt has been made to find out the economic viability of biomass power plant in Chittagong district. Meanwhile the effects of biomass power plant on greenhouse gas reduction are also shown in here. From the existing literatures it can be found that there is no study on economic viability of biomass based power plant in Bangladesh. So this study will focus on the economic viability and environmental impact of biomass power plants in Bangladesh. We hope that the current study will help the authority to evaluate biomass power plants for power generation in Bangladesh.

2. Present Situation of Energy in Bangladesh
Natural gas:

Being the 19th largest producer of natural gas, Bangladesh economy mostly depends on it. It provides 75% of commercial energy of this country [2]. So far 24 gas fields have been discovered. Among 24 gas fields, two of them are located in offshore area. Now-a-days gas is being extracted and produced from79 gas wells [3]. Figure 1 states that between 1993 and 2013, natural gas production of Bangladesh increase significantly from 215.77 to 807.3 billion cubic feet while Figure 2 states that between 1995 and 2014, dry natural gas consumption of Bangladesh grew substantially from 260 to 844 billion cubic feet .

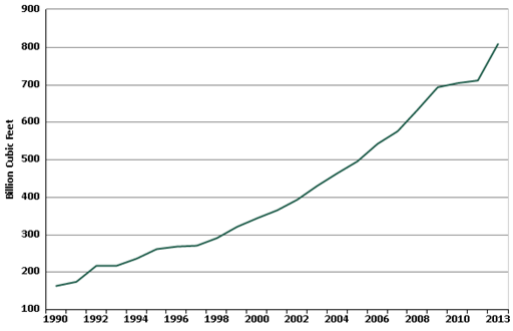

Fig.1: Natural gas production of Bangladesh up to 2013

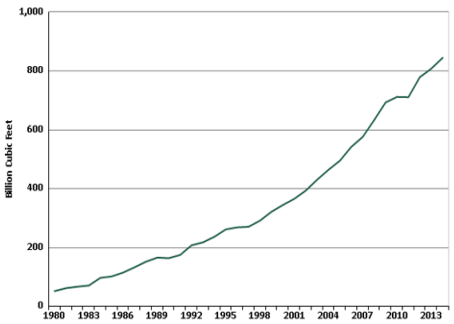

Fig. 2 Natural gas consumption of Bangladesh up to 2013

* Corresponding author.
E-mail addresses: tamalshanto@gmail.com

Coal Sector:

Coal has played an important role in this country's economy. The impact of this sector in national economic security is huge. In 2009-10, for electricity generation, this sector contribution was 3.5% [5]. Coal could have been a good alternative to natural gas but it is not due to proper management, lack of infrastructure.

Energy from tannery:

Table 1 shows the waste water component generated when each steps of tanning process occurs. Besides this a huge amount of soda ash, sulphuric acid, formic acid, resins etc are also used different stages of the tanning process [15].

Table 1: Contents of waste water generated during tanning process [16]

CONTENTS	PROCESS
Salts, fat, protein, preservatives	Soaking
Lime and ammonium salts, ammonia, protein (hair), and sulphides	Fleshing, trimming and bating
Chromium (salts), vegetable tannins and polyphenolic compounds	Tanning
Dye and solvent chemicals	Finishing

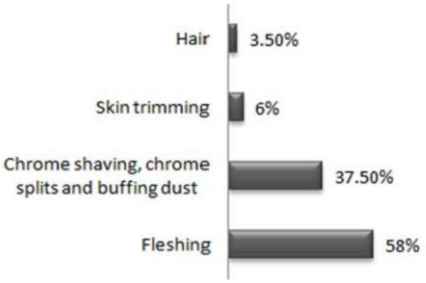

Fig. 3: Components of the solid waste produced during the tanning process [6].

3. Calculation of Biomass Energy

The energy content of the solid waste produced from the tanneries can be calculated by using the following references [7-11]. The findings are listed in table 2.

Table 2: Energy generation from tannery waste

% of organic waste	Solid waste	Amount of methane & produced Electricity
64%	96×10^6 Kg	53.86×10^6 m3 of methane &538.603 GWh of electricity annually

Energy from Dung:

Table 3 denotes the biogas production from animal dung.

Table 3: Biogas from animal manure.

No of animals	Manure per day and availability (%)	Biogas per kg	Total biogas
24.9 million [12]	8-10 kg and 50	0.036 [13-14]	4.482 million per day

4. Results and Simulation

4.1. Simulation

In this study a simulation has been done to find out how much electricity can be generated from biomass. Simulation has been by software RETScreen [17]. Biomass will be converted into gas as it will drive a gas turbine which will generate electricity. Table 4 shows the parameter of gas turbine considered for simulation. In this study Chittagong city has been considered for setting up biomass power plant. Project life has been considered 20 year for simulation.

Table 4: Simulation parameters for gas turbine

Item	Specification
Fuel type	Biomass
Fuel rate ($/t)	.30
Power Capacity	3MW
Availability	91%
Manufacturer	Capstone
Model	C30
No of units	100
Heat rate(kj/kWh)	13000
Fuel required(Gj/h)	39

Here heat rate or lower heating value has been taken from RETScreen database. All of the input parameters are taken from RETScreen database.

Table 5 shows financial parameters considered for simulation.

Table 5: Financial Parameter

Parameter	Value
Inflation rate	2%
Discount rate	9%
Debt ratio	70%
Debt interest rate	7%
Debt term	15
Electricity export escalation rate	2%
Electricity export rate ($/kWh)	0.10
Initial cost($/kW)	2200
Operation and maintenance cost($/kW-year)	133
Fuel cost ($)	4720
Fuel Consumption (ton)	15734

4.2. Result Analysis:

Financial analysis:
From simulation it has been observed that electricity export to grid is 23,915 MWh and revenue earned by selling electricity is $2,391 480. Table 6 shows the financial viability of biomass based power plant in Chittagong.
Table 6: Financial viability of biomass based plant

Parameter	value
Simple Payback Period (year)	3.3
Benefit to cost ratio	8.7

From simulation result it can be seen that it takes 3.3 years to get back the cost incurred on setting up power plant.
From [18] it can be seen that in Kenya for medium scale biogas plant the payback period is 6 years under very favourable conditions and for unfavourable conditions it is 9 years. But in our study it was found that the payback period is 3.3 years which is quite low considering the others.

4.3. Green house gas reduction:
Figure 4 shows that the proposed power plant reduces the emission of CO2. It reduces approximately 13000 tonne of CO2 annually.

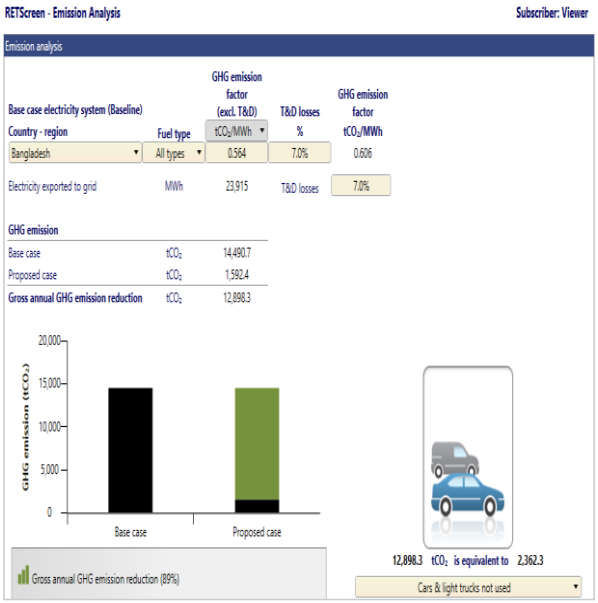

Fig. 4: Annual green house gas reduction

5. Conclusion:

The major findings of the study is

- Annually 538.603 GWh of methane can be generated from tannery waste.
- Approximate biogas generation from dung is 4.482 million per day.
- From simulation it is found that electricity export to grid from biomass pant is 23,915 MWh and revenue earned by selling electricity is $2,391 480.
- It was also observed that the proposed system reduces 13000 tonne CO2 annually.

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