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Potential of Home Biomass System (PHBS) in Bangladesh

Rubayat Hasan Ridoy, Md. Ariful Islam, Tarekul Islam, Dr. Raton Kumar Nondy

[1] *Student, Department of Electrical and Electronics Engineering, IUBAT-International University of Business Agriculture and Technology University, Dhaka-1230, Bangladesh*

[2] *Student, Department of Electrical and Electronics Engineering, IUBAT-International University of Business Agriculture and Technology University, Dhaka-1230, Bangladesh*

[3] *Student, Department of Electrical and Electronics Engineering, Daffodil International University, Dhaka-1207, Bangladesh*

[4] *Associate Professor, Department of Electrical and Electronics Engineering, IUBAT-International University of Business Agriculture and Technology University, Dhaka-1230, Bangladesh*

Corresponding Author: Rubayat Hasan Ridoy

ABSTRACT*- This paper presents a brief overview of recent electricity generation status, energy scenarios, home biomass energy resources in Bangladesh and technologies related to the use of biomass resources. The energy demand in Bangladesh has been increasing at a significantly high rate. The primary home biomass energy sources are dry wood, coal, natural gas, oil, etc. But these kinds of sources will run out gradually. Now the second most important energy source is renewable energy. Since Biomass is a potential renewable energy source, it can be one of the best options. This work discusses overexploited home biomass resources such as forest biomass and underexploited home biomass resources such as municipal solid wastes and animal manures.*

KEYWORD- *Renewable energy, Home biomass, waste materials, biomass conversion technologies, energy status*

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I. INTRODUCTION

Bangladesh is one of the broaden densely (1115.62/km^2 in 2018) populated nations in the world with a place of 147,610 km^2 and a populace of approximately 166 million. More than 70% of the general population of Bangladesh lives in rural regions, meeting maximum in their energy wishes (home, business, and industrial) from conventional biomass fuels and approximately 51% peoples have not to get power access [1]. As a part of developing the rural human beings, the authorities have planned to electrify the whole country through the year 2020[2]. The intention of this plan might be achieved through a quick, medium and longtime technology for growing power through the use of natural gasoline, coal, liquid fuel, nuclear strength and additionally renewable power resources.

For being an agricultural country, Biomass has taken the place of the main source for generating power with vital posses in Bangladesh. Biomass power generation in Bangladesh has so many sources, like as- rice husk, poultry droppings, agricultural relic, cattle dung, water hyacinth, etc. But, there are so many sources those are very common, for example- jute stick, municipal waste, crop residue, sugarcane, animal waste biogases, etc. Nowadays, over 0.20 million uplift pyre and 25,000 biogas plants have been installed in countrywide to save biomass fuel. Commercially there are above 900 briquette machines have been running in Bangladesh [3]. Rice chaff is producing 16 MJ/kg of quantity approximately for energy volume. Near about 13,648 Btu/kWh heat rate containing a biomass plant. All the influential results are shown in a table [4].

Table : Biomass Technical potential[5]

Annual Rice Husk Crop (tons)	HHV(MJ/kg)	Gross Energy Potential (mmBTU)	Gross Electricity (MWh)	Net Electricity Potential (MWh)	Potential Capacity (MW)
10,130,000	16	139,363,715	4,084,514	2,042,258	274

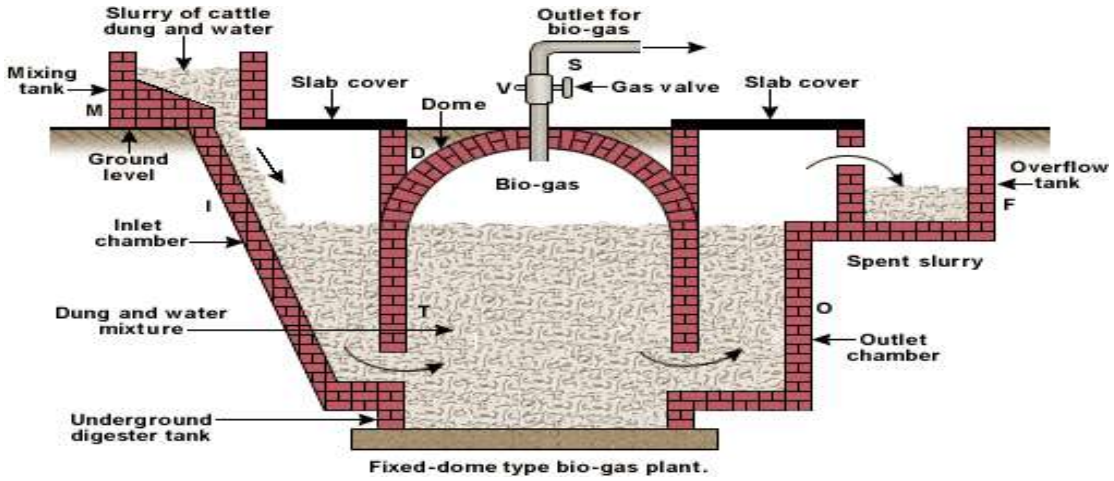

Figure 1: Construction of a Typical Biogas Plant[5].

II. ENERGY STATUS OF BANGLADESH

Power generation capacity was only 667 MW in 1974-75 while it turned into 12,780 MW in August 2016 which includes 600 MW electricity import from India. On the other hand in 2017 the energy capacity stands for 15,821 MW consisting of 2200 MW imported electricity [14].

Perhaps in June 2018 the install capacity of power is 18,753 MW where else 2800 MW power has imported. Figure-1 shows the established energy capability in June 2018. Favorable government rules have attracted private funding and Independent Power Producers (IPP). Coal is the main source to produce power from coal power plant in sense they are now generating 46% of total power in Bangladesh [6].

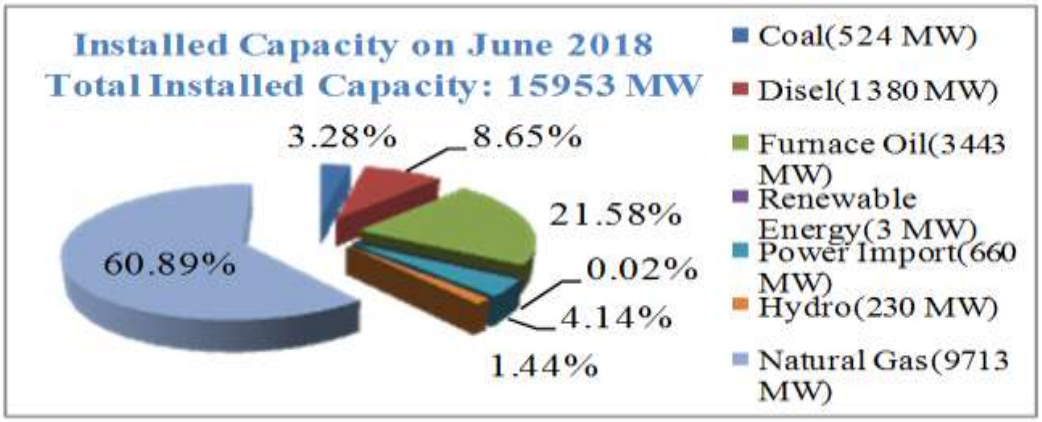

Figure 2: Installed capacity on June 2018[14]

Oil, coal and hydropower are the main element of natural gas which is the primary source of commercial energy in Bangladesh [7]. Now day, generated energy from renewable energy is 404 MW [5]. A sustainable energy, fossil fuel power station, nuclear power station are being developed by the government of Bangladesh and some of private company. There has high production cost per MWh on fossil fuel power stations, nuclear power stations, and other power stations. Biomass is the best choice of a source to generate electricity from our waste materials and other biomass products within low production cost. According to the Power System Master Plan (PSMP) -2010 based on a 7 % GDP growth rate of Bangladesh demand forecast was made. According to the PSMP- 2010 Study forecast of peak demand (year-wise) is given below.

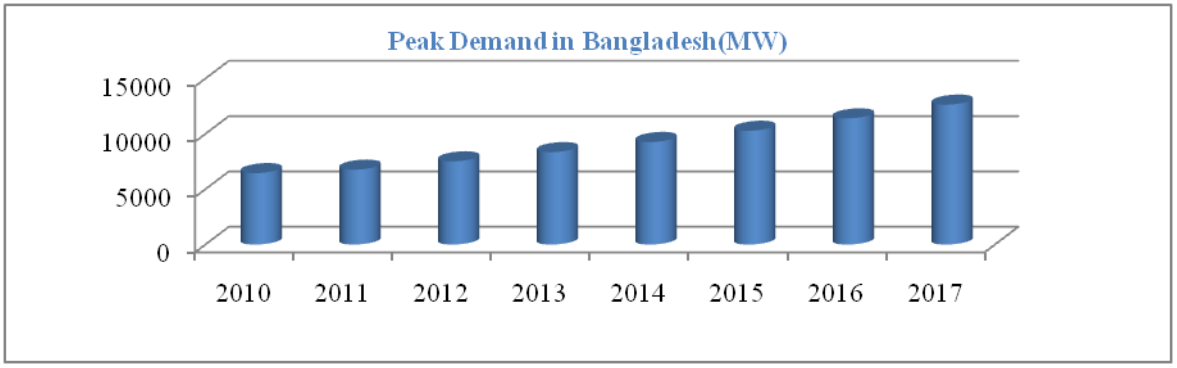

Figure 3: Peak demand from 2010-2017 in Bangladesh

Based upon this study the peak demand would be about 10,283 MW in Forecast Year 2015, 12644 MW in 2017, 17,304 MW in FY2020 and 25,199 MW in 2025[14] .

III. COMBINED HEAT AND POWER STATION

The primary way to produce electrical energy from biomass is biomass power plant which can provide both electricity and heat energy. The efficiency of electricity production in general method is 30-55%, but in Combined Heat and Power (CHP) method this is 80-90%. CHP power plant works based on the second law of thermodynamics.

Firstly generate electricity form high-energy heat then at lower temperature thermal energy is generated from heat. Biomass plants utilize similar Basic Parallel Process (BPP) which steam turbine generators efficiency is around 25%., and fuel conveyance frameworks and the normal BPP is around 20 MW in an estimate, with a couple of devoted wood-let go plants in the 40– 50 MW estimate range [8]. Initially, the combustion chamber containing the heat exchanger, the exchanger tubes are feed by the circulating cold water. Heats up the feed water by burning of the biomass for that hot combustion gasses are released heat, as a result, produce high pressure. In the following stage, the created steam is gathered in the high-pressure boiler, to feed the steam turbine is the end goal to flow the steam pressure at a proper pressure point. After that, the high-pressure steam goes towards the blades of the steam turbine to turn the turbine shaft. The power can be produced by utilizing an electric power generator which is joined to the end of the compressor shaft. The created power can associate with 30 million kWh that can be utilized for various purposes. The consolidated steam needs to get back towards heat trade. However, the continuing heat can be connected for locale warming, just before sending the chilled off water towards the heat exchanger. In such a route every year around 50 million KWh power can be saved, as a result of emitting this heat to the environment through smokestacks its help to avoid the waste of energy. Subsequently, utilizing a Combined Heat and Power (CHP) plant brings about energy cost reserve funds reduces the waste of heat and CO_2 emissions.

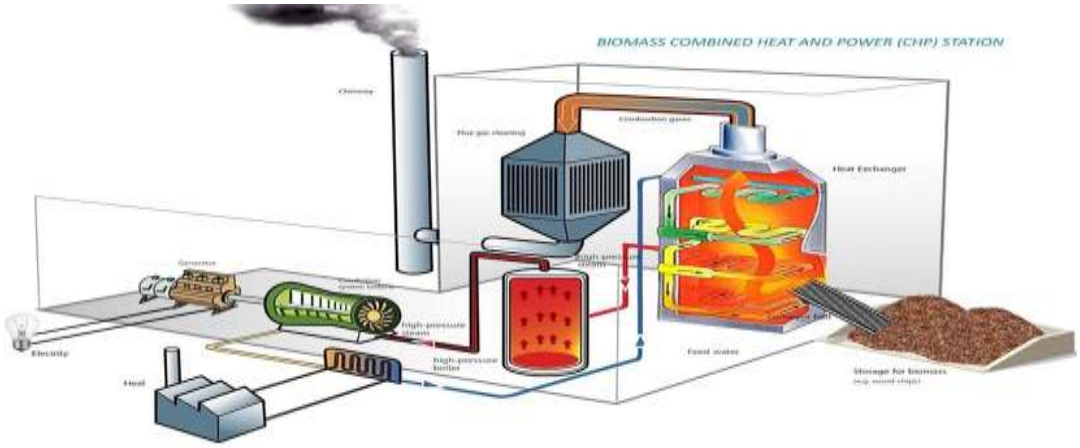

Figure 4: The processes of produce electricity and heat of woody debris[8]

IV. PROCESS FOR BIOMASS TO ENERGY CONVERSION

A. Thermochemical conversion

The thermo chemical conversion process is commonly used for converting biomass into fuels with a higher heating value. The main conversion processes in thermo chemical of biomass are direct combustion, gasification, and pyrolysis [2].

Direct combustion: In the process of direct combustion, biomass is the fuel to generate hot flue gases to produce steam with sufficient air in the combustion chamber. Heat and electricity are generated simultaneously using turbines. Usually, biomass combustion technologies categorized into fixed bed combustion system and the fluidized bed combustion system[9]. At the temperature of around 800-1000°C biomass combustion produces hot gases.

Gasification: It is the conversion of biomass into the gas mixture by the oxidation of biomass at high temperatures. The range of temperature is around 800-900°C. The produces gas that has low calorific value (about 4-6 MJ/N m^3) can be burnt directly or used for gas engines and gas turbines as fuel[2].

Pyrolysis: In the absence of oxygen pyrolysis is a disintegration process biomass at a suitable operating temperature[9]. There are three processes of pyrolysis are conventional slow, fast, and flash pyrolysis. For the production of charcoal under the slow heating rate of 0.01–1 Kelvin per second (K/S) and temperature of 273.85– 626.85°C. Fast pyrolysis is combining with the fast heated biomass at high temperature (576.85–976.85°C) and heating rate (10–200 K/S). The operating temperature and heating rate are about 776.85–1026.85 ^{0}C and above 1000 K/S respectively for flash pyrolysis. Generally, flash pyrolysis is used to convert the small biomass particles into liquid fuel.

Biochemical conversion:

Anaerobic digestion: This is the process to convert the organic material directly to biogas[2]. Biogas is mainly composed of about 50–70% methane (CH_4) and about 30–40% carbon dioxide (CO_2). Also, there have some small amounts of several organic gases like hydrogen sulfide (H_2S), nitrogen (N_2), hydrogen (H_2), ammonia (NH_3) and carbon monoxide (CO)[2].

Fermentation: The fermentation process is used commercially on a large scale in different countries to produce ethanol from sugar crops and starch crops. The starch is converted into sugar by using an enzyme, and the biomass is ground down. Then, by using yeast and ethanol is converted to ethanol and purified by distillation. The solid residue is used as cattle feed which is produced from fermentation and bagasse of sugar cane used as a fuel for subsequent gasification or a boiler.

V. BIOMASS RESOURCES IN BANGLADESH

AGRICULTURAL RESIDUE

The total area of Bangladesh is around 147,610 km², where the aggregate farming area is around 90500 km² which is 61.3% of the aggregate region. The total arable land is 79700 km² which is 54% of the aggregate zone. Roughly 52.54% of the nation's property is utilized for agrarian practices and 17.50% for backwoods. Paddy straw, rice husks

Table 1: Total residue production with % of fractions of some selected agricultural crops

Crops	Production in 2011 (million tons)	Fraction	Amount of fraction	Crop residue (million tons)
Rice	50.63	Straw	50.00	25.31
		Husk	20.00	10.13
Maize	1.02	Stalks	200.00	2.04
		Cobs	30.00	0.31
Wheat	0.97	Straw	65.00	0.63
Jute	1.52	Stalks	58.84	0.90
		Leaves	13.91	0.21
Sugarcane (trimmed)	4.67	Biogas	36.00	1.68
Mustard	0.23	Straw	75.00	0.17
		Husk	31.00	0.024
Coconut	0.08	Shell	24.00	0.019
Lentil	0.081	Straw	72.46	0.058
Total residue production in 2011 (million tons)	41.66			

wheat straw, coconut husk, and shell, aced oil tree, beans, vegetables, trees, jute, and sugar stick biogas, etc are the major agrarian residues[1]. As indicated by the table, the energy in 3 kg of husk around squares with that in 1 kg of fuel oil or 1.5 kg of coal [1]. Approximate to be about 16 MJ/kg energy is contented from rice chaff [14] The Higher Heating Value (HHV) demonstrates the energy substance of given biomass.

Municipal Solid Waste: Municipal Solid Waste (MSW) is the composite structure of waste that are natural and inorganic, quickly and gradually ecological, fresh and decomposition, and unstable and no dangerous, created in different sources in urban zones because of the human act [10]. Rural populace waste produces just 0.15 kg for each capita every day, while the urban populace creates 0.4 to 0.5 kg for each capita every day in Bangladesh[1] is created from various sources as 75 to 85% private, 11 to 22% business, 1 to 1.5% institutional, and 0.5 to 1.25% others. The structures are 68 to 81% sustenance and vegetables, 7 to 11% paper and paper items, 3 to 5% polythene and plastics, and 9 to 16% others [11].

Table 2: MSW Generation Scenario in Urban areas of Bangladesh [15]

MSW Generation Scenario in Urban areas of Bangladesh				
Year	Urban Population	% of Total Population	Waste Generation Rate	Total Waste Generation (tons/day)
1991	20,872,204	20.15	0.49	9,873.5
2001	28,808,477	23.39	0.5	11,695
2004	32,765,152	25.08	0.5	16,382
2015	54,983,919	34.20	0.5	27,492
2025	78,440,000	40.00	0.6	47,064

Total amount of municipal waste =24940323kg
Total amount of produced biogas= (24940323×0.076) m^3
= 1895464.55 m^3
Total electricity generation= (1895464.55 ÷0.71) KW
= 2669668.38 KW= 2669.67 MW[12]

Forest Residue: As indicated by Bangladesh Agency of Measurements and Bureau of Woodland, an aggregate of 2.52 million hectares territory which is almost 17.4 percent of the land mass is timberlands, of which 1.52 million hectares are under direct control of the division. The information concerning wood buildups from various sorts of fuelwood in 2011 was collected from Sustenance and Horticulture Association (FAO) FAOSTAT Insights Database 2011[1]

Table 3: Forests products in Bangladesh

Forest products	*Production*
Saw logs and veneer logs	174000 m^3
Plywood	1000 m^3
Sawn wood	388000 m^3
Wood fuel	27286834 m^3
Industrial round wood	282000 m^3
Pulpwood round and splits	18000 m^3
Particle board	2200 m^3
Hardboard	5100 m^3
Wood charcoal	326684 ton
Paper and paperboard	8000 ton
Writing and printing paper	30000 ton
Fiber pulp	18000 ton
Newsprint	20000 ton

Animal Manure: Animal manure is a blend of natural material, dampness, and burning trash. Develop can be rickety both in high-impact and anaerobic conditions. Under the oxygen-consuming condition, carbon dioxide and settled natural materials are shaped. Then again, at the anaerobic condition, CH_4, CO_2 gas, and balanced out natural materials are made[2].

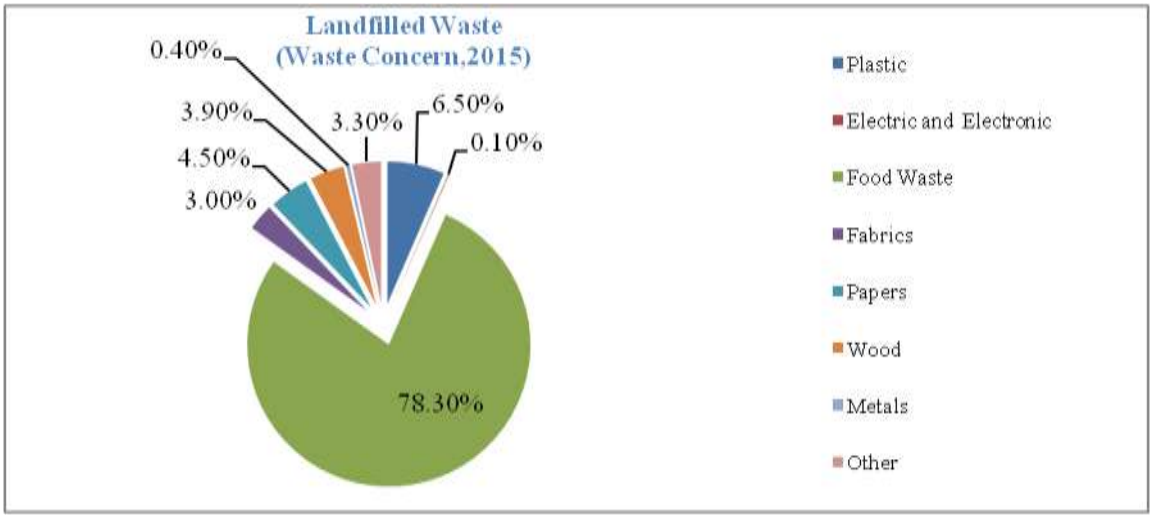

Figure 5: Land filled waste composition in Bangladesh [15]

Cows, goats, and sheep are the general source of animal manure in the nation. Biomass energy production and power generation utilizing animal manure may turn into a feasible energy and power demand settlement in rural areas of Bangladesh. For a reason, the waste harvests are produced more in the windy season than that of summer, since grasses develop all the more during the falling-rainy [2]

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VI. ENVIRONMENTAL BENEFITS

Power generation represents 25 % of the worldwide Green House Gas (GHG) emissions and other ecological effects. Since biomass is considered carbon neutral [13]. Biomass-based power reduces GHG discharges diverge with petroleum product based power. Although, creating biomass energy causes a few natural effects related to the utilization of energy, manures, insecticide and different data sources/outflows identified with planting and developing of sugarcane. Since biogas is a result of sugar generation, it might be viewed as that every one of the effects of sugarcane creation is assigned to sugar. Indeed the fact that a deeper ecological opinion is expected to set up the natural advantages of the diverse situations talked about when diverging and the natural gas-based power as of now created in converges, just the effect on GHG emanations will be considered for this situation. Power produced in Cuba discharges 1.127 kg of CO_2 for each kWh[13]. Since biomass CO_2 emissions are hope about carbon neutral (outflows of combusting biomass meets the mass of CO_2 contained among its development), creating biomass-based power decreases the national net GHG discharges. The net CO_2 emissions in Cuba represent 25,056-kiloton.

VII. CONCLUSION

Home biomass can be a great resource to recover power demand to some extent in Bangladesh. Primary fuels are reducing day by day. We will rely upon the sustainable energies to produce energy. To compare the cost of generation of electrical energy with other sustainable fuels of home biomass is the least expensive fuel. The cost of production is very low. On the other side utilization of home biomass decreases the biomass dust and other waste material with the goal that we get a clean and ecological country. This paper talks about energy prospect, biomass resources and how to utilize home biomass to produce energy in Bangladesh. With a specific end goal to improve this division, the government should be more care for upcoming technical and commercial blockades, checking and fast implantation of projects, giving funds, rising mass awareness and research work.

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