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The Prospect of Biomass Energy Resources in Bangladesh: A Study to Achieve the National Power Demand

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Abstract This paper presents a brief overview of recent electricity generation status, energy scenarios, 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 energy sources are coal, natural gas, oil, etc. but this kind of source will run out. 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 biomass resources such as forest biomass and underexploited biomass resources such as municipal solid wastes and animal manures.

Keywords Renewable energy, Biomass, Waste materials, Biomass conversion technologies, Energy status

1. Introduction

Bangladesh is one of the maxima 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% of peoples have not got 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.

2. Energy Status of Bangladesh

In 1974-75, the installed power generation capacity was 667 MW while in August 2016 it turned into 12,780 MW which includes the 600 MW electricity import from India.

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The established energy capacity in September 2017 is 15,821 MW consisting of 2200 MW imported electricity [12]. Now installed capacity in June 2018 is 18,753 include 2800 MW import power. Figure-1 shows the established energy capability in June 2018. Favorable government rules have attracted private funding and Independent Power Producers (IPP). They are now generating 46% of total power in Bangladesh and it is based on coal power plants [3].

In Bangladesh, the primary source of commercial energy is natural gas followed by oil, coal, and hydropower [4]. Now a day generated energy from renewable energy sources is 404 MW [5] and Government of Bangladesh, and some private company is trying to improve nuclear power stations, sustainable power system, fossil fuel power stations, etc. There has a 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 costs. 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.

Based upon this study the peak demand would be about 12893 MW in Forecast Year 2019, 17053 MW in 2021, 122550 MW in FY 2023, and 29822 MW in 2026.

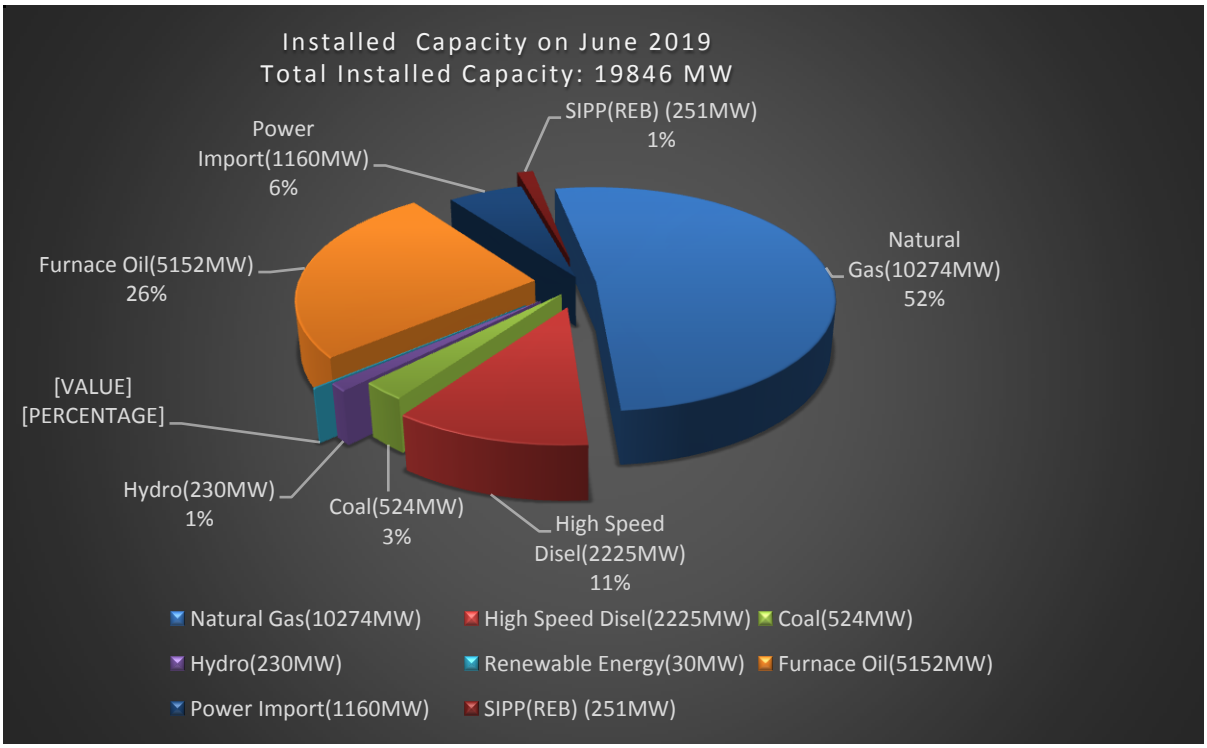

Figure 1. Installed capacity on June 2019 [14]

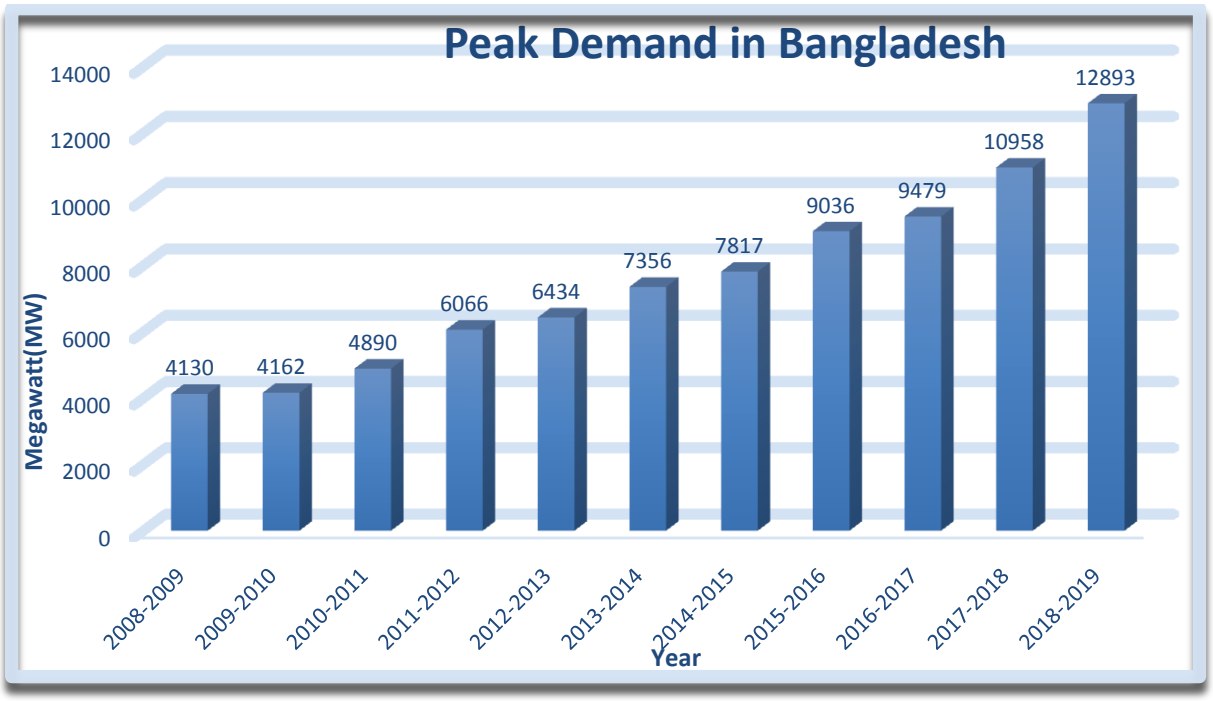

Figure 2. Peak demand from 2008-2019 in Bangladesh [12]

3. Combined Heat and Power Station

The primary way to produce electrical energy from biomass is a biomass power plant that can provide both electricity and heat energy. The efficiency of electricity production in the 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 [6].

Initially, the combustion chamber containing the heat exchanger, the exchanger tubes are feed by the circulating cold water. Heats 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, it helps to avoid the waste of energy. Subsequently, utilizing a Combined Heat and Power (CHP) plant brings about energy cost reserve funds to reduce the waste of heat and CO_2 emissions.

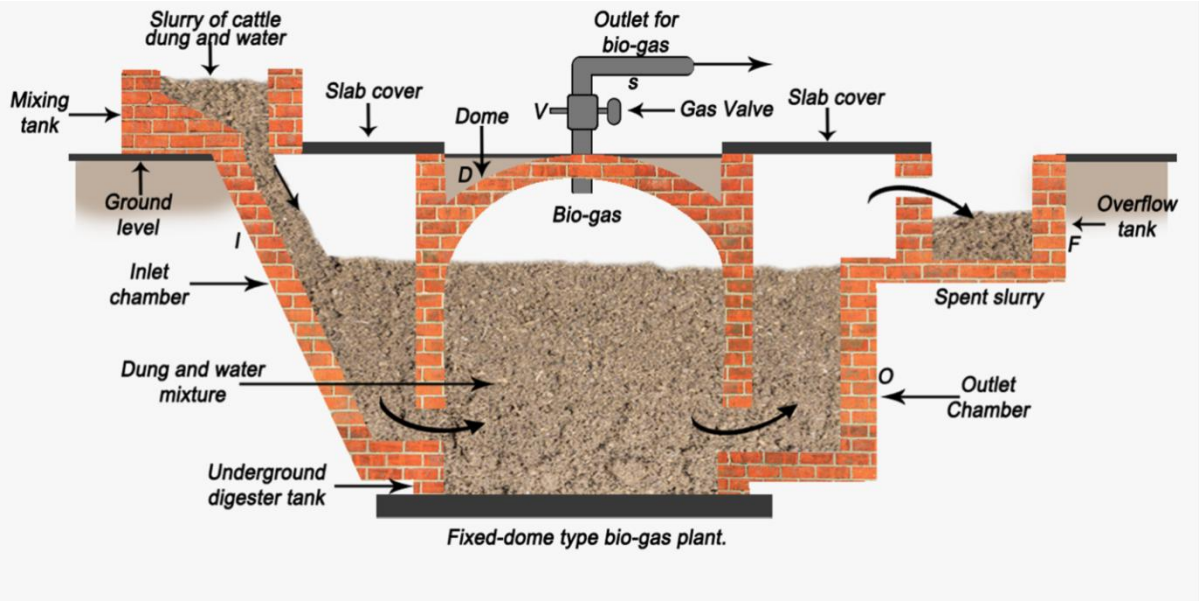

Figure 3. The processes of produce electricity and heat of woody debris [6]

4. Process for Biomass to Energy Conversion

A. Thermo-chemical conversion

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

1) 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 are categorized into a fixed bed combustion system and the fluidized bed combustion system [7]. At the temperature of around 800-1000℃ biomass combustion produces hot gases.

2) 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℃. The produces gas that has a 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].

3) Pyrolysis

In the absence of oxygen pyrolysis is a disintegration process of biomass at a suitable operating temperature [7]. 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℃. Fast pyrolysis is combining with the fast heated biomass at high temperature (576.85–976.85℃) and heating rate (10–200 K/S). The operating temperature and heating rate are about 776.85–1026.85℃ and above 1000 K/S respectively for flash pyrolysis. Generally, flash pyrolysis is used to convert the small biomass particles into liquid fuel.

B. Bio-chemical conversion

1) 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].

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 enzymes, 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 a cattle feed which is produced from fermentation and bagasse of sugar cane used as a fuel for subsequent gasification or a boiler.

5. Biomass Resources in Bangladesh

A. 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	Bagasse	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 is 41.66 (million tons) in 2011				

Wheat straw, coconut husk, and shell aced oil tree, beans, vegetables, trees, jute, and sugar stick bagasse, etc. And 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.

B. 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 [8]. 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]. MSW 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 [9].

Table 2. MSW Generation Scenario in Urban areas of Bangladesh [13]

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 [10].

C. Forest Residue

As indicated by the Bangladesh Agency of Measurements and Bureau of Woodland, an aggregate of 2.52 million hectares territory which is almost 17.4 percent of the landmass is timberlands, of which 1.52 million hectares are under the direct control of the division. The information concerning wood buildups from various sorts of fuel wood in 2011 was collected from the 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
Particleboard	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

D. 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].

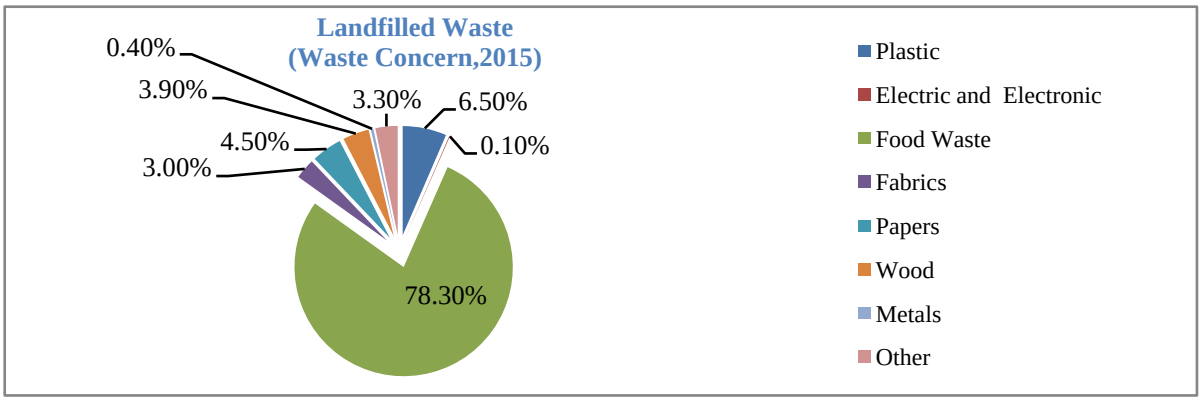

Figure 4. Land filled waste composition in Bangladesh [13]

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].

6. Environmental Benefits

Power generation represents 25% of the worldwide Green House Gas (GHG) emissions and other ecological effects. Since biomass is considered carbon-neutral [11], 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 bagasse 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. The power produced in Cuba discharges 1.127 kg of CO_2 for each kWh [11]. 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-kilotons.

7. Conclusions

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

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