

BIOMASS- THE PERFECT ALTERNATIVE FOR ENERGY SITUATION IN BANGLADESH

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Abstract- Meeting the electricity demand has been a greater challenge over the years in Bangladesh. Among all the renewable energy technologies, solar power and biomass are regarded as the most feasible due to availability of the resource. There's also good potential of Biomass for energy in Bangladesh. With initiatives from the government and successful deployment of the technology, huge amount of energy can be extracted and utilized which will boost the national progress. This paper discusses the potential of biomass as an alternative energy source in Bangladesh. The resource potential is presented and feasibility is analyzed using the triple bottom line analysis method. The feasibility analysis of biomass energy source promises social development with more jobs, improved living standards with better environment. From the economic analysis it is evident that for 1 MWe production, biomass is the cheapest option among all other renewable energy technologies.

Keywords: Renewable energy, Biomass, Triple bottom line analysis, Electricity demand, Climate change.

1. BANGLADESH: THE POWER SECTOR SCENARIO

Bangladesh has struggled to overcome the electricity demand for over a decade. At present, there has been a positive change in this regard, but still there's some shortage. About 59.6% of the total population is connected to the electricity grid. The largest proportion of the population live in the rural areas (more than 75%) with only 42% having access to the electricity grid. The Government of Bangladesh has taken a target to overcome this 'electricity demand' challenge by the year 2020 where renewable energy technologies will play the vital role. Solar energy technology is thought to be the pioneer in this case due to the availability of solar energy all round the year. Bangladesh has a 600-1200 MW deficit of electrical power which results in 'load-shedding'. The scenario gets worse during the irrigation season when the gap between the demand and supply reaches around 1500 MW. Figure 1 illustrates that fact.

87% of the total energy consumption is by the domestic (43%) and industrial (44%) sectors where lighting is one of the main energy consuming sections. Experts found out that, most of the energy deficit occurs in the evening and to cover up for that, energy-efficient lighting technologies are being adopted[1]. The electricity consumption, generation and capacity of Bangladesh is shown in fig. 2.

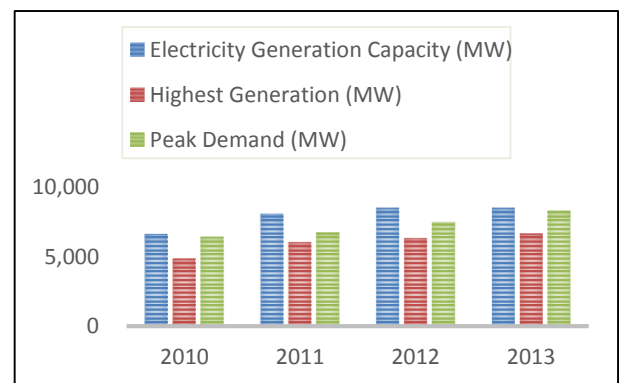


Fig.1: Electricity generation capacity and peak demand gap of Bangladesh.

1. BANGLADESH: THE CURRENT TECHNOLOGY

Bangladesh currently has the electricity generation capacity of 11532 MW. The public sector power companies contribute 6020 MW (52%) and the private sector contributes the rest 5512 MW (48%). The power plants installed uses mostly natural gas (62.76%) as fuel, of which Bangladesh has a good resource. The other fuels which are used in the power plants are diesel, furnace oil, coal, and hydro power among which, hydro power is the only sustainable energy technology

[2]. Figures 3 and 4 respectively show the installed capacity by fuel type and plant type.

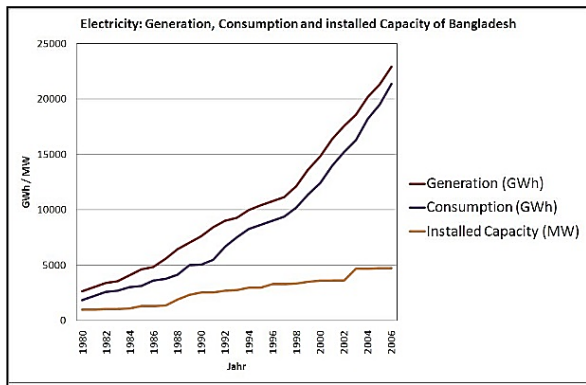


Fig.2: Electricity consumption, generation and capacity of Bangladesh[1].

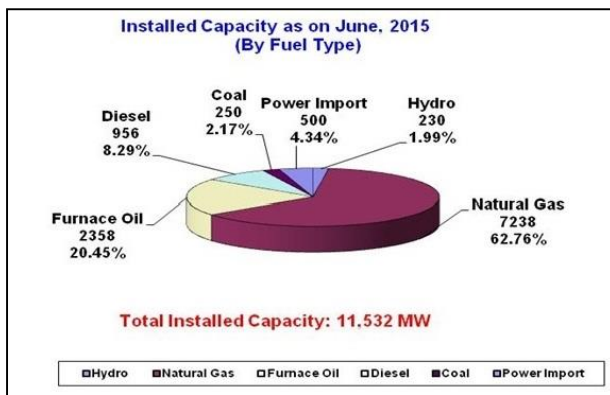


Fig.3: Fuels used in electricity generation in Bangladesh[2].

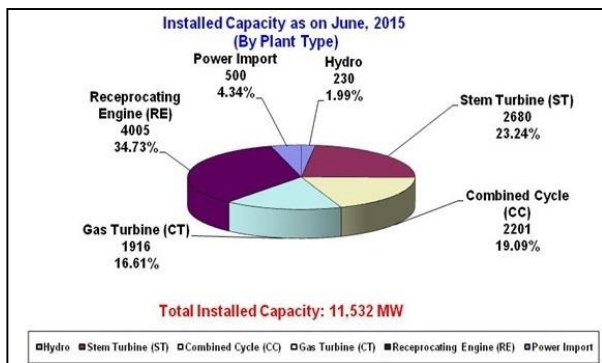


Fig.4: Plant types of electricity production in Bangladesh [2].

The government of Bangladesh has taken various plans to solve the electricity problem. The planning includes installations of coal-fired plants (20 GW by 2030), nuclear power plants (4 GW by 2030) and renewable energy technology (2 GW by 2020) which clearly proves the fact that the implementation of 'Renewable energy' technology is not the top priority here. Nevertheless, it is clear that, the government is very conscious about the electricity crisis and taking serious measures to deal with the problem as quickly as

possible. The electricity generation capacity of Bangladesh has increased rapidly over the years and if the plans succeed, this rate will increase as the time passes which can be seen from the fig. 5.

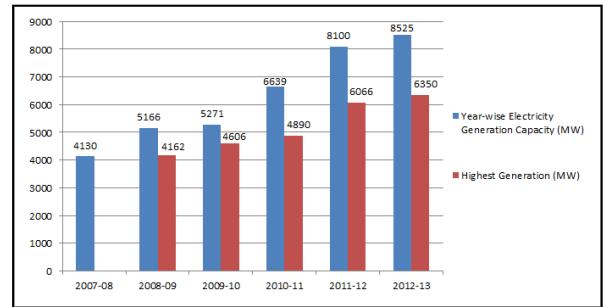


Fig.5: Electricity generation capacity and highest generation over the years in Bangladesh[1].

2. SUSTAINABLE ENERGY RESOURCES AND PRACTICE IN BANGLADESH

Bangladesh has plenty of renewable energy resources which, if properly utilised, can meet the required energy demand. The renewable energy technology is developing gradually which makes the implementation of such technology more practicable, economically feasible. The government of Bangladesh has focused on utilising the renewable energy resources such as solar energy, wind energy, biomass and biogas, mirco-hydro and etc. The ratio of different renewable energy resources in Bangladesh is shown in fig. 6.

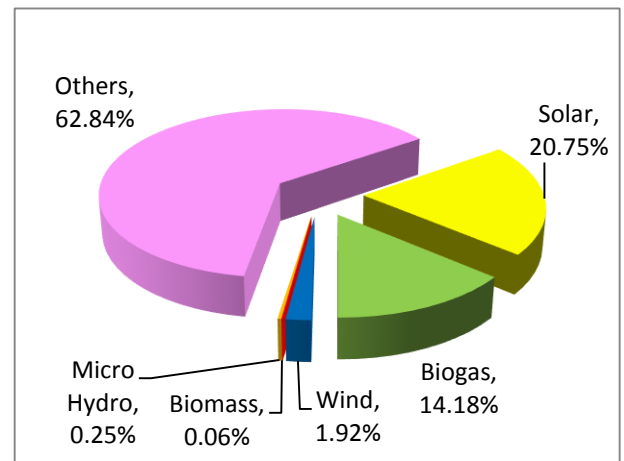


Fig.6: Ratio of different renewable energy resources in Bangladesh[3].

3. POTENTIAL OF BIOMASS IN BANGLADESH

4.1 Biomass Resources

4.1.1 Agricultural Residues

In Bangladesh, the land use for agriculture and forestry are respectively 54.5% and 17.6%. The Biomass industry gets a boost from the agricultural residue contribution. Agricultural remains such as rice husk, rice straw, bagasse from sugarcane and jute stick provide about 46% of the conventional biomass energy.

Some portion of biomass energy is also produced from plants like wheat, potato, oilseeds, spices etc. Crop residues can be classified as field residues and process residues. The traditional use of field residues is as fertilizers. Process residues are the residues that are obtained during the processing of different plants. The remains from cash crops also add to the biomass energy. Jute sticks are used as construction materials as well as fuels for energy purposes[4]. The following table presents the annual production of farming products and the recovered amount for energy purposes in Bangladesh in the year 2003:

Table 1: The amount of agricultural residues produced and recovered in Bangladesh [5].

Crop Residues	Residue Generation (kton)	Residue Recovery (kton)
Field Residues		
Rice Straw	66258	23190
Wheat Straw	2637	923
Sugarcane Tops	2051	718
Jute Stalks	2376	832
Residues from Vegetables	735	257
Process Residues		
Rice Husk	12548	12548
Rice Bran	3244	3244
Sugarcane Bagasse	1983	1983

4.1.2 Wood and Wood Wastes

Every year about 8 million m³ of wood fuel is consumed in Bangladesh. The major portion comprises of domestic cooking (63%) and the rest is used in industrial purposes. The source of this fuel is not only reserve forest but also the homestead trees. In rural areas, the homestead trees contribute most of the fuel for cooking and other activities. It was previously thought that the reserve forest contributes the majority of the wood fuel, but later statistics have shown that, the homestead trees are responsible for 70% of the total wood fuel[4].

4.1.3 Animal Dung

Animal wastes are also a significant resource for biomass in Bangladesh. Dung from cattle, goats, poultry etc. are common sources for biomass in Bangladesh. The amount depends on the size, type of feed and level of nutrition of the animals. Researchers found out that the amount of dung yield for buffalo, cattle and goats are respectively 8-12 kg/animal/day, 5-10 kg/animal/day, 0.25-0.50 kg/animal/day. The amount of waste contribution by the poultry sector is about 0.02 million tons from 200 million chickens every day[4]. About 50% of the animal and poultry wastes are usually collected. The estimate about the collection of animal dung for biomass power generation is about 40 MT[5]. The following table shows the statistics regarding residues.

4.1.4 Human Waste & Municipal Solid Waste

The researchers have estimated that about 4.537 MT of dry matter/year waste is generated in Bangladesh[6]. Also the process of urbanization has led to various

industrial and commercial operations that also contribute to the biomass resource. The following table represents the HW and MSW recovery.

Table 2: Statistics of livestock and their residue [4].

Livestock type	Heads	Dung yield (kg/animal/day)	Residues (tons/year)
Buffalo	828,000	8-12	3,022,200
Cattle	23,652,000	5-10	64,747,350
Goat	33,800,000	0.25-0.50	4,626,375
Sheep	1,121,000	0.25-0.50	153,436
Chicken	200,000,000	0.1	7,300,000
Total			79,849,361

Table 3: Human waste and MSW generation and recovery in Bangladesh in 2002 [6].

Biomass	Rate of generation (Kg/capita/day) (Mtonne/year)		Waste recovery rate (Mtonne/year)	Moisture content (%by mass)	Waste recovery rate (Mtonne/year)
Human waste	0.09	4.537	4.537		4.537
MSW					
Urban	0.4	4.312	4.312	45.0	2.372
Rural	0.15	5.944	5.944	45.0	3.269
Subtotal		10.256	10.256		5.641
Total		14.793	14.793		10.177

4.2 Biomass Consumption

Biomass is used both for energy and non-energy purposes in Bangladesh. The most popular sectors for consumption of this fuel are cooking and heating. The biomass fuels are used not only in the domestic sector, but also in the industrial sectors for process heating. In the dairy and poultry farms, the biomass products are utilized for different activities like animal fodder, animal bedding and also as fertilizer. There is no available data on the non-energy sector use of Biomass fuels. But it is not a huge portion to be taken into account. The usage of the biomass fuels also depend on the socio-economic conditions of the region in the country [6]. Figures 7(a) and 7(b) depicts biomass consumption according to source and consumer sector respectively.

4.3 Energy Potential From Biomass Resources

Recently there has been a lot of research in the field of biomass energy source to determine the potential of energy that can be recovered from the resources. Statistics show that the total annual generation and recoverable rates of biomass are respectively 148.983 and 86.276 MT. Agricultural and animal wastes contribute to this with the percentages of 48.7 and 23.9 respectively[6]. The energy potential of the recoverable biomass is also calculated in some researches and it was found out to be 1282.4 PJ. This amount of energy is comparable to about 356.22 TWh[5]. The following

tables represent amounts of biomass recovery and the energy potential of biomass resources.

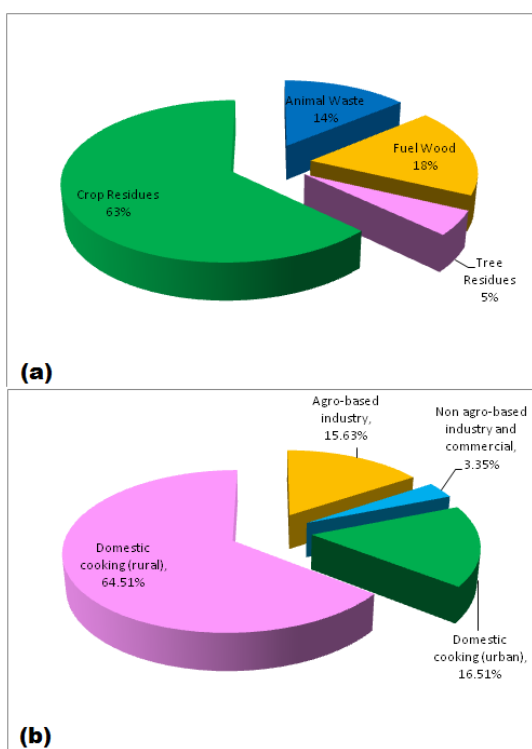


Fig.7: a) Biomass consumption according to biomass source b) Biomass consumption according to consumer sector[6].

Table 4: Annual generation and recovery rates of biomass from various sources [6].

Biomass resource	Rate of generation (M tonne /year)	Waste recovery rate (M tonne /year)	Waste recovery rate (M tonne dry matter /year)
Crop residues			
Field residues	75.035	26.261	22.704
Process residues	15.732	15.732	13.168
Animal wastes and poultry droppings	34.552	20.619	20.619
Human wastes and MSW	14.793	14.793	10.177
Forests and forestry industry	8.871	8.871	7.461
Total	148.983	86.276	74.129

Table 5: Energy potential of biomass resources [5].

Biomass	Recovery Rate (Kton/year)	Energy Content (PJ)
Field Residues	26261	368.43
Process Residues	17843	239.79
Animal Waste	72540	603.25
Poultry Droppings	7300	49.28
MSW	2120	21.64
Total	126064	1282.39

4.4 Technical Practice of Biomass in Bangladesh

4.4.1 Improved Cooking Stoves

In Bangladesh, the biomass energy source is being introduced for cooking purposes. The efficiency of the stoves used generally range within 5-10% with GHG emissions, firing risk and health hazard. Different institutes in Bangladesh such as IFRD (Institute of Fuel Research and Development) of BCSIR are currently undertaking research to improve the cooking systems. The improved cooking stoves are supposed to use biomass fuels so that the GHG emissions are omitted and also exhibited very good efficiency (40-60%) compared to the conventional ones [4].

4.4.2 Biogas Plants

Bangladesh has huge potential in utilizing biogas technology. From the livestock of the country, an approximate amount of 29.7 million m³ of biogas can be found. This amount of biogas is equal to 1.5 million tons of kerosene. Researches also showed the potential of producing 10 billion m³ of biogas from human wastes provided that all the families in Bangladesh are associated with biogas plants [7].

4.4.3 Biomass Briquetting

Various Asian countries have taken up the Biomass briquetting technology in the recent years. A condensed block form of biomass with high calorific value as fuel is known as a briquette. Rice husk, rice straw, sawdust, bagasse, jute stick, wheat husk etc. can be used for briquetting. This practice started in Bangladesh in the '80s. Researches have shown that, Bangladesh has the potential to operate about 15000 briquette machines but merely 906 machines are in operation. Recently researchers have found 20% more efficient briquettes to use as fuel [4].

4.4.4 Gasification & Pyrolysis of Organic Solid Wastes

Biomass gasification in Bangladesh is yet to be implemented. A demonstration plant was set up recently of 200 kW and another one with 250 kW is planned to be established. On the other hand the pyrolysis procedure to generate fuels from organic solid wastes is in the primary stage of research. The implementation of biofuels in Bangladesh is also in blooming process as new plan has been taken to produce bioethanol of 12000 litres from molasses. The project plans to mix the fuel with gasoline in the ratio of 23:77 to produce 'gasohol'. It is expected that the resulting fuel mixture will be 20-30% less expensive than the conventional gasoline [4].

4.5 Contribution of Biomass to Energy Generation

According to recent researches, the amount of recoverable biomass resource in Bangladesh is 126 MT per year. The total energy that can be achieved from this amount is close to 1282 PJ. The biomass resource research has established the fact that rice husk, municipal solid wastes, bagasse can be efficiently used for electricity generation in Bangladesh. The resources

like animal dung and forest residues can be used as fuel for cooking and heating purposes. About half of the rice husks are generally used for cooking and other domestic applications. The other half portion of it can be easily used for electricity generation. Bagasse and municipal solid wastes are also feasible for electricity generation. Recent results have shown that the poultry droppings (about 57%) can also be used for electricity generation [5].

4. TRIPLE BOTTOM LINE ANALYSIS

5.1 Social Analysis

The world is facing serious problems regarding energy crisis and climate change. Recent researches are focused on solving these issues regarding emissions and also the energy security. The implementation of biomass energy source will involve the government, the biomasspower generation organization, the organizations of other power technologies, the environmental organizations, energy distribution companies, researchers and the consumers. Biomass energy source offers a decent solution to the energy crisis and climate change problems. This technology faces a challenge regarding the initial investment and efficiency. As this technology answers the questions concerning the emissions and energy security, it will have strong support of the environmental revolutionists, who might do some marketing for the technology in their fight to reduce the emissions. With this support from the environmentalists, the biomass energy source can also attract the consumers with their low cost, low emission characteristics. Public interest in this technology will inspire the organizations to integrate some innovative technology options which can further support the implementation of this technology. But on the other hand, the competitive organizations will not be idle. Although the biomass energy source will always have an upper hand in the emission reduction sector, the competitive technologies are trying to improve their performance in the emission sector. At the same time these competitive technologies are enhancing their performances in other sectors like efficiency, fuel consumption, innovative energy storage methods, design and also the cost. For successful implementation of biomass energy source, it has to overcome the tough challenges posed by the existing technologies. With all the competitions and challenges from the market, the biomass energy source have to add some more features in their deployment strategy. The researchers will play a vital role in this whole scenario. The advancement of any of these technologies will depend on the researchers' breaking new grounds in respective fields. After considering everything, the successful implementation of the biomass energy source in will depend on the consumers as they will make the final choice. To make that decision-making process easier, the government might introduce new policies and also offer some incentives for shifting to renewable technology. The successful deployment of the biomass energy source will also result in better air quality in the country which will not only reduce emissions and air

pollution but also increase the living standard of the population.

The biomass energy source will also facilitate employment of many engineers, scientists, technicians, business executives and etc. This opportunity can in fact tackle the unemployment issues at least a little bit. The job will also be challenging as the employees have to establish the business which calls for creative and innovative methods. Thus, the job satisfaction will be better. Although as manufacturing processes will be carried out, the occupation will not be completely safe. But following the safety rules can help in reducing the number of casualties. So, considering all the scenarios, it can be said that, the social impact of implementation of biomass energy source will be a positive one.

5.2 Environmental Analysis

The biomass energy source is an innovative alternative to the existing power generation options for reducing the GHG emissions and also solving the energy crisis issue. This technology offers the opportunity of near to 'no emissions' in the power generation sector. The successful implementation of the biomass energy source will result in better air quality. Despite this small amount of emissions, the biomass energy source is still the better option among other power generation technologies from the GHG emission perspective. The following table shows the emission of various power generation technologies.

Table 6: Comparison of lifecycle emissions of different power generation technologies [8].

Technology	Mean	Low	High
	Tonnes CO ₂ e/GWh		
Lignite	1054	790	1372
Coal	888	756	1310
Oil	733	547	935
Natural gas	499	362	891
Solar PV	85	13	731
Biomass	45	10	101
Nuclear	29	2	130
Hydrostatic	26	2	237
Wind	26	6	124

Bangladesh has very low CO₂ emission per capita compared to the countries of South Asia and also the lower middle income countries. The inclusion of biomass energy source in the power generation system of Bangladesh will help in developing a sustainable future.

5.3 Economic Analysis

The deployment of biomass energy source in Bangladesh depends the most on the economic feasibility of the technology. The renewable energy technologies are still very expensive for developing countries like Bangladesh. But as science progresses, the technologies are also becoming cost-effective and efficient. Figure 8 presents the levelised cost of electricity of renewable technologies of various scales.

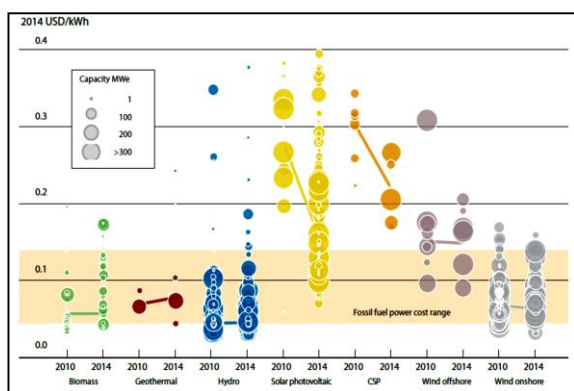


Fig.8: Levelised cost of electricity of various renewable energy technologies [9].

The fig. above clearly shows that although biomass plant capacity is still in a small scale but it is cost-effective, which is promising for a country like Bangladesh with a huge resource of biomass.

5. POLITICAL CONTEXT

The government always try their best to satisfy the people so that in the next election, they get a positive feedback. Sustainable technologies are way better than other technologies in the long run, but the success also depends on the resources and investment. Depending on the resources, there can be less generation in one day whereas there are other technologies which will deliver at a constant rate while polluting the environment. The government is also hesitating in taking long term plans as if they are not elected in the next term, the other party might just enjoy the positive feedback for the previous party's deeds. In fact, the effect of environmental pollution will not be visible very soon, but the satisfaction of the people might even win the election for them. These political issues come up as people don't raise their voice to save the environment much as they do when they don't get electricity. In those moments, the government decides to invest more in technologies which are able to deliver quickly. The sustainable energy technologies are proven techniques and can meet the energy demand when implemented successfully, but there's a long way to go for Bangladesh as a lot of explorations need to be done. Also the initial investment is very high in sustainable technologies. These are the reasons why the growth of sustainable technology in Bangladesh is still slow. The first priority is electricity not environment, for the people and so as for the government. Despite this scenario, the government is taking initiatives to introduce sustainable energy in the national grid and have major plans for the deployment. Although the coal-fired technology is introduced again in the country as a fast solution, the government is also concerned about the environment and has set up targets for energy production utilizing the renewable energy sources, which is a silver lining for the sustainable technology in Bangladesh.

6. CONCLUSION

Bangladesh has huge resources of biomass energy which are not yet utilized. So, the deployment of

biomass energy technology has a very bright prospect. There are some social, political and economic barriers but these can be solved. The recent initiatives of the government in the renewable energy sector has opened the door for successful implementation of biomass energy source in Bangladesh. The effective exploitation of this available energy can help in meeting the electricity demand as well as preserving the environment. The triple bottom line analysis shows that implementation of biomass energy will not only improve the social standards but also the environmental situation. Also the cost-effectiveness of the technology makes it economically viable for Bangladesh.

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