

Present Energy Scenario and Potentiality of Wind Energy in Bangladesh

Md. Alamgir Hossain, Md. Raju Ahmed

Abstract—Scarcity in energy sector is a major problem, which can hamper the growing development of a country. Bangladesh is one of the electricity-deprived countries; however, the energy demand of Bangladesh is increasing day by day. Due to the shortage of natural resources and environmental issues, many nations are now moving towards renewable energy. Among various form of renewable energy, wind energy is one of most potential source. In this paper, the present energy condition of Bangladesh is discussed and the necessity of moving towards renewable energy is clarified. The wind speed found at different locations at different heights and different years from the survey of several organizations are presented. Although, the results of installed low capacity wind turbines (from few kW to few tens of kW) operated by private or government organization at different places in Bangladesh are not so encouraging; however, it is shown that Bangladesh has a high potential of using large wind turbine (MW range) for capturing wind energy at different places. The present condition of wind energy in Bangladesh and other countries in the world are also presented to emphasize the requisite of moving towards wind energy.

Keywords—Renewable energy, wind speed, wind power, modern wind turbine, scarcity of power and gas crisis.

I. INTRODUCTION

WIND energy is being popular all over the world due to its attractive contribution on almost zero fuel cost and lower environmental effect than conventional sources with ensuring forever energy supply; also the energy capturing capacity of wind generator is higher as compared to photovoltaic generator. Conventional energy sources contributing to climate change and global warming are restricted besides exhausted. After the conventional sources fully depleted the country will face a serious problem. So, before the finishing of conventional sources, energy sector of Bangladesh should be turned toward the renewable sources.

Technological development and the level of progress of a nation depend on electricity consumption [1]. Bangladesh is one of the lowest electricity consumptive country regionally and globally [2]. Power shortage is the most important infrastructural restraint in improvement and progress. Bangladesh, which has 160 million population [3], has not yet ensured 100% electricity accessibility but has planned to reach by 2021 [4]. Only 46% people are now grid connected and 88 million people have no access to electricity [3].

People have a great unfulfilled demand of energy, which is growing by an average 10% yearly [5]. The demand for

electricity has been increased due to growing population and economical development. Though the maximum electricity generation capacity stands at 6350 MW on 04/08/2012; however, shortage of electricity was 1452 MW to meet the peak demand. According to ref. [6], in 2010, about 500-800 MW electricity could not be produced due to dearth of gas supply. Now the production of Karnaphuli Fertilizer Company Limited (Kafco) and Chittagong Urea Fertilizer Ltd (CUFL) are very often suspended due to the shortage of gas supply. In Bangladesh, more than 75% of electricity is generated from natural gas. The reserve of natural gas is decreasing very rapidly due to overuse. If the use rate of natural gas for production of electricity remains same, within several years the reserve of gas will be at a dangerous level. It is the time to find alternative sources of energy. In concerning the environmental issues, renewable energy can be potential alternative sources of energy. Bangladesh has intended to generate 5% of total power production by 2015 and 10% by 2020 from renewable energy sources like solar energy, air, water and waste.

Wind can be a major source of energy for Bangladesh, if accurately examined and utilized. Most of the earlier wind speed data measurements, accessible from Bangladesh Meteorological Department, were at lower elevation which marks that only small wind turbines can be implemented in the coastal regions of the country [7]. Various studies [8]-[10] have been conducted on wind energy and its utility in coastal areas; and discussed about the potentiality of small size wind turbine. The wind speed at higher altitude and the potentiality of using large wind turbine need further investigation. In this paper the present energy scenario of Bangladesh is discussed first, then necessity of moving towards renewable energy is clarified and the potentiality of using large wind turbine is also discussed.

II. PRESENT ENERGY SCENARIO OF BANGLADESH

In Bangladesh, power generation is mostly dependent on natural gas, around 76.74 % of electricity is being produced from our gas reserve [11] and this percentage of electricity generation uses 37% of total gas consumption [12], while demand for gas consumption is increasing by about 8% per year [11]. However, our net remaining recoverable reserve of gas was 11.48 TCF at the end of 2010 and would be available up to 2020 at the present consumption rate [11]. Table I indicates the present status and future prediction of gas reserve.

If estimated gas reserve is wrong to prove present status and/or gas consumption is increased due to increasing new

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industry, household, power plant, etc., and new gas field is not uncovered then scarcity of supply may be felt early.

Moreover, almost 20% of the fuels running power plants are of 20 years old among the installed capacity [13]; as a result, momentary shutdown and high repairing cost are involved. Table II shows the age of installed generators and their capacities, and Fig. 1 shows the percentage of installed generation (8072 MW) in Bangladesh from various sources.

TABLE I
GAS CONSUMPTION AND REMAINING RECOVERABLE RESERVE OF NATURAL GAS

Descriptions	2010	2012	2014	2016	2018	2020
Gas Reserve (TFC)	12.21	10.69	8.92	6.86	4.45	1.64
Growth Rate of Consumption	8%	8%	8%	8%	8%	8%
Yearly Consumption (TCF)	0.73	0.85	0.99	1.16	1.35	1.58
Total Reserve remaining (TFC)	11.48	9.84	7.93	5.70	3.10	0.06

TABLE II
INSTALLATION YEAR OF POWER PLANTS UP TO 2012

Generator years	Installed capacity (MW)
40+	80
31-40	305
21-30	1105
11 to 20	1378
01 to 10	5132
Total	8000

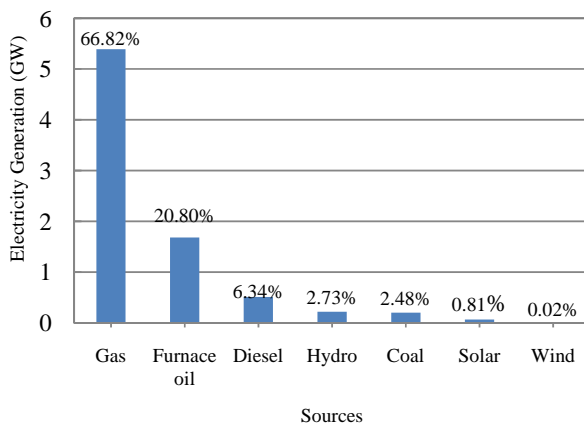


Fig. 1 Electricity generation in Bangladesh from different sources [6], [14]

It can be seen from Fig. 1 that gas dependent power generation is more than two-third of total electricity production, where only 3.56% of electricity is producing from renewable sources (hydro, solar and wind). A large portion of generation, 96.44% of total energy, is generating from non-renewable sources which are polluting air, land, water and organic environment gradually. However, this scenario should be changed very soon otherwise our future generation would probably be in serious power crisis, experience severe harmful environmental effects, and may not stand before other countries. The forecasted power demand is figured out in Fig.

2 indicating projected power demand of Bangladesh up to 2030.

In Fig. 2, it is shown that power demand is gradually increasing, and this increasing demand is going to be met by unsustainable energy sources [5]. It is a matter of great concern that the recent power demand is being met by quick-rental power plants which involve expensive liquid fuels and causes severe harmful effects on environment.

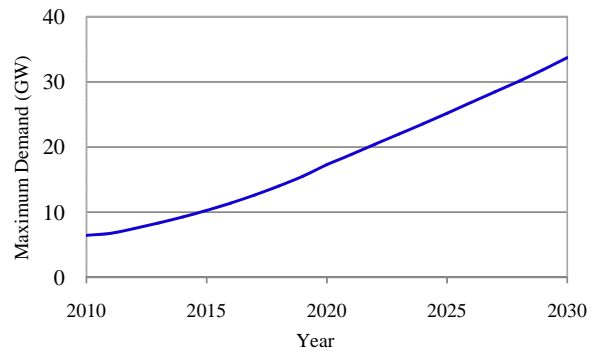


Fig. 2 Projected electricity demand of Bangladesh up to 2030 [7]

To accomplish the next power generation, Power Development Board of Bangladesh proposed a roadmap up to 2030-“The Power System Master Plan (2010)” recommending that 30% of power generation would be coal-based. But, in 2012, coal-based power generation contributed only ~2% of total power generated [1], and that was 2.46% in 2011 [15]. Overall coal reserves are 2,527 million tones according to BNEP-2004.

So, in such state, it is being expected that the country will face grievous energy dearth in upcoming years. For any country, sustainable energy growth is a compulsory need for the sustainable economical development. Only shifting to the renewable sources would be the best fit for any country for a sustainable energy expansion while a wonderful merge of different sources of energy in the intermediary period is a crucial requirement to maintain current economic development.

III. WIND SPEED IN BANGLADESH

Bangladesh consisting of numerous diminutive islands and 724km long coast line in the Bay of Bengal experiences brawny south-westerly steady wind, calm north-easterly trade wind, land zephyr in winter months and sea-breeze blast in the summer months [16]. The annual average wind speed at 30 m height is more than 5m/s [17]. Wind speed in north-eastern parts of Bangladesh is above 4.5m/s while in the other parts of the country is around 3.5m/s [16], [18]. Patenga, Feni, Kuakata, Kutubdia, Mognamaghat and Munshigonj have immense potential to produce electricity from wind energy. Average wind speeds of these sites are more than 6.2m/s which is, according to NREL (USA), viable for harnessing wind power. Different organizations of Bangladesh (PDB, BUET, LGED, etc.) have conducted wind mapping [19] at several places in distinct years.

From Table III it is seen that Patenga, Feni, Kuakata, Kutubdia, Munshigonj and Mognamaghat have sufficient wind speed to produce power. It is also seen that with the increasing height, wind speed is also increasing in some places that are more suitable to set wind turbines. The relation between height and wind speed is shown in Fig. 3.

TABLE III
WIND MAPPINGS OF DIFFERENT LOCATIONS IN DISTINCT YEARS

Places	Sensor height (m)	Annual avg. wind speed (m/s)	Organizations
Kuakata	25	4.54	
Kutubdia	25	4.18	Wind mapping at 7 places by
Char Fassion	10/25	3.28/4.07	LGED/BCAS/DF
Patenga	25	3.84	ID
Cox's Bazar	25	3.34	(1996-97)
Noakhali	25	2.96	
Kutubdia	25	4.18	Wind mapping at
St. Martin	25	4.69/4.56/4.8	St. Martin by BCSIR
			(1999-2001)
Patenga		6.70	
Feni		6.20	Wind mapping at
Kuakata	50	6.89	5 places by PDB
Kutubdia		6.73	(2003-05)
Mognamaghat		7.1	
Kuakata	30	4.23	
Pakshy	30	2.78	
Khagrachari	20	3.28	Wind mapping at
Naogaon	20	1.92	10 places by
Panchagarh	20	3.00	LGED/BUET/UN
Kishoregonj	30	2.37	DP
Kutubdia	20	3.58	(2005-07)
Cuet	20	2.33	
Munshigonj	40	6.26	
Sitakunda	30	4.15	

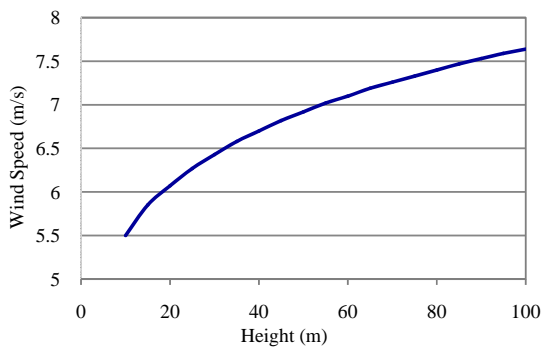


Fig. 3 Variation of wind speeds with height [20]

Fig. 3 illustrates the increase in height causes of wind speed rise in exponential form. It is seen that wind speed curve is rising sharply up to 50 m then the rise is gradual, and it is seen that at a height of 80 meters wind speed is more than 7 m/s which is enough to produce power from wind. Besides, the entire wind mappings conducted by different organizations were in onshore but it is expected that wind mapping in offshore will provide satisfactory result regarding wind speed. So, it is predicted that there is a great possibility of capturing wind power in Bangladesh with proper attention.

Monthly wind speed [19] at different locations of Bangladesh is shown in Fig. 4 demonstrating accepted average wind speed line (6.2 m/s) according to NREL (USA).

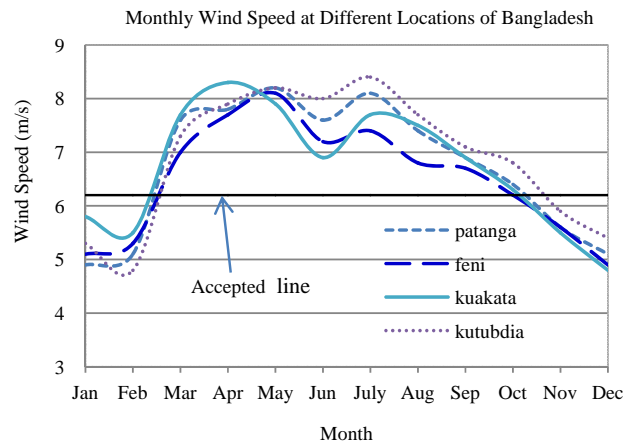


Fig. 4 Wind speed at different locations at 50 meters height conducted by BPDB

Fig. 4 shows that wind speed is varying throughout the year, where wind speed is found greater than accepted value, 6.2 m/s, in between March and October; and wind speed is found below, 6.2 m/s, in between November to February. The lowest and highest average wind speeds are 4.8 m/s in February and 8.4 m/s in July occurred at Kutubdia. These speeds are enough to generate power from wind.

From the above analysis it can be concluded that some places of Bangladesh are more suitable to harness the wind energy namely Patenga, Feni, Kuakata, Kutubdia, Mognamaghat, and Munshigonj based on the data Table III conducted at 50 meters height in onshore. If these places are conducted more than 50 meters height, from the Fig. 3, it is hoped that it will definitely exceed the wind speed value more than 7 m/s at height 80-100 meters, these height ranges are available in modern wind turbines. It is also anticipated that if the conducted data would be in offshore, wind speed would also increase.

IV. WIND ENERGY IN BANGLADESH

Wind power contribution to the whole renewable power is 39% of world capacity where it outstripped 1,470 GW in 2012 [2]. In 2012, total installed world wind power capacity was increased to 283 GW by adding around 45 GW, which was 19% of the total amount. By the end of 2012, total wind power capacity was available to supply the minimum 2.6–3% of world electricity consumption [3]. Fig. 5 illustrates the contribution of top ten countries to the world wind power capacity.

Global wind power capacity, the average cumulative growth rate of which was 25% from 2007 to 2012, enhanced by the top 10 countries was more than 85% of total capacity. Although, almost 44 countries have contributed in wind capacity, China and United States both contribute around 60% of total installed capacity keeping individual contribution 13

GW, which is 29% of world market, and 13.1 GW, which is 30% of global market, respectively in 2012.

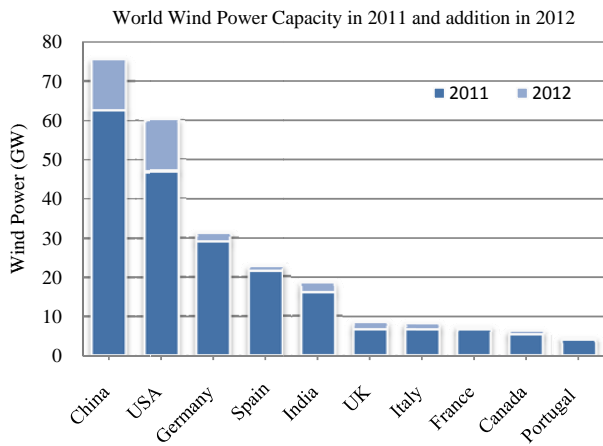


Fig. 5 Contribution and growth of wind energy in top ten countries up to 2012 [3]

Addition of 11.9 GW wind power capacity in 2012, European Union’s capacity, which contributed just above 37% of total world wind power capacity and wind energy account for 11.4% of total electricity capacity, surmounted 100 GW milestones was 106 GW.

The comparative growths of wind power in world and Bangladesh have shown in Fig. 6 [21].

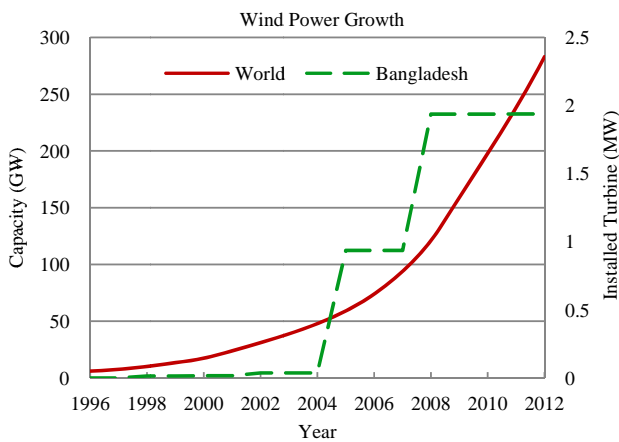


Fig. 6 Comparative growth study of wind power capacity, World and Bangladesh

In Fig. 6, solid line indicates world’s wind power, the raising rate of installing wind turbine was increasing slightly at the beginning then it was growing steadily in between 2004-2008. After that total world wind power capacity was growing up sharply as years passing beyond 2008. In contrast, discontinuous line for Bangladesh, wind power generation progress was negligible. It is seen that no remarkable progress in installing wind turbine was observed.

Table IV indicates wind turbine installed in Bangladesh at different years and heights.

TABLE IV
LOCATIONS AND SPECIFICATIONS OF INSTALLED WIND TURBINES AT DIFFERENT YEARS AND HEIGHTS

Locations	Height (m)	Total capacity (KW)	Year
Patuakhali and Barguna	30	14.5	1998
Teknaf and Meghnaghat	25	1.5	2000
Turbines with solar support at St. Martin	25	21	2002
Feni	50	900	2005
Kutubdia	15	1000	2008
Sandwip	24	1.5	2011

The largest wind turbine installed in Bangladesh is 225 KW at only 50 meter height; although the world largest rated capacity is 7.58 MW with overall height 198 m [22], and the tallest wind turbine is 210 m established in Poland, [23]. In United States, a typical 1.5 MW wind turbine is often seen with a tower of 80 meters.

Two chief components of a wind turbine are responsible for capturing energy are the generator and the sweeping blades; however it does not mean that the largest generator will produce more power, but the length of blades and height of turbine both play a vital role in capturing energy. The average wind speeds at the swept area of the blades and the turbine’s location determine the production of power. As the blade length and turbine height increase, the amount of capturing energy also increases. So, the capacity of turbine mostly depends on its rotor diameter. Now, the modern commercial available wind turbines are rated between 500 kW and 4.5 MW having rotor diameter from 30 m to more than 99 m and hub height from 50 m to more than 80 m. Table V indicates modern wind turbines’ specifications.

TABLE V
MODERN WIND TURBINES AND THEIR SPECIFICATIONS [22], [24]-[27]

Manufacturer	Name	Capacity (MW)	Hub height (m)	Rotor diameter (m)	Swept area (m ²)
Enercon	E-126	7.58	135	127	12668
Siemens Wind Power	SWT-6.0-154	6	Site-specific	154	18600
Gamesa	G 128-5.0 MW	5	80-94	128	12868
Siemens Wind Power	SWT-3.0-113	3	79.5-142.5	113	10000
Goldwind	GW 100	2.5	100	100	7823
Ming Yang	MY 1.5s	1.5	65.70-75.50	82.6	5320

The main difficulty of installing modern wind turbine may be natural disasters such as cyclone, tornados, etc., which are not actually a problem for installing and maintaining wind turbines, where a great deal of economical, social, and infrastructural developments of a country is involved due to sustainable energy source. Japan is the one of the most natural disaster prone country in the world, where installed wind power generation is 2614 MW [19] and every year on average 167 MW is added to power sector using modern wind turbines [28].

V. CONCLUSIONS AND DISCUSSIONS

Energy dependency on conventional sources is not benediction for Bangladesh, and the upcoming days would be more difficult if it keep continuing; where Bangladesh have opportunity to increase its wind power generation at different locations utilizing modern wind turbine, which are being used other parts of the world with satisfactory result. Although, the present wind turbines installed in Bangladesh are not more than 50 m height, and harnessing energy from wind is not utilized properly. As it is expected that with the increasing height, wind speed is also increasing; and its speed would be more than 7.2 m/s at above 80 meters height. Therefore, in this height, modern wind turbine (MW range) would be a best fit to produce wind power with adequate wind speed. This would be better a decision for Bangladesh to meet the upcoming power crises by renewable energy like wind power.

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