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FEASIBILITY STUDY FOR WIND POWER STATIONS AT DIFFERENT LOCATIONS IN BANGLADESH

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Abstract- *In developing country like Bangladesh, the demand of electrical energy is very higher than the available production. Wind energy is an important source of electrical power in recent years. Its main advantage comes from the fact of being a renewable and environmental-friendly energy. Wind, as we all know, is an important source of renewable energy. Bangladesh being a tropical country does have a lot of wind flow in different seasons of the year. However, there are some windy locations in which wind energy projects could be feasible. This paper studied previously collected data on the wind resources available in Bangladesh. By analyzing this data, this work has been carried out to predict if these wind energy resources are sufficient for wind power, in the hope to discover and determine to what extent the electrical energy produced from wind is capable of satisfying the energy demands. Windographer is used as the tool of this analysis.*

Keywords: Wind energy, Windographer, Wind power class, Bangladesh

1. INTRODUCTION

Now a day's worldwide energy crisis is one of the great problem. The interest in renewable energy has been revived over last few years, especially after global awareness regarding the ill effects of fossil fuel burning. The use of renewable energy technology to meet the energy demands has been steadily increasing for the past few years, however, the important drawbacks associated with renewable energy systems are their inability to guarantee reliability and their lean nature [1]. Renewable energy sources are considered to be the better option to meet these challenges. This paper deals with an estimation of electrical energy from the previously collected wind energy data on the windy locations in Bangladesh [7].

2. MOTIVATIONS

Bangladesh is situated between 20.30 – 26.38 degrees North latitude and 88.04 – 92.44 degrees east [4]. It has seven hundred Km coastal line. Analyzing the upper air data by CWET India show that wind energy resource of Bangladesh is poor in wind resource for grid connected wind parks [6]. At present several wind resource assessment program of BPDB is ongoing in the country. From the previous studies it can be inferred that the small wind turbines can be installed in the coastal regions of the country.

3. WIND ENERGY

Winds are caused by the uneven heating of the atmosphere by the sun, the irregularities of the earth's surface, and rotation of the earth. Wind is a renewable resource because it is inexhaustible. It is a result of the sun shining unevenly on the earth. The corresponding daily and seasonal changes in temperature consistently generate wind, producing a fuel source that can never be depleted. Wind power is the world's fastest growing electricity generation technology.

3.1 Windographer

The software is used for analysis; Windographer is a wind data analysis program [8]. It reads raw data files, does advanced statistical processing of the data, produces a variety of graphs for visualizing the data, and provides tools for quality control of the data. Windographer has been developed by Mistaya Engineering. It allows opening three types of raw data files: text files, NRG Systems data logger (.RWD) files, and Microsoft Excel (.xls) files. When opening one or more raw data files, Windographer creates a Windographer document and stores a copy of the data from each file in the document. Windographer never modifies the collected wind data in the original data files.

3.2 Wind Turbine System

The In a wind turbine system, the kinetic energy in the wind is converted into rotational energy in a rotor of the wind turbine. The rotational energy is then transferred to a generator, either directly or through a gearbox for stepping up the rotor speed. The mechanical energy is then converted to electrical energy (variable-frequency, variable-voltage) by the generator. From the generator, the electrical energy is transmitted to a utility grid either directly or through an electrical energy conversion stage that produces constant-frequency, constant-amplitude voltage suitable for interface to the utility [2]. Region I, Where the wind speed is below the cut-in speed. The power in the wind is insufficient to overcome the power losses within the turbine system. Region II, Where the wind speed is between the cut-in speed and the rated wind speed. Generally, the rated wind speed is the wind speed at which the maximum output power of the generator is reached. Region III, Where the wind speed is between the rated wind speed and the cut-out speed. The cut-out speed is the maximum wind speed at which the turbine is allowed to deliver energy. Usually, the cut-out speed is limited by engineering design and safety constraints [2].

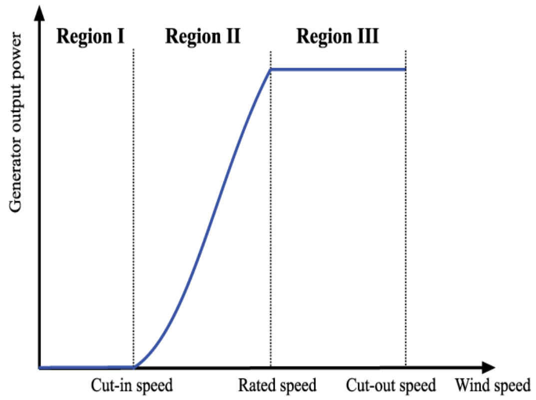

Fig.3.1: Characteristic of a typical Wind turbine generator.

3.3 Output Power and Performance Coefficient

The output power of the wind turbine is given by the following equation [2].

$$P_m = \tfrac{1}{2} C_p(\beta,\lambda)\rho A V^3 \qquad (1)$$

The Cp is the fraction of the upstream wind power, which is captured by the rotor blades. The remaining power is discharged or wasted in the downstream wind.

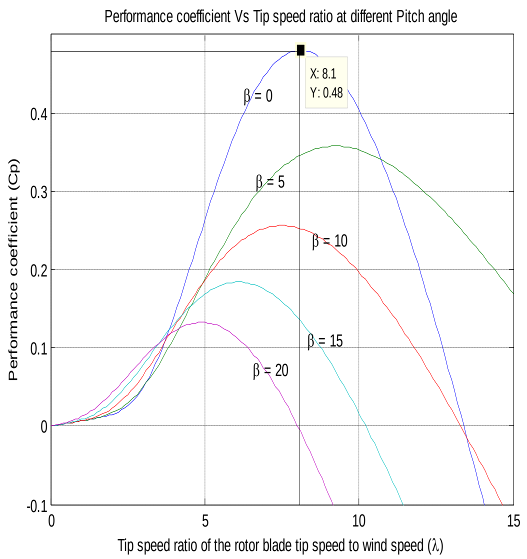

Fig.3.2: Performance coefficient vs. Tip speed ratio at different pitch angle

From the C_p-λ characteristics, for different values of the pitch angle β, are illustrated above. The maximum value of Cp ($C_{p\ max}$ = 0.48) is achieved for β = 0 degree and for λ = 8.1. It has the maximum value of 0.59. The maximum power is extracted from the wind at that speed ratio. The theoretical maximum value of Cp is 0.59. In practical designs, the maximum achievable Cp is below 0.5 for high-speed, two-blade turbines, and between 0.2 and 0.4 for slow speed turbines with more blades [4].

3.4 Wind Power Class

The wind power class is a number indicating the mean energy content of the wind resource. Wind power classes are based on the mean wind power density at 50 meters above ground [1]. According to the Wind Energy Resource Atlas of USA, wind power class distributions are shown below [8].

Table 3.1: Wind Power Class

Wind Power Class	Description	Power Density at 50m (W/m^2)
1	Poor	0-200
2	Marginal	200-300
3	Fair	300-400
4	Good	400-500
5	Excellent	500-600
6	Outstanding	600-800
7	Superb	800-2000

4. WIND DATA ANALYSIS

The wind is never steady at any site. It is influenced by the weather system, the local land terrain, and the height above the ground surface. The wind speed varies by the minute, hour, day, season, and year. Therefore, the annual mean speed needs to be averaged over 5 or more years. However, long-term measurements are expensive, and most projects cannot wait that long. In such situations, the short term, say one year, data is compared with a nearby site having a long term data to predict the long term annual wind speed at the site under consideration. This is known as the "measure, correlate and predict (mcp)" technique. The LGED and BPDB provided us the data of January 2007 to January 2008 for three regions named Saint Martin, Cox's Bazar, and Patenga. We have analyzed these data by the help of software named Windographer.

4.1 Wind Data from Bangladesh

Most of the previous wind speed data in Bangladesh available from the Bangladesh Meteorological Department at lower height [6]. However, normal hub-heights of modern wind turbines ranges from 25 to 45m.Thus using meteorological data, designing wind energy conversion system would end in a failure and there are some previous experiences [5]. Wind data were recorded from January 2007 to January 2008 as a daily basis and recorded by a data logger. These types of wind measurement systems provide a more accurate assessment than anemometer wind resource evaluation system of the wind resource at any location, but are more expensive. Measurement equipment is set high enough to avoid turbulence created by trees, buildings or other obstructions. The wind speed frequency distribution is processed from these data and fitted to Weibull function to predict the nature of wind. Monthly average wind speeds measured at 30m height at different locations are summarized below [7].

Table 4.1: Monthly average speeds measured at 30m height at different locations

Month	Measured Wind speed in Saint Martin at 30m height	Measured Wind speed in Cox's Bazar at 30m height	Measured Wind speed in Patenga at 30m height
January	4.48 ms^{-1}	4.09 ms^{-1}	3.95 ms^{-1}
February	4.62 ms^{-1}	4.17 ms^{-1}	4.02 ms^{-1}
March	4.54 ms^{-1}	3.96 ms^{-1}	3.73 ms^{-1}
April	4.09 ms^{-1}	3.82 ms^{-1}	3.56 ms^{-1}
May	5.37 ms^{-1}	4.79 ms^{-1}	4.23 ms^{-1}
June	6.47 ms^{-1}	5.23 ms^{-1}	4.87 ms^{-1}
July	5.86 ms^{-1}	5.32 ms^{-1}	4.98 ms^{-1}
August	5.98 ms^{-1}	4.93 ms^{-1}	4.39 ms^{-1}
September	4.77 ms^{-1}	4.42 ms^{-1}	4.11 ms^{-1}
October	4.41 ms^{-1}	4.09 ms^{-1}	3.79 ms^{-1}
November	3.83 ms^{-1}	3.81 ms^{-1}	3.63 ms^{-1}
December	4.31 ms^{-1}	3.97 ms^{-1}	3.48 ms^{-1}

4.2 Wind Data Study at Different Locations

At the starting of the year i.e. in January the wind speed is low and it continues to march. From April, the speed starts to increase and during June, July and August. Wind shear profile and wind power class are demonstrated below.

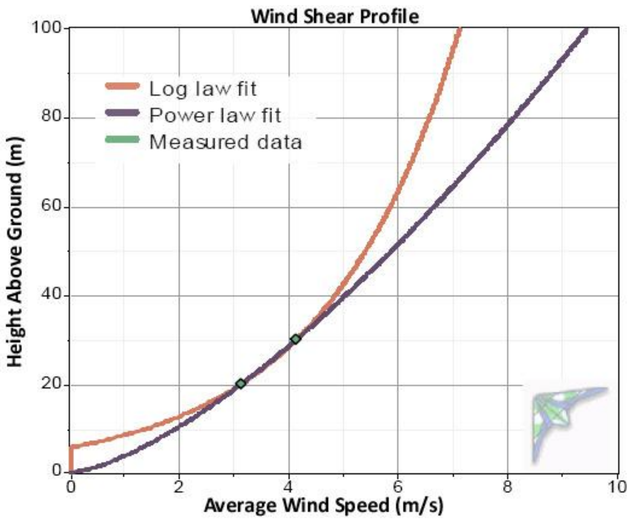

Fig.4.1: Wind Shear Profile at Saint Martin

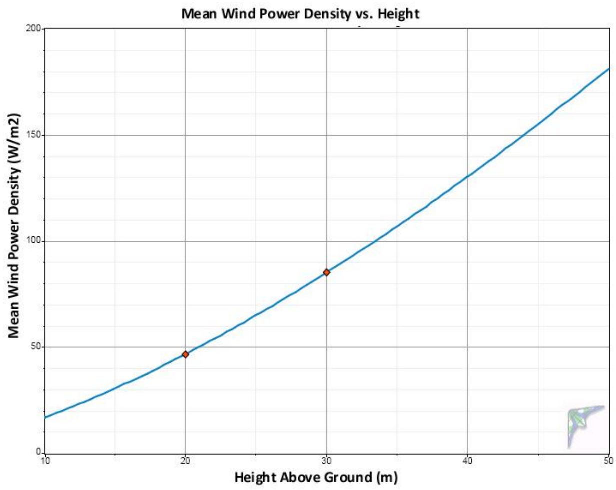

Fig.4.2: Wind Power Class at Saint Martin

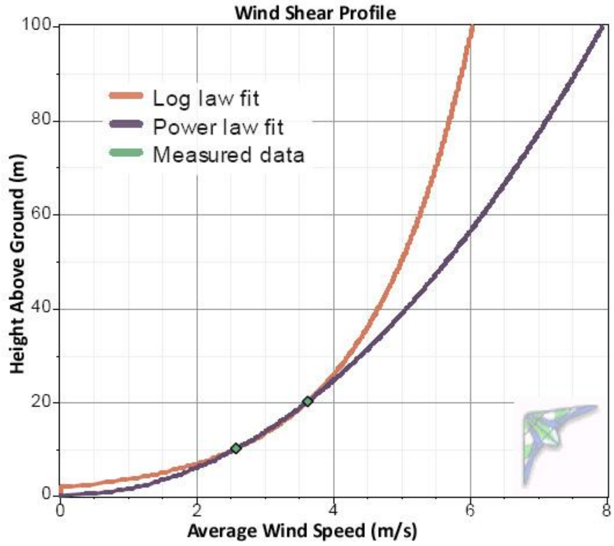

Fig.4.3: Wind Shear Profile at Cox's Bazar

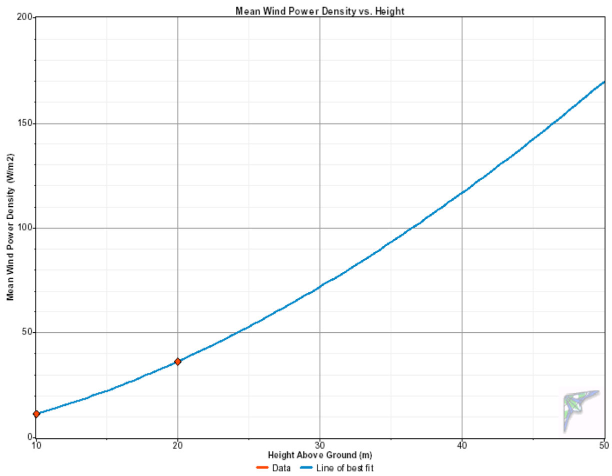

Fig.4.4: Wind Power Class at Cox's Bazar

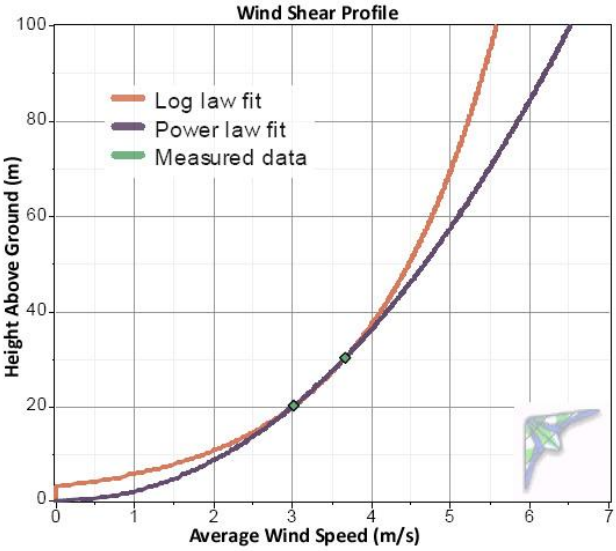

Fig.4.5: Wind Shear Profile at Patenga

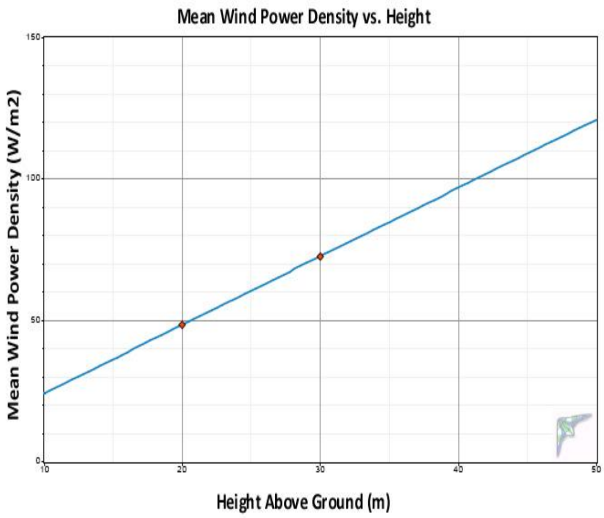

Fig.4.6: Wind Power Class at Patenga

5. COMPARISON OF WIND POWER CLASS AT DIFFERENT LOCATIONS

From the simulated graph by using windographer, obtained results are summarized below.

Table 5.1: Comparison of Power Class at different locations

Name of the Location's	Wind Power Density(W/m^2)	Wind Power Class
St. Martin	182	Poor
Coax's Bazar	171	Poor
Patenga	142	Poor

6. CONCLUSIONS

The location selected for analysis has poor power class. Thus, from all the aforementioned, it can now be better understood that for the locations, the system like the one which was used for the analysis, cannot meet the energy demands of the area in a totally realistic situation from an economic point of view. The electrical energy produced from windy location selected for analysis is not capable of satisfying the energy demands effectively.

7. REFERENCES

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8. NOMENCLATURE

Symbol	Meaning	Unit
C_p	Performance coefficient of the turbine	Dimension less
ρ	Air density	(kg/m^3)
A	Turbine swept area	(m^2)
V	Wind speed	(m/s)
β	Blade pitch angle	(degree)
λ	Tip speed ratio of the rotor blade	Dimension less