Short communication

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Study on grid-tied wind energy system at Feni

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I. Introduction

A grid-tied wind system may be as simple as a wind turbine and a grid-tie inverter. Depending on the amount of power being used by the household, energy is either fed to or accepted from the utility. On the other hand, the pattern of wind blowing over Bangladesh, shows the peak windy season of a year coincides with the peak demand for electricity of the country.

II. Wind resource assessment at Feni

Japan International Cooperation Agency (JICA) installed calibrated anemometers at the height of 40, 50 and 60 meters at Feni (Latitude 22.83^0 and Longitude 91.45^0 and Elevation 03m) in February 2007 for monitoring wind resources from the ground surface[1]. Available measured average wind speeds over March 2007 to December 2008 are given in the following Table 1.

Table. 1. Monthly wind speeds (m/s)

	40m	50m	60m
Jan	3.00	3.20	3.40
Feb	3.30	3.60	3.80
Mar	3.45	3.60	3.75
Apr	4.80	5.00	5.10
May	4.65	4.80	5.00
Jun	5.40	5.90	6.15
Jul	6.00	6.25	6.40
Aug	5.00	4.80	5.35
Sep	3.95	3.80	4.30
Oct	3.10	2.95	3.45
Nov	2.70	2.85	3.10
Dec	2.55	2.60	2.95
Avg	3.99	4.11	4.40

It has been found that from 21 months study, yearly average value is almost same for any twelve months and the monthly averaged wind speed varies from 2.5 m/s to 6.4 m/s with a standard deviation of 2.65 m/s at 60m height (overall hourly averaged min and max wind speed varies from 0 m/s to 18 m/s and at 10 minute interval it varies from 0 m/s to 27.9 m/s with a standard deviation of 5.4 m/s). Variations of wind speed with time are shown in the Figure 1.

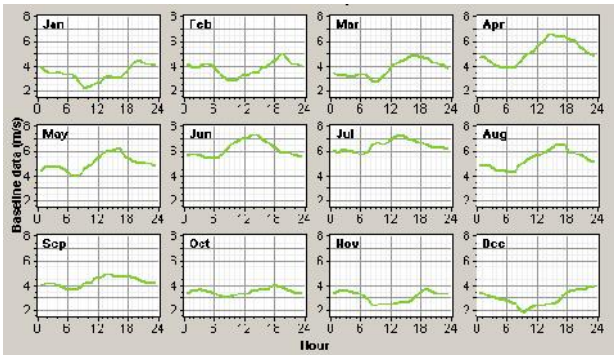

Fig. 1. Variation of wind speed with day

III. Wind Power density

Wind Power Density (W/m^2) depends on the density of the air and cube of the wind speed. In fact, there is no dependence on size, efficiency or other characteristics of wind turbines when determining WPD.

At 60m height the power density varies from 15 W/m^2 to almost 160 W/m^2 for Mar'07 to Dec'08. The variations of wind speeds and WPD with months have been shown in the following Figure 2.

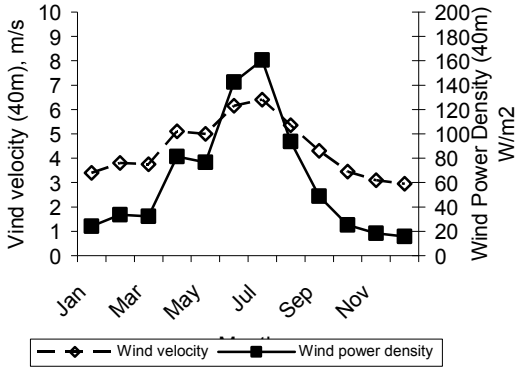

Fig. 2. Monthly speed and PWD at 60m height

IV. Probability Distribution Function

To find out the percentage, Probability Distribution Function (PDF) can be used to model the frequencies and probabilities of occurrences over time. A probability distribution function associates a list of probabilities with each possible value of a discrete random variable. In this analysis PDFs have been calculated for wind speed data at 60m. The results are shown in Figure 2 and Table 2.

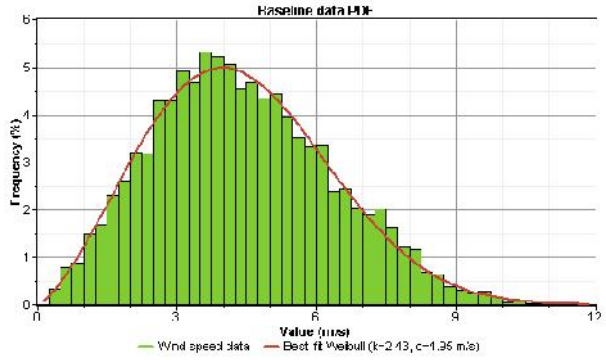

Fig. 2. Variation of PDF

Table. 2. Weibull and other parameters

Parameter	Value
Weibull k	2.43
Autocorrelation factor	0.915
Diurnal pattern strength	0.117
Hour of peak wind speed	19
Wind shear profile	Logarithmic
Surface roughness length	0.01m

V. Wind Energy Production

In this study, to evaluate the many possible system configurations, the optimization and sensitivity analysis algorithms of Hybrid Optimization Model for Electric Renewables[2] (HOMER) have been considered. For a proposed 1MW grid-tied wind farm, eight Fuhrlander 100 wind turbines[3] of 125kW wind turbines are placed at 60m at Feni. The turbines have rotor diameter of 68.9m, tower of 35m freestanding tubular and lifetime of 15yrs. The monthly outputs from the farm are shown in Figure 3 and Table 3.

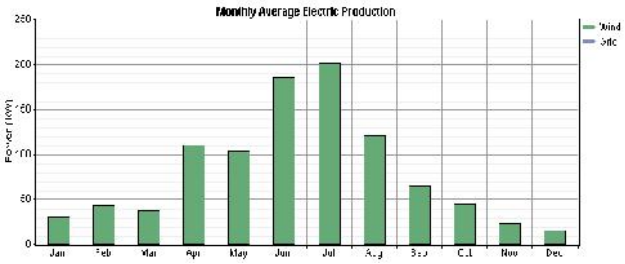

Fig. 3. Monthly wind farm output

Table. 3. Output power from the wind farm

Variable	Value
Total rated capacity	1000 kW
Minimum output	0.00 W
Maximum output	791 kW
Mean output	82k W
Wind penetration	0.00%
Capacity factor	8.18%
Hours of operation	7879 hr/year

VI. Economics and Constrains

The total initial cost of the 15 years wind farm project is 130000000BDT. Here at 10% nominal interest rate and 5% inflation rate or 4.76% real interest rate the operation and maintenance cost of the project is 5064054BDT.

VII. Results and Discussion

In this system, total net present cost of the 15 years project is 135364064BDT, the annualized capital is 12322144BDT and operation and maintenance cost is 480000BDT and total annualized cost is 12802142BDT/year. Hence the levelized cost of energy is 17.86BDT/kWh in this project.

The initial capital cost of the grid extension is 850,000 Tk/km., the annual cost of maintaining the grid extension[4] is 20,000 Tk/yr/km. The proposed site is within 0.5km from the national grid and hence the grid extension cost is not significant. Moreover the site is connected by concrete roads.

Conclusion

The measured wind data by a recent JICA project shows that a 1MW grid connected wind farm at Feni with turbines at 40m, 50m and 60m height show that the farm can produce 605975kWh, 665740kWh and 716715kWh electricity per year. Considering the current prices of components, installation costs and other economic parameters the energy production cost is around 21BDT, 19BDT and 18BDT respectively per kWh. The energy production cost for wind turbines at 60m height is compatible with the energy production cost in the national grid from diesel based generators. Moreover the site is connected with concrete roads and within 0.5km from the grid. For all these reasons, the site emerges as one of the most suitable areas for grid connected wind farm in Bangladesh.

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1. Final report of Studies on Verification of Wind Observation at Feni, JICA,RERC, University of Dhaka, 2009
2. HOMER, V2.14. NREL, www.nrel.gov/homer
3. www.lorex-energy.com
4. Bangladesh Power Sector: 2002 Program in the last one year and future development plan.