Pakistan Meteorological Department

Diagnostic Study for Wind Power Potential in FATA Region in Comparison to NREIs Projections

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Abstract

World's energy needs have encouraged the development of wind power sources. This paper compares the results of a study on wind resource mapping conducted by Pakistan Meteorological Department (PMD) in western parts of Northwest Frontier Province (NWFP) termed as Federally Administered Tribal Areas (FATA) and projections made by National Renewable Energy Laboratory (NREL), USA for the same area.

Analysis of recorded data at 30 meters height and extrapolated at 50 meters using probabilistic approach at four locations indicates that all the four sites are below marginal sites and not suitable for developing wind farms. These results are contrary to the projections developed by NREL USA that mark the area as marginal to good region for developing large scale wind farms.

Based on comparison of the recorded data with NRELs projections, it is recommended that before planning any large scale farm in these areas, micro-siting analysis must be completed for promising economic benefits. Further keeping in view growing energy demands, it is advocated that maximum area of Gharo Wind Corridor may be acquired on priority for developing wind energy farms to exploit maximum wind power generation potential of the region.

Key Words: Wind, FATA. NREL, Marginal, Micro-siting

Introduction

Wind energy is the fastest growing renewable energy source today. Continued pressure on World's energy needs developed interest in wind energy development worldwide and has produced steady improvements in technology and performance of wind power plants. New wind power projects have proven that wind energy not only is cost competitive but also offers additional benefits to the economy and the environment.

A steady supply of reasonably strong wind is necessary requirement for utilizing the power in the wind. Development of wind energy depends upon a clear understanding of wind resources. Pakistan Meteorological department has started the Wind Mapping Project (Phase-II) in July-2005. In this phase 42 wind masts are installed in the Northern parts of Pakistan to study the Wind regime. Including areas are Swat, Dir, Chitral, Gilgit, Skardu, Haripur, Shangla, Buneer, Nowshara, Peshawar, Rawalpindi, Mohmand Agency, Khyber Agency and Azad Kashmir.

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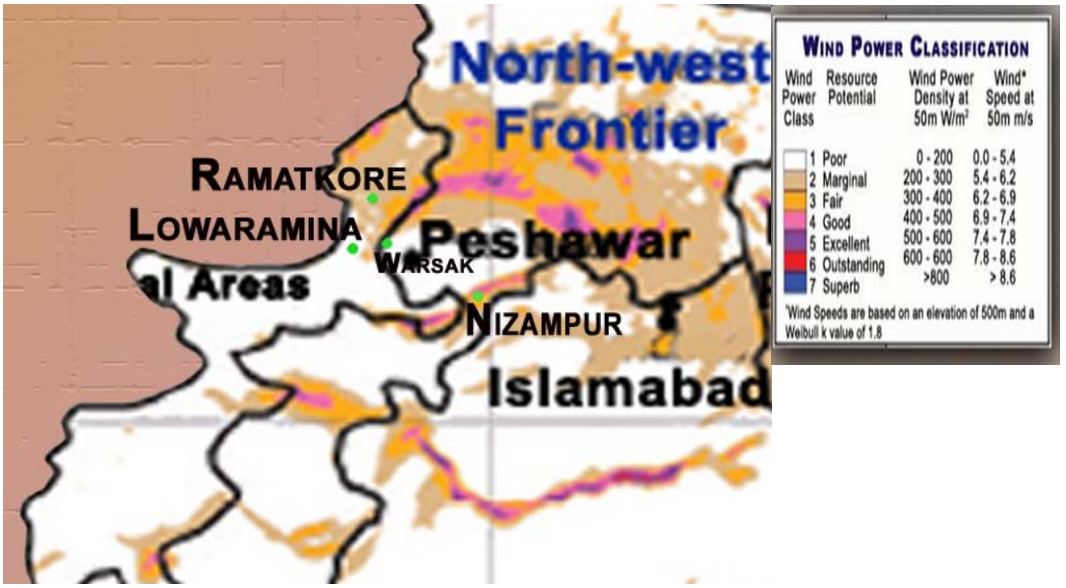
Accurate assessment of local wind resources is vital for the planning and management of hilly terrains wind farms, where in-situ measurements are scarce, therefore validation of modeled dataset is essential through micro-siting. The boundary layer flow over the terrains is quite variable due to the complex surface discontinuity which affects both the surface roughness and the thermal stability. Growing interest in harvesting wind energy necessitates the verified reliable maps for estimating the wind resources and extreme turbulent conditions over complex topographies.

Wind Power Classification Map of Pakistan

Wind Power classification of northern Pakistan at 50 m height provided by NREL (National Renewable Energy Laboratory) USA is shown in Fig-1. Upper NWFP comprising areas of district Jahangeera, , Khyber Agency, Mehmand Agency have been marked as good sites.



Pakistan Meteorological Department selected four sites for wind mapping and installed equipment at 30 m height. Details of selected sites are given below.

Details of Four Potential Wind Mapping Sites Identified by NREL in Northern Areas of Pakistan

S No.	Station	District	Tower Height	Longitude	Latitude	Elevation	Equipment Installed
1	Warsak	District Peshawar	100 Ft	71.25	34.10	1088 Ft	Symphonic NRG Logger
2	Lorramiana	Khyber Agency FATA	100 Ft	71.19	34.08	2362 Ft	Wind Speed Sensor at 100 feet
3	Ramatkore	Mohmand Agency FATA	100 Ft	71.07	34.35	5707 Ft	Wind Speed Sensor at 30 feet
4	Nizampur	District Nowshera	100 Ft	72.01	33.47	1067 Ft	Wind Direction Sensor at 100 feet

As per NREL projection, Nizampur is represented as good site, Warsak as fair site, Ramatkore as marginal site and Lowaramana as poor site on the map in terms of wind power generation potential (Fig 1).

Data Generation

To undertake this study, 30-meter high towers are erected at the locations mentioned above. On each of these towers two wind speed anemometers are installed at the height of 10 meters and 30 meters, respectively; wind vane for recording wind direction is installed at 30 meters height. NRG Automatic data loggers have been installed to record data at each site. These data loggers are recording, ten-minute average wind speed at both level, ten-minute average wind direction and 10-minute average minimum and maximum wind speed. While selecting the above-mentioned locations for wind monitoring; the main objective was to identify potentially windy areas that also possess other desirable qualities of wind energy developed site. Further following guidelines as far as possible were also kept in mind while choosing an exact location for monitoring towers.

- Towers are placed as for as possible away from the local obstruction to the wind
- Selected location should be representative of the majority of the site.

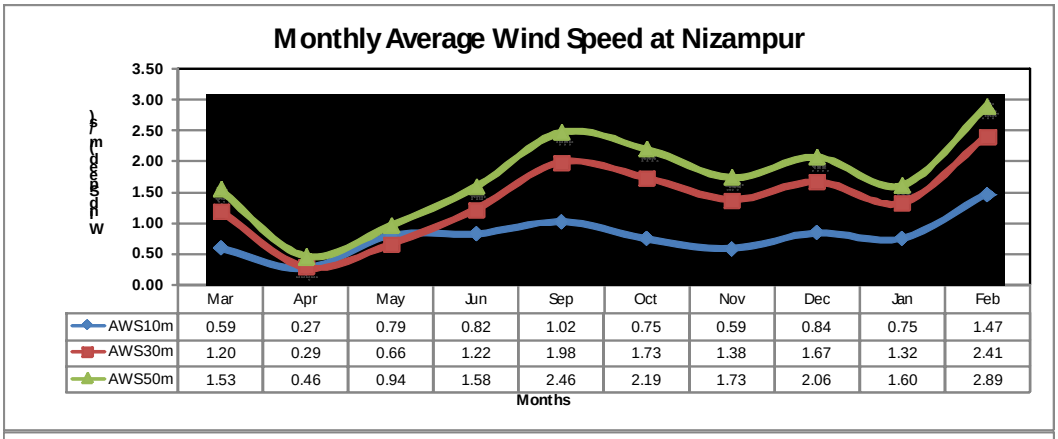
Since sating a tower near obstructions such as trees or building can adversely affect the analysis of the site's wind characteristics such as magnitude of wind resource, wind shear and turbulence levels the tower in most cases are placed as for as possible away

from local obstructions to the wind. But where this rule could not be followed, the tower was placed at horizontal distance of 10 times the height of the obstruction in the prevailing wind direction as required internationally. The following parameters have been recorded during the study.

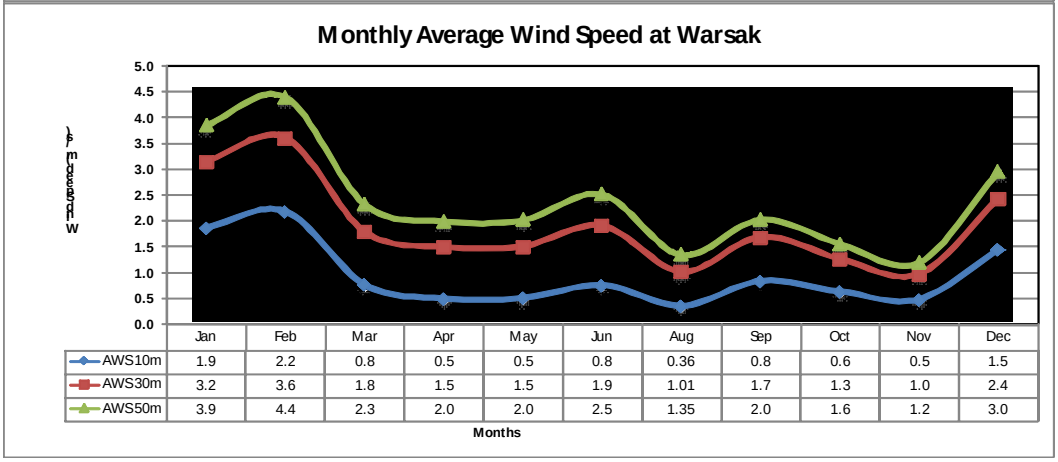
i. Wind speed ten minute average at 10 & 30 meters
ii. Maximum wind speeds during 10 minutes
iii. Minimum wind speeds during 10 minutes
iv. Wind direction ten minutes average at 30 meters

Data Analysis:

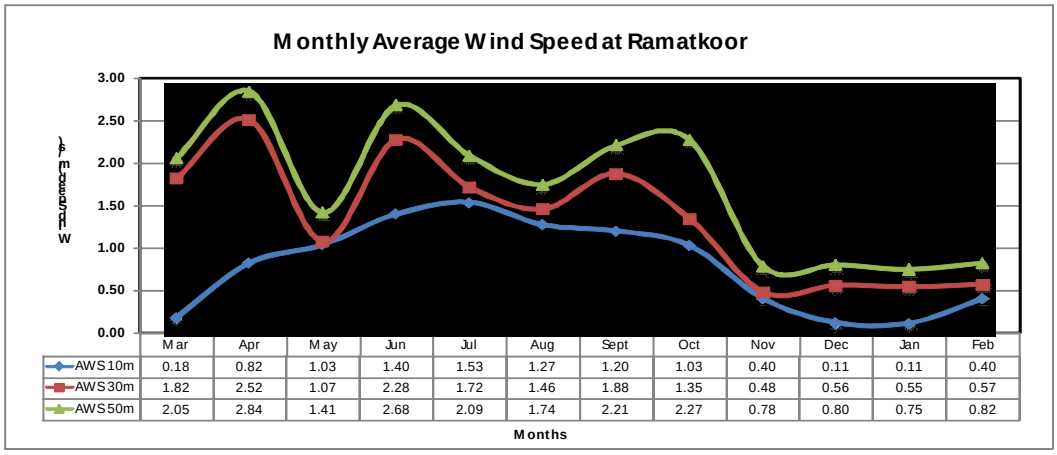
By using above mentioned parameters the wind speed at 50 meters has been computed. Monthly average wind speed at three heights 10, 30 and 50 meters have been calculated and shown below in graphical as well as tabular form.



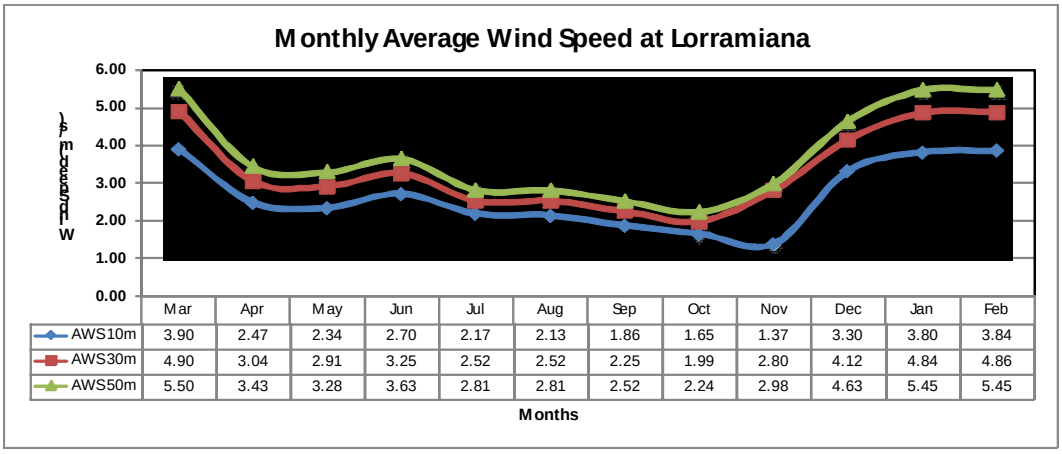
	Mar	Apr	May	Jun	Sep	Oct	Nov	Dec	Jan	Feb
AWS10m	0.59	0.27	0.79	0.82	1.02	0.75	0.59	0.84	0.75	1.47
AWS30m	1.20	0.29	0.66	1.22	1.98	1.73	1.38	1.67	1.32	2.41
AWS50m	1.53	0.46	0.94	1.58	2.46	2.19	1.73	2.06	1.60	2.89



	Jan	Feb	Mar	Apr	May	Jun	Aug	Sep	Oct	Nov	Dec
AWS10m	1.9	2.2	0.8	0.5	0.5	0.8	0.36	0.8	0.6	0.5	1.5
AWS30m	3.2	3.6	1.8	1.5	1.5	1.9	1.01	1.7	1.3	1.0	2.4
AWS50m	3.9	4.4	2.3	2.0	2.0	2.5	1.35	2.0	1.6	1.2	3.0



	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb
AWS10m	0.18	0.82	1.03	1.40	1.53	1.27	1.20	1.03	0.40	0.11	0.11	0.40
AWS30m	1.82	2.52	1.07	2.28	1.72	1.46	1.88	1.35	0.48	0.56	0.55	0.57
AWS50m	2.05	2.84	1.41	2.68	2.09	1.74	2.21	2.27	0.78	0.80	0.75	0.82



	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
AWS10m	3.90	2.47	2.34	2.70	2.17	2.13	1.86	1.65	1.37	3.30	3.80	3.84
AWS30m	4.90	3.04	2.91	3.25	2.52	2.52	2.25	1.99	2.80	4.12	4.84	4.86
AWS50m	5.50	3.43	3.28	3.63	2.81	2.81	2.52	2.24	2.98	4.63	5.45	5.45

Table-1: Annual Average Wind Speed at 50 m Height

Site Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
NizamPur	1.60	2.89	1.53	0.46	0.94	1.58	-	-	2.46	2.19	1.73	2.06	1.74
Warsak	3.9	4.4	2.3	2.0	2.0	2.5	-	1.35	2.0	1.6	1.2	3.0	2.40
Ramatkore	0.75	0.82	2.05	2.84	1.41	2.68	2.09	1.74	2.21	2.27	0.78	0.80	1.70
Lorramiana	5.45	5.45	5.50	3.43	3.28	3.63	2.81	2.81	2.52	2.24	2.98	4.63	3.73

Power Density (W/m2)

The monthly power densities for Nizampur, Warsak, Ramatkore and Lorramiana at 50 meter height with annual average is given below in Table-3

Table-2: Wind Power Density at 50 m Height

Site Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	P/A (w/m2)
NizamPur	9.0	42.1	18.6	8.7	13.1	2.1	-	-	20.3	12.6	8.2	14.4	14.90
Warsak	137.8	228.4	64.46	21.99	49.95	-	88.00	13.54	20.07	8.86	8.03	106.0	67.94
Ramatkore	1.2	0.5	14.5	26.5	13.3	29.5	34.2	17.6	18.1	14.2	1.4	1.3	14.40
Lorramiana	101.4	263.2	75.0	77.2	63.6	136.1	21.1	29.5	24.4	19.5	3.9	162.1	81.40

Results

Keeping in view limited record of measured data set, complex topography of the area and virtually high degree of variation in wind resource, generation of wind resource maps is not attempted for comparision with NREL's projections. Rather annual average wind speed and power density data is listed in tabular format for comparison purpose.

Conclusion

According to above mentioned calculations of Wind Speed and Wind Power Density, these four sites are categorized as a below marginal site for wind power generation. As such these sites and surrounding areas can be classified as un-suitable sites for installing large economically viable wind farms. The wind resource assessment at the site level is required to provide not only information on the mean wind field and distribution, but also on the extreme conditions at the relevant time resolutions and scales. It is, therefore, recommended that before planning any large scale farm in these areas, micro-siting analysis must be completed for promising economic benefits. **Further keeping in view growing energy demands, it is advocated that maximum area of Gharo Wind Corridor may be acquired on priority for developing wind energy farms to exploit maximum wind power generation potential of the region.**

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