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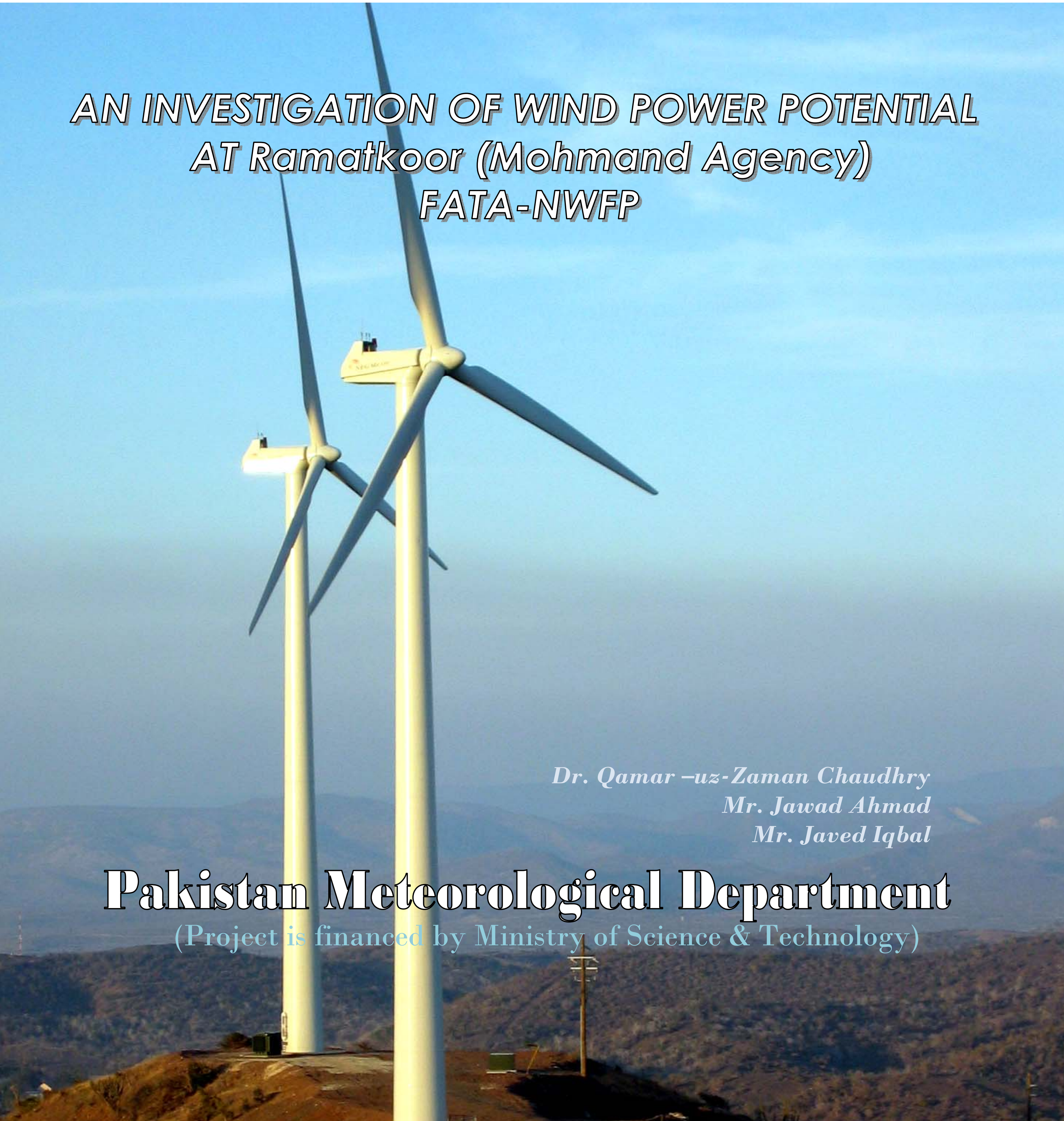
(Preliminary report based on 12 months data)
March 2007-Feburary 2008

AN INVESTIGATION OF WIND POWER POTENTIAL AT Ramatkoor (Mohmand Agency) FATA-NWFP



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(Project is financed by Ministry of Science & Technology)

Executive Summary

Pakistan Meteorological Department (PMD) conducted a wind power potential survey of the Northern Areas of Pakistan. Funding for this project was provided by the Ministry of Science & Technology. Under this wind data was collected at 42 sites along the Northern parts of the Country.

In this report the analysis based on one year wind data has been presented along with the wind generated electric power at Ramat Koor (FATA), NWFP. Wind data with one minute average speed and direction were collected at 10 meters and 30 meters height and 50 meters values were computed from models.

At 50 meters we have the annual average wind speed of 2.09 m/s during twelve months March-2007 to February–2008, the highest of 2.84m/s is observed in April-07. Seasonal Diurnal Wind variation indicates that maximum wind speed is available in the Night thought-out the year. Wind frequency distribution shows that during 10% of the time wind speed is 5 m/s or above.

Sometimes simply wind speed averages do not give the true picture of the wind power optional of an area. For the purpose it is common to assign areas to one of the seven wind classes based on “wind power density” of the area. Monthly and annual wind power density has been computed and added in the report. The annual power density of Ramat Koor – FATA is 14.37 w/m^2 according to international wind classification, this power density categorize Ramat Koor - FATA as a below marginal site for wind power generation. Monthly power density values indicates that the power density is blow marginal category.

Wind generated electric power has as also been computed on hypothetical 600Kw wind turbine and its hourly, monthly and annual values has been added in this report. The annual power production from a single 600kw wind turbine come out to 36,998 kWh which shows the capacity factor of 1% for Ramat Koor - FATA. Internationally it is accepted that if any site has a capacity factor of 25% and above then that site is suitable for installation of economically viable wind power farms. As such Ramat Koor - FATA and surrounding areas can be classified as no suitable site for installing big economically viable wind farms.

1. Introduction:

Wind energy is the fastest growing renewable energy source today. A continued interest in wind energy development worldwide 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. Site location, turbine performance and physical effects of turbulence and energy extraction represent a few of the issues that must be addressed by anyone interested in developing wind energy.

As such any plan to develop wind energy must begin by understanding the wind resource. Where are the best potential wind sites located? How much energy could be extracted from the wind at those sites?

1.1 Characteristic of wind:

The global winds are caused by pressure differential across the earth's surface. The amount of solar radiation absorbed at the earth's surface is greater at the equator than at the poles. This variation in incoming heat sets up convective cells in the lowest layer of the atmosphere. In the simplest form air rises at the equator and sinks at the poles. However the rotation of the earth complicates this simple heat transfer. A series of circulations are set up in both northern and southern hemispheres.

The areas of the globe where air is descending are zones of high pressure and where the air is ascending, low-pressure zones are formed. The pressure gradient drives the flow of air from high to low pressure, thus causing the wind. The wind is then acted on the corriolis force due to the earth's rotation. The resultant wind is turned easterly or westerly. On a smaller scale, wind is created because of temperature difference between land and sea and mountains and valleys. The local topographical features and roughness of the terrain also cause air movements.

2.0 Wind Mapping Project of Pakistan Meteorological Department:

As any plan to develop wind energy must begin by understanding the wind resources. Where are the best potential wind sites located? How much energy could be extracted from the wind at those sites? Will the wind turbine performance be affected by the turbulence or other wind resource characteristics?

To answer these questions and to provide wind resource database for the different potential parts of the country, Pakistan Meteorological Department prepared a phased programme. Government of Pakistan, Ministry of Science and Technology provided the necessary funding for undertaking the Phase II. Second phase covers the Northern areas of Pakistan.

2.1 Study Area:

The project area for the wind mapping Phase-II covers the Northern areas of Pakistan including Districts are Swat, Dir, Chitral, Gilgit, Skardu, Haripur, Shangla, Buneer, Nowshara, Peshawar, Mohmad Agency, Khyber Agency and Azad Kashmir.

Forty-Two stations for collecting wind data have been installed to study the wind regime as shown in Map-1. The list of stations is given below:

Ramatkoor, Bahrain, Kalam, Khawazakhaila, Malamjabba, Tahash, Khungipayan, Dir, Tarbella, Nizampur, Warsak, Chitral City, Drosh, Mirkhani, Shagore, Garam Chasma, Khagozi, Reshan, Mastuj, Kalash, Ayune, Astore, Bunji, Chillas, Gilgit, Gupis, Sost, Passu, Aliabad, Shigar, Barapayan, Sermik, Lowaramaina, Ramatkore, ShahidaSir, Danakool, Besham, Moorti Pahari, Rangla, Pedar, Lempiapatian, Dargaye.

Ramatkoor is situated in Mohmand Agency-FATA. Latitude & Longitude of Ramatkoor is: **Lat = 34.35°, Long = 71.07°.**

2.2 Data source:

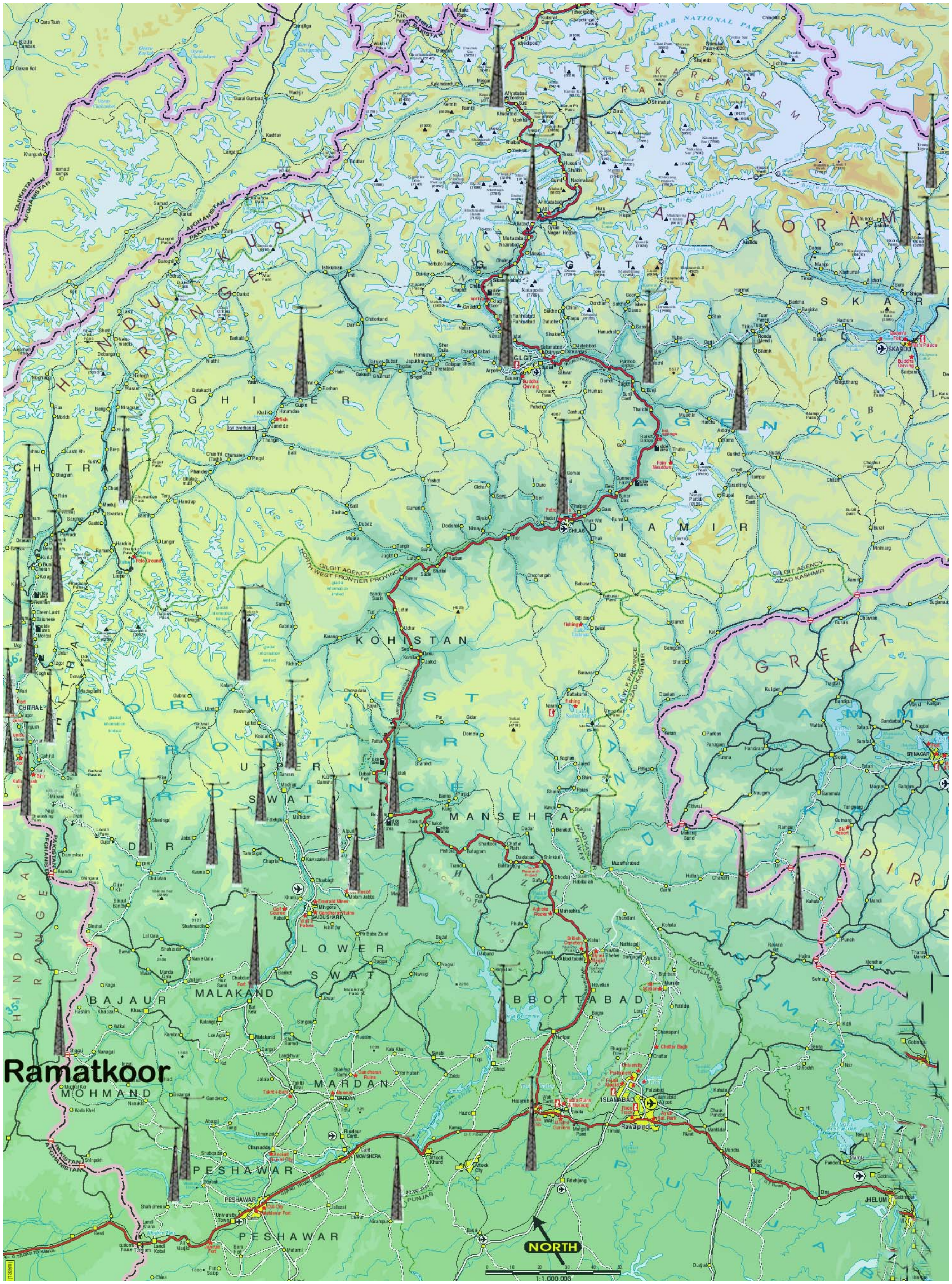
To undertake this study 30-meter high towers are erected at the locations mentioned above. On each of these high towers two wind speed anemometers are installed at the height of 10 meters and 30 meters, respectively; wind vane for recording wind direction is installed at 30 meters height. Temperature sensors are also installed at 10 meters height. Automatic data loggers developed locally have been installed to record data at each site. These data loggers are recording, one-minute average wind speed at both level, five-minute average wind direction, five-minute average temperature 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 one minute average at 10 & 30 meters
ii. Maximum wind speeds during 10 minutes
iii. Minimum wind speeds during 10 minutes
iv. Wind direction five minutes average at 30 meters
v. Temperature 5 minutes average in °C

Every month a team of observers and Maintenance Engineers visit site to inspect the instruments and to download the data on a laptop. Finally, the data is compiled and analyzed at Renewable Energy Research Cell established at Meteorological Department Islamabad.



Map-1: Shows 42-Towers Installed in Wind Mapping Project in Northern Areas

3.0 Methodology; Analysis & Discussion:

3.1 Wind speed variation with height:

Wind speed tends to increase with height in most locations, a phenomenon known as wind shear. The degree of wind shear depends mainly upon on two factors, atmospheric mixing and the roughness of the terrain.

Atmospheric mixing typically follows a daily cycle driven by solar heating. At the hub height of a wind turbine, this cycle often causes wind speeds to increase in the daytime and decrease at night. However, the range of variation between night and day typically diminishes as hub height increases. At a height of approximately 50 meters, it weakens or may even disappear in some cases.

Terrain roughness also affects wind shear by determining how much the wind is slowed near the ground. In areas with a high degree of roughness, such as forests or cities, near- surface wind speeds tend to be low and wind shear high, whereas the converse is true in areas of low roughness such as flat, open fields. Wind shear may be greatly reduced or eliminated where there is an abrupt change in terrain height such as a sea cliff or mountain ridge.

To save money wind measurements sometimes are taken at a lower height than the wind turbine tower. In that case, it is essential to measure wind shear at different times of day in different seasons to accurately predict the performance of a wind power plant. The shear can be measured by monitoring wind speeds at two or three heights on a tower. Since wind turbines produce much more power in stronger winds, wind turbine designers try to put turbines on the tallest possible towers. At some point, however, the increased cost of towers outweighs the benefits. With current wind turbine technology, the optimum tower height for large wind machines appears to be approximately 40 to 50 meters.

For calculating the wind speed at 50 meters the following two methods has been used in this study.

3.1.1 *Log Law:*

The turbulent mixing in the atmosphere may be considered in a similar way to molecular mixing (this is called k theory). Assuming the mixing is dominated by mechanical mixing due to shear forces a relationship of wind speed with height is derived.

$$u = \frac{u_*}{k} \ln\left(\frac{z - D}{z_o}\right)$$

Where

u_* is the friction notify

k is the von Karman constant

Z_o is the roughness length

D is the displacement height

The von Karman constant is generally taken as 0.4. The roughness length Z_o is related to the vegetation cover of the area. The values of roughness length are given in Table-1. The displacement height D is the height above the roughness elements where the flow is free. For most vegetation it is small and is generally treated as zero. For large roughness elements like trees and building in towns it is not negligible and is the order of the average height of the elements. The **log law** may only be used for heights above D. Turbines are rarely sited in forests or towns, so D is usually taken as zero.

The wind speed at any height z can then be computed provided that the wind speed at a height Z_R is known. Thus:

$$\frac{u}{u_R} = \frac{\ln\left(z / z_o \right)}{\ln\left(z_R / z_o \right)}$$

Where

U_R is the wind speed at reference height Z_R

The reference height is usually 10m or 30m as this is the height at which mean wind data is generally collected.

3.1.2 *Power Law:*

Engineers often prefer to use a Power Law to describe the increase in wind speed with height, as it is easier to evaluate.

$$\frac{u}{u_R} = \left(\frac{z - D}{z_R} \right)^{\alpha}$$

Where:

α is the power law exponent

u_R is the wind speed at reference height z_R

The power law exponent typically varies between 0.1 and 0.32 depending upon the landscape type. A value of 1/7 is often quoted as a reasonable value for the power law exponent in countryside. The exponent can be calculated from the roughness length.

$$\alpha = \frac{\ln\left(\ln\left(z / z_o \right) \Big/ \ln\left(z_R / z_o \right) \right)}{\ln\left(z / z_R \right)} \approx \frac{1}{\ln \sqrt{\dfrac{z \cdot z_R}{z_o}}}$$

Where: Z is the measurement height

Z_R is the reference height

Z_0 is the roughness length

The power law exponent therefore varies with the interval between the two measurement heights. The power law should be carefully employed since it is not a physical representation of the surface layer and does not describe the flow nearest to the ground very well. Both the log law and the power law are simplified expressions of the wind profile. They are valid in flat homogeneous terrain. So they do not include the effects of topography, obstacles or changes in roughness or stability.

Table 1: Typical values of surface roughness length Z_O and power law exponent α for various types of terrain

Type of terrain	**Z_0**	**α**
Mud Flats, Ice	10^{-5} to 3x 10^{-5}	
Calm Sea	$2x10^{-4}$ to $3x10^{-4}$	
Sand	$2x10^{-4}$ to 10^{-3}	0.01
Mown Grass	0.001 to 0.01	
Low Grass	0.01 to 0.04	0.13
Fallow Field	0.02 to 0.03	
High Grass	0.04 to 0.1	0.19
Forest and Woodland	0.1 to 1	
Built up area, Suburb	1 to 2	0.32
City	1 to 4	

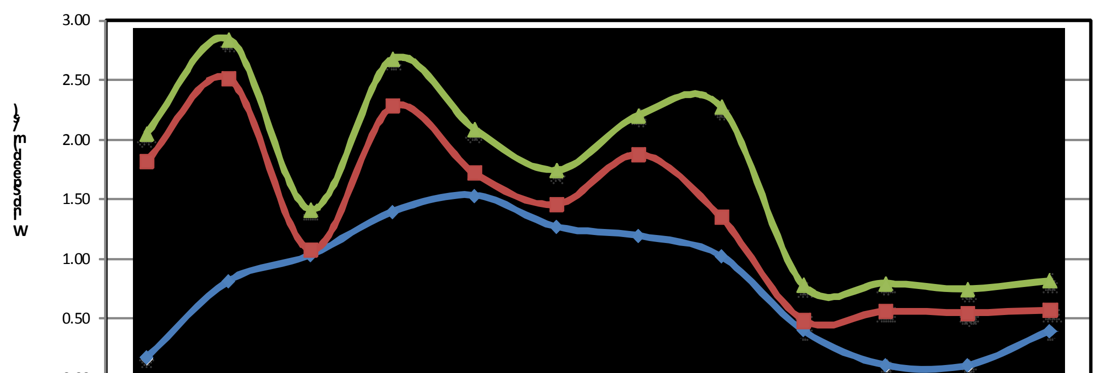
3.2 **Average Wind Speed:**

By using above mentioned methods the wind speed at 50 meters has been computed and monthly average of these wind speed at 50 meters height have been given in Fig 2 in graphical as well as tabular form.

Fig-1 shows monthly average wind speed at height of 10 meters, 30 meters and 50 meters. At 30 meters height, we have the annual average wind speed of 1.35 m/s from January to December where as maximum average wind speed of 2.52 m/s at this height is during April. At 50 meters we have the annual average wind speed of 1.70 m/s from January to December.

Fig-1

Monthly Average Wind Speed at Ramatkoor (m/s)



	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb
AWS 10m	0.18	0.82	1.03	1.40	1.53	1.27	1.20	1.03	0.40	0.11	0.11	0.40
AWS 30m	1.82	2.52	1.07	2.28	1.72	1.46	1.88	1.35	0.48	0.56	0.55	0.57
AWS 50m	2.05	2.84	1.41	2.68	2.09	1.74	2.21	2.27	0.78	0.80	0.75	0.82

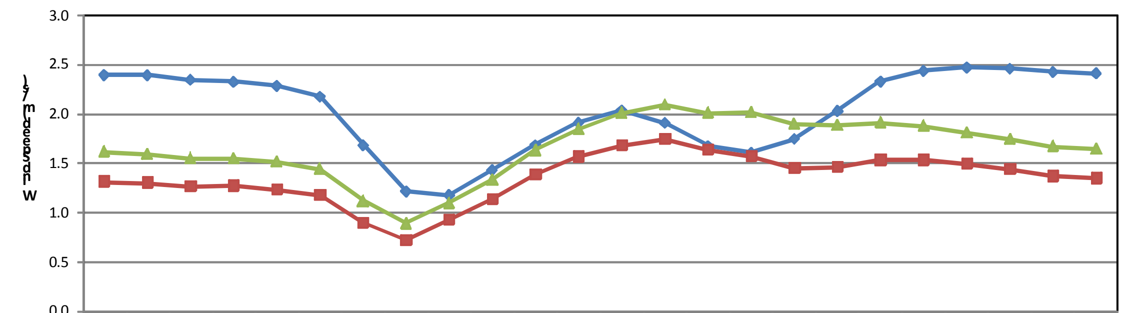
Months

3.3 Diurnal Wind speed Variation:

Fig-2 shows the diurnal wind speed variations at Ramatkoor - FATA for 1 year (Jan-Dec). The wind speed is generally lower during Morning and after 8:00 a.m. it starts picking up and reaches maximum around 2 p.m. which is around 1.75 m/s and 2.09 m/s at 30 meters and 50 meters height respectively. Figure-2 shows that the maximum wind speed during night times at 50 meters height reaches to 1.91 m/s at 9 p.m.

Fig-2

Diurnal Variation Wind Speed at Ramatkoor
March-07 to Feburary-08



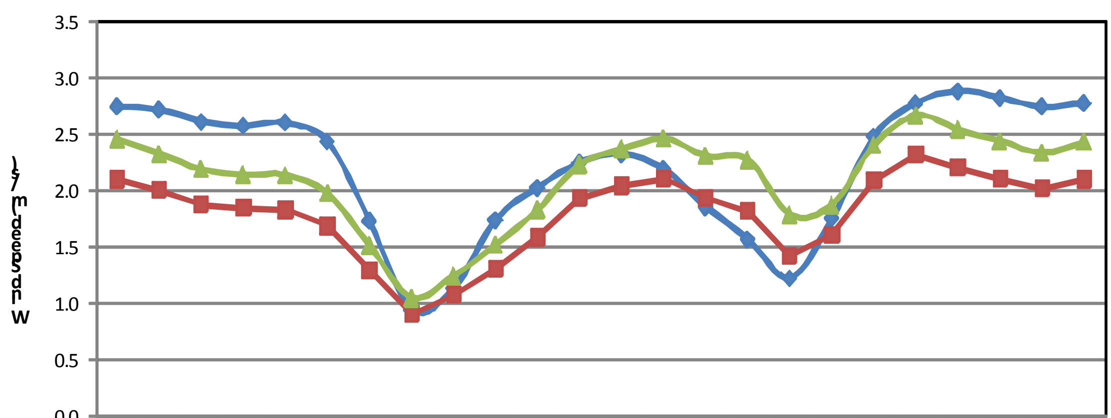
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
WS 10m	2.40	2.39	2.35	2.33	2.29	2.18	1.68	1.22	1.18	1.43	1.69	1.91	2.04	1.91	1.68	1.61	1.75	2.03	2.33	2.44	2.47	2.46	2.43	2.41
WS 30m	1.32	1.30	1.27	1.27	1.24	1.18	0.90	0.72	0.92	1.14	1.39	1.57	1.68	1.75	1.64	1.58	1.45	1.46	1.54	1.54	1.50	1.44	1.37	1.35
WS 50m	1.62	1.59	1.55	1.55	1.52	1.44	1.12	0.89	1.10	1.33	1.63	1.85	2.01	2.09	2.01	2.01	1.90	1.88	1.91	1.88	1.81	1.74	1.67	1.64

PST (Hours)

Fig-3 and Fig-4 shows the diurnal wind speed variations at Ramatkoor – FATA for first and second quarter of the year (March-May) and (June-August) respectively. The wind speed is generally stronger during evening and night time for March-May, but the wind speed is generally lower forenoon time (5-9 am). After sunset the wind starts picking up and reaches maximum around midnight.

Fig-3

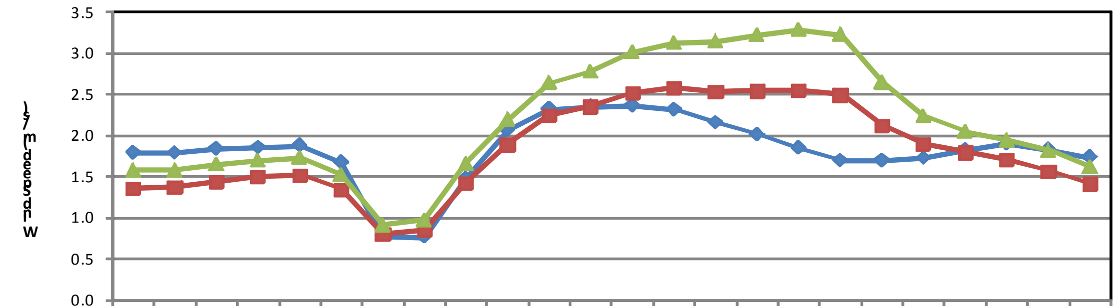
Diurnal Variation Wind Speed at Ramatkoor (March to May)



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
WS10m	2.7	2.7	2.6	2.6	2.6	2.4	1.7	0.9	1.1	1.7	2.0	2.3	2.3	2.2	1.9	1.6	1.2	1.8	2.5	2.8	2.9	2.8	2.7	2.8
WS30m	2.1	2.0	1.9	1.9	1.8	1.7	1.3	0.9	1.1	1.3	1.6	1.9	2.0	2.1	1.9	1.8	1.4	1.6	2.1	2.3	2.2	2.1	2.0	2.1
WS50m	2.5	2.3	2.2	2.1	2.1	2.0	1.5	1.0	1.2	1.5	1.8	2.2	2.4	2.5	2.3	2.3	1.8	1.9	2.4	2.7	2.5	2.4	2.3	2.4

PST (Hours)

Fig-4 **Diurnal Variation Wind Speed at Ramatkoor (Jun to Aug)**

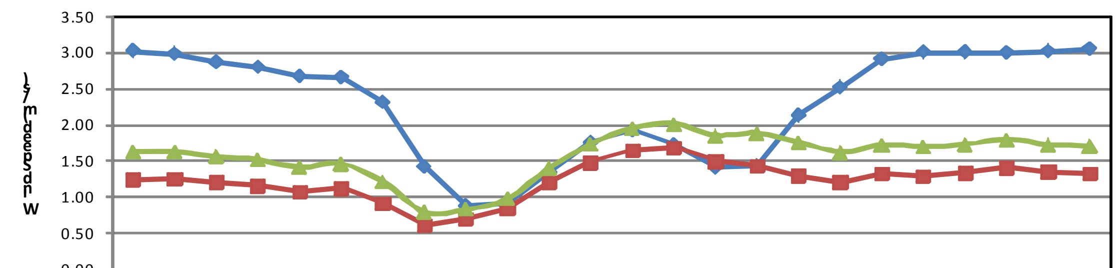


PST (Hours)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
WS10m	1.8	1.8	1.8	1.9	1.9	1.7	0.8	0.8	1.5	2.1	2.3	2.4	2.4	2.3	2.2	2.0	1.8	1.7	1.7	1.7	1.8	1.9	1.8	1.7
WS30m	1.4	1.4	1.4	1.5	1.5	1.3	0.8	0.8	1.4	1.9	2.2	2.3	2.5	2.6	2.5	2.5	2.5	2.5	2.1	1.9	1.8	1.7	1.6	1.4
WS50m	1.6	1.6	1.6	1.7	1.7	1.5	0.9	1.0	1.7	2.2	2.6	2.8	3.0	3.1	3.1	3.2	3.3	3.2	2.6	2.2	2.0	1.9	1.8	1.6

PST (Hours)

Fig-5 and Fig-6 shows the diurnal wind speed variations at Ramatkoor for third and fourth quarter of the year (Sept-Nov) and (Dec-Feb) respectively.

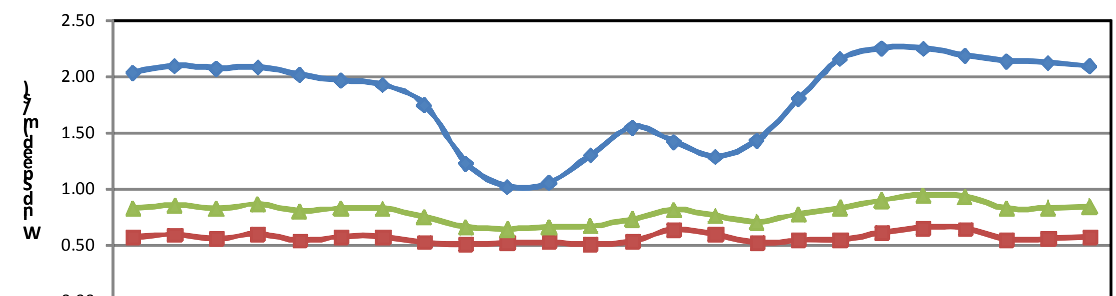
Fig-5 **Diurnal Variation Wind Speed at Ramatkoor (Sep to Nov)**



PST (Hours)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
WS10m	3.0	2.9	2.8	2.8	2.6	2.6	2.3	1.4	0.8	0.9	1.3	1.7	1.9	1.7	1.4	1.4	2.1	2.5	2.9	3.0	3.0	3.0	3.0	3.0
WS30m	1.2	1.2	1.2	1.1	1.0	1.1	0.9	0.6	0.7	0.8	1.2	1.4	1.6	1.6	1.5	1.4	1.3	1.2	1.3	1.2	1.3	1.4	1.3	1.3
WS50m	1.6	1.6	1.5	1.5	1.4	1.4	1.2	0.7	0.8	0.9	1.4	1.7	1.9	2.0	1.8	1.8	1.7	1.6	1.7	1.6	1.7	1.7	1.7	1.7

PST (Hours)

Fig-6 **Diurnal Variation Wind Speed at Ramatkoor (Dec to Feb)**



PST (Hours)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
WS10m	2.0	2.0	2.0	2.0	2.0	1.9	1.9	1.7	1.2	1.0	1.0	1.3	1.5	1.4	1.2	1.4	1.8	2.1	2.2	2.2	2.1	2.1	2.1	2.0
WS30m	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.5	0.5	0.5
WS50m	0.8	0.8	0.8	0.8	0.7	0.8	0.8	0.7	0.6	0.6	0.6	0.6	0.7	0.8	0.7	0.7	0.7	0.8	0.8	0.9	0.9	0.8	0.8	0.8

PST (Hours)

3.4 Wind speed Frequency Distribution:

Wind speed frequency distribution can simply be obtained by plotting the different wind speeds against their frequencies / relative frequencies. For obtaining frequency distribution the following two procedures are necessary.

3.4.1 *Binning of Data:*

The sorting of the data into narrow wind speed bands is called binning of the data. In our case a bin width of 1m/sec has been used e.g. a measured wind speed of 3.5 m/sec would be placed in 3<X<=4 m/sec bin. The central value of each bin i.e. 0.5 m/sec, 1.5 m/sec etc has been used in calculations and frequency distribution group.

3.4.2 *Relative Frequency:*

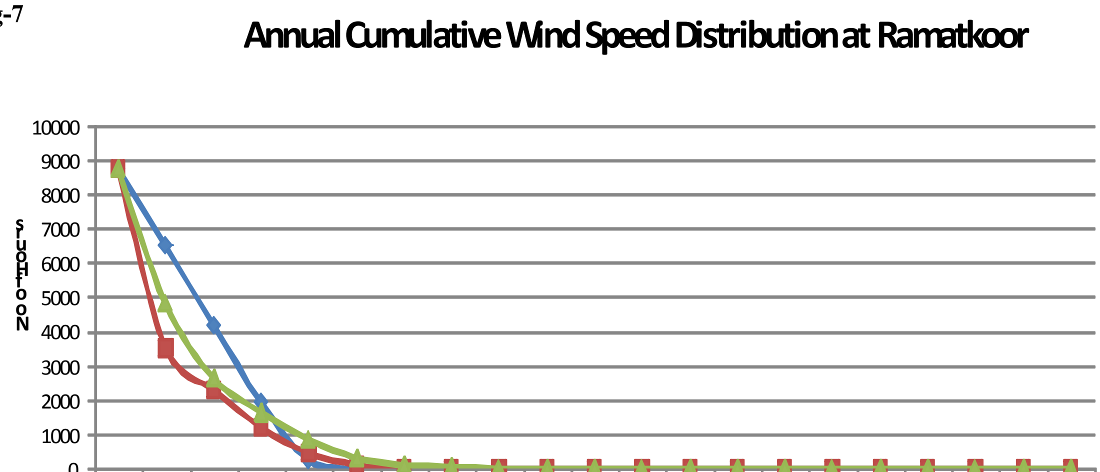
It is proportional wind speed in each bin. It can be viewed as the estimate of probability of given wind speed in the bin. Relative frequency is defined as

R .F = probability P (V_i) = Frequency of given wind speed / Total period

3.4.3 *Annual Cumulative Wind Frequency:*

Fig-7 shows the annual (March-07 to Feb-08) Cumulative Wind Frequency distribution at three heights 10, 30 and 50 meters. The analysis indicate that in a year at a height of 10 meters during 1945 hours the wind speed is 4m/s, at 30 meters during 1222 hours the wind speed is 4 m/s. Whereas at 50 meters, in a year during 1642 hours the wind speed is equal or greater than 4m/s.

Fig-7



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
CWS10m	8771	6549	4214	1945	245	6	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CWS30m	8771	3532	2316	1222	449	96	20	4	1	1	0	0	0	0	0	0	0	0	0	0	0
CWS50m	8771	4851	2659	1642	850	308	117	43	14	4	1	1	0	0	0	0	0	0	0	0	0

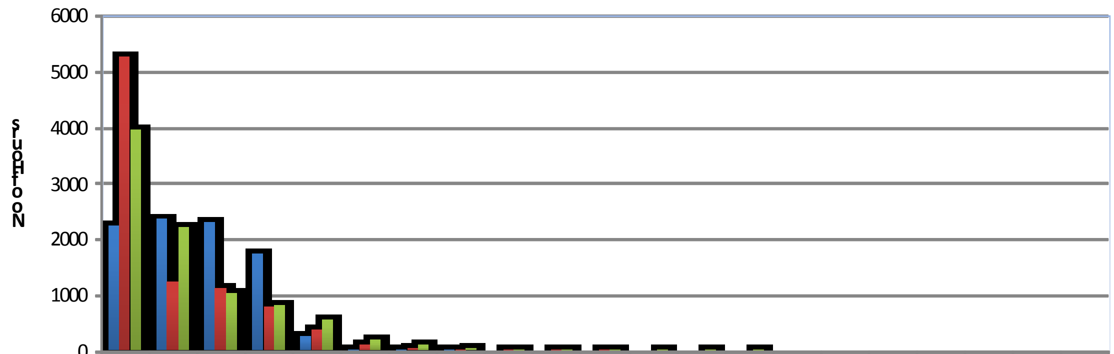
Wind Speed (m/s)

3.4.4 *Wind Frequency Distribution:*

Fig-8 shows the frequency distribution. We can see that at 50 meters during 541 hours wind speed is 5 m/s, 792 hours speed is 4 m/s, 1017 hours speed is 3 m/s, 192 hours speed is 6 m/s and during 74 hours the wind speed is 7m/s and so on. This indicates wind potential in this area.

Fig-8

Annual Wind Frequency Distribution at Ramatkoor



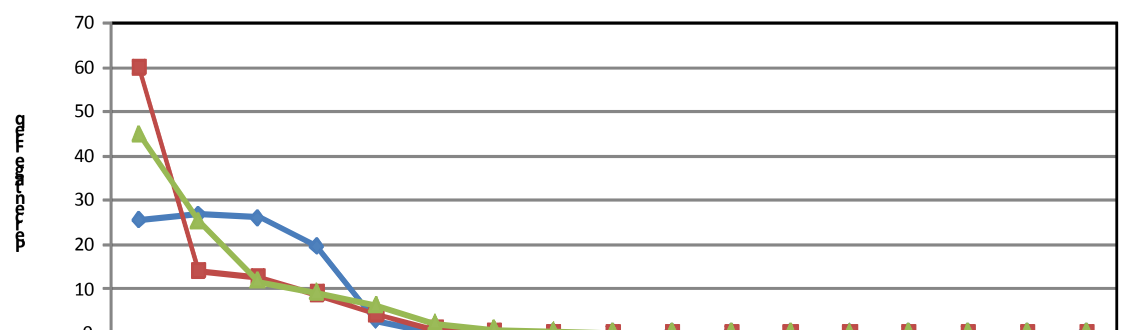
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
CWS 10m	2222	2335	2269	1700	239	4	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CWS 30m	5240	1216	1094	773	353	76	16	3	1	0	0	0	0	0	0	0	0	0	0	0	0
CWS 50m	3920	2193	1017	792	541	192	74	29	10	3	1	1	0	0	0	0	0	0	0	0	0

Wind Speed (m/s)

Fig-9 gives this frequency distribution in percentage. At 50 meters we find that during 6.2% of time wind is 5m/s, 2.2% of the time 6m/s and 0.8% of the time it is 7m/s. whereas at 30 meters height we get 4% of the time wind speed 5m/s, 0.9% of the times 6m/s and 0.2% of the time 7m/s.

Fig-9

Annual Percenatge Wind Frequency Distribution at Ramatkoor



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
WS 10m	25.3	26.6	25.8	19.4	2.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WS 30m	59.7	13.9	12.5	8.8	4.0	0.9	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WS 50m	44.6	25.0	11.6	9.1	6.2	2.2	0.8	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Wind Speed (m/s)

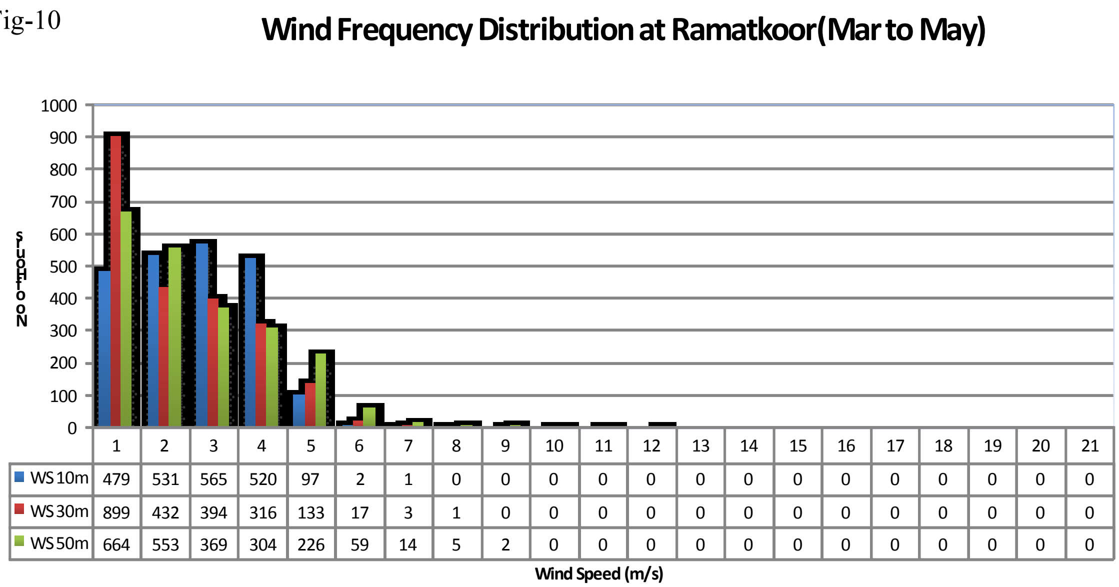
3.4.5 *Seasonal Wind Frequency Distribution:*

Figures 10–17 gives seasonal wind frequency distribution and percentage wind frequency distribution.

<u>(March – May)</u>

Fig-10 shows this distribution during the months of March to May. We can see that in this period at 30 meters and 50 meters height during 133 hours and 226 hours we get 5m/s respectively.

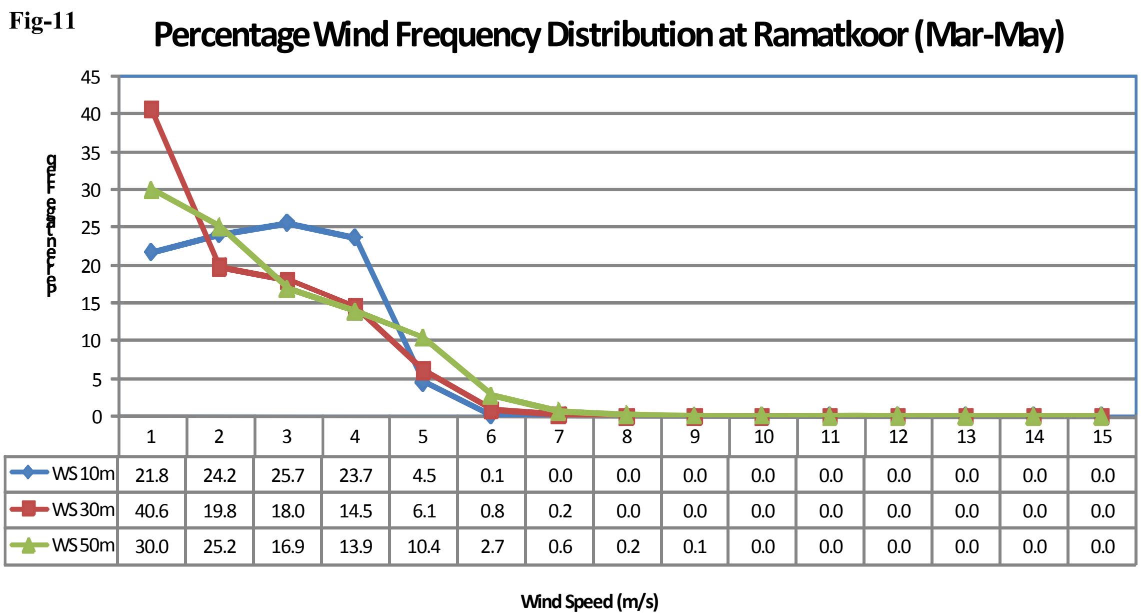
Fig-10



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
WS 10m	479	531	565	520	97	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WS 30m	899	432	394	316	133	17	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0
WS 50m	664	553	369	304	226	59	14	5	2	0	0	0	0	0	0	0	0	0	0	0	0

Similarly in Fig-11 at 50 meters we get 10.4% of wind equal to 5m/s, 2.7% of wind equal to 6 m/s and at 30 meter 6.1% wind equal to 5m/s, 0.8% wind equal to 6 m/s respectively.

Fig-11



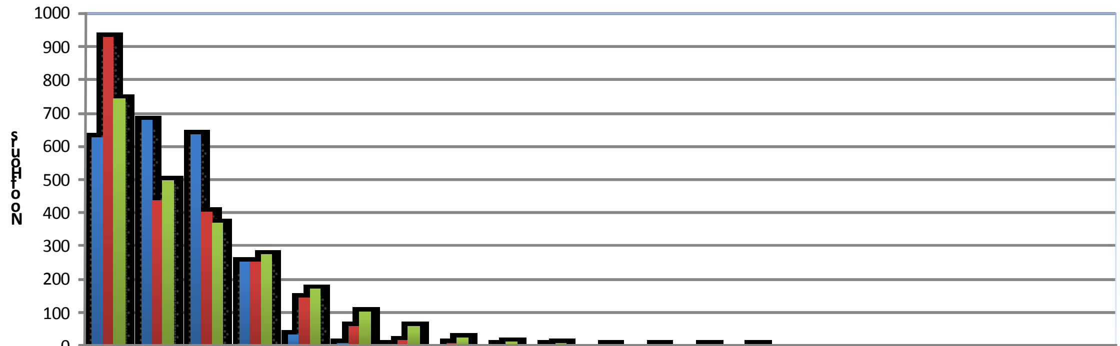
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
WS 10m	21.8	24.2	25.7	23.7	4.5	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WS 30m	40.6	19.8	18.0	14.5	6.1	0.8	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WS 50m	30.0	25.2	16.9	13.9	10.4	2.7	0.6	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0

<u>(June – August)</u>

Fig-12 shows wind frequency distribution during the months of June to August. We can see that in this period at 30 meters height during 139 hours we get 5m/s, similarly at 50 meters height during 165 hours we get wind speed of 5m/s.

Fig-12

Wind Frequency Distribution at Ramatkoor(Jun to Aug)



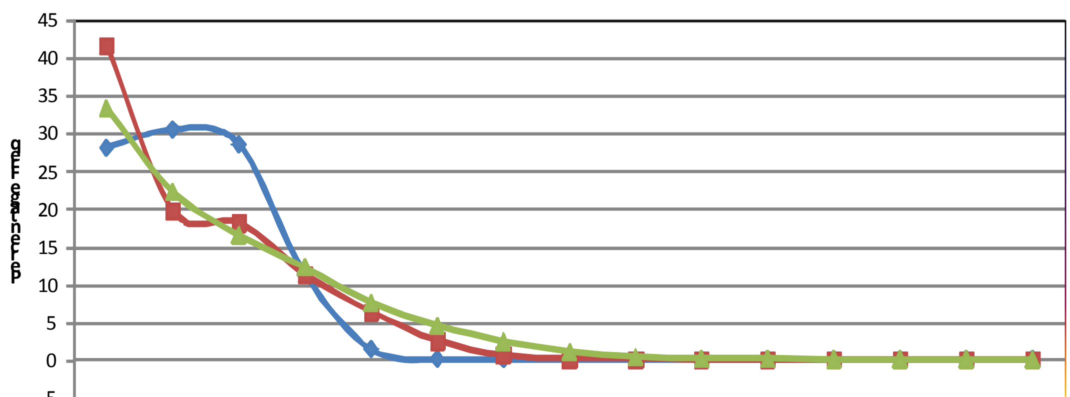
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
WS 10m	621	675	631	249	30	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WS 30m	923	433	398	247	139	54	12	2	1	0	0	0	0	0	0	0	0	0	0	0	0
WS 50m	739	491	362	268	165	97	53	22	8	2	0	0	0	0	0	0	0	0	0	0	0

Wind Speed (m/s)

Fig-13 shows percentage distribution of wind frequency during the months of June to August. It shows that 6.3% and 7.5% we get wind speed of 5m/s at 30m and 50m respectively.

Fig-13

Percentage Wind Frequency Distribution at Ramatkoor (Jun-Aug)



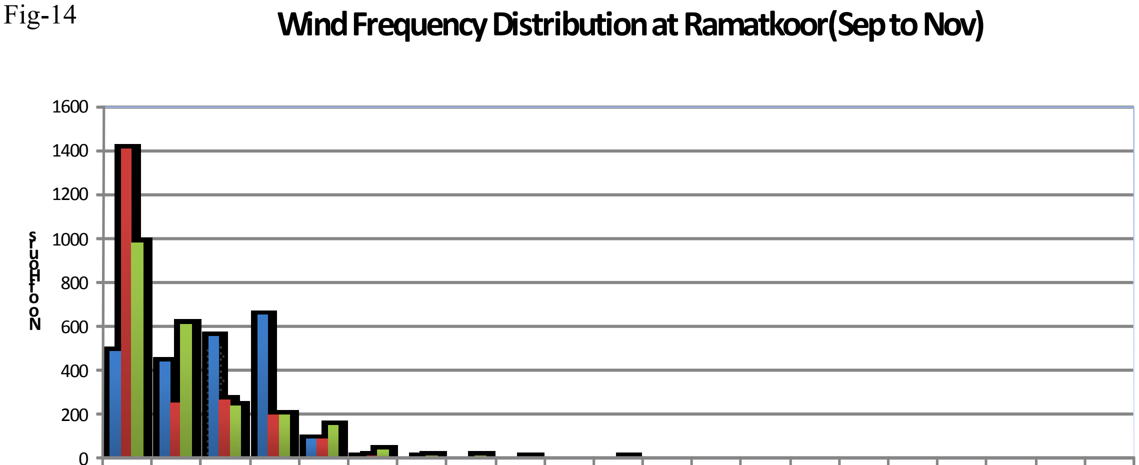
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
WS 10m	28.1	30.6	28.5	11.3	1.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WS 30m	41.6	19.7	18.1	11.2	6.3	2.4	0.5	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WS 50m	33.3	22.3	16.5	12.2	7.5	4.4	2.4	1.0	0.3	0.1	0.0	0.0	0.0	0.0	0.0

Wind Speed (m/s)

<u>(Sep – Nov)</u>

Fig-14 shows wind frequency distribution during the months of Sept to Nov. We can see that in this period at 30 meters height during 79 hours we get 5m/s, similarly at 50 meters height during 143 hours we get wind speed of 5m/s.

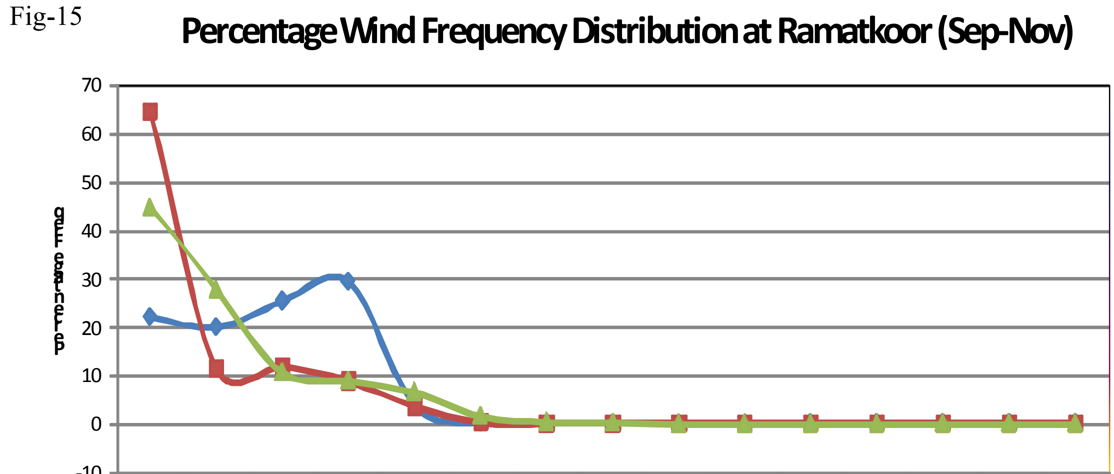
Fig-14



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
WS 10m	477	432	551	642	82	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WS 30m	1404	246	257	192	79	5	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WS 50m	974	602	229	192	143	35	8	2	0	0	0	0	0	0	0	0	0	0	0	0	0

Fig-15 shows percentage distribution of wind frequency during the months of Sep to Nov. It shows that3.6 % and 6.4% we get wind speed of 5m/s at 30m and 50m respectively.

Fig-15

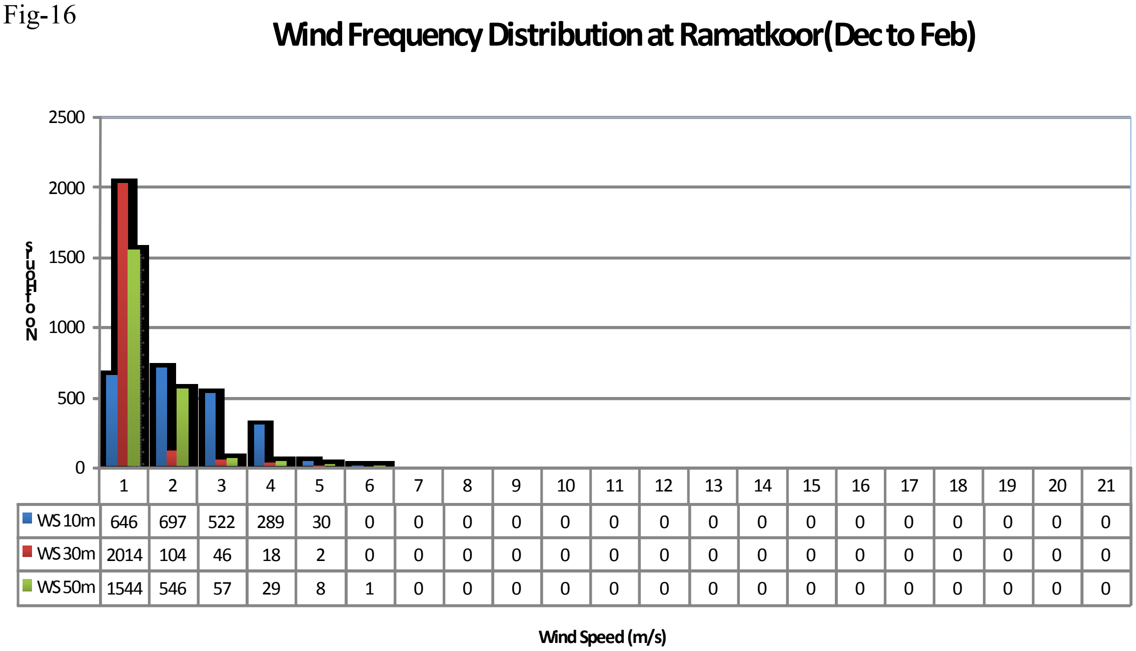


	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
WS 10m	21.9	19.8	25.2	29.3	3.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WS 30m	64.3	11.3	11.8	8.8	3.6	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WS 50m	44.6	27.5	10.5	8.8	6.5	1.6	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0

<u>(Dec – Feb)</u>

Fig-16 shows wind frequency distribution during the months of Dec to Feb. We can see that in this period at 30 meters height during 2 hours we get 5m/s, similarly at 50 meters height during 8 hours we get wind speed of 5m/s.

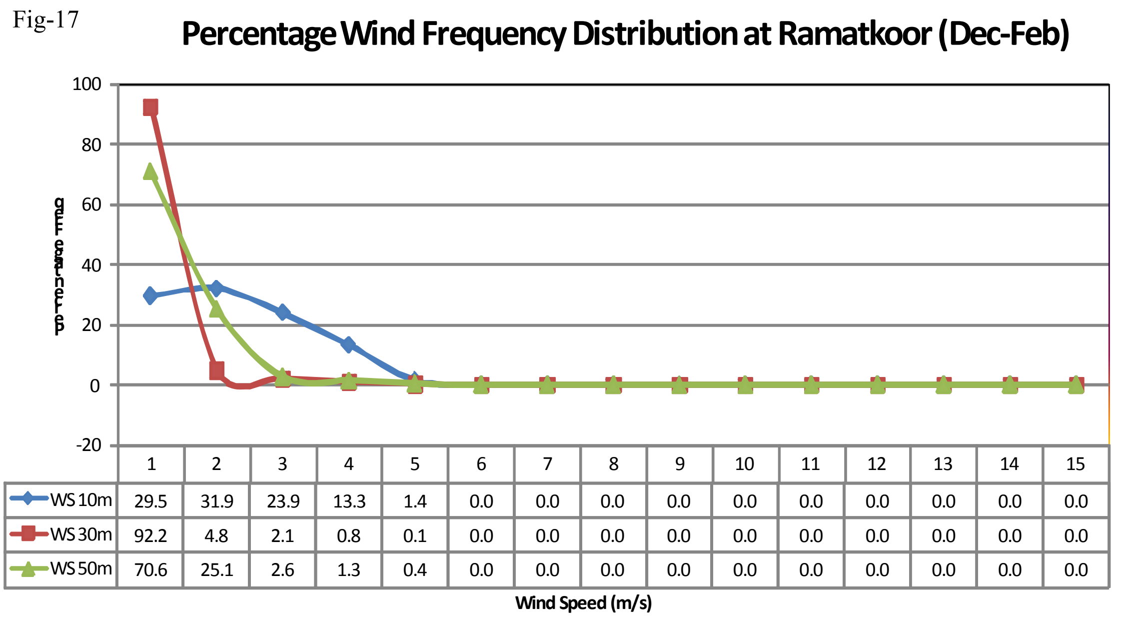
Fig-16



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
WS 10m	646	697	522	289	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WS 30m	2014	104	46	18	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WS 50m	1544	546	57	29	8	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Fig-17 shows percentage distribution of wind frequency during the months of Oct to Dec. It shows that 21.5% and 19.8% we get wind speed of 5m/s at 30m and 50m respectively.

Fig-17



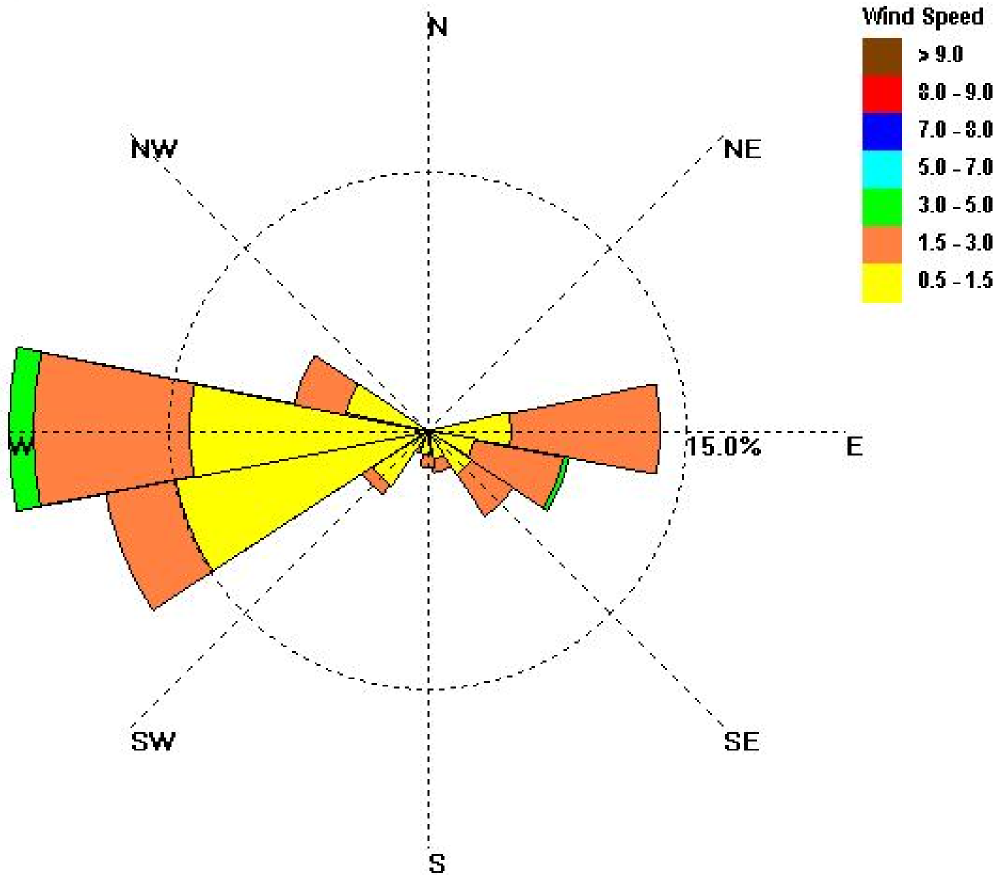
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
WS 10m	29.5	31.9	23.9	13.3	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WS 30m	92.2	4.8	2.1	0.8	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WS 50m	70.6	25.1	2.6	1.3	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

3.5 **Wind Rose:**

Fig-18 shows the Annual Wind Rose based on data from March – February collected at 30 meters height. Wind Rose indicates that most of the time the wind direction was West and South West. The annual average wind speed at 30 meter height is 1.35m/s and the percentage when wind speed greater than 2m/s is 1.736%.

Annual Wind Rose at Ramatkoor-FATA (30m height)

Fig-18 **(m/s)**



Average Wind Speed	Wind greater than 2 m/s
1.35 m/s	1.736%

3.6 Wind speed statistic:

3.6.1 *The statistical Mean:*

It is the average of a set of n numbers. Mathematically, we can write

$$Mean = \frac{\left[\sum_{i=1}^{n} x_i \right]}{N}$$

The Mean Wind Speed V can be calculated by the formula.

$$V = \sum_{i=1}^{n} V_i P(V_i)$$

Where Vi is the central wind speed of bin 1 and P(Vi) is the probability/relative frequency that the wind speed has in bin i.

3.6.2 *Variance:*

It is one of the several indices of variability that statistician, use to characterize the dispersion among the measures in a given set of data. Mathematically, variance is written as

$$\text{Variance} = \sigma^2 = \sum (X_i - V)^2$$

Where V is mean of data set

In case of wind speed data, we can write it, as

$$\sigma^2 = \sum V_i^2 P(Vi) - (V)^2$$

3.6.3 *Standard Deviation*

It is the square root of the variance, denoted by σ

$$\sigma^2 = (\sigma)^{1/2} = \sum \left(V_i^2 P(V_i) - (V)^2 \right)^{1/2}$$

3.7 Wind power density:

While investigating a wind power potential of an area, the average values of wind speed does not truly represent this potential because lot of information regarding frequency distribution of wind speed is suppressed in the process of averaging wind speed. As such the most important values for estimating the wind power potential of a given site is the value of the wind power density or the available theoretical instantaneous power from the wind. This available wind power in the wind is the flux of Kinetic Energy crossing the wind energy conversion system and its cross – sectional area.

Like water flowing in the river, wind contains energy that can be converted to electricity using wind turbines. The amount of electricity that wind turbines produce depends upon the amount of energy in the wind passing through the area swept by the wind turbines blades in a unit of time. This energy flow is referred to as the wind power density.

A key aspect of wind power density is its dependence on wind speed cubed. This means that the power contained in the wind increases very rapidly with wind speed; if the speed doubles, the power increases by a factor of eight. In practice, the relationship between the power output of a wind turbine and wind speed does not follow a cubic relationship. Below a certain minimum speed, the turbine does not have enough wind to operate, whereas above a certain speed its output levels off or begins to decline. In very high winds the turbine may even be shut down to prevent damage to it.

Wind power density also depends on air density. At higher attitudes, air density decreases and, as a result, so does the available power. This effect can reduce the power output of wind turbines on high mountains by as much as 40 percent compared to the power that could be produced at the same wind speeds at sea level. Air density depends inversely on temperature: colder temperatures are favorable for higher air densities and greater wind power production.

3.7.1 *Wind power classes:*

To simplify the characterization of the wind power potential, it is common to assign areas to one of seven wind classes, each representing arrange of wind power density at the special height above the ground. The standard International wind power classifications are shown in Table 2.

Table-2: International Wind Power Classification

Class	Resource Potential	30m Height		50m Height	
		Wind Speed m/s	Wind Power W/m²	Wind Speed m/s	Wind Power W/m²
1	---	0 – 5.1	0 – 160	0 – 5.6	0 – 200
2	Marginal	5.1 – 5.9	160 – 240	5.6 – 6.4	200 – 300
3	Moderate	5.9 – 6.5	240 – 320	6.4 – 7.0	300 – 400
4	Good	6.5 – 7.0	320 – 400	7.0 – 7.5	400 – 500
5	Excellent	7.0 – 7.4	400 – 480	7.5 – 8.0	500 – 600
6	---	7.4 – 8.2	480 – 640	8.0 – 8.8	600 – 800
7	---	8.2 – 11.0	640 – 1600	8.8 – 11.9	800 – 2000

By and large, the areas being developed today using large wind turbine are ranked as class 5 and above. Class 4 areas are also being considered for further development as wind turbines are adopted to run more efficiently a lower wind speeds. Class1 and class2 areas are not being deemed suitable for large machines, although a smaller wind turbine may be economical in areas where the value of the energy produced is higher

3.7.2 ***Power of wind Energy:***

A parcel of Wind possesses kinetic energy

$$E = \tfrac{1}{2} mV^2$$

From this, power density is calculated as

$$P = \tfrac{e}{t} = \tfrac{1}{2} \tfrac{dm}{dt} V^2$$

Where $\tfrac{dm}{dt}$ is the mass of air following time.

From fluid dynamics, it can be proved that

$$\tfrac{dm}{dt} = \varphi AV$$

Volume of cylindrical cross section can be written as

$$V = \pi r^2 L \qquad \text{---------------} \quad (1)$$

Where r is radius of cylinder and L is length of it.

The wind moving with velocity V travels this distance L in time t so

$$S = L = Vt,$$

So equation L takes the form

$$V = \pi r^2 Vt$$

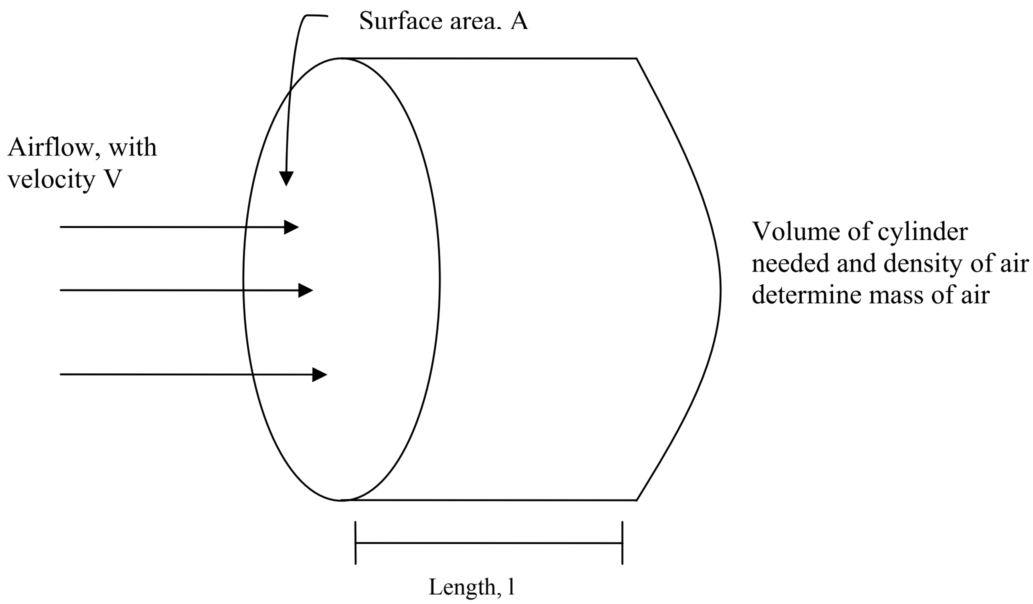
Now mass of wind can be written as

$$M = \varphi Avt$$

Differentiating

$$\tfrac{dm}{dt} = \varphi AV \tfrac{d}{dt(t)} = \varphi AV$$

Where φ is density of wind and others parameters have been defined in diagram.



So the power is then,

$$P = \tfrac{1}{2}\ \tfrac{dm}{dt}\ V^2 = \tfrac{1}{2}\varphi AVT/t\ V^2$$
$$= \tfrac{1}{2}\varphi AV^3$$

And power density

$$\tfrac{P}{A} = \tfrac{1}{2}\varphi V^{3}$$

Density of wind at mean sea level is 1.225 kg/m^3

At 15° C, The area depends upon the size of the rotor. Therefore, it is clear that power density chiefly depends on wind velocity and goes up as a cube of it.

3.7.3 ***Wind power calculation using Mean Wind Speed:***

Wind power calculated from Mean wind speed is not true representative of wind power. In real world, the wind varies constantly. Actual wind power density at most sites can rang from 1.0 to 3 times greater then that calculated. For example, we take wind speed of 5, 7 and 8 m/sec respectively the respective power densities are 76 wat/m^2, 210 $watt/m^2$ and 313 $watt/m^2$. The average of which is 200 $watt/m^2$. On the other hand, the average wind speed is 6.7 m/sec and power density of average wind is 181 $watt/m^2$. So the power of wind calculated by mean wind speed is less than the actual power present in wind i.e. Mean wind speed is not true representative for the wind power calculations.

To overcome this drawback we find some alternative arrangement, which reduces the deficit. The Weibull distribution is the best fit of wind data to calculate wind power based on mean wind speed and variance/standard deviation.

3.7.4 ***Weibull distribution:***

The Weibull distribution (named after the Swedish physicist W. Weibull, who applied it when studying material strength in tension and fatigue in the 1930s) provides a close approximation to the probability laws of many natural phenomenons. It has been used to represent wind speed distribution for application in wind loads studies for sometime. In recent years most attention has been forced on this method for wind frequency applications not only due to its greater flexible and simplicity but also because it can give a good fit to experimental data.

The Weibull distribution function, which is a two-parameter function, has been found to fit much wind data with acceptable accuracy is expressed mathematically as

$$\phi(u) = \frac{k}{c}\left(\frac{u}{c}\right)^{k-1} \exp\left(-\left(\frac{u}{c}\right)^{k}\right)$$

Where:

u is the wind speed

c is the scale parameter with units of speed

k is the shape parameter and is dimensionless

When k = 2 the distribution reduces to Rayleigh distribution and if k=1 an exponential distribution is found. These are special cased of Weibull distribution.

Solving the equation, we find that the scale factor c is closely related to the mean wind speed for the site.

$$\overline{u} = c\tau\left(1 + \frac{1}{K}\right)$$

Where τ is the complete gamma function

Similarly

$$\overline{u^{n}} = c^{n}\tau\left(1 + \frac{n}{k}\right)$$

And so

$$\overline{u^{3}} = c^{3}\tau\left(1 + \frac{3}{k}\right)$$

The available power density is obtained:

$$E = \frac{1}{2}\varphi c^{3}\tau\left(1 + \frac{3}{k}\right)$$

Where

E is the power density in watts / m^2

The shape factor k is related to the variance of the wind

$$\sigma^2 = c2\left[\left(1+\frac{2}{k}\right)-\left(\tau\left(1+\frac{1}{k}\right)\right)^2\right]$$

The two Weibull parameters k and c may be derived from site data.

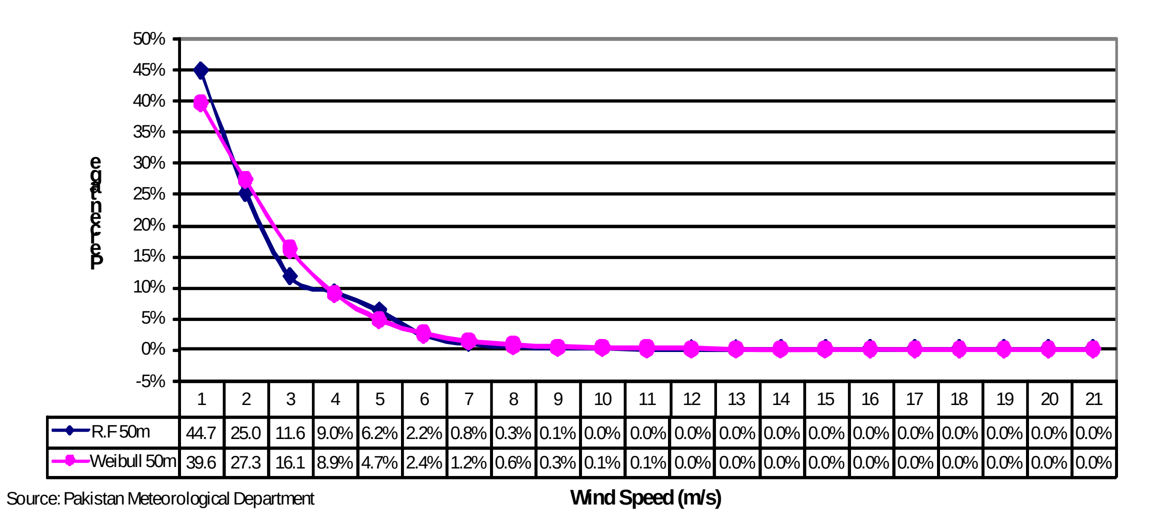
A measure of the confidence of the fit of the Weibull curve to the real data is also returned. Often the Weibull curve is a good fit to the most of the data, but a poor fit to some. If the poor fit is in the low wind speed range, i.e. below cut in it may be possible to ignore the poor fit as this portion of wind does not contribute greatly to the overall power production.

The mathematical description of the wind frequency allows us to match with the turbine power curve. Thus a measure of the average total power capture in a year is achieved. Additionally the choice of turbine cut in and furling speed may be chosen to maximum the total energy capture.

3.7.5 *Weibull Parameters:*

Fig-19 shows the Weibull fit to the relative frequency of wind speed.

Fig-19



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
R.F 50m	44.7	25.0	11.6	9.0%	6.2%	2.2%	0.8%	0.3%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Weibull 50m	39.6	27.3	16.1	8.9%	4.7%	2.4%	1.2%	0.6%	0.3%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

The Weibull parameters for three different heights 10 meters, 30 meters and 50 meters are given in **Table-3** along with other key results of analysis. If we look at the shape parameters K and scale parameter C for 50 meters height we can find that the shape parameter K varies over a wind range from the lowest of 1.08 during May to the highest of 2.01 during the month of April with an annual of K being 1.40.

The lowest values of the scale parameter C 0.71m/s observed in February while the highest value of 3.20 is obtained in April and with an annual value of 1.89 m/s.

3.7.6 *Average Wind Speed & Standard Deviation:*

In Table-3 monthly average wind speed and standard deviation at three different heights are also given. The average wind speed values for 10 meters and 30 meters height have been obtained from the recorded data, whereas the values for the 50 meters height have been computed by using the power law as explained in the earlier section.

At 10 meters height the annual average wind speed is 1.90 m/s with Standard deviation of 1.07, at 30 meters this average speed is 1.48 m/s with Standard deviation of 1.08.

At 50 meters the monthly average wind speed varies from the lowest of 0.63 m/s in February to highest of 2.89 m/s during April. Whereas the annual average wind speed is 1.68 m/s with Standard deviation of 1.23.

3.7.7 *Power Density:*

The monthly power densities for three different heights 10meters, 30meters and 50meters have also been given in Table-3. At 10 meters this power density varies between 1.47 W/m^2 in January to 17.51 W/m^2 in October with Average of 9.59 W/m^2.

At 30 meters height the power density varies from 0.45 W/m^2 in December to the highest of 18.87 W/m^2 in July and the average values is about 9.52 W/m^2.

At 50 meters height the power density of Ramatkoor varies from 0.55 W/m^2 in February to 34.23 W/m^2 in July. The average annual power density of the area is 14.37 W/m^2.

Table-3: Monthly Average Wind, St. Deviation and Wind Power Density at Ramatkoor - FATA

[redacted]

ESTIMATING WIND GENERATED ELECTRIC POWER OUTPUT

Appendix-I

Monthly Average Diurnal Variation of Wind Generated Electric Power Output.

Appendix-II

Hourly Wind Generated Electric Power Output

4.0 Estimating Wind Generated Electric Power Output

The average power output of wind energy conversion technologies (WECT) is a very important parameter since it determines the energy output over time thereby influencing the economic feasibility of a wind project. It is by far more useful than the rated power, which does not account for the variability of wind velocity thereby easily overestimating energy revenues. The average power of wind turbine, $\overline{P_{WT}}$, is the power produced at each wind speed multiplied by the fraction that wind speed is experienced, integrated over all possible wind speeds. In integral form this can be expressed as (Manwell et al., 2002; Borowy and Salameh, 1996):

$$\overline{P_{WT}} = \int_0^\infty P_{WT}(v)df(v)$$

This integral can be replaced with a summation over bins, N_B, to calculate the average wind turbine power (Manwell et al., 2002).

$$\overline{P_{WT}} = \sum_{j=1}^{N_B} \left\{ \exp\left[-\left(\frac{v_{j-1}}{c} \right)^k \right] - \exp\left[-\left(\frac{v_j}{c} \right)^k \right] \right\} P_{WT}\left(\frac{v_{j-1} + v_j}{2} \right)$$

Please note that the relative frequency, f_j/N, corresponds to the term in brackets and the power output is calculated at the midpoint between v_{j-1} and v_j .

The available power at any given wind speed *v* that is convertible by a turbine is defined by (Manwell et al., 2002 Johnson, 1985)

$$P_{WT}(v) = \frac{1}{2}\rho A C_p \eta \upsilon^3$$

Where η is the drive train efficiency (i.e. generator power/rotor power), C_p, is the machine power coefficient. In an idealized wind turbine no losses are experienced and the power coefficient, C_p, is equal to Betz' limit (i.e. $C_{p,Betz}$ = 16/27) and $\eta = 1$. Of course, in reality both the drive train efficiency and the power coefficient cannot be maximized. The extent to which the power output is limited by physical laws as well as engineering inefficiency is dependent on the specific characteristics of individual wind turbine types. This aspect will be discussed further in the analysis of the case study.

WECTs have a range of different power output performance curves, which need to be recognized when estimating the potential power output. The power output performance curves are not only defined by parameters such as the power coefficient and the drive train efficiency but also constrained by cut-in speed, furl-out speed and rated wind speed. Where the cut-in wind seed, v_c, is the minimum wind velocity to generate power from a turbine, the rated wind speed, v_R, is the wind speed at which the 'rated power' of a WETC is achieved and generally corresponds to the point at which the conversion efficiency is near its maximum and furl-out wind speed, v_F, is the wind speed at which the turbine shuts down to prevent structural damage.

To account for the above-mentioned constraints we can formulate a novel formula for the average electrical power output of a turbine, $\overline{P_{WTA}}$:

$$\overline{P_{WTA}} = \begin{cases} \sum_{j=1}^{N_B} \left\{ \exp\left[-\left(\frac{v_{j-1}}{c}\right)^k\right] - \exp\left[-\left(\frac{v_j}{c}\right)^k\right] \right\} P_{WT}\left(\frac{v_{j-1}+v_j}{2}\right) & (v_c \le v \le v_R) \\ \sum_{j=1}^{N_B} \left\{ \exp\left[-\left(\frac{v_{j-1}}{c}\right)^k\right] - \exp\left[-\left(\frac{v_j}{c}\right)^k\right] \right\} P_{WT}(v_r) & (v_R \le v \le v_F) \\ 0 & (v < v_c \text{ and } v > v_F) \end{cases}$$

The energy production of the wind turbine WE(t) over time t can thus be calculated as

$$\text{WE(t)} = \overline{P_{WTA}}\, t$$

Another way of stating the energy output from a wind turbine is to look at the capacity factor for the turbine in its particular location. The capacity factor CF, is the actual energy output over a given period of time, WE(t), divided by the theoretical maximum energy output (i.e. this means that the machine is constantly running at its rated output) during the selected time-span, RO(t). This can be formulated as

$$CF = \frac{WE(t)}{RO(t)}$$

Theoretically capacity factor vary from 0 to 100%. In practice they usually range from 20 to 70% and mostly be around 20-30 percent. However, the economic feasibility of a wind turbine does not of course depend on the capacity factor of a wind turbine alone but also depends on the costs of alternative power systems. Therefore, a low capacity factor does not automatically render a wind turbine project unfeasible.

In order to maximize the energy output of a given wind regime the optimum wind speed, v_{opt}, needs to be determined. The optimum wind speed indicates at what wind velocity most energy is available in a given wind regime. It is at this particular wind speed that engineers should ensure that the power coefficient is most efficient to allow for the highest energy conversion of a turbine. The optimum wind speed can be calculated as follows (Lu et al., 2002):

$$v_{opt} = c\left(\frac{k+2}{k}\right)^{\frac{1}{2}}$$

In this regard, the power density of a turbine is a good comparative indicator to show the average power output per m^2 of wind swept area, A, at a given site. This can be defined as

$$\text{Power Density} = \frac{\overline{P_{WTA}}}{A}$$

Another important aspect of that critically determines the energy output of a turbine is elevation. In many cases the available recorded wind speed data has been measured at a lower level than the planned hub height of the wind turbine. As wind velocity increases vertically the recorded wind speed data can be adjusted using the following standard formula (Borowy and Salameh, 1996.) where *v* is the projected wind speed, v_i the wind speed at reference height, H the hub height of a turbine, Hi the reference height and α the power-law exponent.

$$v = v_i \left(\frac{H}{H_i} \right)^{\alpha}$$

α is often quoted to have a value of 1/7 and is seen as a reasonable power law exponent for even and unobstructed landscapes. However, where WECT development is planned either offshore or near woodlands or close to any other non flat terrains this value can differ subsequently and a more thorough analysis of α is necessary. Justus as well as Counnihan offer mathematical solution for 'fitting' α to these environments (Manwell et al., 2002).

4.1 **Hypothetical Wind Generated Electric Power**:

A **wind turbine** is a machine for converting the kinetic energy in wind into mechanical energy. If the mechanical energy is used directly by machinery, such as a pump or grinding stones, the machine is usually called a windmill. If the mechanical energy is then converted to electricity, the machine is called a wind generator.

Hypothetical wind generated electric power output at Ramatkoor-FATA has been estimated by using the 600KW wind turbine bonus 600/44 MK IV type. The cut in wind speed of this turbine is 3m/s and cutout wind speed is 25m/s. Rotor diameter of this turbine is 44 meters and hub height has been taken as 50 meters. The monthly and annual wind generated electric power outputs at Rramatkoor-FATA along with the capacity factor are given in table 4.

Table-4: Hypothetical wind generated electric energy output & capacity Factor for a Bonus 600/44MK IV Turbine at Ramatkoor - FATA.

PMD Calculator (using 50M)				
Month	**Input W/m^2**	**Output W/m^2**	**C.F.**	**KWh / Month**
January	1	0	0%	**99**
February	1	0	0%	**10**
March	15	5	1%	**5,297**
April	28	10	2%	**10,410**
May	14	5	1%	**5,244**
June	31	11	3%	**12,134**
July	36	13	3%	**14,308**
August	19	6	2%	**7,116**
September	19	6	2%	**6,773**
October	15	5	1%	**5,508**
November	1	0	0%	**113**
December	1	0	0%	**92**
Annual	**10**	**3**	**1%**	**36,998**

Wind Turbine specification	
Turbine	Bonus 600 / 44 MK IV
Power	600 KW
Cut in Wind	3 m/s
Cut out wind	25 m/s
Rotor Diameter	44 m
Hub height	50 m

The **watt-hour** (symbol W·h or Wh) is a unit of energy. It is most commonly used on household electricity meters in the form of the kilowatt-hour (kW·h or KWh), which is 1,000 watt-hours.

Figure 20 shows the average diurnal variation of wind generated electric energy output at Ramat Koor – FATA (March - Feb). The graph shows that the maximum power is produced at about 0500; of course, this is the same time when we have the maximum wind speed in 24 hours. Figure 21 & 22 shows the monthly and daily wind generated electric power output. Figure 21 depicts that at Ramat Koor - FATA the wind have more potential in April & June as compared to other months. Figure 23 to 30 shows the monthly average diurnal variation of wind generated electric energy output.

Note:

During November, December, January & February the wind sensors were out of order due to that reasons data obtained was faulty and the graphs of these months are not plotted here.

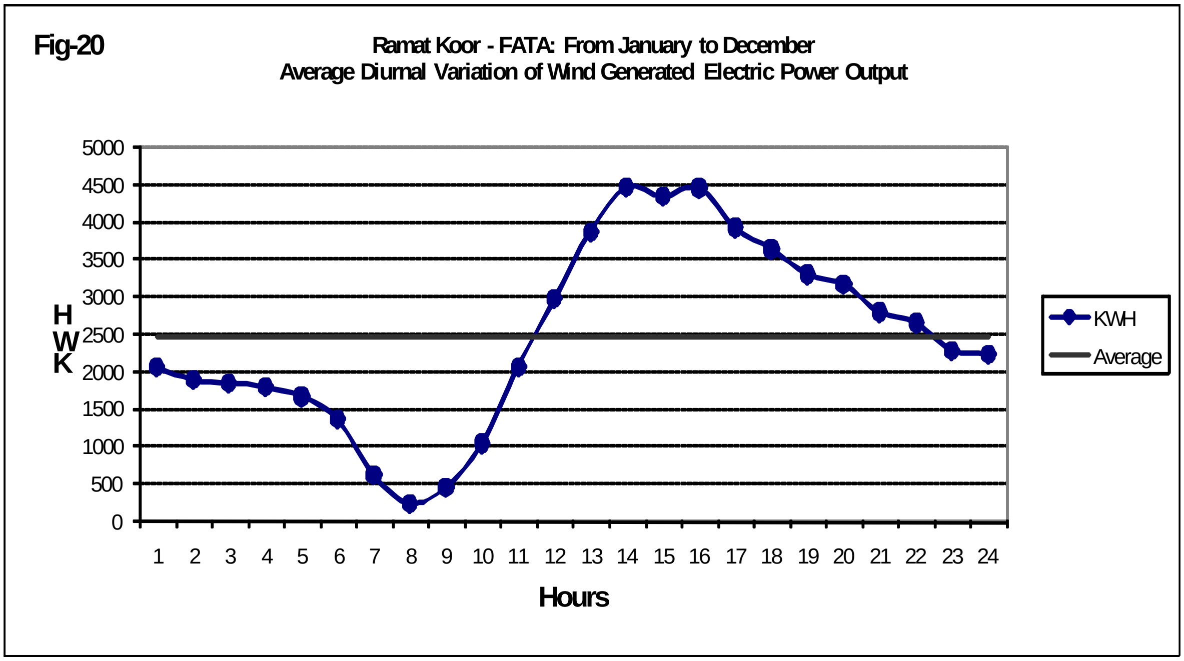


Fig-20
Ramat Koor - FATA: From January to December
Average Diurnal Variation of Wind Generated Electric Power Output
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
KWH
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Hours
KWH
Average

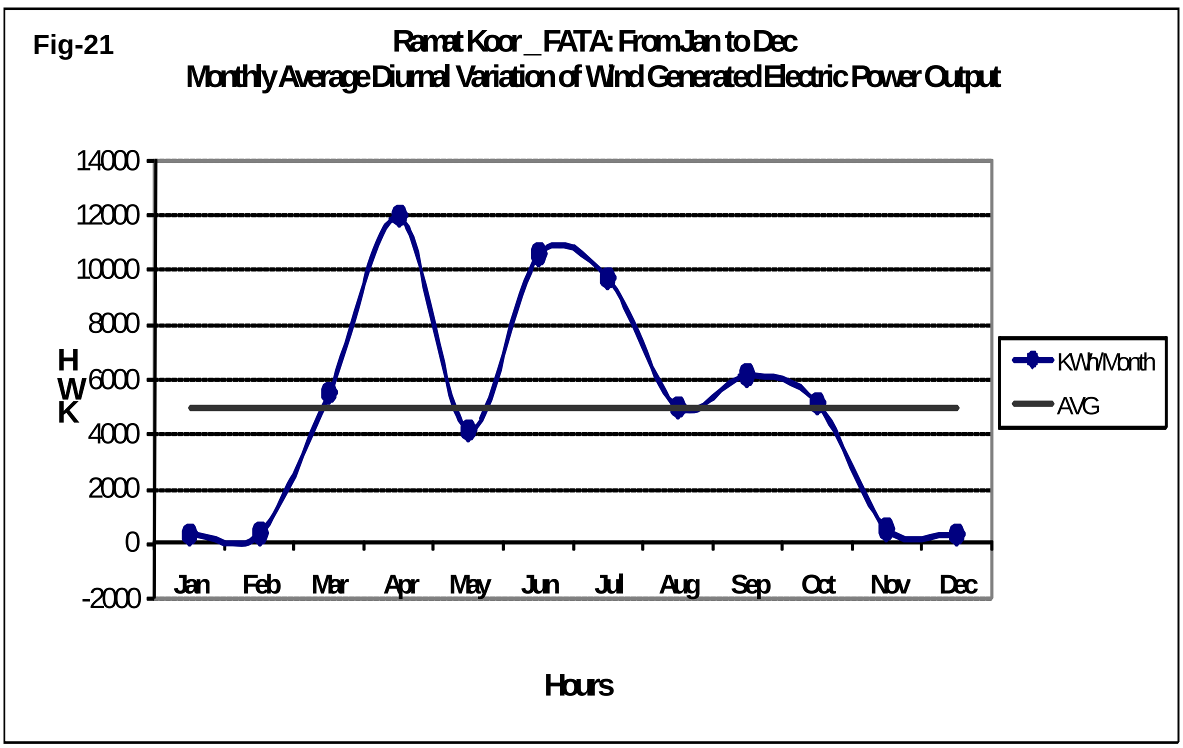


Fig-21
Ramat Koor _FATA: From Jan to Dec
Monthly Average Diurnal Variation of Wind Generated Electric Power Output
14000
12000
10000
8000
6000
4000
2000
0
-2000
KWH
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Hours
KWh/Month
AVG

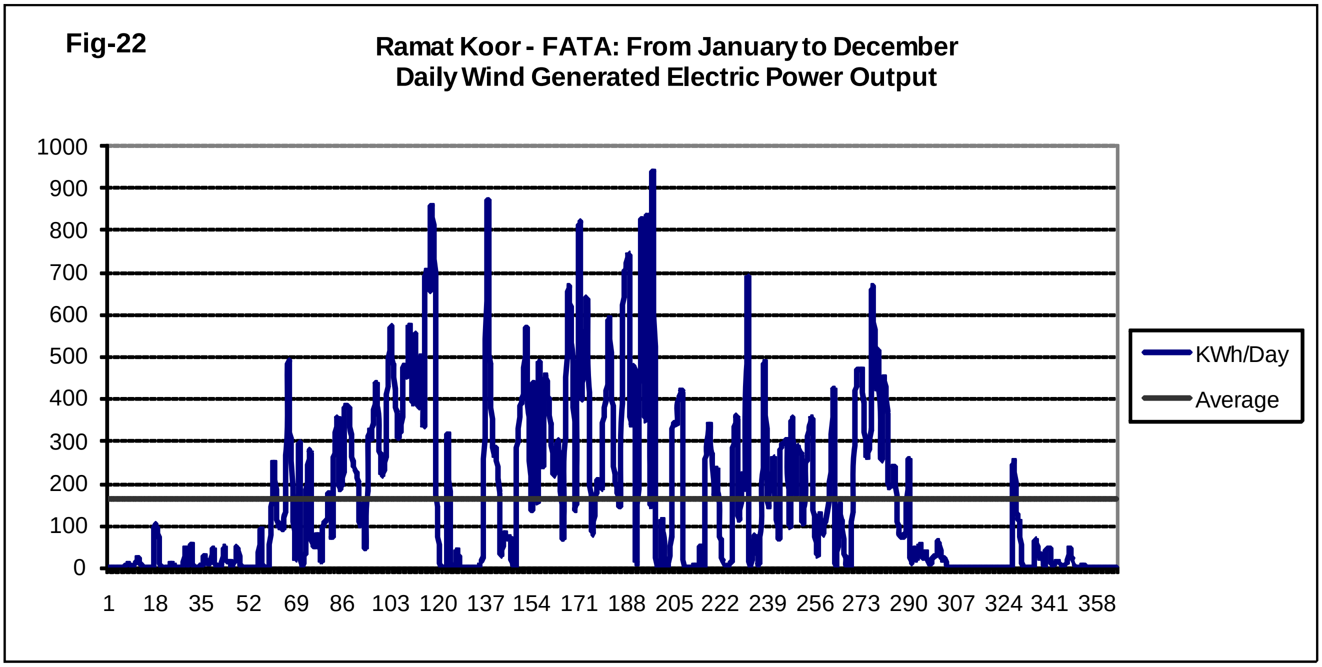


Fig-22
Ramat Koor - FATA: From January to December
Daily Wind Generated Electric Power Output
1000
900
800
700
600
500
400
300
200
100
0
1 18 35 52 69 86 103 120 137 154 171 188 205 222 239 256 273 290 307 324 341 358
KWh/Day
Average

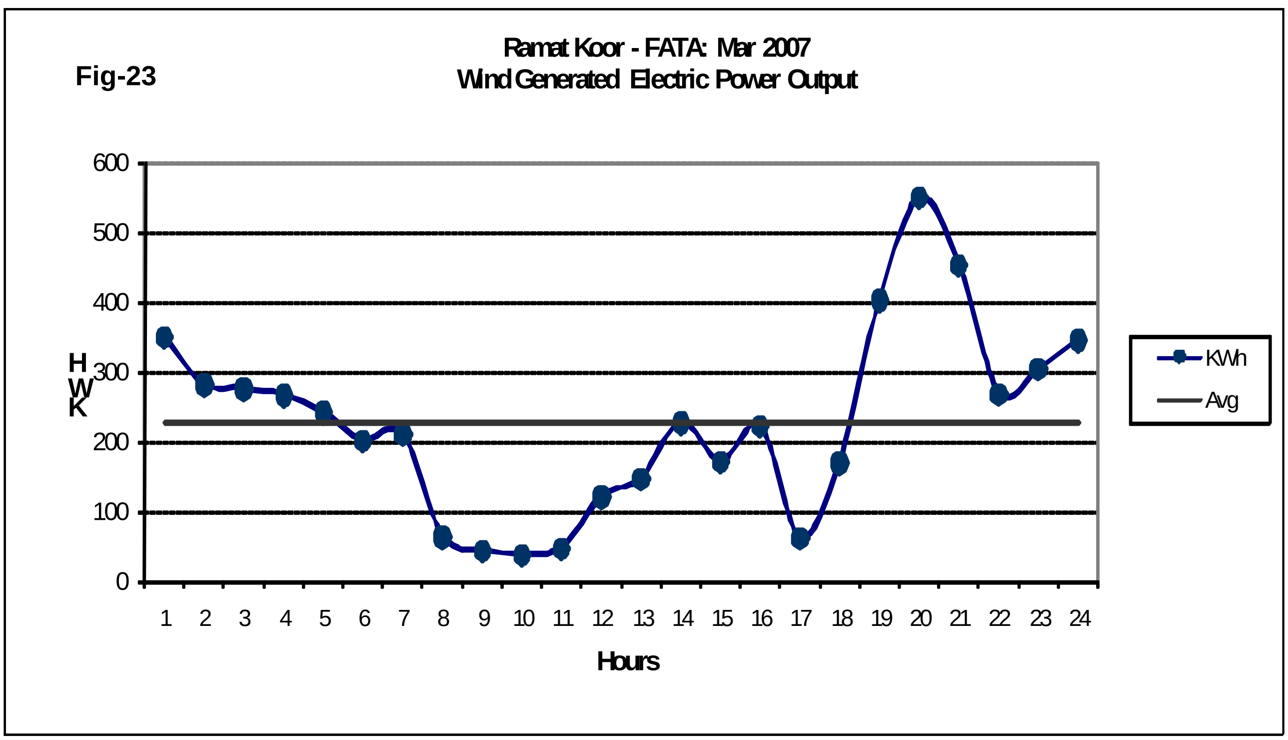


Fig-23
Ramat Koor - FATA: Mar 2007
Wind Generated Electric Power Output
600
500
400
300
200
100
0
KWH
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Hours
KWh
Avg

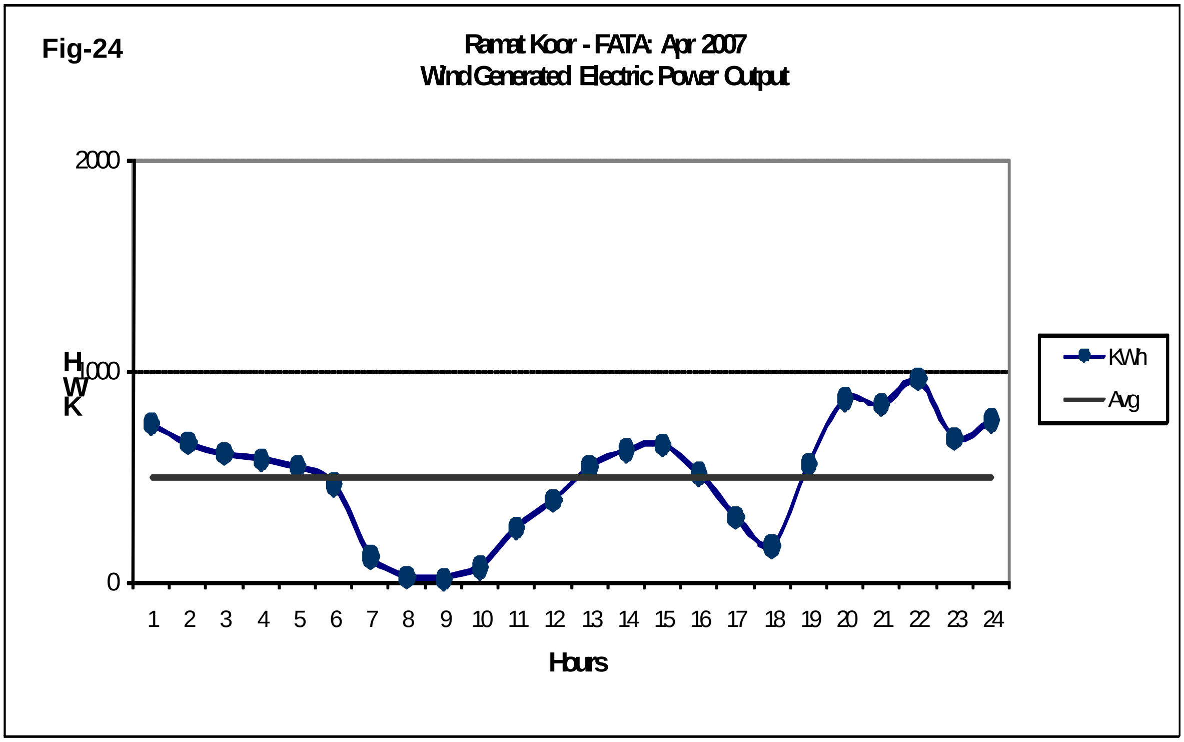


Fig-24
Ramat Koor - FATA: Apr 2007
Wind Generated Electric Power Output
2000
1000
0
KWH
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Hours
KWh
Avg

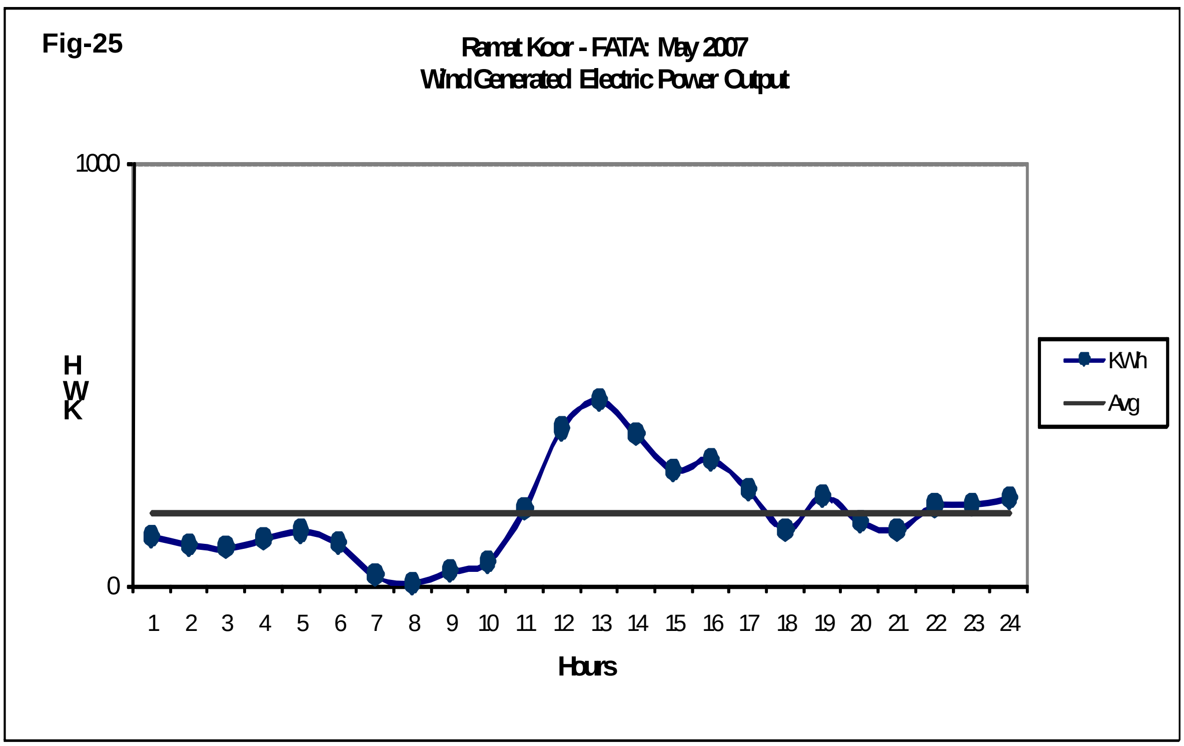


Fig-25
Ramat Koor - FATA: May 2007
Wind Generated Electric Power Output
1000
0
KWH
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Hours
KWh
Avg

Fig-26

Ramat Koor - FATA: June 2007
Wind Generated Electric Power Output

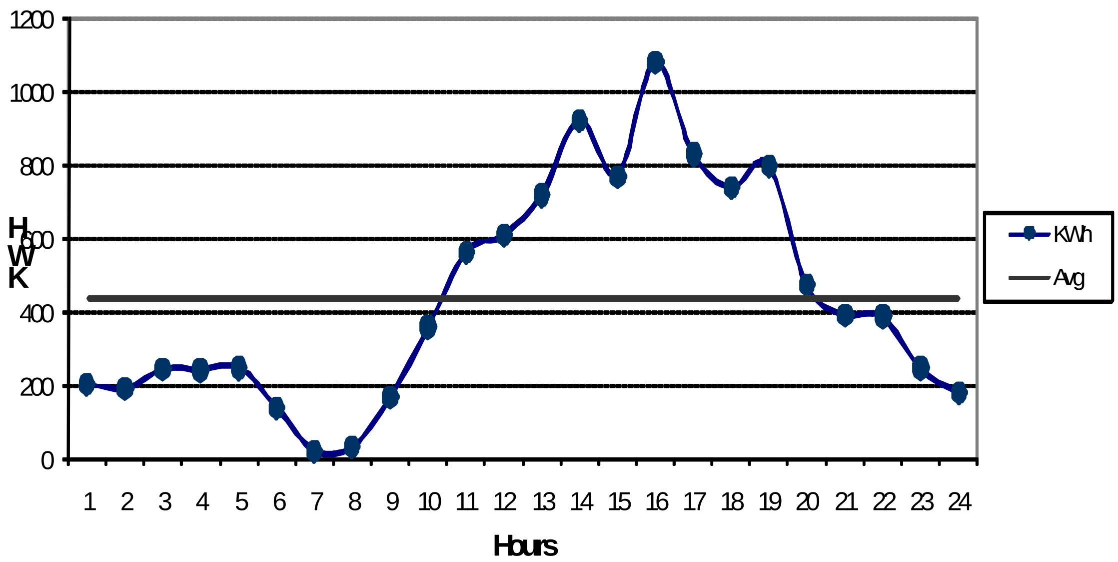


Fig-27

Ramat Koor - FATA: July 2007
Wind Generated Electric Power Output

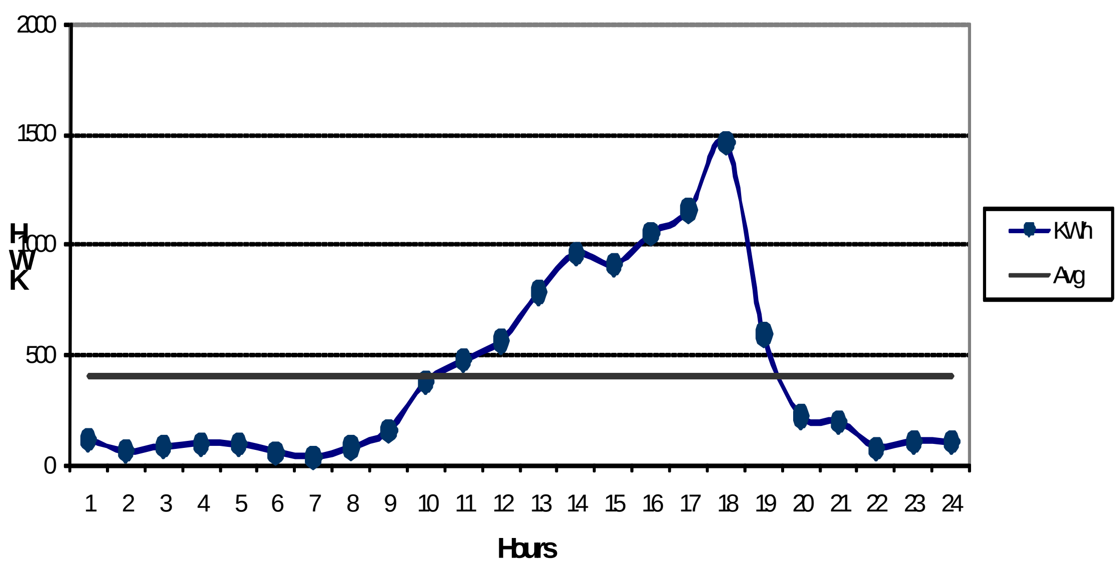


Fig-28

Ramat Koor - FATA: August 2007
Wind Generated Electric Power Output

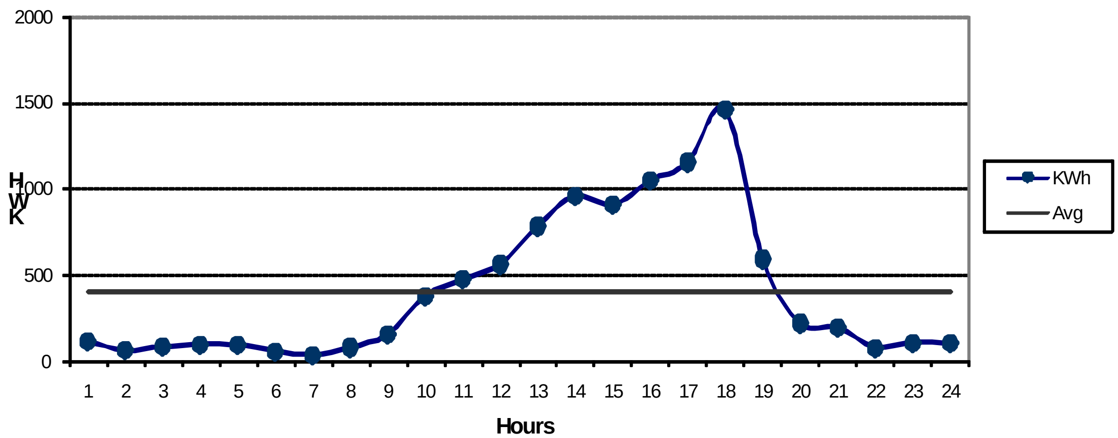


Fig-29

Ramat Koor - FATA: Sep 2007
Wind Generated Electric Power Output

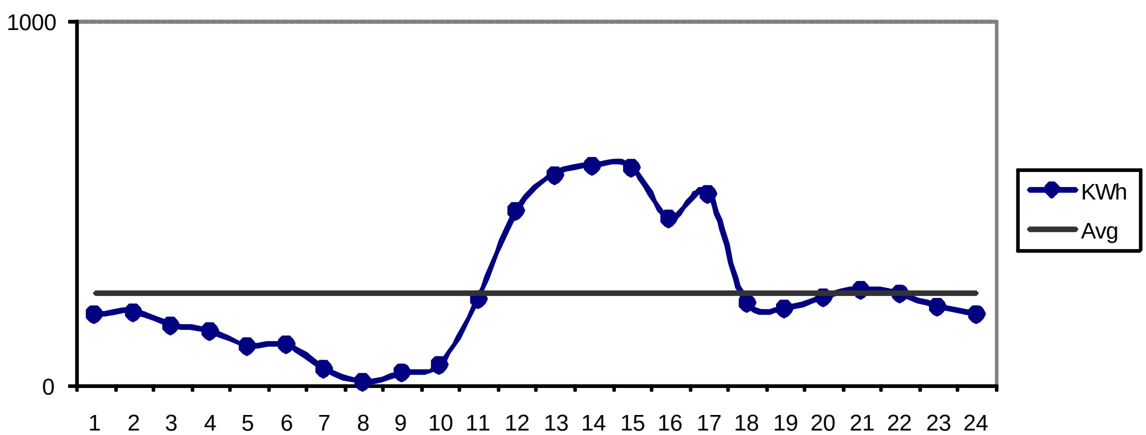
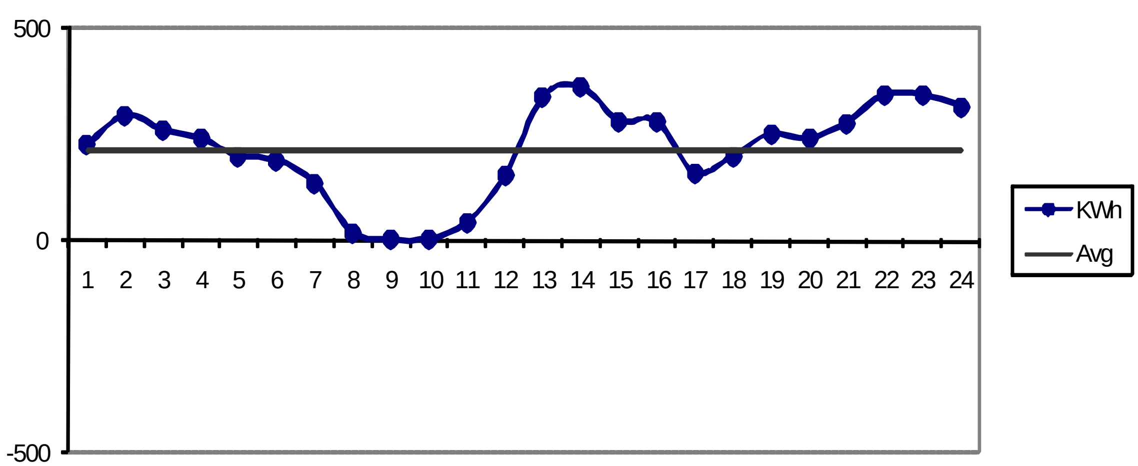


Fig-30

Ramat Koor - FATA: Oct 2007
Wind Generated Electric Power Output

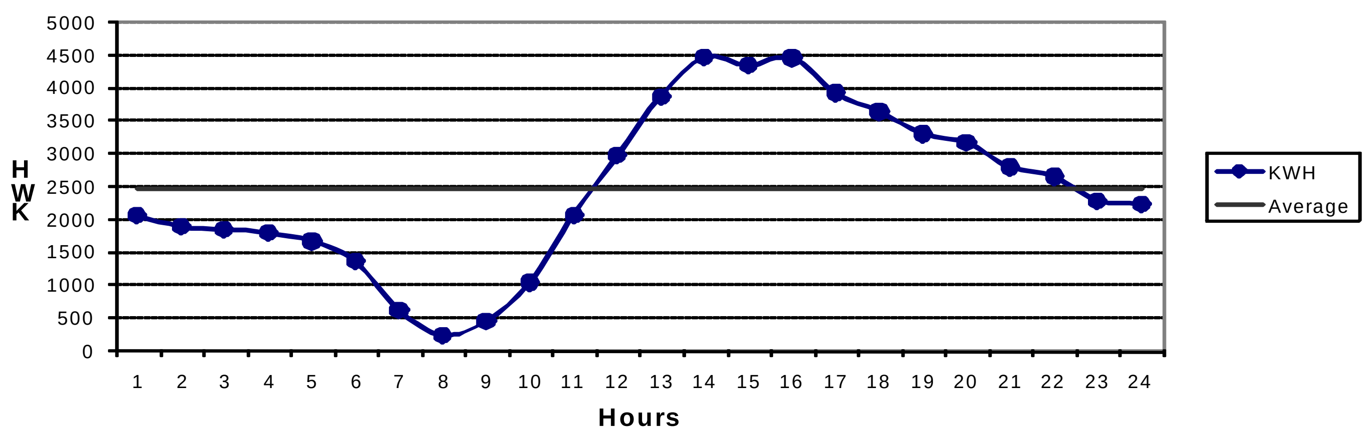


Ramatkoor   January to December   Wind Power Output of Bonus 600/44 Turbine (Six Month's Summary)

Dt./Hrs	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24 Hrs
Jan	28	15	10	10	7	4	11	8	1	0	1	1	7	36	19	2	2	1	13	26	77	9	10	19	**316**
Feb	6	16	21	20	11	5	2	12	1	1	11	11	23	22	34	8	12	11	23	34	15	12	10	2	**323**
Mar	350	281	275	266	241	200	210	63	43	38	46	120	146	227	170	221	61	169	402	548	452	268	303	345	**5445**
Apr	748	656	605	577	543	459	120	24	15	70	252	384	541	622	649	512	307	169	558	862	838	956	678	761	**11908**
May	115	96	88	109	128	100	23	4	34	54	180	372	440	358	273	299	226	132	211	150	132	189	190	206	**4110**
Jun	200	190	242	240	246	137	20	32	168	356	561	606	716	919	766	1077	828	735	797	472	388	386	245	178	**10507**
Jul	108	56	77	92	86	50	30	72	147	370	469	556	778	956	903	1043	1150	1457	586	214	189	71	101	96	**9658**
Aug	46.1	47.767	96.283	51.867	74.1667	86.35	16.45	0	24.017	104.57	274.48	295.78	303.85	345.73	647.18	555.07	637.93	490.53	180.9	298.13	83.767	94.133	132.12	55.85	**4943.03**
Sep	193	201	164	149	106	111	44	8	32	54	235	475	577	601	597	456	523	226	208	239	263	249	214	194	**6119**
Oct	222	293	258	238	197	187	134	15	0	2	41	150	336	362	280	279	156	197	250	239	274	342	340	314	**5106**
Nov	23	12	6	21	26	13	1	11	1	0	0	0	1	0	1	0	5	38	36	72	75	61	48	34	**482**
Dec	32	31	9	31	9	19	17	2	1	0	0	0	0	11	0	0	13	13	34	21	9	13	18	27	**309**
KWH	**2070**	**1895**	**1850**	**1806**	**1674**	**1371**	**626**	**252**	**466**	**1050**	**2070**	**2971**	**3869**	**4459**	**4339**	**4452**	**3922**	**3639**	**3299**	**3175**	**2795**	**2651**	**2290**	**2233**	**59225**
Average	**2468**	**2468**	**2468**	**2468**	**2468**	**2468**	**2468**	**2468**	**2468**	**2468**	**2468**	**2468**	**2468**	**2468**	**2468**	**2468**	**2468**	**2468**	**2468**	**2468**	**2468**	**2468**	**2468**	**2468**	

Fig-20

Ramat Koor - FATA: From January to December
Average Diurnal Variation of Wind Generated Electric Power Output



Appendix-II

Ramatkoor March 2007 Wind Power Output of Bonus 600/44 Turbine (Month's Summary)

Dt./Hrs	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24 Hrs
1	3.9	6.1	3.3	1.3	3.3	2.6	2.0	5.5	0.0	0.0	2.0	0.7	0.0	1.3	0.7	0.0	0.0	2.0	15.4	23.0	25.9	18.3	21.2	21.2	159
2	21.2	21.2	21.2	25.9	25.9	21.2	21.2	8.4	0.0	0.0	0.0	0.0	0.0	0.7	0.7	9.7	2.0	4.8	11.9	15.4	21.2	2.0	2.6	9.7	247
3	12.6	33.3	0.0	8.4	0.0	0.0	1.3	2.0	27.6	12.6	3.5	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.3	105
4	0.7	3.3	3.9	2.6	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	6.1	18.3	15.4	6.1	15.4	21.2	94
5	21.2	12.6	12.6	5.5	2.6	4.8	0.7	0.0	0.0	0.7	0.7	3.3	9.7	2.6	3.5	0.0	2.0	2.6	0.7	0.7	0.0	0.0	2.0	0.7	89
6	0.7	0.0	0.0	0.0	0.0	2.0	6.8	0.7	0.0	0.7	1.3	2.6	9.0	15.4	11.9	2.6	2.0	9.0	15.4	3.9	3.9	5.5	9.7	27.7	131
7	35.3	25.9	44.6	35.3	35.3	21.2	20.1	1.3	0.0	0.0	0.0	3.3	5.5	3.9	3.3	0.0	3.5	12.6	39.9	39.9	39.9	39.9	39.9	35.3	486
8	44.6	39.9	49.3	21.2	18.3	20.1	25.3	4.8	0.0	0.0	0.7	0.7	1.3	15.4	9.0	15.4	5.5	8.4	12.6	5.5	9.0	0.0	0.0	1.3	308
9	4.8	14.1	3.5	8.4	7.7	0.7	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	3.5	17.1	0.0	0.0	0.7	3.5	20.1	0.7	0.0	0.0	85
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.7	1.3	5.5	2.6	5.5	7.7	25
11	6.8	2.6	2.6	3.9	9.7	0.0	3.9	0.7	9.0	0.0	0.0	0.7	0.0	39.0	93.4	105.3	15.9	0.0	0.7	0.0	0.0	0.0	0.0	0.0	294
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3
13	0.0	0.0	0.7	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	24.2	0.0	0.0	0.0	0.0	1.3	3.3	0.0	0.0	0.0	1.3	31
14	2.0	6.8	0.0	6.8	4.2	6.1	6.8	1.3	0.0	2.0	0.7	1.3	2.0	9.0	4.2	0.0	0.7	9.0	21.2	30.6	35.3	9.7	8.4	30.6	198
15	18.3	18.3	21.2	25.9	21.2	18.3	16.6	0.0	0.0	0.7	0.7	1.3	4.2	7.7	0.0	0.0	0.0	1.3	12.6	30.6	12.6	12.6	25.9	21.2	271
16	12.6	1.3	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	2.0	0.7	0.7	0.0	0.0	0.0	0.0	3.3	19.5	11.3	52
17	5.5	8.4	1.3	0.0	9.5	4.8	0.7	0.7	0.0	0.0	0.0	0.0	0.0	0.0	1.3	3.5	0.0	0.0	0.0	4.8	2.6	1.3	2.6	0.7	48
18	0.0	0.0	1.3	2.0	5.5	18.3	15.4	9.7	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	2.0	1.3	8.4	5.5	0.0	4.2	0.7	0.0	75
19	3.5	2.0	0.0	0.0	0.0	4.2	0.7	0.7	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12
20	31.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.7	23.0	0.7	1.3	0.0	0.0	4.2	0.7	0.0	2.0	2.0	18.3	4.2	97
21	0.0	0.0	0.0	0.0	0.0	0.7	0.7	0.0	0.0	0.0	0.0	3.5	14.8	0.7	0.0	50.3	23.4	0.0	0.7	4.8	3.3	9.7	1.3	0.7	114
22	2.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.7	12.4	44.6	6.8	18.3	0.7	0.0	0.0	17.7	35.3	21.2	11.9	2.0	0.7	0.0	175
23	4.2	5.5	4.2	0.7	3.5	0.0	5.5	0.0	1.3	13.7	3.3	5.5	6.1	2.6	2.0	2.0	0.0	6.1	0.0	1.3	0.0	0.7	2.0	2.0	72
24	2.0	1.3	0.7	0.0	0.7	0.0	0.0	0.0	1.3	2.0	2.0	4.8	30.6	12.6	2.0	0.0	2.6	32.4	55.0	50.3	44.6	23.0	2.0	2.0	271
25	0.0	1.3	4.8	21.2	30.6	35.3	18.3	0.0	0.0	0.7	7.7	15.4	12.6	30.6	9.7	8.4	0.7	11.9	30.6	27.7	49.3	15.4	11.9	9.7	354
26	16.6	1.3	12.6	21.2	17.7	0.7	0.7	0.0	1.3	1.3	2.0	2.6	2.0	0.7	0.0	0.0	0.0	5.5	13.7	9.0	6.8	12.6	15.4	39.9	183
27	23.0	4.2	9.0	9.7	1.3	2.0	0.0	0.7	0.0	0.0	6.1	18.3	11.9	6.8	2.0	2.0	0.0	27.7	30.6	23.0	25.9	6.1	13.7	1.3	225
28	12.6	30.6	14.8	13.1	17.2	12.4	10.2	0.0	0.0	0.0	0.7	0.7	0.7	4.2	2.0	0.0	0.0	5.5	35.3	30.6	44.6	49.3	49.3	49.3	383
29	30.6	21.2	25.9	30.6	25.9	14.8	9.0	4.2	0.0	0.0	0.0	0.0	4.8	30.6	9.7	2.0	0.0	2.6	30.6	30.6	27.7	35.3	25.9	15.4	377
30	32.4	15.4	30.6	21.2	1.3	1.3	30.5	7.7	0.0	0.0	0.0	0.0	0.0	0.0	7.1	0.7	0.0	0.0	16.6	51.6	2.6	4.8	5.5	18.7	248
31	2.0	4.2	6.1	0.0	0.0	9.0	12.6	15.4	2.6	2.6	0.7	0.0	0.7	0.0	0.7	0.0	0.0	4.2	6.1	111.7	42.1	1.3	3.5	8.9	234
KWh	**350**	**281**	**275**	**266**	**241**	**200**	**210**	**63**	**43**	**38**	**46**	**120**	**146**	**227**	**170**	**221**	**61**	**169**	**402**	**548**	**452**	**268**	**303**	**345**	**5445**

Appendix-II

Ramatkoor April 2007 Wind Power Output of Bonus 600/44 Turbine (Month's Summary)

Dt./Hrs	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24 Hrs
1	21.6	48.7	17.7	0.7	0.0	3.5	8.2	0.0	0.0	0.0	0.7	0.7	0.7	0.7	0.7	0.0	0.0	0.0	1.3	25.9	25.9	39.9	3.3	0.0	**200**
2	5.5	2.6	1.3	0.0	7.7	9.0	1.3	4.8	4.8	5.5	1.3	6.8	5.5	12.6	6.1	6.1	0.7	0.0	0.0	0.7	0.0	0.7	1.3	15.9	**100**
3	6.8	18.3	0.0	35.3	39.9	5.5	4.8	0.0	0.0	1.3	11.9	3.9	4.8	4.8	0.0	0.7	0.0	0.0	1.3	5.5	1.3	0.0	4.8	0.0	**151**
4	5.5	0.0	0.0	4.8	20.1	7.7	0.0	0.7	0.0	0.0	0.7	0.7	1.3	0.0	0.0	0.0	0.0	0.0	0.0	1.3	1.3	1.3	0.0	0.0	**45**
5	0.0	0.0	0.0	3.5	1.3	8.4	1.3	0.0	0.0	2.6	8.4	18.3	21.2	23.0	9.7	1.3	0.0	8.4	24.8	45.6	40.9	30.6	35.3	35.3	**320**
6	39.9	18.3	21.2	1.3	11.3	5.5	0.0	0.0	0.0	0.7	0.7	12.6	2.6	0.7	0.0	0.0	4.2	10.6	25.9	25.9	44.6	28.8	23.0	25.9	**303**
7	9.0	12.6	12.6	3.3	8.4	21.2	0.7	0.0	0.0	3.5	6.1	4.8	9.0	1.3	2.6	3.3	1.3	8.4	46.6	66.3	24.8	35.3	47.4	55.0	**383**
8	50.3	49.3	49.3	39.9	49.3	21.9	14.1	0.0	0.0	0.7	2.0	2.6	2.0	6.8	8.4	2.6	4.8	2.6	18.3	30.6	30.6	19.5	9.0	17.2	**432**
9	26.3	9.7	1.3	16.6	4.2	5.5	1.3	0.0	0.7	0.0	4.2	1.3	9.7	5.5	9.0	5.5	1.3	1.3	15.4	39.9	25.9	25.9	27.7	30.6	**269**
10	25.9	6.1	15.4	8.4	15.4	4.8	0.7	0.0	4.8	6.8	2.0	3.3	2.6	0.7	1.3	0.0	0.0	1.3	21.2	21.2	21.2	30.6	14.8	7.7	**216**
11	14.1	1.3	2.0	0.0	11.9	2.6	0.0	0.0	0.7	0.7	6.8	6.8	3.3	2.0	0.7	0.0	0.0	0.7	15.4	30.6	39.9	49.3	39.9	35.3	**264**
12	30.6	27.7	35.3	13.7	2.6	9.0	1.3	0.0	0.0	0.7	1.3	0.7	1.3	4.8	2.0	9.0	7.7	8.4	32.4	55.9	44.6	39.9	49.3	49.3	**427**
13	49.3	35.3	37.4	20.1	25.9	5.5	1.3	0.0	0.0	0.0	0.7	2.6	6.8	12.6	25.9	44.6	31.0	2.0	15.4	39.9	49.3	49.3	66.3	49.3	**570**
14	49.3	49.3	30.6	39.9	21.2	6.8	7.7	0.0	0.0	0.0	6.1	6.1	21.2	30.6	30.6	39.9	24.8	10.6	21.2	25.9	25.9	12.6	13.7	3.3	**477**
15	1.3	11.3	1.3	20.6	15.4	11.9	10.6	0.0	0.0	0.0	0.0	5.5	25.9	9.7	9.0	6.8	4.8	4.8	12.6	39.9	44.6	39.9	35.3	55.0	**366**
16	49.3	30.6	35.3	21.2	18.3	35.3	18.8	0.0	1.3	0.0	0.7	1.3	11.3	12.6	2.6	1.3	0.7	0.7	3.9	45.9	4.8	4.8	1.3	3.5	**305**
17	16.6	7.7	0.7	0.7	7.7	0.0	0.0	0.0	0.0	0.7	3.9	9.7	55.0	50.3	44.6	32.4	15.4	0.0	22.4	35.3	30.6	18.3	4.8	0.7	**357**
18	0.7	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.7	15.9	63.8	85.5	77.6	85.5	55.0	41.7	4.2	5.5	1.3	3.3	9.7	6.8	3.9	15.3	**477**
19	23.0	12.6	18.3	25.9	35.3	35.3	4.8	0.0	0.0	2.0	25.9	35.3	39.9	14.8	92.2	4.2	0.7	0.0	1.3	2.6	21.2	21.2	11.3	25.9	**453**
20	21.2	21.2	24.8	28.8	9.0	4.2	0.0	0.0	0.0	1.3	9.7	21.2	27.7	66.3	40.9	25.9	30.6	8.4	23.0	35.3	30.6	39.9	49.3	55.0	**574**
21	13.7	23.0	14.4	27.7	30.5	55.0	2.6	0.0	0.0	0.7	2.0	0.7	9.0	15.4	20.1	27.7	44.6	1.3	17.2	6.1	22.4	35.3	3.3	17.2	**390**
22	8.9	7.7	18.3	25.9	2.0	21.9	1.3	0.0	0.0	11.9	50.3	55.0	60.6	44.6	51.2	42.7	9.7	11.9	61.6	27.7	15.4	4.8	7.7	11.3	**552**
23	15.4	25.9	30.6	2.0	9.0	0.7	3.5	0.0	0.0	0.0	3.3	12.6	18.3	25.9	9.7	32.4	4.2	8.4	18.3	2.6	19.5	44.6	44.6	49.3	**381**
24	44.6	30.6	44.6	44.6	44.6	30.6	0.7	0.0	1.3	0.7	3.3	5.5	23.5	8.9	13.1	74.2	0.7	29.8	16.6	15.4	27.7	5.5	15.9	18.3	**500**
25	11.9	21.2	21.2	1.3	2.0	0.7	0.7	0.0	0.7	7.7	21.2	11.3	0.0	0.7	1.3	5.5	0.7	14.8	44.6	35.3	55.0	39.9	37.1	1.3	**336**
26	39.9	49.3	60.6	55.0	25.9	20.0	0.0	0.0	0.0	2.6	1.3	2.6	9.7	25.9	39.9	27.7	19.5	8.4	44.6	66.3	49.3	55.0	49.3	49.3	**702**
27	35.3	44.6	23.0	30.6	30.6	27.7	3.5	0.0	0.0	0.0	0.0	2.0	5.5	6.1	6.8	15.4	39.9	6.1	25.9	71.9	83.2	60.6	60.6	77.6	**657**
28	66.3	55.0	49.3	44.6	44.6	55.0	14.8	0.0	0.0	0.7	2.6	16.6	50.3	83.2	122.8	53.0	17.2	9.0	14.4	35.3	45.6	18.3	18.3	39.9	**857**
29	44.6	31.5	37.1	60.6	49.3	44.6	0.7	0.0	0.0	0.0	10.6	30.6	25.9	66.3	42.7	8.2	35.0	0.7	7.7	9.7	2.0	174.6	0.0	17.4	**700**
30	21.3	4.2	1.3	0.7	0.0	0.0	15.3	18.8	0.0	3.5	1.3	18.3	9.7	0.7	0.0	0.0	3.5	5.5	3.5	14.8	0.0	23.0	0.0	0.0	**145**
KWh	**748**	**656**	**605**	**577**	**543**	**459**	**120**	**24**	**15**	**70**	**252**	**384**	**541**	**622**	**649**	**512**	**307**	**169**	**558**	**862**	**838**	**956**	**678**	**761**	**11908**

Appendix-II

Ramatkoor May 2007 Wind Power Output of Bonus 600/44 Turbine (Month's Summary)

Dt./Hrs	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24 Hrs
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0**
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0**
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0**
4	2.0	18.8	9.5	18.3	21.2	3.3	4.2	0.0	0.0	2.0	1.3	24.8	83.2	55.0	30.6	38.5	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	**314**
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0**
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0**
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	28.9	13.9	0.0	**43**
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0**
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0**
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**1**
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0**
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0**
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0**
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0**
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**1**
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.6	0.0	0.0	0.0	0.0	**21**
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	5.5	18.3	25.9	18.3	27.7	41.7	21.3	23.0	21.2	8.4	32.4	25.9	35.3	**306**
18	44.6	32.4	10.6	19.5	25.9	21.2	5.5	0.0	4.8	25.9	93.4	110.9	170.3	131.2	69.6	1.3	3.5	0.0	51.6	8.4	14.4	18.3	6.1	1.3	**871**
19	1.3	2.0	9.0	13.1	35.3	30.6	4.2	0.0	0.0	15.9	60.6	35.3	21.3	4.2	37.1	75.1	49.6	16.6	37.1	6.1	13.7	10.6	4.2	0.7	**483**
20	0.7	5.5	1.3	0.7	4.2	0.0	0.0	0.0	0.0	1.3	6.1	23.0	13.7	17.2	16.6	9.7	40.9	7.7	6.1	2.6	25.9	35.3	21.3	25.9	**266**
21	21.2	4.8	1.3	14.8	23.0	11.9	0.0	0.0	0.0	0.0	4.8	21.2	3.3	7.1	7.1	0.0	4.8	0.0	30.0	36.6	21.2	21.2	25.9	21.2	**281**
22	11.9	18.3	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	34.5	73.8	36.3	0.0	0.0	0.0	0.0	0.0	**178**
23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	18.1	1.3	0.0	0.0	0.0	0.0	0.0	8.2	**28**
24	13.1	1.3	12.4	1.3	6.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	8.2	4.2	0.7	2.6	5.5	7.7	4.8	11.3	**80**
25	0.0	0.0	0.0	0.0	0.0	0.0	4.8	0.0	13.7	8.9	0.0	1.3	2.0	33.3	0.0	2.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	**67**
26	0.0	0.0	0.0	0.0	0.7	12.4	4.2	4.2	15.9	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	14.8	14.1	**67**
27	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**9**
28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0**
29	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	142.6	93.4	4.2	0.7	15.3	2.0	0.7	0.0	2.6	11.9	11.3	6.1	8.4	**300**
30	7.1	1.3	14.8	2.0	0.0	2.0	0.0	0.0	0.0	0.0	0.7	5.5	15.4	39.5	59.2	79.8	12.6	4.8	11.9	30.6	21.3	3.3	45.6	30.6	**388**
31	13.7	11.9	25.9	39.9	11.9	18.3	0.0	0.0	0.0	0.0	2.0	2.0	18.8	40.9	33.3	46.6	9.7	2.0	11.9	18.3	9.7	20.1	21.9	49.3	**408**
KWh	**115**	**96**	**88**	**109**	**128**	**100**	**23**	**4**	**34**	**54**	**180**	**372**	**440**	**358**	**273**	**299**	**226**	**132**	**211**	**150**	**132**	**189**	**190**	**206**	**4110**

Appendix-II

Ramatkoor June 2007 Wind Power Output of Bonus 600/44 Turbine (Month's Summary)

Dt./Hrs	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24 Hrs
1	39.9	35.3	44.6	44.6	44.6	30.6	2.0	0.0	0.0	0.7	0.7	15.4	39.9	42.7	13.1	40.1	2.0	13.1	55.3	33.3	21.3	30.6	6.1	7.7	**563**
2	9.0	3.5	9.0	15.4	15.4	3.3	0.0	0.0	0.0	0.0	21.3	25.9	55.0	25.9	24.8	21.2	32.4	20.1	19.5	9.0	6.1	6.1	23.0	12.6	**358**
3	6.1	8.4	0.0	5.5	0.7	1.3	2.6	0.0	0.0	2.0	9.0	6.1	4.2	0.7	3.5	37.4	4.8	0.0	1.3	23.0	8.4	0.7	0.7	8.4	**135**
4	4.8	2.0	2.6	0.0	2.6	9.0	0.7	0.0	7.7	36.2	75.1	99.0	27.7	48.1	13.1	24.2	41.9	8.4	0.0	0.0	1.3	11.9	2.6	18.3	**437**
5	3.3	1.3	9.7	15.4	21.2	12.6	0.0	0.0	2.0	9.0	9.0	4.2	1.3	1.3	2.0	0.7	7.7	1.3	0.7	1.3	26.9	9.0	8.2	5.5	**153**
6	4.8	2.0	15.4	20.1	21.2	5.5	0.0	0.0	0.0	8.4	24.8	51.2	50.3	69.5	8.4	15.4	71.9	38.0	12.4	5.5	12.6	18.3	15.4	15.4	**487**
7	21.2	18.3	15.4	5.5	0.7	0.0	0.0	0.0	5.5	4.8	3.3	2.0	0.7	5.5	0.7	0.7	0.7	3.3	15.4	18.3	44.6	44.6	21.2	5.5	**238**
8	0.7	2.0	13.7	3.3	12.6	12.6	3.5	0.7	0.0	5.5	6.1	21.2	30.5	45.6	29.2	1.3	0.0	4.8	51.2	71.9	50.3	55.0	19.5	9.7	**450**
9	5.5	8.4	3.5	2.0	0.7	17.7	1.3	0.0	0.0	2.6	6.8	23.0	24.2	4.8	0.0	0.0	4.8	7.7	39.9	66.3	66.3	49.3	55.9	9.0	**400**
10	29.5	17.2	11.9	23.0	24.8	4.2	0.7	18.4	7.7	4.8	2.6	4.8	16.6	9.0	17.2	1.3	0.0	3.5	30.6	44.6	40.9	15.4	4.2	6.8	**340**
11	0.7	0.0	0.0	1.3	0.0	0.0	0.0	0.0	0.7	17.7	14.8	2.6	15.9	17.2	0.0	0.7	2.0	2.0	18.3	20.1	30.6	45.6	17.2	10.6	**218**
12	12.4	25.9	35.3	25.9	21.2	3.9	4.2	0.0	0.0	1.3	23.0	4.2	0.0	0.0	0.0	0.0	0.0	0.0	8.2	51.2	4.2	15.4	25.9	35.3	**297**
13	25.9	30.6	25.9	30.6	25.9	15.4	0.7	0.0	0.0	2.6	1.3	2.0	12.6	6.1	2.0	50.3	4.8	8.4	17.7	0.0	0.0	0.0	0.0	0.0	**263**
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.6	3.3	5.5	6.1	7.7	2.0	12.6	6.8	6.8	4.8	2.0	0.7	6.1	**67**
15	6.8	3.3	9.7	3.3	2.0	0.7	0.0	0.0	5.5	1.3	0.0	0.0	0.0	0.0	3.5	127.8	46.6	32.4	40.8	5.5	2.6	8.9	4.8	0.7	**306**
16	0.0	0.0	0.7	2.6	3.3	0.7	0.0	0.0	0.0	0.0	2.0	25.9	23.0	20.1	9.7	47.4	179.5	158.4	95.3	34.5	28.8	28.8	0.0	1.3	**662**
17	1.3	3.9	2.0	0.0	2.6	1.3	3.5	3.5	0.0	0.0	0.0	0.0	0.0	99.6	146.6	159.6	46.4	64.5	45.3	2.0	4.2	0.0	25.1	5.5	**617**
18	0.7	0.7	0.0	0.0	2.6	2.0	0.0	0.0	0.0	0.0	0.0	1.3	17.2	66.6	45.6	75.1	16.6	15.9	48.4	39.5	11.8	0.0	0.0	2.0	**346**
19	6.1	2.6	14.4	25.9	21.2	6.8	0.0	0.0	1.3	6.8	9.0	11.8	4.8	3.9	0.7	10.6	1.3	0.0	8.4	0.7	0.0	2.0	0.0	12.4	**150**
20	6.1	1.3	2.0	6.1	6.8	3.3	0.0	0.0	1.3	42.7	66.3	66.3	118.8	166.4	126.8	80.2	83.1	24.8	5.5	0.0	1.3	1.3	3.3	3.9	**817**
21	6.8	15.4	11.9	6.8	3.9	4.8	0.0	2.0	35.3	66.3	44.6	7.7	12.4	55.0	59.2	23.0	11.3	24.2	3.3	2.6	2.6	3.3	0.7	0.7	**403**
22	0.7	0.0	2.0	0.7	0.0	0.0	0.0	0.0	59.0	71.9	61.6	40.9	60.6	75.1	50.3	32.4	39.9	61.6	4.2	0.0	0.0	0.0	0.7	0.0	**561**
23	4.8	1.3	5.5	0.0	2.6	0.0	0.0	0.0	3.3	30.6	60.6	32.6	15.9	6.1	69.5	178.2	48.1	25.8	134.7	9.5	0.7	0.7	0.0	0.0	**630**
24	0.7	0.0	4.2	0.7	0.0	0.0	0.0	0.0	9.0	12.6	27.7	9.0	8.4	2.6	5.5	24.2	19.5	6.1	6.1	14.8	9.7	11.9	0.0	0.0	**172**
25	0.0	0.0	0.0	0.0	0.0	0.7	0.0	1.3	3.5	1.3	0.7	0.0	4.8	1.3	0.7	1.3	20.6	6.8	1.3	3.3	3.9	21.9	6.1	0.0	**79**
26	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	16.6	15.4	8.4	41.1	0.0	0.0	0.0	1.3	58.4	25.6	1.3	1.3	0.7	3.5	0.0	**176**
27	0.0	0.0	0.0	0.7	0.7	0.0	0.7	6.1	19.0	4.8	15.4	35.1	35.3	28.7	23.0	20.1	11.9	0.7	2.0	0.7	0.0	0.7	0.7	1.3	**207**
28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.1	5.5	48.1	87.7	16.4	8.4	15.3	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	**188**
29	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.6	6.1	14.8	25.9	35.3	40.9	66.3	77.6	83.1	6.1	0.0	0.0	0.0	0.0	**359**
30	1.3	6.8	3.3	1.3	9.0	1.3	0.0	0.0	0.0	0.7	9.7	9.0	60.6	77.6	55.0	55.9	60.6	55.0	15.3	0.0	3.3	2.0	0.0	0.0	**427**
KWh	**200**	**190**	**242**	**240**	**246**	**137**	**20**	**32**	**168**	**356**	**561**	**606**	**716**	**919**	**766**	**1077**	**828**	**735**	**797**	**472**	**388**	**386**	**245**	**178**	**10507**

Appendix-II

Ramatkoor July 2007 **Wind Power Output of Bonus 600/44 Turbine (Month's Summary)**

Dt./Hrs	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24 Hrs
1	0.0	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.7	27.7	21.2	25.9	66.3	71.9	101.3	99.0	99.0	61.3	8.4	2.0	3.3	0.7	0.7	**590**
2	0.0	0.0	0.7	0.7	0.0	0.0	11.3	47.4	36.4	46.6	31.0	36.4	24.8	38.0	24.8	23.0	20.1	30.6	9.0	1.3	1.3	1.3	1.3	0.0	**386**
3	0.0	0.0	0.0	3.9	9.7	7.7	0.0	0.0	0.0	3.3	5.5	2.0	23.0	39.9	49.3	16.6	6.8	16.6	12.6	11.3	11.3	0.0	1.3	2.0	**222**
4	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	3.9	5.5	11.9	25.9	31.6	40.9	4.8	2.6	2.6	3.9	21.2	4.8	1.3	3.9	2.0	**167**
5	0.0	0.0	0.0	0.0	4.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	94.4	1.3	0.0	4.2	11.3	10.6	17.2	**143**
6	0.7	0.0	10.6	15.4	4.2	1.3	0.0	0.0	2.0	18.3	15.4	50.3	60.6	55.0	67.2	77.6	77.6	114.9	63.8	3.5	0.7	2.0	2.0	0.0	**643**
7	0.0	0.7	0.0	0.7	1.3	1.3	0.0	0.7	5.5	64.8	62.9	87.7	107.0	97.2	31.7	55.9	63.7	53.1	68.2	5.5	0.7	1.3	0.7	0.7	**711**
8	0.0	0.0	0.0	0.0	0.0	0.0	3.5	21.6	5.5	0.7	5.5	35.3	45.9	114.9	85.5	107.0	109.2	66.3	83.2	20.6	0.7	1.3	31.6	0.7	**739**
9	5.5	3.9	12.6	9.7	0.7	0.7	0.0	0.7	0.0	9.7	2.6	5.5	35.3	44.6	45.6	60.6	38.0	17.2	3.5	4.2	3.9	6.8	12.6	18.3	**342**
10	21.2	3.9	3.3	6.8	15.4	2.0	0.0	0.0	5.5	18.3	12.6	18.3	44.6	74.2	66.3	55.9	79.8	32.4	6.8	0.0	2.6	0.0	0.0	0.7	**470**
11	0.7	0.0	2.0	0.0	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	1.3	1.3	0.0	**8**
12	1.3	6.8	9.7	9.7	9.7	6.1	0.7	0.0	3.3	23.0	38.0	8.4	21.3	40.9	36.2	20.1	15.4	202.3	7.1	0.7	0.0	0.0	0.0	0.0	**460**
13	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.7	51.2	56.9	50.3	50.3	62.9	85.5	58.2	129.0	129.0	110.8	13.7	25.3	1.3	0.0	0.7	1.3	**828**
14	6.8	3.3	1.3	0.7	1.3	3.3	0.0	0.0	19.5	15.4	9.0	7.7	17.2	20.1	42.7	37.4	110.9	48.1	1.3	0.7	0.7	0.7	0.0	0.0	**348**
15	0.0	0.0	0.7	0.7	0.7	0.7	0.0	0.7	15.9	44.6	61.6	66.3	85.5	83.2	99.0	85.5	91.1	122.8	49.3	1.3	12.6	1.3	6.8	3.9	**834**
16	2.0	2.0	3.9	3.9	3.9	2.6	0.0	0.0	1.3	12.6	11.9	6.8	40.9	50.3	0.7	0.7	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	**145**
17	0.0	0.0	0.0	0.0	0.0	0.0	11.8	0.7	0.0	12.4	30.6	66.3	99.0	66.3	77.6	114.9	134.7	158.4	105.3	56.9	3.5	0.7	0.0	0.7	**939**
18	0.0	0.7	0.7	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**3**
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	**1**
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	58.4	0.0	0.0	55.7	0.0	0.0	0.0	**114**
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0**
22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0**
23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	34.5	29.2	10.8	0.0	0.0	0.0	0.0	0.0	**74**
24	0.0	0.0	0.0	0.0	0.0	4.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	63.8	58.7	48.4	66.3	35.3	18.3	41.7	**337**
25	49.3	27.7	17.2	25.9	25.9	15.3	1.3	0.0	0.0	0.7	23.0	23.0	9.7	17.2	30.6	20.1	13.7	0.7	1.3	2.6	15.4	3.9	9.7	6.8	**341**
26	12.6	6.8	12.6	6.8	2.6	0.7	0.7	0.0	0.7	2.0	0.7	9.7	9.0	5.5	56.8	102.4	68.0	74.2	22.7	2.0	0.0	0.0	0.0	0.0	**396**
27	7.7	0.7	0.7	6.8	6.1	2.0	0.0	0.0	0.7	36.1	75.1	49.3	39.9	25.9	18.3	30.6	55.0	61.6	0.0	0.0	0.0	0.0	0.0	0.0	**416**
28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0**
29	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0**
30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0**
31	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0**
KWh	**108**	**56**	**77**	**92**	**86**	**50**	**30**	**72**	**147**	**370**	**469**	**556**	**778**	**956**	**903**	**1043**	**1150**	**1457**	**586**	**214**	**189**	**71**	**101**	**96**	**9658**

Appendix-II

Ramatkoor August 2007 Wind Power Output of Bonus 600/44 Turbine (Month's Summary)

Dt./Hrs	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24 Hrs
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.5	2.0	0.0	0.0	0.0	0.0	0.0	0.0	**5**
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0**
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.5	32.4	0.0	5.5	7.7	0.7	0.0	0.0	**50**
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0**
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	82.0	66.6	21.6	1.3	16.6	20.1	34.2	23.5	0.7	**267**
6	12.6	2.0	1.3	1.3	0.0	15.4	7.1	0.0	0.0	0.0	0.0	7.7	45.6	39.9	39.9	16.6	125.1	13.1	0.7	0.0	1.3	1.3	0.7	6.8	**338**
7	1.3	0.7	0.7	4.2	9.7	18.3	0.0	0.0	0.0	0.0	4.8	35.3	13.1	2.0	18.4	4.8	45.6	25.8	8.4	15.4	12.6	9.7	18.3	18.3	**267**
8	1.3	3.3	15.4	18.3	6.8	18.3	4.2	0.0	0.0	0.0	4.2	13.1	9.0	14.4	11.9	7.7	1.3	0.0	0.7	23.0	6.8	2.0	0.7	3.3	**165**
9	0.0	0.7	1.3	0.7	0.7	0.7	0.0	0.0	19.5	44.6	21.3	27.7	5.5	45.6	11.9	12.6	23.5	8.2	4.2	1.3	0.0	0.0	0.0	0.0	**230**
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.7	2.0	0.0	0.0	0.0	0.7	0.0	0.7	2.0	20.1	13.7	2.6	11.5	4.8	2.6	**62**
11	3.9	6.8	0.7	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**13**
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0**
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0**
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.8	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.7	**15**
15	0.0	0.7	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	2.0	2.0	16.6	35.3	20.1	12.6	20.1	20.1	25.3	116.0	0.7	0.7	13.1	6.1	**292**
16	9.7	12.6	2.6	15.4	18.3	11.3	0.0	0.0	0.0	0.0	8.4	15.4	27.7	36.2	50.3	35.3	46.6	50.3	4.8	2.0	1.3	3.3	1.3	0.0	**352**
17	0.0	0.0	0.0	0.0	3.9	2.0	0.0	0.0	0.0	0.0	0.0	0.7	2.6	4.2	17.2	18.3	51.2	8.9	0.0	0.0	0.0	0.7	0.0	1.3	**111**
18	0.7	0.7	0.0	2.6	3.9	6.8	0.7	0.0	0.0	0.0	2.6	2.6	32.4	35.3	48.4	55.9	23.4	1.3	0.0	0.0	2.6	0.0	0.0	0.0	**220**
19	0.0	1.3	0.0	0.7	3.9	2.6	0.0	0.0	1.3	8.4	39.9	11.3	11.9	4.8	8.4	9.0	9.0	20.6	11.9	0.0	0.7	0.0	41.4	0.7	**188**
20	0.0	0.0	59.2	0.0	0.0	0.0	0.0	0.0	0.0	4.8	23.5	66.3	77.6	45.6	63.8	71.9	85.5	66.3	55.9	63.8	1.3	0.7	0.0	0.0	**686**
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0**
22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	5.5	0.7	0.7	4.2	0.0	0.0	4.8	25.3	4.8	8.9	3.3	3.9	3.9	1.3	**68**
23	0.0	0.0	0.0	0.0	1.3	2.0	0.7	0.0	0.0	0.0	1.3	15.4	8.4	4.8	7.7	15.9	10.2	0.0	4.2	0.0	0.0	0.0	0.0	0.0	**72**
24	0.0	0.0	0.0	0.0	0.0	2.0	0.7	0.0	0.7	2.0	3.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	**9**
25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	4.8	5.5	14.8	43.0	42.7	38.0	61.6	23.5	0.0	0.0	0.0	0.0	0.0	**235**
26	0.0	0.7	0.0	0.0	0.7	0.0	0.0	0.0	1.3	31.0	137.5	26.0	0.0	0.7	124.0	89.3	16.6	50.3	4.2	1.3	1.3	2.6	0.0	0.7	**488**
27	0.7	2.6	2.0	2.0	21.2	1.3	0.0	0.0	0.0	0.0	3.9	15.4	9.7	6.1	2.6	2.0	2.0	37.0	2.0	0.7	2.0	6.8	15.4	9.7	**145**
28	15.4	15.4	12.6	6.8	2.6	3.3	2.0	0.0	0.0	0.0	0.0	2.0	4.2	16.5	12.6	1.3	28.2	40.9	1.3	1.3	3.3	6.1	2.6	1.3	**179**
29	0.0	0.0	0.0	0.0	0.0	2.6	0.0	0.0	0.0	11.9	9.7	9.0	17.2	11.3	122.7	40.1	4.8	1.3	7.7	2.6	3.9	9.7	3.3	1.3	**259**
30	0.0	0.7	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	21.2	12.6	23.0	35.3	14.1	10.6	0.0	0.0	24.8	12.6	0.7	0.7	0.0	**159**
31	0.7	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.7	0.0	2.0	7.7	2.0	1.3	8.4	23.0	17.2	2.0	0.0	1.3	0.0	0.0	1.3	1.3	**69**
KWh	**46**	**48**	**96**	**52**	**74**	**86**	**16**	**0**	**24**	**105**	**274**	**296**	**304**	**346**	**647**	**555**	**638**	**491**	**181**	**298**	**84**	**94**	**132**	**56**	**4943**

Appendix-II

Ramatkoor September 2007 Wind Power Output of Bonus 600/44 Turbine (Month's Summary)

Dt./Hrs	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24 Hrs
1	0.7	6.8	0.0	0.7	3.9	3.9	5.5	0.0	3.5	9.5	13.1	17.2	18.8	45.6	66.6	11.3	46.6	14.4	1.3	2.0	6.1	0.7	3.9	3.9	**286**
2	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.7	0.7	0.0	47.4	24.8	55.9	56.9	56.3	22.4	1.3	1.3	2.0	6.8	9.7	2.0	3.9	**295**
3	3.3	1.3	0.0	6.8	2.6	3.3	0.0	0.0	4.2	0.0	12.6	21.9	39.9	30.6	37.1	30.6	64.8	4.8	19.5	0.7	6.1	9.7	1.3	2.0	**303**
4	9.7	6.8	3.9	12.6	18.3	18.3	2.6	0.0	0.0	0.0	0.7	2.0	2.0	1.3	1.3	4.8	5.5	0.7	4.8	0.0	1.3	0.0	0.0	0.7	**97**
5	0.0	0.0	0.0	0.0	2.0	2.6	2.0	0.0	0.0	0.7	9.7	50.3	50.3	39.9	35.3	42.7	64.8	24.0	1.3	5.5	0.7	20.0	0.0	0.0	**351**
6	0.7	2.6	1.3	0.7	0.0	2.0	1.3	0.0	1.3	0.0	0.0	8.9	24.7	56.9	12.6	22.9	23.0	1.3	4.2	1.3	0.0	0.0	0.0	4.8	**170**
7	18.3	0.7	0.0	0.0	0.0	3.9	2.0	0.0	0.0	4.8	20.1	30.6	30.6	39.9	39.9	23.0	25.9	15.9	9.0	3.9	1.3	2.6	6.8	6.8	**286**
8	2.6	2.6	0.7	0.7	0.0	0.0	0.0	0.0	0.0	5.5	32.9	23.0	13.1	0.0	11.9	5.5	77.6	11.8	3.5	18.3	27.7	25.9	4.8	0.0	**268**
9	2.6	1.3	2.0	2.6	2.0	2.0	0.0	0.0	0.0	0.0	1.3	0.0	11.9	14.1	8.4	4.8	8.4	1.3	2.6	1.3	3.5	24.2	7.7	0.7	**103**
10	9.0	6.1	6.8	6.1	2.6	9.7	3.3	0.0	0.0	0.0	4.8	18.3	9.7	12.6	2.0	9.0	60.6	29.2	15.9	9.7	2.0	3.5	18.3	15.4	**255**
11	14.1	0.7	1.3	1.3	0.0	0.0	0.0	0.0	0.0	8.4	3.3	15.4	30.6	49.3	55.9	50.3	29.8	0.7	17.7	16.6	9.0	3.9	6.8	3.9	**319**
12	3.9	3.3	0.7	3.3	2.6	5.5	2.6	0.0	0.0	1.3	20.1	18.3	49.3	35.3	35.3	55.0	30.6	13.7	35.3	23.0	9.7	0.7	1.3	0.7	**351**
13	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	8.4	2.6	9.7	22.4	35.3	4.2	4.8	5.5	0.7	15.4	6.1	3.3	0.0	0.0	**120**
14	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	7.7	2.0	0.0	1.3	2.0	8.4	1.3	1.3	0.0	0.0	0.7	**26**
15	0.7	2.0	0.0	0.0	0.0	0.0	0.0	3.5	2.6	4.2	0.0	1.3	25.9	25.8	9.0	23.5	0.0	0.7	0.7	5.5	3.3	1.3	11.5	3.9	**125**
16	9.7	2.6	0.0	0.0	0.0	0.0	0.0	0.0	2.0	5.5	3.3	6.8	4.2	11.9	6.8	1.3	2.6	0.7	0.0	11.3	2.0	0.7	3.9	2.6	**78**
17	4.8	19.5	15.4	5.5	0.7	6.8	0.0	0.0	17.4	0.0	0.0	0.7	0.0	0.7	9.0	8.4	0.7	8.2	0.7	4.2	0.0	0.7	2.0	3.3	**108**
18	0.7	0.0	1.3	6.1	4.2	0.0	0.7	0.0	0.0	2.0	9.7	18.3	15.4	21.2	21.2	8.4	0.0	2.6	12.6	3.9	15.4	9.0	2.0	2.6	**157**
19	3.3	3.9	1.3	3.3	3.3	3.9	2.6	0.0	0.0	9.0	16.6	4.8	0.0	0.0	68.9	0.0	0.0	5.5	8.4	9.7	18.3	21.2	21.2	21.2	**226**
20	21.2	21.2	15.4	21.2	12.6	9.7	2.0	0.0	0.0	0.0	58.4	101.9	93.4	60.6	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**418**
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0**
22	0.0	0.0	0.0	0.0	0.0	2.0	11.9	4.2	0.0	0.0	15.9	0.7	27.0	2.0	4.8	0.0	0.7	0.7	18.3	21.2	15.4	2.0	6.8	12.6	**146**
23	9.0	15.4	18.3	8.4	9.7	9.0	1.3	0.0	0.0	0.7	0.0	1.3	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.7	13.7	12.6	**109**
24	7.1	0.0	7.7	6.8	2.0	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**25**
25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0**
26	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**1**
27	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.1	16.6	7.7	23.1	11.8	0.7	7.7	4.2	14.8	23.0	**130**
28	4.8	50.3	42.7	4.8	15.4	1.3	0.7	0.0	0.0	0.0	0.7	27.7	35.3	39.9	51.2	40.9	14.4	20.1	6.8	12.6	31.7	9.7	5.5	12.6	**429**
29	23.0	9.7	9.7	18.3	2.6	11.9	2.6	0.0	0.0	0.7	2.6	39.9	44.6	22.4	1.3	31.7	21.9	25.9	9.7	35.3	32.4	49.3	39.9	35.3	**470**
30	39.9	44.6	35.3	39.9	21.2	15.4	2.0	0.0	0.0	0.0	1.3	15.4	12.6	4.8	4.2	4.8	9.7	12.6	14.1	34.2	55.0	39.9	39.9	21.3	**468**
KWh	**193**	**201**	**164**	**149**	**106**	**111**	**44**	**8**	**32**	**54**	**235**	**475**	**577**	**601**	**597**	**456**	**523**	**226**	**208**	**239**	**263**	**249**	**214**	**194**	**6119**

Appendix-II

Ramatkoor October 2007 Wind Power Output of Bonus 600/44 Turbine (Month's Summary)

Dt./Hrs	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24 Hrs
1	8.4	0.7	2.0	0.7	0.7	5.5	23.0	0.0	0.0	0.0	0.7	2.0	15.4	23.0	20.1	20.6	11.8	3.5	9.7	15.4	30.6	21.2	44.6	44.6	304
2	21.2	30.6	23.0	21.2	27.7	25.9	6.8	0.0	0.0	1.3	4.8	0.7	2.6	3.5	8.9	1.3	0.7	9.7	13.1	0.0	15.9	9.7	5.5	25.9	260
3	25.9	44.6	0.0	23.5	19.5	3.5	0.0	0.0	0.0	0.0	1.3	3.9	2.6	2.0	3.9	14.8	5.5	4.8	39.9	36.4	7.7	25.9	20.1	39.9	326
4	39.9	39.9	44.6	25.9	35.3	35.3	14.1	0.0	0.0	0.0	1.3	24.8	60.6	46.6	35.3	35.3	35.3	38.4	4.2	25.9	30.6	25.9	35.3	30.6	665
5	15.4	15.4	25.9	30.6	25.9	18.3	17.2	0.0	0.0	0.0	1.3	17.2	50.3	39.9	20.1	2.6	2.0	9.0	21.2	31.5	11.9	25.9	25.9	16.6	424
6	18.3	15.4	21.3	4.2	21.2	30.6	25.9	7.7	0.0	0.0	11.3	30.6	50.3	39.9	55.9	23.5	47.7	29.5	21.2	8.4	21.2	18.3	9.0	1.3	513
7	0.0	2.0	6.1	0.7	0.0	1.3	0.7	0.0	0.0	0.7	0.0	2.6	5.5	0.7	0.0	0.0	1.3	20.1	27.7	55.0	49.3	50.3	27.7	3.3	255
8	2.6	0.0	20.6	36.2	18.8	5.5	0.7	0.0	0.0	0.0	0.0	6.1	24.8	35.3	50.3	35.1	11.3	12.6	30.6	15.9	20.1	35.3	35.3	50.3	447
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	4.2	15.4	35.3	17.2	11.9	8.4	23.0	35.3	35.3	39.9	44.6	44.6	49.3	365
10	35.3	35.3	25.9	18.3	0.0	0.0	1.3	0.0	0.0	0.0	0.0	4.8	10.6	11.3	15.3	20.6	5.5	0.0	0.0	0.0	3.5	1.3	0.0	0.0	189
11	7.1	21.2	11.8	27.0	4.8	18.3	21.2	6.1	0.0	0.0	0.0	7.7	30.6	15.4	14.1	0.0	0.0	0.0	0.0	0.0	7.7	0.0	0.0	0.7	194
12	0.0	35.3	27.7	14.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.3	9.0	0.0	0.0	0.0	0.0	0.0	11.8	35.3	25.9	35.3	30.6	237
13	25.9	18.8	0.0	0.0	3.5	23.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.6	7.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	96
14	0.0	0.0	0.0	0.7	11.8	0.0	12.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22.7	23.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.5	74
15	0.0	0.0	0.0	0.0	20.6	15.4	9.7	0.7	0.0	0.0	0.0	0.0	0.7	7.1	0.0	0.0	4.8	10.6	0.0	0.0	0.0	1.3	0.0	0.0	71
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	1.3	0.0	0.0	0.0	0.0	0.0	0.7	4.2	0.0	0.0	35.3	30.6	8.4	81
17	15.4	24.8	44.6	34.2	7.1	4.2	0.0	0.0	0.0	0.0	17.7	35.3	39.9	24.2	0.0	0.0	0.0	0.0	4.2	0.0	0.0	2.0	1.3	0.0	255
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.7	8.4	2.6	0.0	0.0	0.0	0.0	12
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	1.3	4.8	26.9	10.6	0.0	0.0	0.7	0.0	0.0	0.0	0.0	45
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.2	0.7	6.1	3.5	0.0	0.0	0.0	0.7	1.3	0.0	0.0	16
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0.7	2.6	0.7	1.3	0.0	4.2	0.0	0.0	0.0	15.9	15.4	9.7	52
22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	9.7	9.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21
23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	19.5	0.7	17.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	37
24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0.7	0.0	12.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14
25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4
26	7.1	9.0	4.2	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21
27	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.7	0.0	0.0	15.3	0.0	0.0	0.0	0.0	0.0	2.6	9.7	0.0	29
28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	30.3	30.3	0.0	0.0	0.0	0.0	0.0	61
29	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.8	9.0	4.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18
30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.2	14.8	0.7	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22
31	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1
KWh	222	293	258	238	197	187	134	15	0	2	41	150	336	362	280	279	156	197	250	239	274	342	340	314	5106