PAKISTAN METEOROLOGICAL DEPARTMENT

A STUDY OF WIND POWER POTENTIAL AT NIZAMPUR-NWFP

By:

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(Preliminary Report based on 18 months data)
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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 18 months wind data has been presented along with the wind generated electric power at Nizampur. Wind data with one minute and ten 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 average wind speed of 2.18 m/s during Eighteen months *March-2007 to November-2008* the highest of 3.10 m/s is observed in June. Seasonal Diurnal Wind variation indicates that maximum wind speed is available in the noon through-out the whole period. Wind frequency distribution shows that during 6.4% 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 average power density of Nizampur at 50m is 25 w/m^2 according to international wind classification, this power density categorize Nizampur as a below marginal site for wind power generation.

Wind generated electric power has also been computed on hypothetical 600Kw wind turbine and its hourly, monthly and annual values has been added in this report. The total power production from a single 600kw wind turbine come out to 103,652 kWh which shows the capacity factor of 2% for Nizampur. Internationally it is accepted that if any site has a capacity factor of 25% and above than that site is suitable for installation of economically viable wind power farms. As such Nizampur 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 is 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 is 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:

Nizampur, Bahrain, Kalam, Khawazakhaila, Malamjabba, Tahash, Fatehpur, Dir, Tarbella, Lowaramina, Warsak, Chitral City, Drosh, Mirkhani, Shagore, Garam Chasma, Khagozi, Reshan, Mastuj, Kalash, Ayune, Astore, Bunji, Khungi-Payan, Gilgit, Gupis, Sost, Passu, Aliabad, Shigar, Barapayan, Sermik, owaramaina, Ramatkore, ShahidaSir, Danakool, Besham, Moorti Pahari, Rangla, Pedar, Lempiapatian, Dargaye, Chilas.

Nizampur is situated in District Nowshera, NWFP. Latitude & Longitude of Nizampur is:

Lat = 35.12°, Long = 72.32°, Elevation = 3042 Ft.

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. 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

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.

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

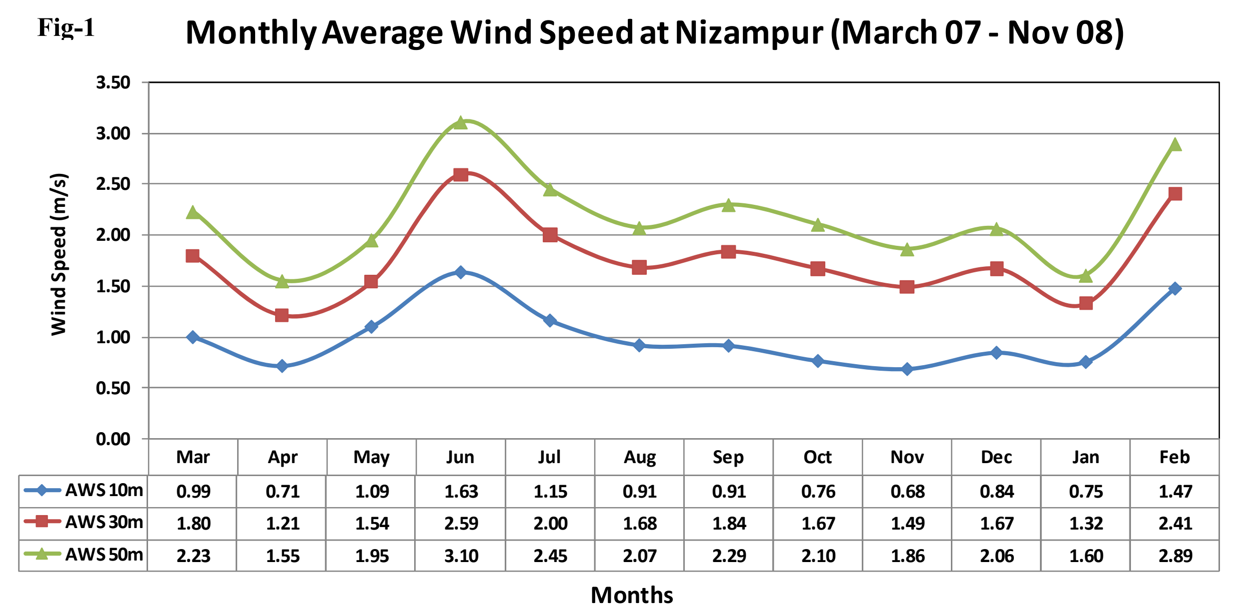
Type of terrain	**Z_0**	**α**
Mud Flats, Ice	10^{-5} to $3x\ 10^{-5}$	
Calm Sea	$2x10^{-4}$ to $3x10^{-4}$	
Sand	$2x10^{-4}$ to 10^{-3}	0.01
Mown Grass	0.001 to 0.01	
Low Grass	0.01 to 0.04	0.13
Fallow Field	0.02 to 0.03	
High Grass	0.04 to 0.1	0.19
Forest and Woodland	0.1 to 1	
Built up area, Suburb	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 1 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 1.77 m/s from March-07 to Nov-08 where as maximum average wind speed of 2.59 m/s at this height is during June. At 50 meters we have the annual average wind speed of 2.18 m/s from March-07 to Nov-08.

Fig-1

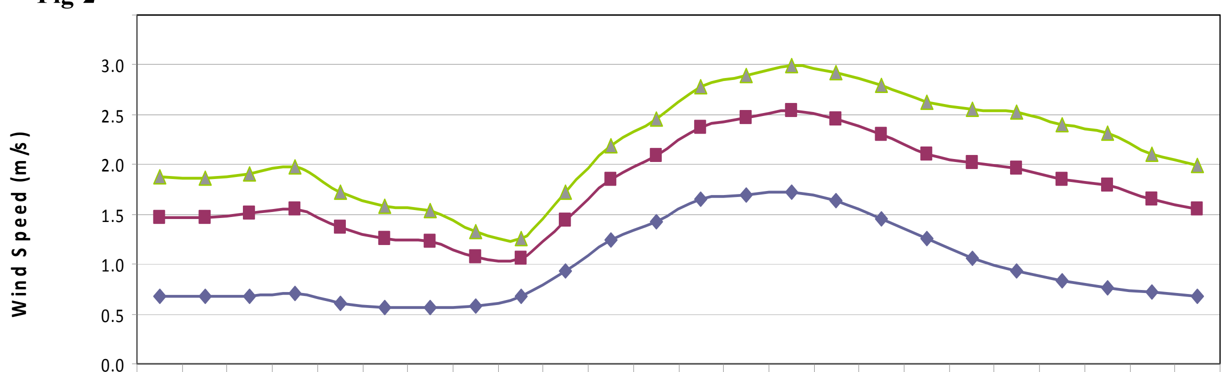


	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
AWS 10m	0.99	0.71	1.09	1.63	1.15	0.91	0.91	0.76	0.68	0.84	0.75	1.47
AWS 30m	1.80	1.21	1.54	2.59	2.00	1.68	1.84	1.67	1.49	1.67	1.32	2.41
AWS 50m	2.23	1.55	1.95	3.10	2.45	2.07	2.29	2.10	1.86	2.06	1.60	2.89

3.3 Diurnal Wind speed Variation:

Fig-2 shows the diurnal wind speed variations at Nizampur for 18 months (March-07 to Nov-08). The wind speed is generally lower during morning and in the noon it starts picking up and reaches maximum around 03 p.m. which is around 2.5 m/s and 2.9 m/s at 30 meters and 50 meters height respectively. Figure-2 shows that the maximum wind speed during noon times at 50 meters height reaches to 2.8 m/s at 01:00 p.m.

Fig-2 Diurnal Variation Wind Speed at Nizampur (March 07 - Nov 08)

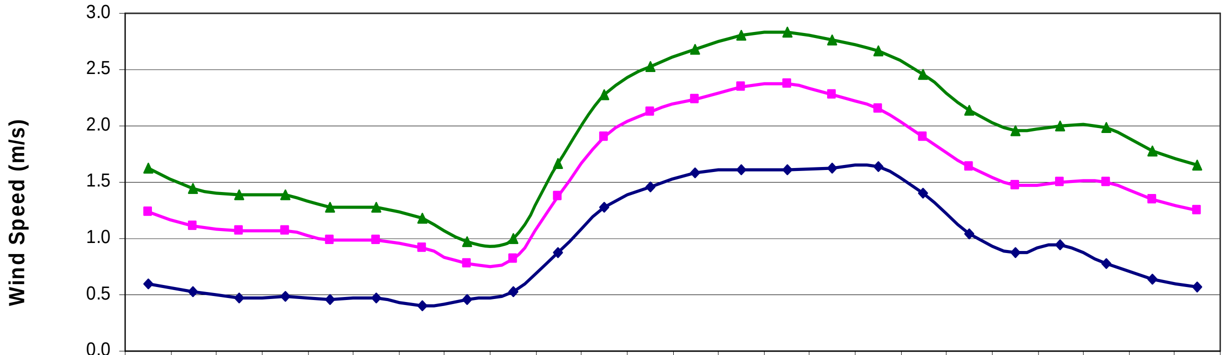


	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
WS 10m	0.7	0.7	0.7	0.7	0.6	0.6	0.6	0.6	0.7	0.9	1.2	1.4	1.6	1.7	1.7	1.6	1.5	1.3	1.1	0.9	0.8	0.8	0.7	0.7
WS 30m	1.5	1.5	1.5	1.6	1.4	1.3	1.2	1.1	1.1	1.4	1.9	2.1	2.4	2.5	2.5	2.5	2.3	2.1	2.0	2.0	1.8	1.8	1.6	1.6
WS 50m	1.9	1.9	1.9	2.0	1.7	1.6	1.5	1.3	1.3	1.7	2.2	2.5	2.8	2.9	3.0	2.9	2.8	2.6	2.6	2.5	2.4	2.3	2.1	2.0

PST (Hours)

Fig-3, Fig-4, Fig-5 and Fig-6 shows the seasonal diurnal wind speed variations at Nizampur for (Mar-May), (Jun-Aug), (Sep-Nov) and (Dec-Feb) respectively.

Fig-3 Diurnal Variation Wind Speed at Nizampur (Mar to May)

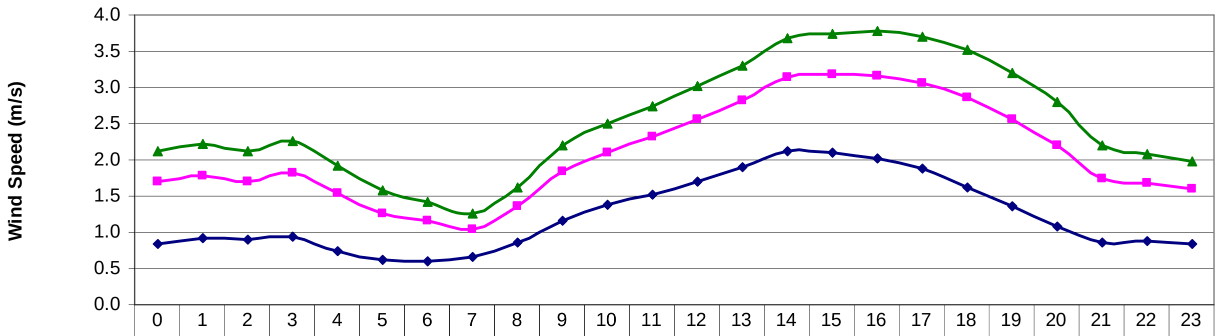


	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
WS 10m	0.6	0.5	0.5	0.5	0.5	0.5	0.4	0.5	0.5	0.9	1.3	1.5	1.6	1.6	1.6	1.6	1.6	1.4	1.0	0.9	0.9	0.8	0.6	0.6
WS 30m	1.2	1.1	1.1	1.1	1.0	1.0	0.9	0.8	0.8	1.4	1.9	2.1	2.2	2.3	2.4	2.3	2.2	1.9	1.6	1.5	1.5	1.5	1.4	1.3
WS 50m	1.6	1.4	1.4	1.4	1.3	1.3	1.2	1.0	1.0	1.7	2.3	2.5	2.7	2.8	2.8	2.8	2.7	2.5	2.1	2.0	2.0	2.0	1.8	1.7

PST (Hours)

Fig-4

Diurnal Variation Wind Speed at Nizampur (Jun to Aug)

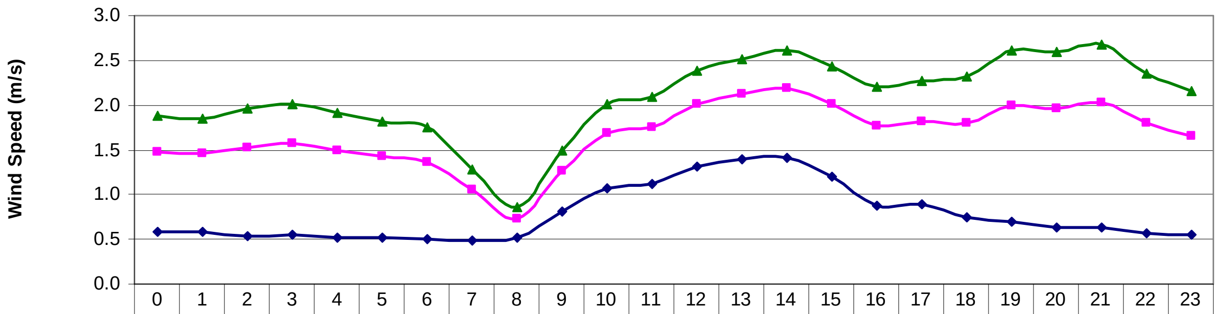


PST (Hours)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
WS 10m	0.8	0.9	0.9	1.0	0.7	0.6	0.6	0.7	0.9	1.2	1.4	1.5	1.7	1.9	2.1	2.1	2.0	1.9	1.6	1.4	1.1	0.9	0.9	0.8
WS 30m	1.7	1.8	1.7	1.8	1.5	1.3	1.2	1.1	1.4	1.8	2.1	2.3	2.6	2.8	3.1	3.2	3.2	3.1	2.9	2.6	2.2	1.8	1.7	1.6
WS 50m	2.1	2.2	2.1	2.3	1.9	1.6	1.4	1.3	1.6	2.2	2.5	2.7	3.0	3.3	3.7	3.7	3.8	3.7	3.5	3.2	2.8	2.2	2.1	2.0

PST (Hours)

Fig-5

Diurnal Variation Wind Speed at Nizampur (Sep to Nov)

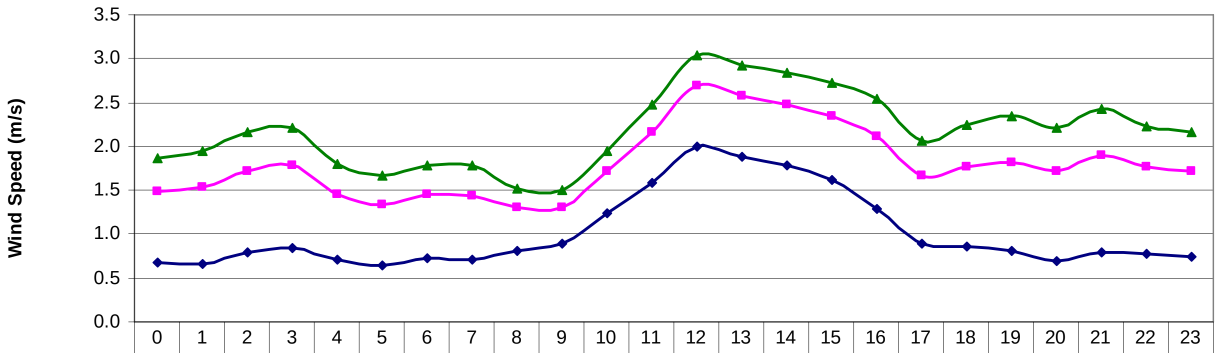


PST (Hours)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
WS 10m	0.6	0.6	0.5	0.6	0.5	0.5	0.5	0.5	0.5	0.8	1.1	1.1	1.3	1.4	1.4	1.2	0.9	0.9	0.7	0.7	0.6	0.6	0.6	0.5
WS 30m	1.5	1.5	1.5	1.6	1.5	1.4	1.4	1.0	0.7	1.3	1.7	1.8	2.0	2.1	2.2	2.0	1.8	1.8	1.8	2.0	2.0	2.0	1.8	1.7
WS 50m	1.9	1.8	2.0	2.0	1.9	1.8	1.7	1.3	0.9	1.5	2.0	2.1	2.4	2.5	2.6	2.4	2.2	2.3	2.3	2.6	2.6	2.7	2.3	2.2

PST (Hours)

Fig-6

Diurnal Variation Wind Speed at Nizampur (Dec to Feb)



PST (Hours)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
WS 10m	0.7	0.7	0.8	0.8	0.7	0.6	0.7	0.7	0.8	0.9	1.2	1.6	2.0	1.9	1.8	1.6	1.3	0.9	0.9	0.8	0.7	0.8	0.8	0.8
WS 30m	1.5	1.5	1.7	1.8	1.5	1.3	1.5	1.4	1.3	1.3	1.7	2.2	2.7	2.6	2.5	2.4	2.1	1.7	1.8	1.8	1.7	1.9	1.8	1.7
WS 50m	1.9	1.9	2.2	2.2	1.8	1.7	1.8	1.8	1.5	1.5	2.0	2.5	3.0	2.9	2.8	2.7	2.5	2.1	2.2	2.3	2.2	2.4	2.2	2.2

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

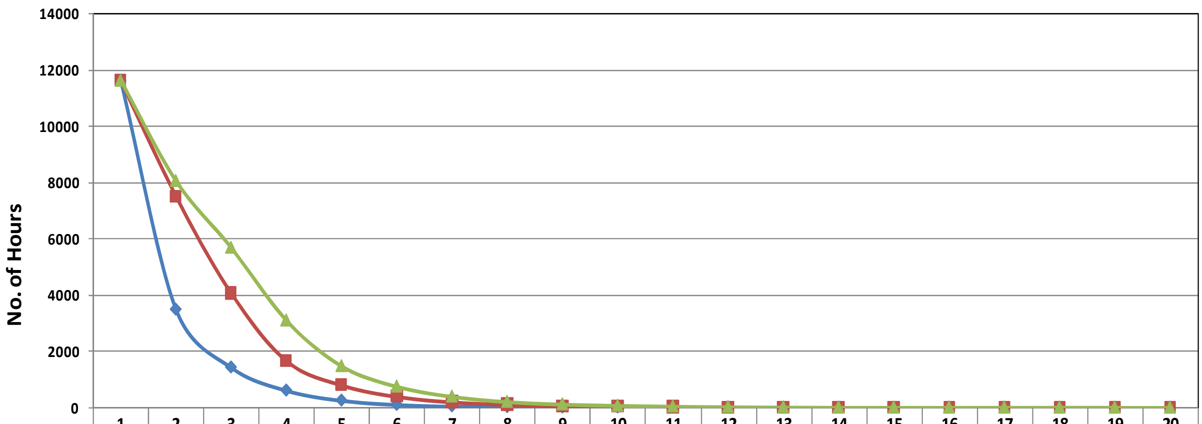
R .F = probability P (V_i) = Frequency of given wind speed / Total period

3.4.3 *Annual Cumulative Wind Frequency:*

Fig-7 shows the Cumulative Wind Frequency distribution from March 2007 to Nov 2008 at three heights 10, 30 and 50 meters. The analysis indicate that at a height of 30 meters during 794 hours the wind speed is greater than or equal to 5 m/s. Whereas at 50 meters, during 1475 hours the wind speed is equal or greater than 5m/s.

Fig-7

Cumulative Wind Speed Distribution at Nizampur (March 07 to Nov 08)



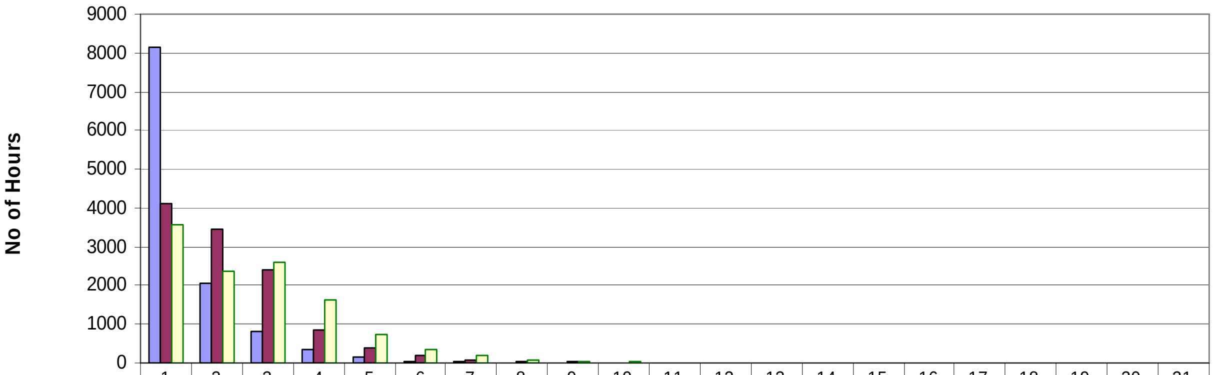
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
CWS10m	11621	3483	1425	605	250	99	44	18	6	3	2	1	0	0	0	0	0	0	0	0
CWS 30m	11621	7507	4060	1659	794	388	193	103	51	28	15	7	4	3	2	1	1	0	0	0
CWS 50m	11621	8056	5683	3099	1475	749	392	204	116	66	38	24	14	8	5	4	2	2	1	1

Wind Speed (m/s)

3.4.4 *Wind Frequency Distribution:*

Fig-8 shows the frequency distribution. We can see that at 50 meters during 726 hours wind speed is 5 m/s, 357 hours speed is 6 m/s, 187 hours speed is 7 m/s, 88 hours speed is 8 m/s and during 50 hours the wind speed is 9m/s and so on. This indicates wind potential in this area.

Fig-8 Wind Frequency Distribution at Nizampur (March 07 - Nov 08)

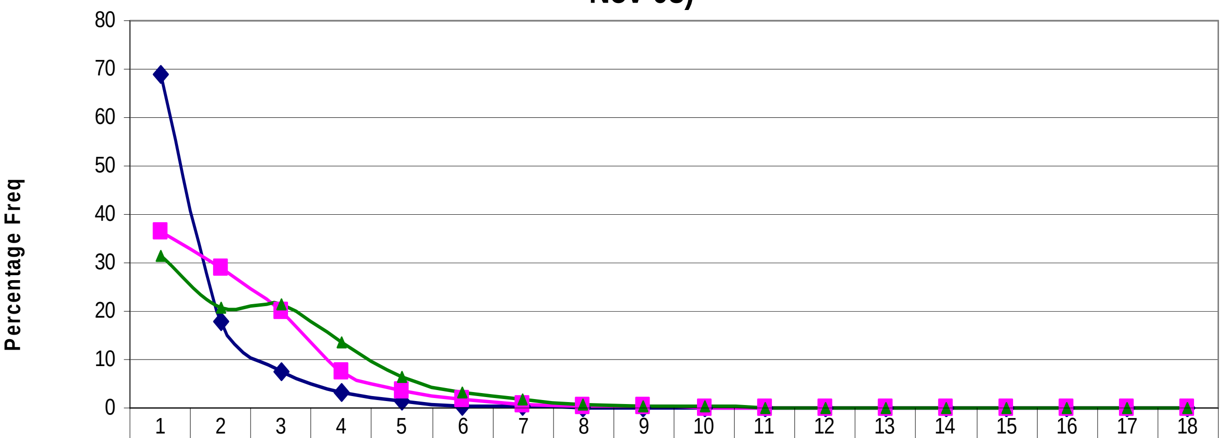


	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
CWS 10m	8138	2058	820	355	151	54	26	12	3	1	1	0	0	0	0	0	0	0	0	0	0
CWS 30m	4115	3447	2401	864	406	195	89	52	23	13	8	3	1	1	0	0	0	0	0	0	0
CWS 50m	3566	2373	2584	1624	726	357	187	88	50	28	14	10	6	3	1	2	1	0	0	0	0

Wind Speed (m/s)

Fig-9 gives this frequency distribution in percentage from March-2007 to Nov-2008. At 50 meters we find that during 6.4% of time wind is 5m/s, 3.3% of the time 6m/s and 1.7% of the time it is 7m/s. whereas at 30 meters height we get 3.7% of the time wind speed 5m/s, 1.8% of the times 6m/s and 0.8% of the time 7m/s.

Fig-9 Percenatge Wind Frequency Distribution at Nizampur (March 07 to Nov 08)



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
WS 10m	69.1	17.9	7.5	3.3	1.4	0.5	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WS 30m	36.3	28.9	20.0	7.6	3.7	1.8	0.8	0.4	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WS 50m	31.3	20.5	21.3	13.7	6.4	3.3	1.7	0.8	0.4	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0

Wind Speed (m/s)

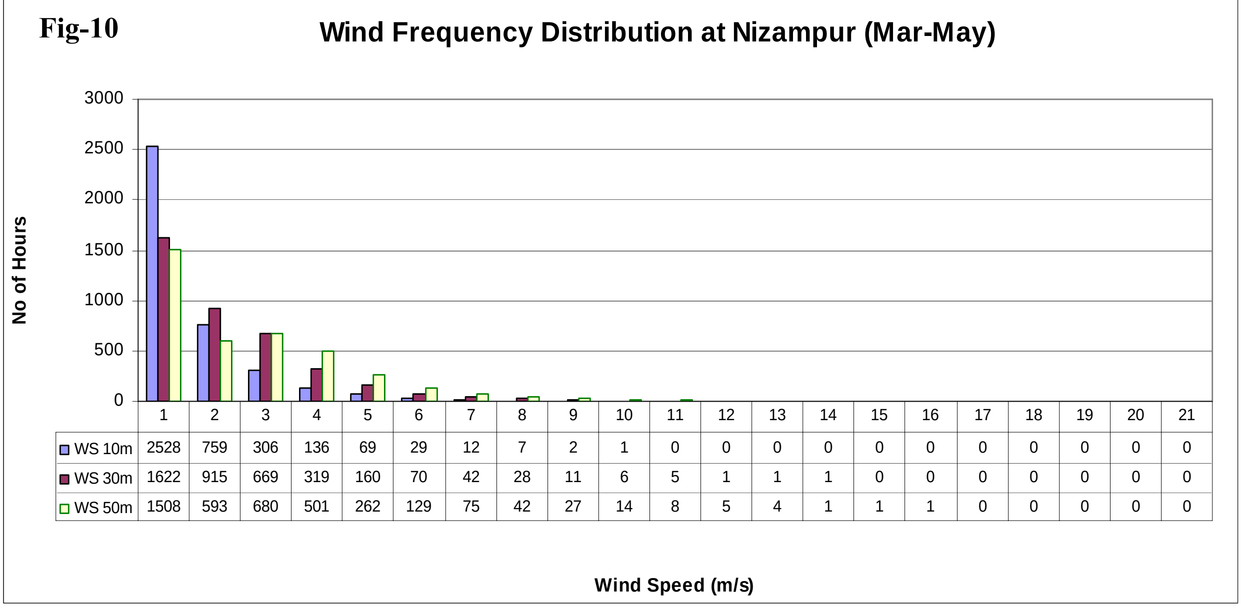
3.4.5 ***Seasonal Wind Frequency Distribution:***

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

<u>March - May</u>

Fig-10 shows frequency distribution during the months of March to May. We can see that in this period at 30 meters and 50 meters height during 160 hours and 262 hours we get 5m/s respectively.

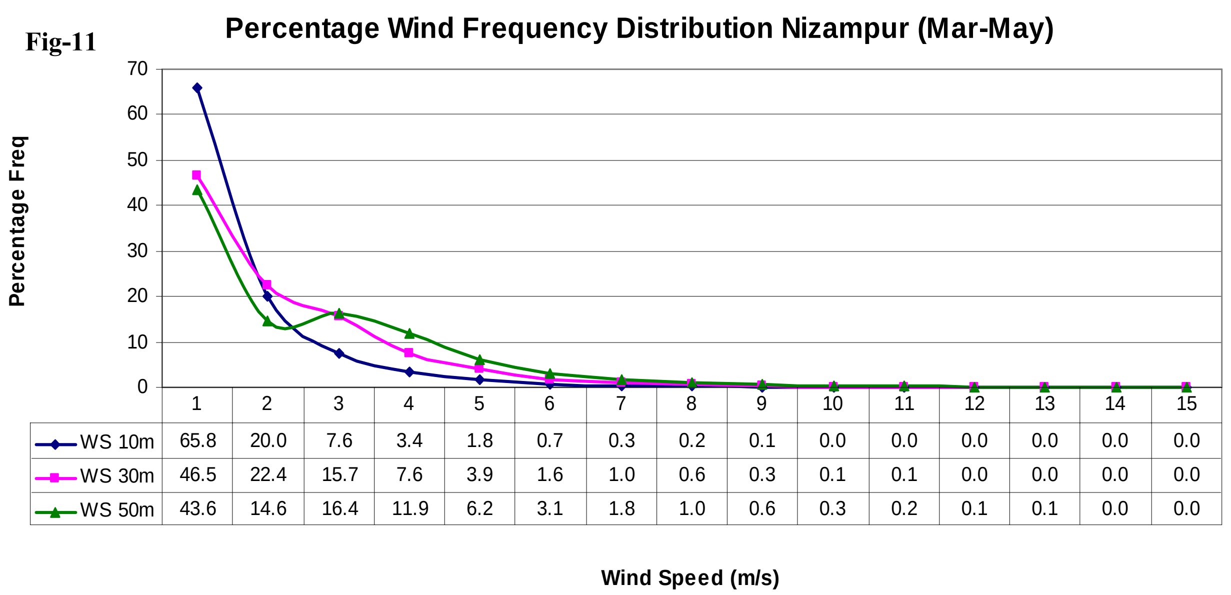
Fig-10



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
WS 10m	2528	759	306	136	69	29	12	7	2	1	0	0	0	0	0	0	0	0	0	0	0
WS 30m	1622	915	669	319	160	70	42	28	11	6	5	1	1	1	0	0	0	0	0	0	0
WS 50m	1508	593	680	501	262	129	75	42	27	14	8	5	4	1	1	1	0	0	0	0	0

Similarly in Fig-11 shows percentage frequency distribution. At 50 meters we get 6.2% of wind equal to 5m/s, 3.1% of wind equal to 6 m/s and at 30 meter 3.9% wind equal to 5m/s, 1.6% 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	65.8	20.0	7.6	3.4	1.8	0.7	0.3	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0
WS 30m	46.5	22.4	15.7	7.6	3.9	1.6	1.0	0.6	0.3	0.1	0.1	0.0	0.0	0.0	0.0
WS 50m	43.6	14.6	16.4	11.9	6.2	3.1	1.8	1.0	0.6	0.3	0.2	0.1	0.1	0.0	0.0

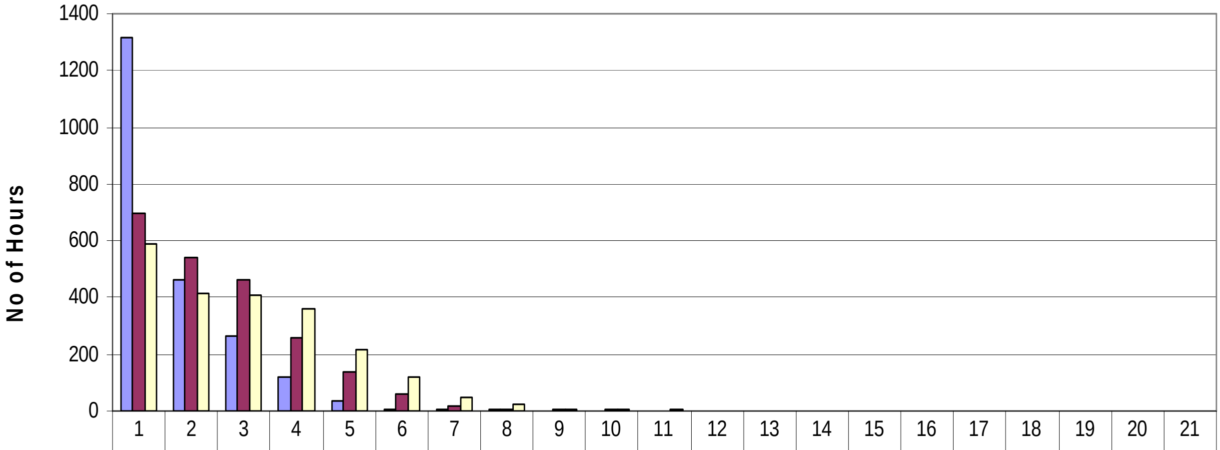
<u>June - August</u>

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 216 hours we get wind speed of 5m/s.

Fig-13 shows percentage distribution of wind frequency during the months of June to August. It shows that 6.4% and 9.9% we get wind speed of 5m/s at 30m and 50m respectively.

Fig-12

Wind Frequency Distribution at Nizampur (Jun-Aug)

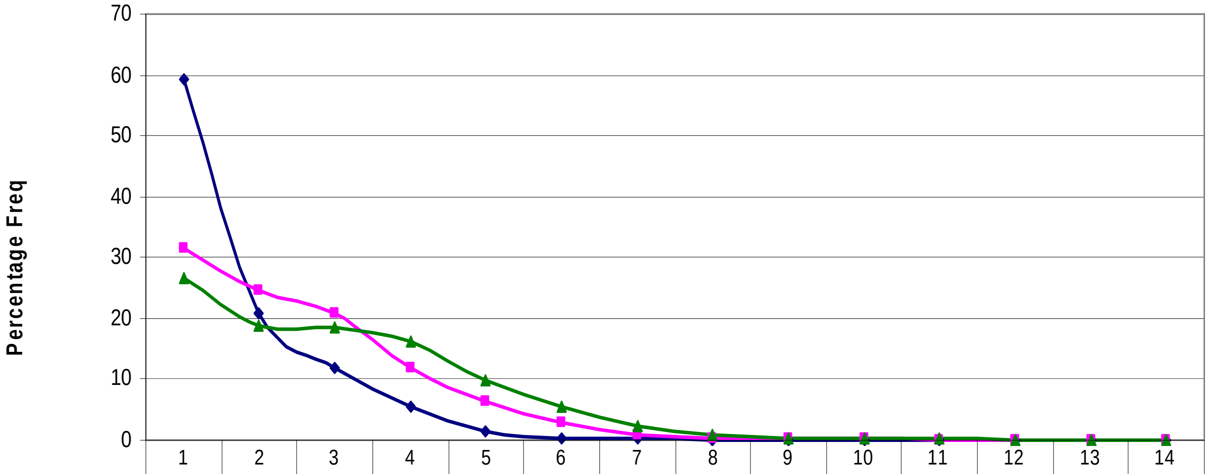


	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
WS 10m	1314	460	263	120	35	8	5	3	0	0	0	0	0	0	0	0	0	0	0	0	0
WS 30m	699	544	460	261	139	63	21	9	6	4	1	2	0	1	0	0	0	0	0	0	0
WS 50m	591	417	407	360	216	121	50	22	9	5	4	3	1	1	0	1	0	0	0	0	0

Wind Speed (m/s)

Fig-13

Percentage Wind Frequency Distribution at Nizampur (Jun-Aug)



	1	2	3	4	5	6	7	8	9	10	11	12	13	14
WS 10m	59.3	20.8	12.0	5.5	1.6	0.4	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0
WS 30m	31.6	24.6	20.8	11.9	6.4	2.9	0.9	0.4	0.2	0.2	0.1	0.1	0.0	0.0
WS 50m	26.7	18.8	18.4	16.3	9.9	5.5	2.3	1.0	0.4	0.2	0.2	0.1	0.1	0.1

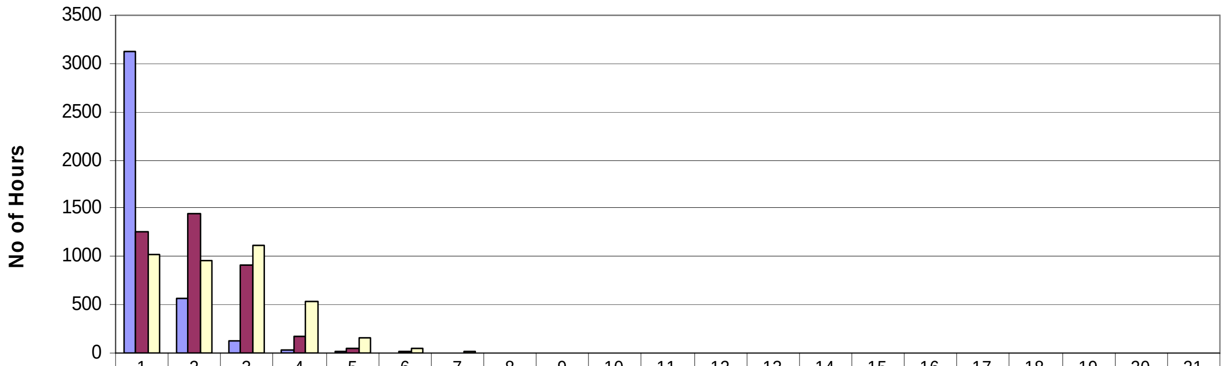
Wind Speed (m/s)

<u>September - November</u>

Fig-14 shows wind frequency distribution during the months of September to November. We can see that in this period at 30 meters height during 43 hours we get 5m/s, similarly at 50 meters height during 154 hours we get wind speed of 5m/s.

Fig-15 shows percentage distribution of wind frequency during the months of Sep to Nov. It shows that 1.3% and 4.5% we get wind speed of 5m/s at 30m and 50m respectively.

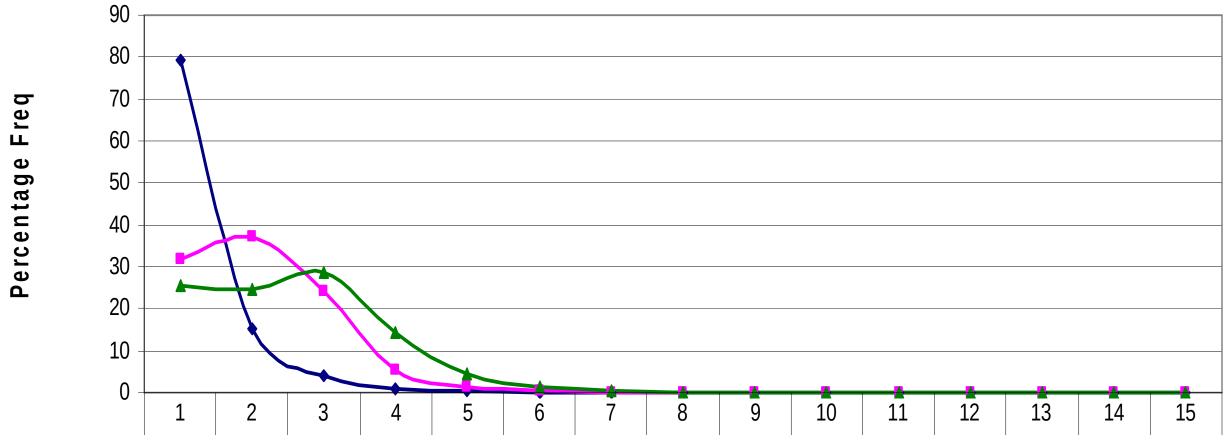
Fig-14 **Wind Frequency Distribution at Nizampur (Sep-Nov)**



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
WS 10m	3122	568	132	32	10	2	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0
WS 30m	1255	1451	914	176	43	16	7	3	2	2	1	0	0	0	0	0	0	0	0	0	0
WS 50m	1026	963	1108	534	154	49	20	8	3	2	2	2	1	0	0	0	0	0	0	0	0

Wind Speed (m/s)

Fig-15 **Percentage Wind Frequency Distribution at Nizampur (Sep-Nov)**



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
WS 10m	79.3	15.3	4.1	0.8	0.3	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WS 30m	31.6	37.1	24.0	5.3	1.3	0.4	0.2	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0
WS 50m	25.7	24.6	28.5	14.3	4.5	1.4	0.5	0.2	0.1	0.1	0.0	0.1	0.0	0.0	0.0

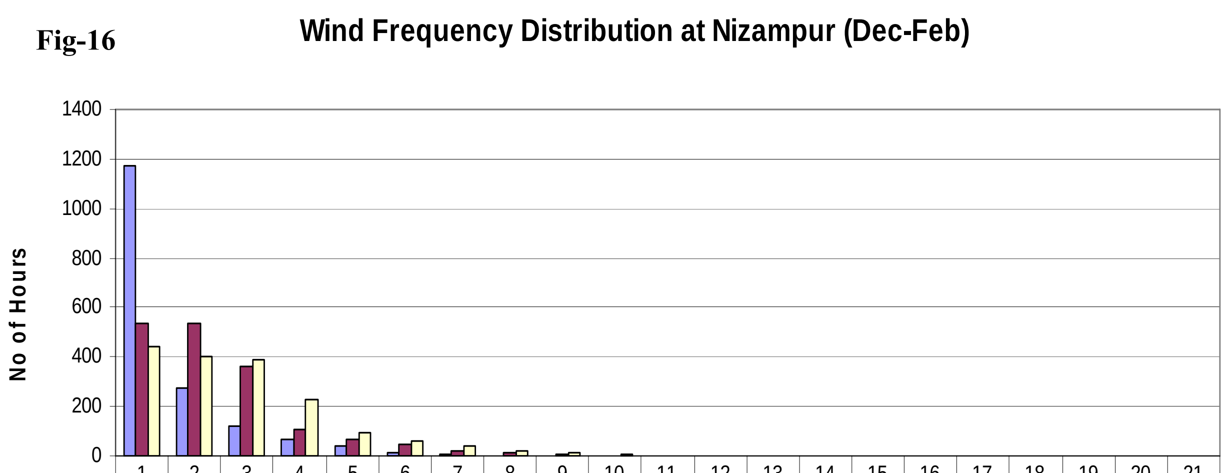
Wind Speed (m/s)

December – February

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 64 hours we get 5m/s, similarly at 50 meters height during 94 hours we get wind speed of 5m/s.

Fig-17 shows percentage distribution of wind frequency during the months of Dec to Feb. It shows that 3.4% and 5.0% we get wind speed of 5m/s at 30m and 50m respectively.

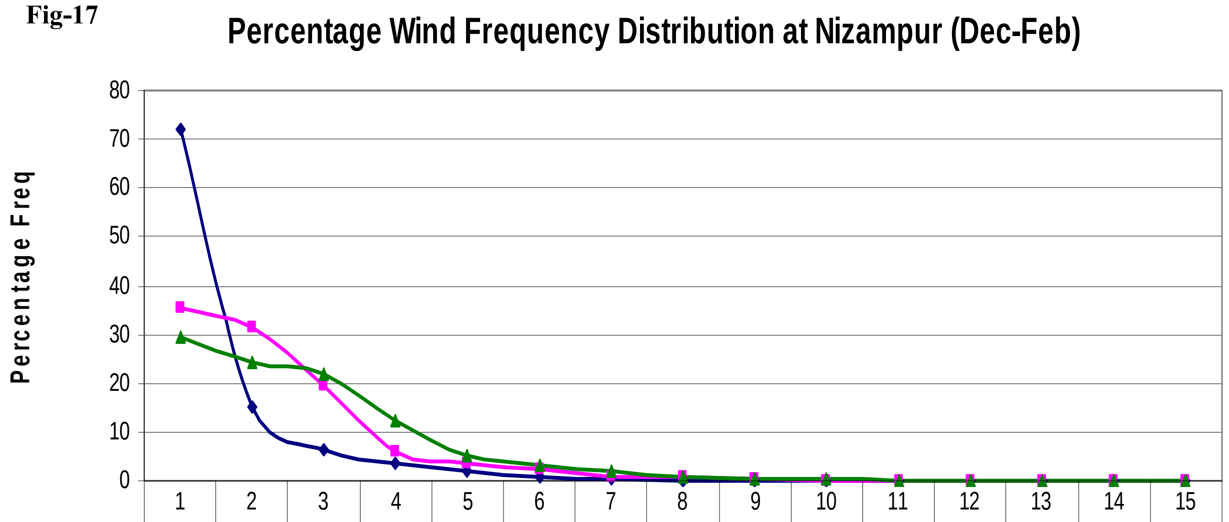
Fig-16



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
WS 10m	1175	272	119	67	37	16	7	1	0	0	0	0	0	0	0	0	0	0	0	0	0
WS 30m	539	537	359	109	64	47	20	13	4	2	0	0	0	0	0	0	0	0	0	0	0
WS 50m	441	401	389	229	94	58	43	17	12	6	1	1	0	0	0	0	0	0	0	0	0

Wind Speed (m/s)

Fig-17



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
WS 10m	71.9	15.3	6.4	3.4	1.9	0.7	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WS 30m	35.5	31.4	19.7	5.8	3.4	2.3	1.0	0.6	0.2	0.1	0.0	0.0	0.0	0.0	0.0
WS 50m	29.4	24.2	22.0	12.4	5.0	3.0	2.1	0.8	0.6	0.3	0.1	0.0	0.0	0.0	0.0

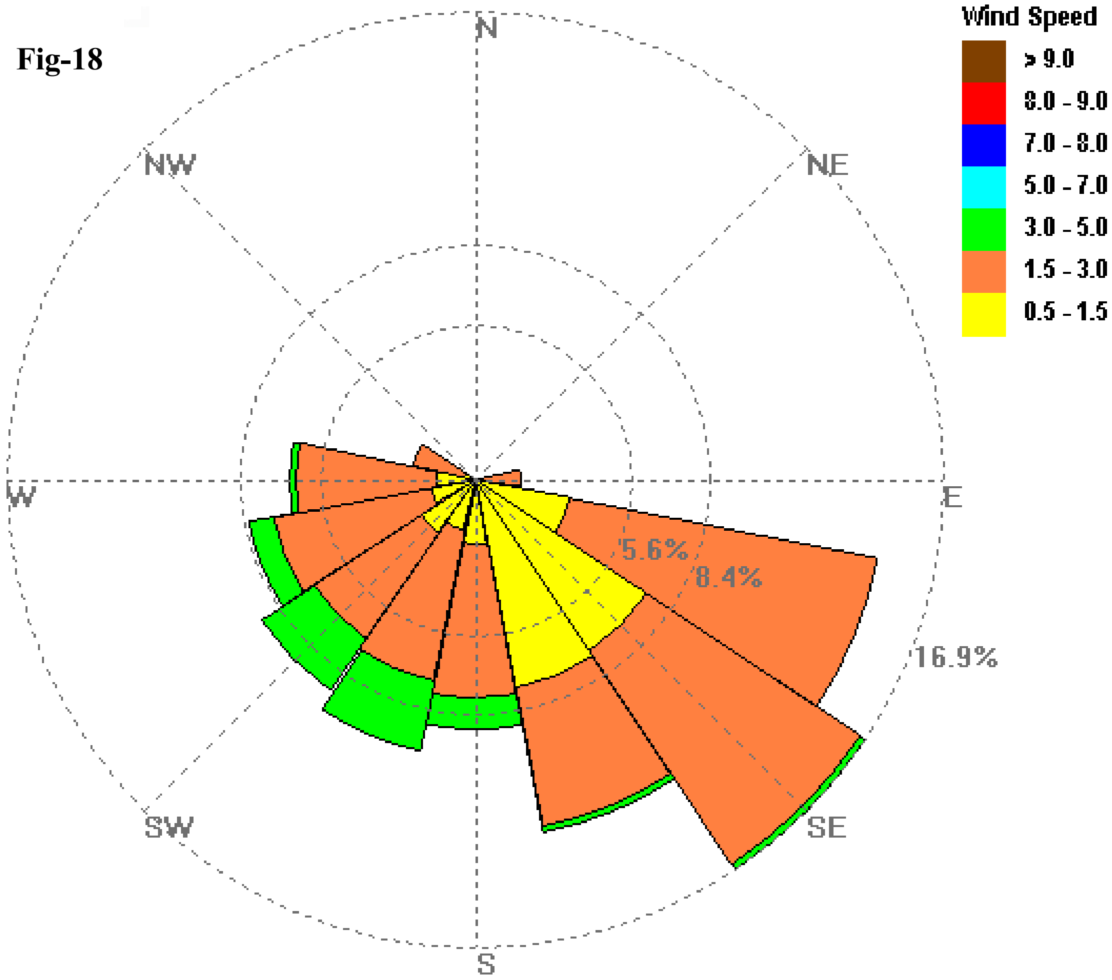
Wind Speed (m/s)

3.5 Wind Rose

Fig-18 shows the Wind Rose based on data from Mar-2007 to Nov-2008 (18 months) collected at 30 meters height. Wind Rose indicates that most of the time the wind direction was South East. The annual average wind speed at 30 meter height is 1.77 m/s and the percentage when wind speed greater than 5m/s is 3%.

Wind Rose at Nizampur (30m height)

Fig-18



Average Wind Speed	Wind greater than 5 m/s
1.77 m/s	3

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

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

From this, power density is calculated as

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

Where dm/dt is the mass of air following time.

From fluid dynamics, it can be proved that

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

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

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

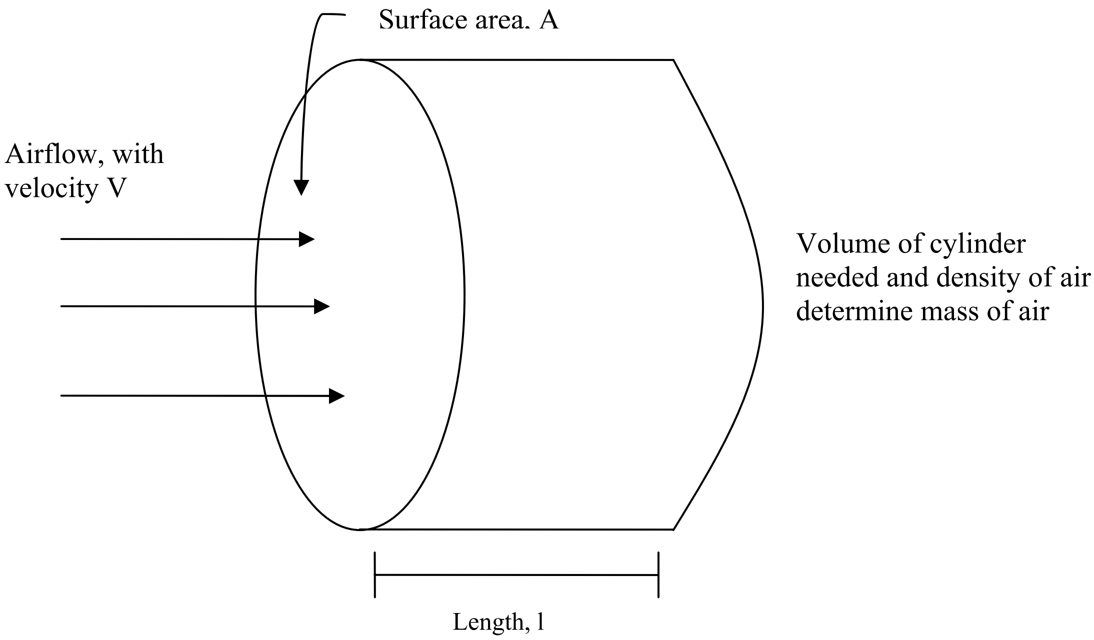
Now mass of wind can be written as

$$M = \varphi Avt$$

Differentiating

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

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



So the power is then,

$$P = \tfrac{1}{2}\, {}^{dm}\!/\!_{dt}\; V^2 = \tfrac{1}{2}\varphi AVT / t\; V^2$$

$$= \tfrac{1}{2}\varphi AV^3$$

And power density

$$P/_A = \tfrac{1}{2}\,\varphi V^{\;3}$$

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.

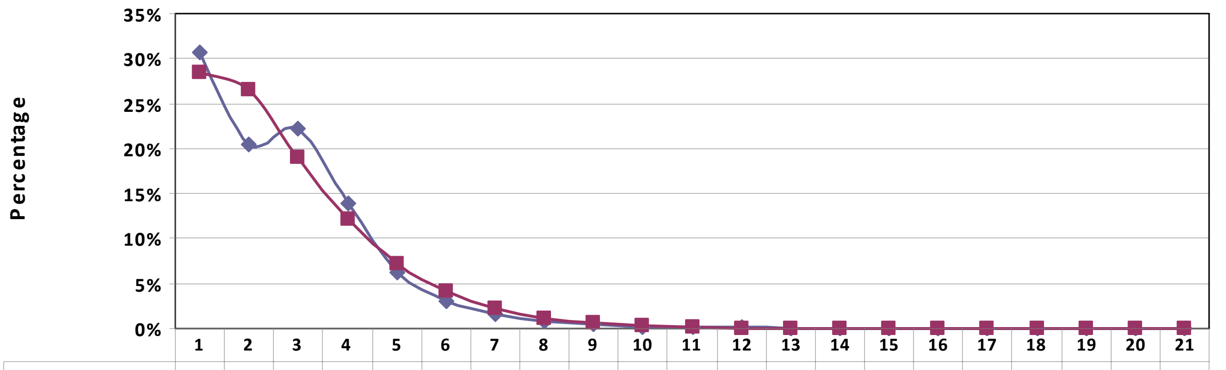
A measure of the confidence of the fit of the Weibull curve to the real data is also returned. Often the Weibull curve is a good fit to the most of the data, but a poor fit to some. If the poor fit is in the low wind speed range, i.e. below cut in it may be possible to ignore the poor fit as this portion 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 Relative Frequency and Weibull Probability at Nizampur (50 m height)



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
R.F 50m	30.7	20.4	22.2	14.0	6.2%	3.1%	1.6%	0.8%	0.4%	0.2%	0.1%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Weibull 50m	28.4	26.6	19.0	12.2	7.3%	4.1%	2.2%	1.1%	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%

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 0.98 during April to the highest of 1.68 during the month of October with an annual of K being 1.38.

The lowest values of the *scale parameter* C 1.74 m/s observed in April while the highest value of 3.50 is obtained in June and with an annual value of 2.45 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 average wind speed is 1.04 m/s with Standard deviation of 0.93, at 30 meters this average speed is 1.80 m/s with Standard deviation of 1.30.

At 50 meters the monthly average wind speed varies from the lowest of 1.61 m/s in January to highest of 3.10 m/s during June. Whereas the average wind speed is 2.24 m/s with Standard deviation of 1.69.

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 0.81 W/m^2 in November to 13.77 W/m^2 in February with Average of 4.27 W/m^2.

At 30 meters height the power density varies from 5.05 W/m^2 in November to the highest of 28.60 W/m^2 in June and the average values is about 13.52 W/m^2.

At 50 meters height the power density of Nizampur varies from 10.23 W/m^2 in January to 50.76 W/m^2 in June. The average power density of the area is 24.67 W/m^2.

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

10 m					
	AvgV (m/s)	**St Dev**	**C (m/s)**	**K**	**P/A (w/m²)**
January	0.75	0.65	0.85	1.18	**1.31**
February	1.44	1.39	1.63	1.04	**13.77**
March	1.16	1.11	1.18	1.05	**5.07**
April	0.92	0.91	0.92	1.01	**2.82**
May	1.31	1.28	1.33	1.03	**7.81**
June	1.61	1.28	1.74	1.29	**8.97**
July	1.14	1.02	1.20	1.14	**4.10**
August	0.91	0.82	0.95	1.12	**2.14**
September	0.84	0.78	0.87	1.09	**1.78**
October	0.77	0.61	0.83	1.28	**0.98**
November	0.71	0.58	0.76	1.24	**0.81**
December	0.85	0.77	0.89	1.12	**1.74**
Average	**1.04**	**0.93**	**1.10**	**1.13**	**4.27**
30 m					
	AvgV (m/s)	**St Dev**	**C (m/s)**	**K**	**P/A (w/m²)**
January	1.30	1.02	1.47	1.29	**5.28**
February	2.36	1.77	2.66	1.36	**27.96**
March	1.89	1.54	2.03	1.25	**15.38**
April	1.43	1.39	1.44	1.02	**10.03**
May	2.06	1.80	2.18	1.16	**22.90**
June	2.57	1.78	2.84	1.48	**28.60**
July	1.98	1.54	2.14	1.31	**16.04**
August	1.63	1.29	1.77	1.29	**9.29**
September	1.69	1.18	1.87	1.48	**8.26**
October	1.63	1.01	1.82	1.68	**6.13**
November	1.46	0.99	1.62	1.52	**5.05**
December	1.62	1.14	1.80	1.47	**7.36**
Average	**1.80**	**1.37**	**1.97**	**1.36**	**13.52**
50 m					
	AvgV (m/s)	**St Dev**	**C (m/s)**	**K**	**P/A (w/m²)**
January	1.61	1.28	1.82	1.29	**10.23**
February	2.88	2.05	3.17	1.44	**42.10**
March	2.33	1.89	2.50	1.25	**28.27**
April	1.76	1.79	1.74	0.98	**21.12**
May	2.55	2.17	2.71	1.19	**41.16**
June	3.10	2.10	3.50	1.53	**50.76**
July	2.45	1.87	2.67	1.34	**29.17**
August	2.05	1.60	2.23	1.31	**17.86**
September	2.19	1.49	2.42	1.51	**17.14**
October	2.10	1.30	2.35	1.68	**13.16**
November	1.86	1.28	2.05	1.49	**10.69**
December	2.05	1.42	2.27	1.49	**14.43**
Average	**2.24**	**1.69**	**2.45**	**1.38**	**24.67**

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 η = 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 through 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 Nizampur 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 Nizampur 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 Nizampur.

PMD Calculator (using 50M) Mar 2007 to Nov 2008				
Month	**Input W/m^2**	**Output W/m^2**	**C.F.**	**KWh / Month**
January	11	3	1%	3,607
February	44	16	4%	17,278
March	30	11	3%	11,982
April	22	8	2%	8,265
May	43	15	4%	17,421
June	54	20	5%	21,846
July	31	11	3%	12,433
August	19	6	2%	7,140
September	18	6	1%	6,385
October	14	4	1%	4,515
November	11	3	1%	3,456
December	15	5	1%	5,329
Annual	23	8	2%	103,652

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 annual values of Table-4 are calculated using twenty-six months data and not the total or average of monthly values, therefore annual values may slightly vary with monthly values.

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 Nizampur (March 07- Nov 08). The graph shows that the maximum power is produced at about 1400; 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 20 depicts that at Nizampur the wind have more potential in the February & June as compared to other months. Figure 23 to 33 shows the monthly average diurnal variation of wind generated electric energy output.

Fig 20

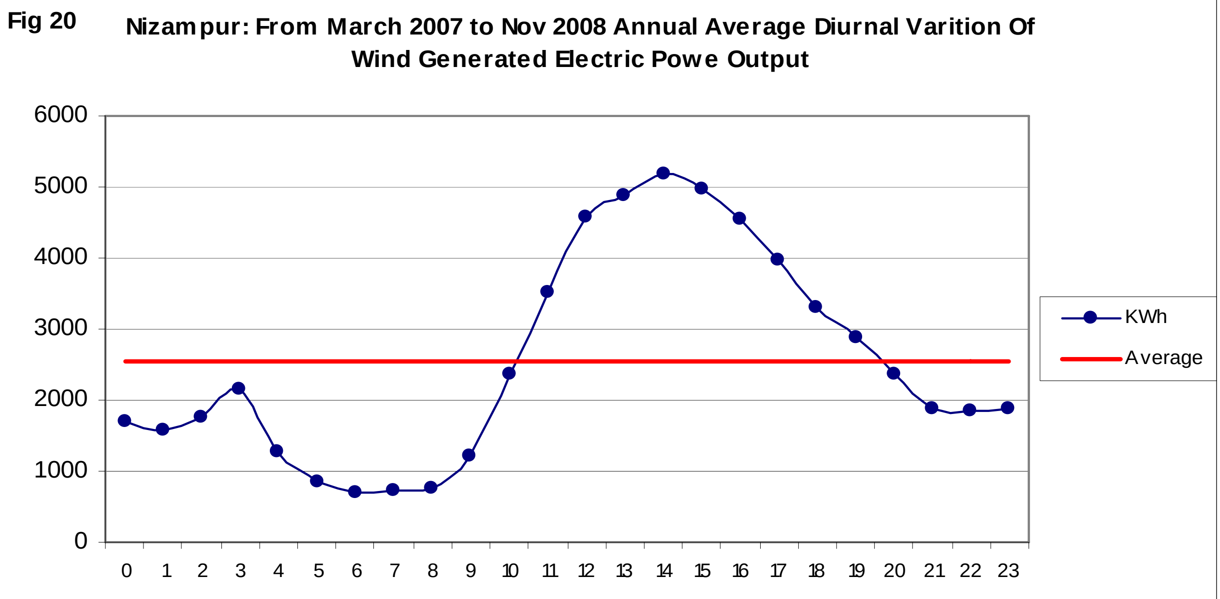


Fig 21

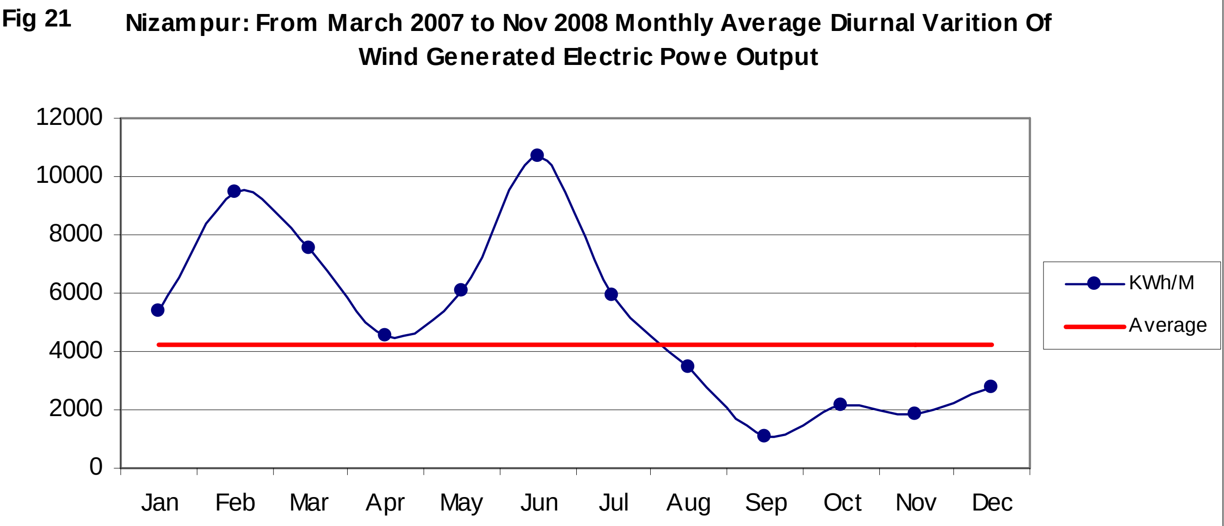


Fig 22

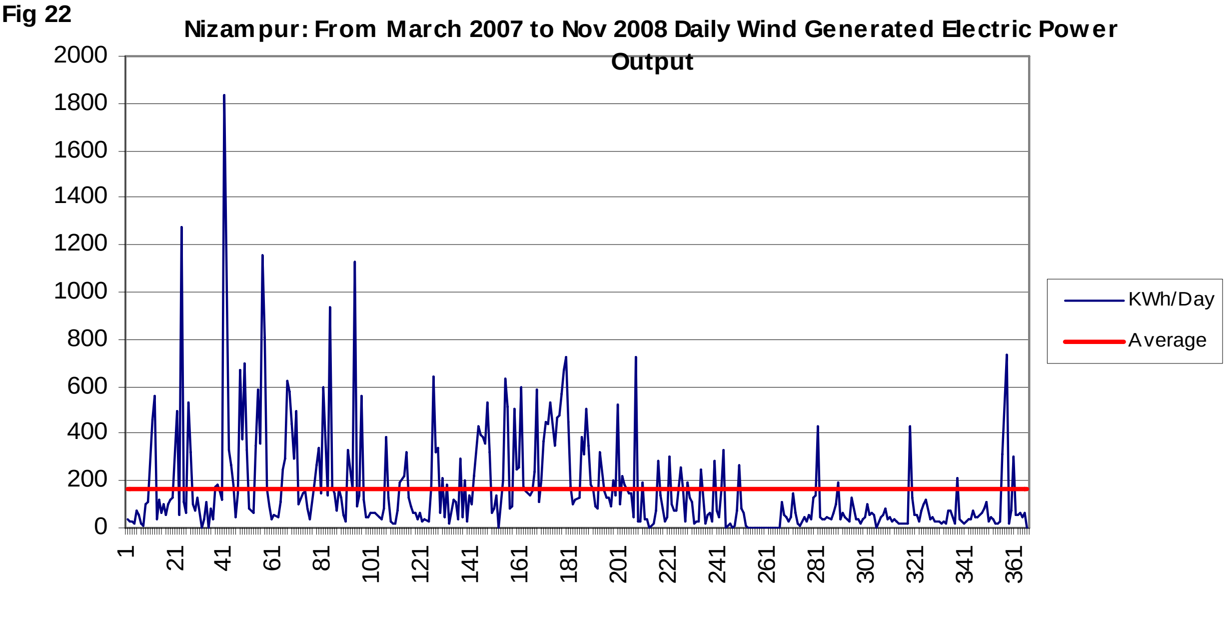


Fig 23 **Nizampur Jan: Diurnal Variation of Wind Genrated Electric Energy Output**

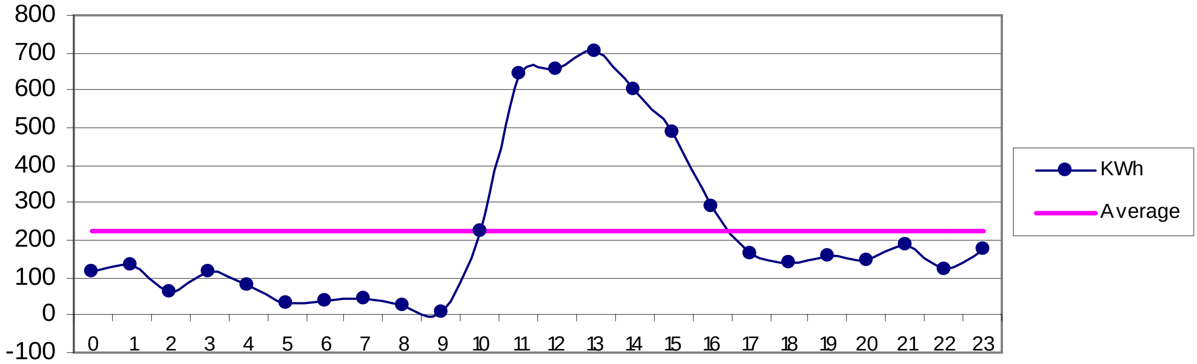
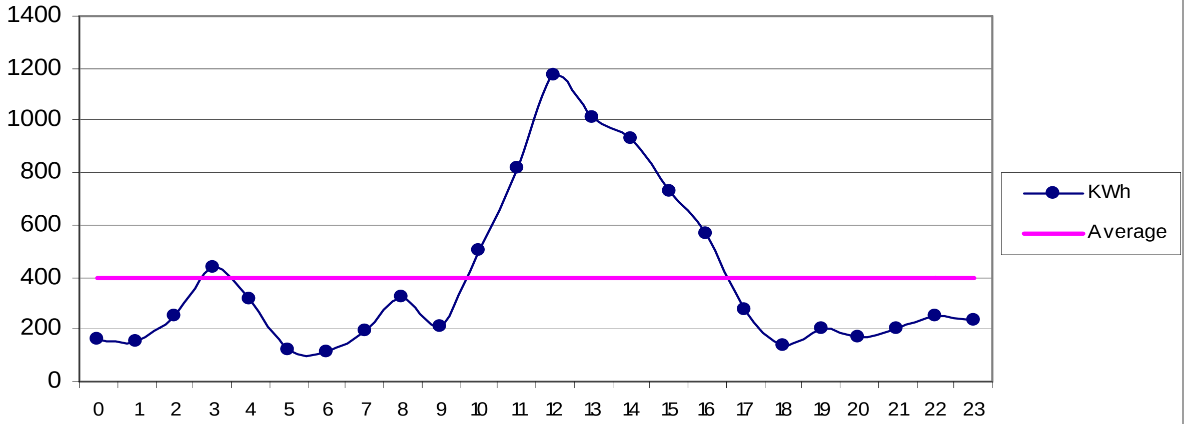
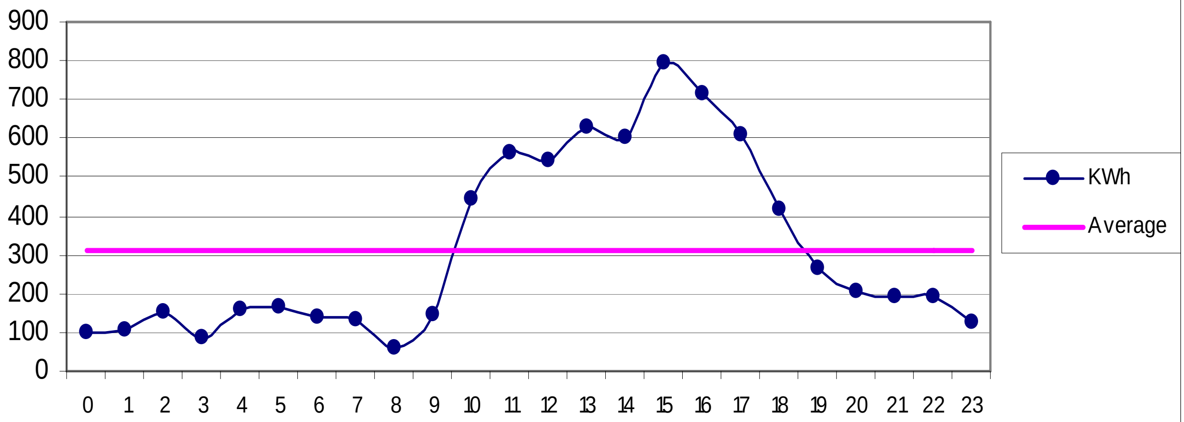


Fig 24 **Nizampur Feb: Diurnal Variation of Wind Genrated Electric Energy Output**



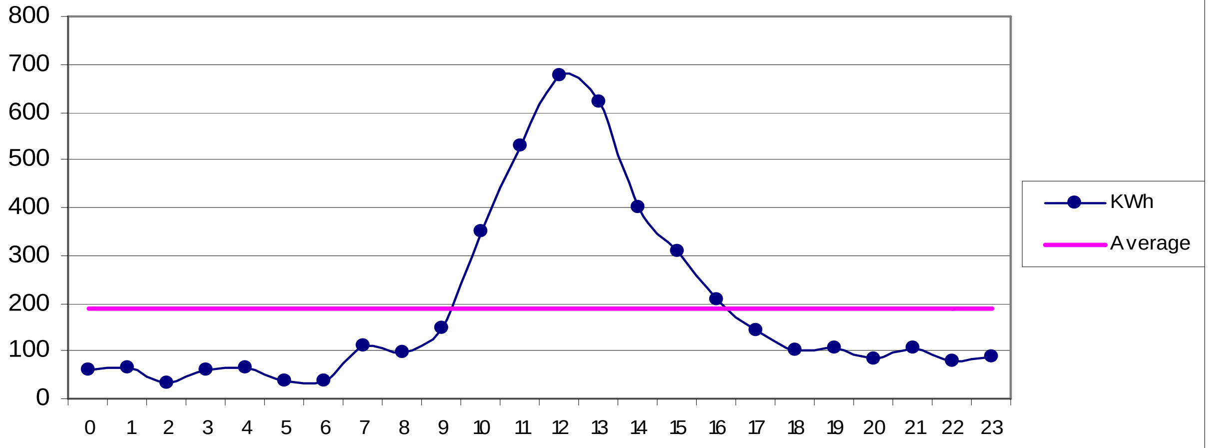
Source: Pakistan Meteorological Department

Fig 25 **Nizampur Mar: Diurnal Variation of Wind Genrated Electric Energy Output**



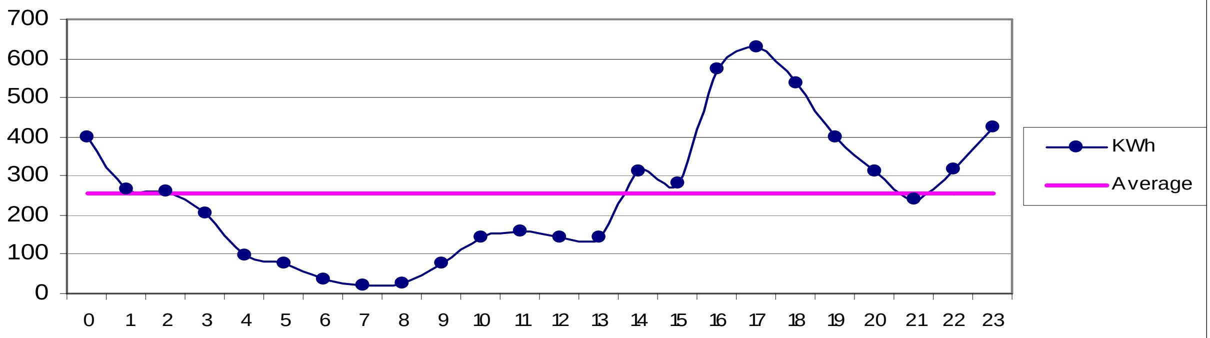
Source: Pakistan Meteorological Department

Fig 26 **Nizampur Apr: Diurnal Variation of Wind Genrated Electric Energy Output**



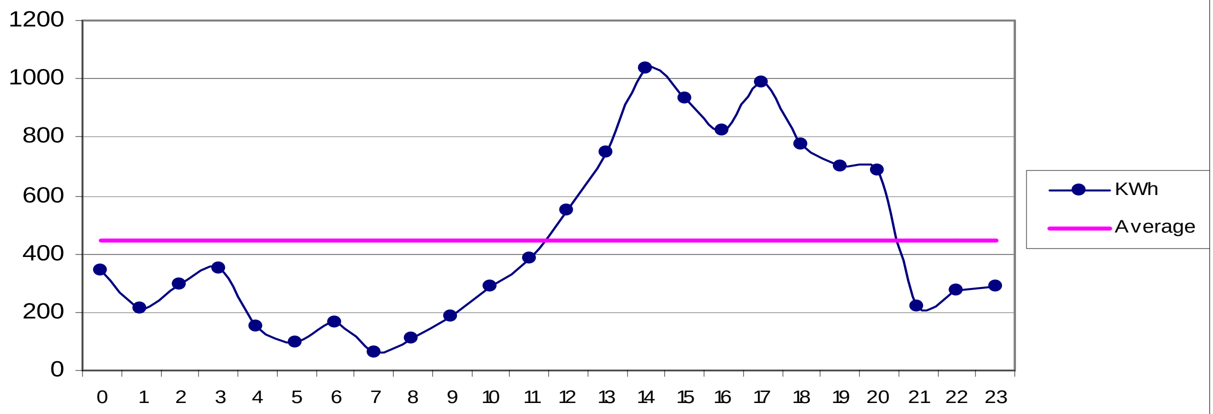
Source: Pakistan Meteorological Department

Fig 27 **Nizampur May: Diurnal Variation of Wind Genrated Electric Energy Output**



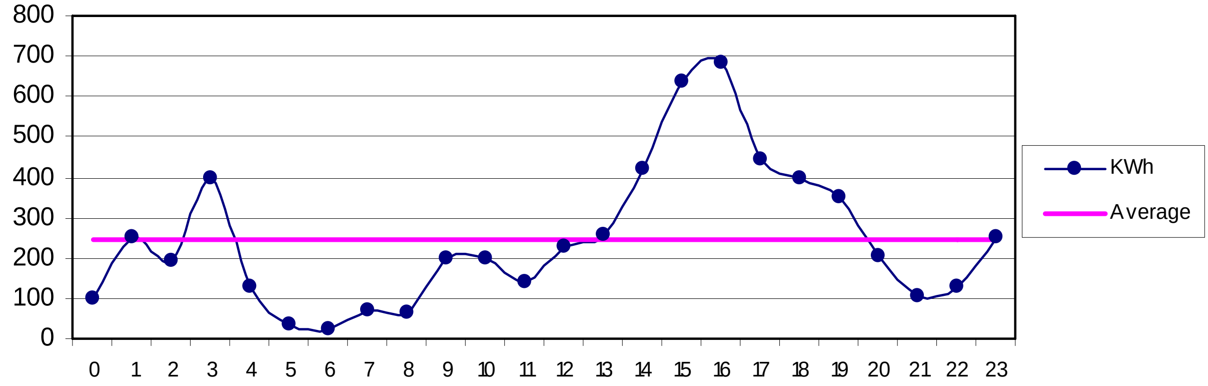
Source: Pakistan Meteorological Department

Fig 28 **Nizampur Jun: Diurnal Variation of Wind Genrated Electric Energy Output**



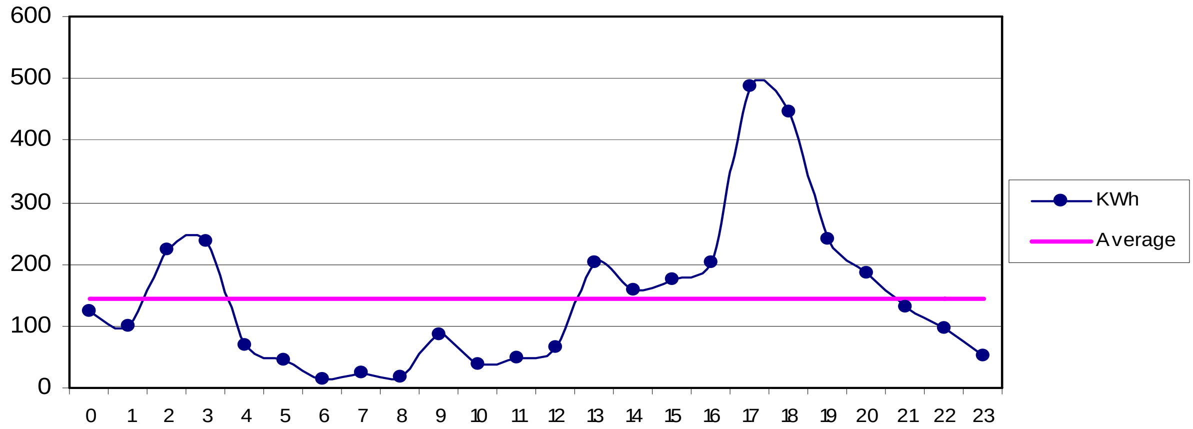
Source: Pakistan Meteorological Department

Fig 29 **Nizampur July: Diurnal Variation of Wind Genrated Electric Energy Output**



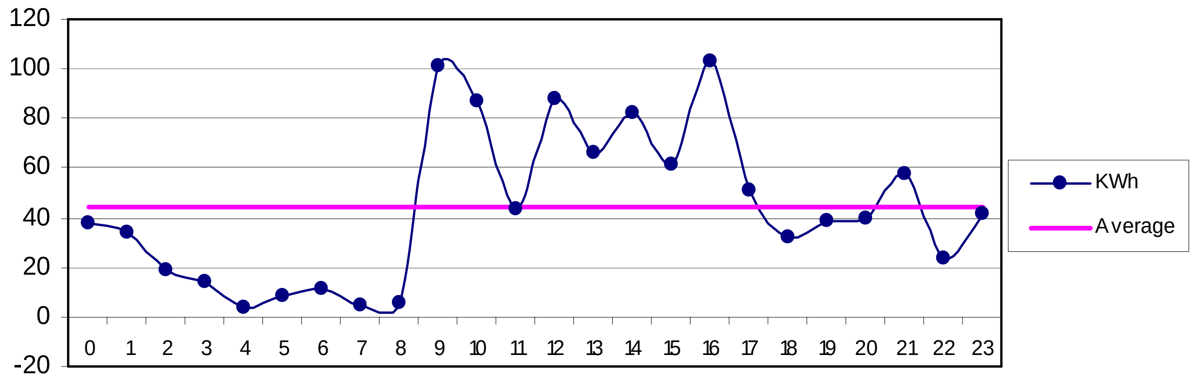
Source: Pakistan Meteorological Department

Fig 30 **Nizampur Aug: Diurnal Variation of Wind Genrated Electric Energy Output**



Source: Pakistan Meteorological Department

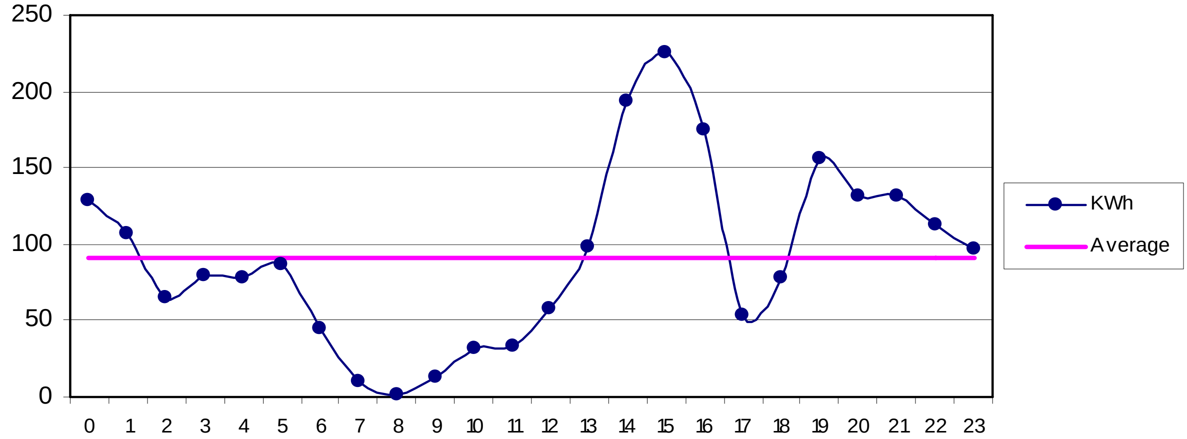
Fig 31 **Nizampur Sep: Diurnal Variation of Wind Genrated Electric Energy Output**



Source: Pakistan Meteorological Department

Fig 32

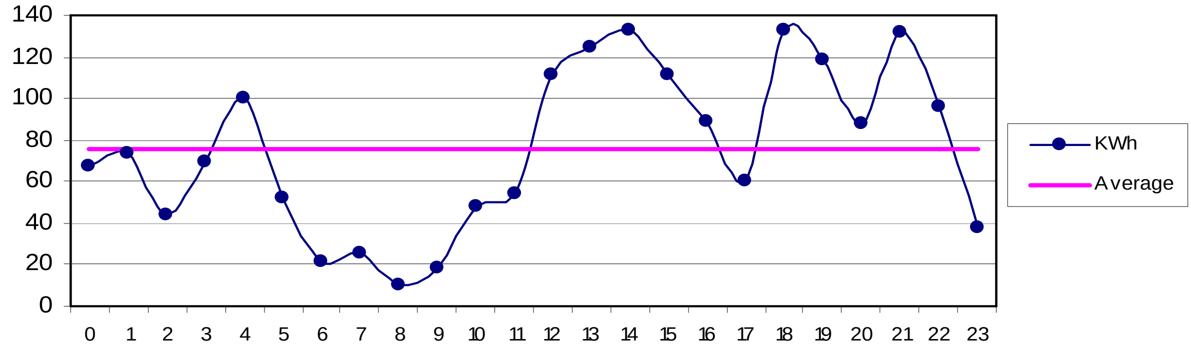
Nizampur Oct: Diurnal Variation of Wind Genrated Electric Energy Output



Source: Pakistan Meteorological Department

Fig 33

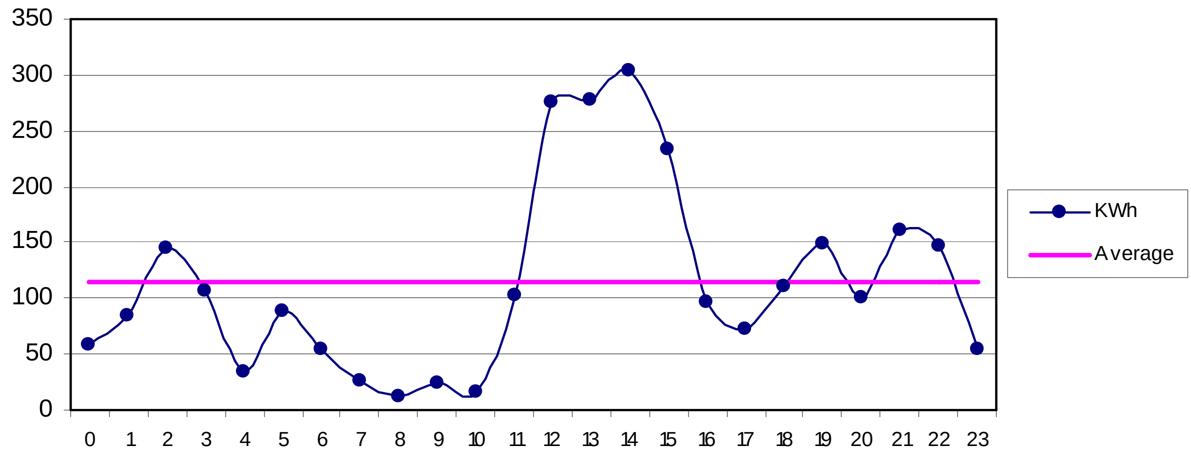
Nizampur Nov: Diurnal Variation of Wind Genrated Electric Energy Output



Source: Pakistan Meteorological Department

Fig 34

Nizampur Dec: Diurnal Variation of Wind Genrated Electric Energy Output

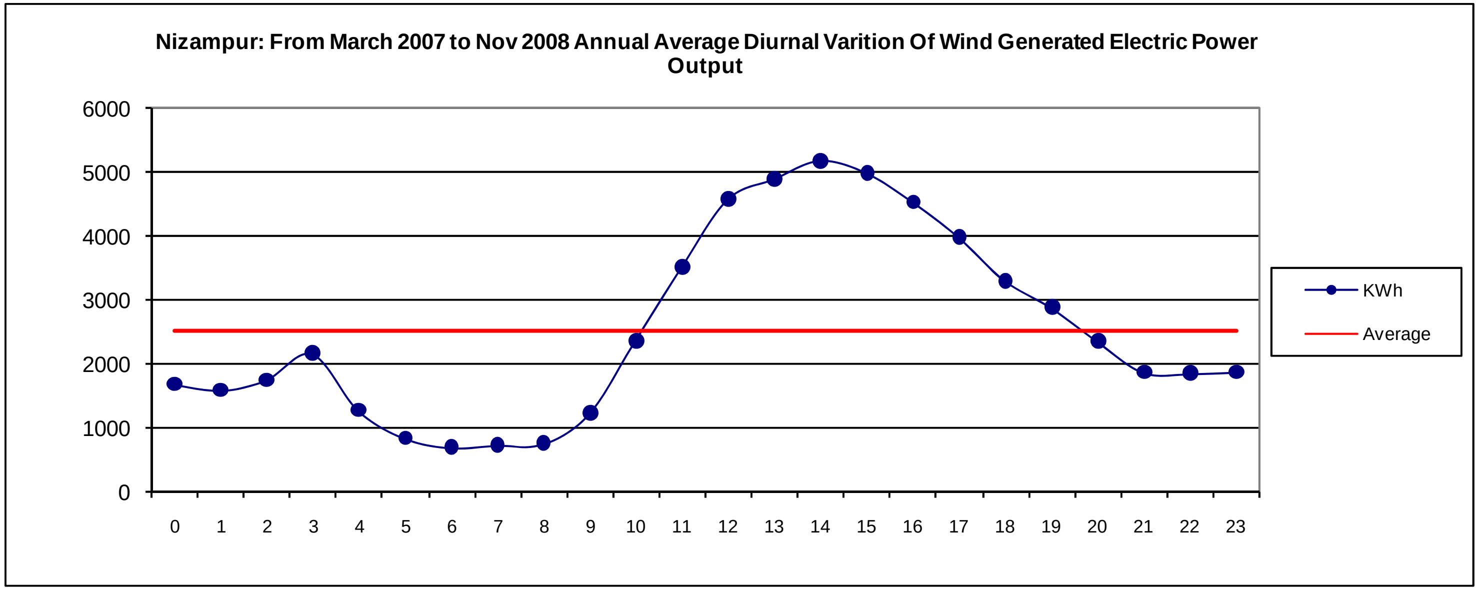


Source: Pakistan Meteorological Department

Appendix-I

Nizampur **May 2007 to October 2008** **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
Jan	114	136	64	115	77	31	40	46	26	10	224	641	658	703	604	491	288	163	140	157	144	185	125	177	5359
Feb	161	155	250	440	313	125	112	198	323	214	501	815	1172	1014	928	727	569	275	140	203	173	200	251	235	9494
Mar	98	103	151	84	160	162	138	133	62	146	444	565	544	629	601	792	716	609	416	266	207	192	194	123	7535
Apr	58	63	34	59	62	38	38	112	96	146	350	527	674	620	399	310	208	144	102	108	85	108	77	89	4506
May	397	265	259	206	97	75	34	20	24	75	144	157	144	143	313	281	574	631	536	399	311	241	319	427	6072
Jun	342	214	297	349	152	95	165	61	109	188	286	382	551	749	1037	935	825	989	774	697	688	221	274	288	10669
Jul	99	253	195	399	127	37	21	70	65	198	197	139	225	258	422	639	684	443	395	349	203	108	131	254	5912
Aug	124	99	223	238	70	44	15	25	17	87	38	50	67	201	157	176	203	488	444	240	185	131	94	52	3469
Sep	37	34	19	14	4	8	11	5	6	102	87	43	88	66	82	62	103	51	32	39	40	57	24	42	1056
Oct	128	107	66	79	78	87	45	10	1	13	32	34	58	99	193	225	175	53	77	156	132	131	113	97	2189
Nov	68	74	44	70	100	52	21	25	10	18	48	54	112	125	133	112	89	60	133	118	88	132	96	37	1819
Dec	57	84	145	106	34	88	54	26	13	25	16	103	276	278	304	234	96	73	111	149	100	162	148	54	2735
KWH	1686	1588	1747	2158	1274	842	693	731	751	1222	2365	3509	4568	4886	5174	4982	4530	3980	3302	2882	2356	1868	1846	1875	60815
Average	2534	2534	2534	2534	2534	2534	2534	2534	2534	2534	2534	2534	2534	2534	2534	2534	2534	2534	2534	2534	2534	2534	2534	2534	



Nizampur January 2007,2008 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	1	0	1	1	0	0	0	0	0	0	0	0	0	0	3	2	9	6	4	5	0	33
2	0	0	2	6	0	0	0	0	0	0	0	0	0	1	1	0	12	1	0	0	1	1	0	2	26
3	4	8	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	1	2	8	0	0	0	24
4	0	1	4	0	0	0	0	0	0	0	0	0	0	0	0	3	8	0	0	0	0	0	0	0	16
5	0	1	2	1	1	9	26	6	11	1	0	0	0	0	0	0	0	0	0	9	1	0	2	1	70
6	0	0	2	37	9	1	4	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0	0	57
7	0	0	1	0	1	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	3	2	7	21
8	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	7
9	0	0	0	0	0	0	0	0	0	1	0	1	1	1	0	0	0	0	0	0	0	7	18	73	103
10	14	3	5	1	0	0	2	3	0	0	0	0	0	0	3	18	4	22	27	8	0	1	0	0	111
11	0	0	0	0	0	0	0	1	0	1	6	15	43	55	88	70	27	27	10	12	27	42	35	1	459
12	21	59	14	39	33	5	0	14	3	4	16	10	10	130	79	64	42	10	3	0	0	0	0	1	557
13	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	3	14	3	1	2	4	6	5	0	40
14	0	0	0	0	3	0	0	0	0	0	0	2	13	23	40	14	11	10	5	0	0	0	0	0	121
15	1	0	0	0	0	0	0	3	0	0	5	4	5	30	1	5	4	0	0	0	0	0	0	3	62
16	34	36	6	5	3	3	0	2	5	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0	97
17	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	2	1	21	3	8	5	1	13	56
18	15	13	3	2	1	0	0	6	0	0	0	0	0	0	5	6	7	3	1	18	16	1	0	0	97
19	0	1	10	3	2	1	0	0	0	0	0	6	6	0	17	30	13	3	2	6	4	8	4	2	120
20	0	0	0	0	0	0	0	0	0	0	5	2	2	5	39	41	19	0	0	4	2	1	9	3	132
21	0	1	2	0	0	0	0	0	2	1	29	153	108	76	51	27	13	5	3	6	0	4	6	7	494
22	0	0	1	2	5	0	0	0	0	0	1	2	1	6	7	8	8	4	4	6	4	0	0	0	59
23	0	0	0	0	7	0	0	0	0	0	17	192	259	239	184	123	50	24	36	30	34	55	8	15	1272
24	2	5	1	2	1	1	1	0	0	0	2	0	0	5	2	4	16	9	4	13	6	13	6	15	108
25	0	2	1	2	1	0	0	0	0	0	1	4	2	0	0	1	0	0	4	3	11	17	10	9	66
26	13	2	3	0	0	1	1	0	0	0	20	131	147	53	40	30	25	28	5	15	3	1	0	17	532
27	0	3	0	1	2	3	2	5	6	2	102	95	48	33	5	3	2	1	1	1	0	0	0	1	317
28	0	0	1	0	0	0	0	0	0	0	14	8	2	21	21	14	4	4	8	5	1	2	0	0	105
29	0	0	1	4	3	0	0	0	0	0	1	6	6	6	6	5	4	3	2	5	1	10	2	6	70
30	9	2	3	6	2	3	2	1	0	0	5	11	4	16	14	18	4	1	1	0	8	6	11	1	126
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
KWh	114	136	64	115	77	31	40	46	26	10	224	641	658	703	604	491	288	163	140	157	144	185	125	177	5359

Nizampur February 2007, 2008 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	2	2	0	0	0	0	1	3	1	8	6	9	8	40
2	7	2	1	0	0	0	0	0	0	0	0	0	6	1	10	40	17	10	6	3	0	11	0	0	114
3	0	3	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	3
4	0	2	5	3	0	0	1	0	0	1	0	0	0	0	0	0	9	9	8	0	2	18	9	10	79
5	5	0	0	0	0	0	0	0	0	0	2	9	8	1	0	0	1	0	3	5	0	0	0	0	35
6	0	0	7	7	0	0	5	0	0	0	2	0	1	1	0	1	21	1	8	8	0	3	31	79	175
7	25	22	0	0	1	5	5	42	48	21	0	0	0	0	3	3	2	0	0	0	1	5	0	2	185
8	12	13	3	1	7	2	6	1	1	1	0	5	27	27	21	21	6	0	0	1	1	0	1	2	157
9	0	0	0	0	0	0	0	0	0	0	2	0	1	48	17	2	36	5	2	3	0	1	0	0	118
10	1	13	69	192	125	51	31	23	80	119	162	60	81	169	123	153	134	76	47	108	19	3	4	0	1839
11	0	1	1	5	2	0	0	0	0	14	9	6	10	55	69	59	56	8	21	2	1	1	1	15	335
12	14	0	0	0	0	1	1	0	0	0	10	9	66	59	34	19	18	17	5	8	0	1	1	0	265
13	0	0	3	0	0	0	0	1	1	6	2	22	34	27	29	25	23	0	1	0	0	3	3	4	183
14	2	6	0	2	0	0	0	0	0	0	0	4	0	0	0	0	2	2	3	3	6	8	0	10	46
15	6	0	0	0	0	0	0	0	0	2	9	4	10	7	48	18	16	14	1	5	2	0	1	1	145
16	2	1	1	0	1	0	0	23	47	25	102	130	122	71	45	40	30	27	2	0	0	0	0	0	668
17	1	1	0	0	0	0	0	2	4	4	20	108	58	32	65	31	31	8	2	0	0	0	9	0	376
18	0	3	40	56	0	1	0	24	58	1	5	29	208	107	57	70	10	15	4	5	4	0	0	0	698
19	0	0	1	7	0	0	4	2	0	7	21	32	67	51	76	18	13	1	1	4	6	7	9	3	330
20	0	11	5	5	14	0	0	0	0	0	0	1	1	1	2	2	1	0	4	3	4	10	18	3	86
21	3	3	1	1	8	7	5	0	1	0	1	0	0	1	1	0	0	0	0	3	3	14	9	6	65
22	0	0	0	0	1	0	0	3	6	0	10	30	65	61	37	37	21	13	13	9	23	22	0	0	351
23	0	0	7	12	27	27	50	43	13	0	30	115	66	40	43	35	40	13	0	0	0	2	9	12	585
24	10	4	4	3	0	0	0	4	3	0	3	31	100	59	40	30	16	9	1	7	12	8	10	3	355
25	1	2	7	1	0	4	0	0	20	10	83	200	185	75	94	83	49	33	2	13	55	74	100	61	1152
26	71	70	87	137	115	9	2	28	42	1	26	14	42	68	51	25	5	0	5	3	4	1	1	1	808
27	0	1	2	0	5	12	0	0	0	0	0	2	6	48	61	9	4	2	0	1	7	1	6	1	170
28	1	0	3	6	6	5	0	0	0	0	0	1	6	4	4	5	9	11	1	6	14	1	9	2	93
29	0	0	3	0	0	0	2	1	0	0	0	1	2	0	0	0	0	0	0	3	1	0	10	12	36
KWh	161	155	250	440	313	125	112	198	323	214	501	815	1172	1014	928	727	569	275	140	203	173	200	251	235	9494

Nizampur March 2007,2008 **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	7	1	2	1	0	1	10	9	0	0	0	2	1	0	2	1	0	0	0	2	4	9	4	4	59
2	3	7	3	0	1	0	1	1	0	0	0	0	2	2	1	1	2	2	1	2	1	1	10	6	47
3	1	0	0	4	7	0	1	1	5	11	8	8	13	9	4	3	5	3	8	3	5	2	1	7	107
4	6	1	2	1	0	43	30	5	1	7	11	15	12	8	13	18	35	7	8	1	10	11	2	1	246
5	0	2	4	0	0	0	1	1	0	0	0	29	69	62	37	27	20	13	2	2	8	11	2	1	292
6	6	2	1	0	0	2	6	23	3	9	25	47	30	68	34	42	50	53	80	36	24	23	43	17	623
7	9	8	1	3	15	0	1	0	0	10	17	2	14	44	64	103	144	72	8	9	15	12	23	7	582
8	7	41	48	19	4	1	2	1	24	76	65	32	54	22	22	4	8	5	1	1	0	0	0	2	442
9	1	0	42	2	58	30	6	2	4	2	5	14	10	13	13	24	13	8	13	4	10	11	10	1	295
10	1	5	1	2	2	13	3	11	6	5	15	12	30	33	47	110	45	122	12	9	5	5	2	3	498
11	0	1	4	0	2	0	0	0	0	0	1	1	2	15	20	19	16	6	2	5	2	3	2	3	102
12	0	0	5	13	21	4	2	1	0	1	8	2	3	17	6	13	13	2	1	7	12	11	2	0	143
13	1	2	1	0	2	4	0	2	0	0	0	0	1	1	5	8	10	46	53	3	3	8	9	0	158
14	1	1	4	8	3	1	1	4	0	0	4	10	4	7	4	4	3	1	4	3	1	3	4	8	83
15	1	0	0	2	3	6	3	0	0	0	1	0	0	1	1	0	2	3	1	1	4	3	2	2	36
16	2	2	2	3	2	0	0	0	0	3	4	6	4	17	16	10	17	9	8	1	3	1	1	0	111
17	1	0	0	1	6	10	6	0	0	1	9	9	4	1	0	23	47	11	24	14	9	1	1	6	183
18	6	8	16	11	12	17	10	4	1	4	4	18	14	12	27	46	21	9	8	1	1	1	3	11	263
19	4	4	2	1	0	0	1	16	10	4	54	79	27	14	10	12	13	31	2	31	1	4	21	2	341
20	1	1	3	3	1	12	3	0	0	1	6	6	17	20	25	20	14	4	0	0	0	2	2	6	148
21	9	0	1	0	1	4	34	46	1	0	37	69	53	73	73	74	34	8	7	16	26	4	19	10	598
22	3	0	2	0	0	1	0	0	0	0	36	30	13	7	9	7	3	4	4	3	3	6	4	0	138
23	8	4	4	1	3	3	4	0	3	4	130	121	97	93	122	150	99	24	11	17	9	10	12	6	934
24	7	1	0	0	0	0	0	0	0	0	1	43	46	19	6	13	7	12	5	6	1	4	2	1	174
25	3	1	1	3	8	2	5	0	0	1	1	1	5	6	5	7	23	39	30	2	2	2	1	1	147
26	2	1	0	0	0	2	0	0	0	2	1	0	1	5	1	5	22	9	0	4	4	5	4	4	75
27	3	0	0	1	3	0	3	6	3	2	2	7	8	24	18	26	28	24	5	0	0	2	0	2	167
28	3	2	0	2	0	0	0	0	0	1	1	0	10	34	15	13	1	6	10	0	3	12	2	11	126
29	3	8	1	0	4	6	7	1	0	0	0	0	0	1	1	2	4	1	5	0	2	1	2	1	51
30	0	0	1	3	0	0	0	0	0	0	0	1	0	0	1	3	1	5	9	1	1	2	1	2	32
31	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1	6	17	69	93	78	37	24	5	0	333
KWh	98	103	151	84	160	162	138	133	62	146	444	565	544	629	601	792	716	609	416	266	207	192	194	123	7535

Nizampur April 2007,2008 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	0	2	1	1	1	12	7	14	14	5	11	2	2	27	21	22	3	2	2	2	2	1	162
2	0	2	3	2	0	0	7	10	14	52	143	283	261	158	92	48	28	11	0	2	3	1	4	0	1125
3	2	0	0	1	1	0	1	0	0	0	0	1	61	12	10	4	2	0	0	0	0	0	0	0	96
4	1	3	0	0	1	0	0	0	0	1	0	4	5	11	14	11	6	22	30	6	7	4	2	4	134
5	1	0	0	0	0	0	9	27	14	20	68	35	81	153	83	34	26	2	4	0	0	0	0	4	562
6	2	1	0	0	0	0	0	0	0	2	1	1	11	15	43	25	9	1	1	4	0	3	2	2	123
7	0	0	0	0	0	0	0	0	0	1	3	4	5	7	7	3	0	0	0	0	1	2	7	3	44
8	1	1	6	0	0	0	0	0	0	0	0	1	2	1	1	0	8	8	7	0	0	0	1	3	41
9	1	0	2	7	0	0	0	9	1	0	1	0	11	24	2	3	2	0	0	0	0	0	0	0	63
10	5	3	0	4	0	0	0	1	0	1	1	1	2	3	0	2	0	1	0	0	3	6	19	11	62
11	3	3	0	0	0	0	0	0	0	0	0	2	2	8	6	6	6	9	8	1	0	3	1	2	60
12	1	0	1	2	1	0	0	0	0	6	3	0	1	1	1	1	0	1	8	18	2	0	1	0	48
13	1	4	0	1	0	0	0	0	0	0	0	0	1	15	6	2	2	0	0	2	1	0	1	3	38
14	0	6	3	0	4	0	0	0	1	1	1	8	0	14	0	8	20	3	0	15	1	2	0	0	86
15	0	0	0	1	0	1	0	1	6	0	7	28	58	82	61	61	34	18	4	13	3	5	0	0	383
16	0	0	1	1	0	7	6	0	2	4	4	11	20	10	1	0	0	2	7	4	22	26	2	2	130
17	0	0	2	3	1	0	0	0	0	1	3	3	1	0	1	10	1	3	0	0	0	1	1	1	32
18	2	1	0	0	0	0	0	0	0	0	0	1	2	3	0	0	0	0	0	2	1	0	2	1	16
19	1	1	0	0	0	1	1	0	0	0	0	0	0	1	6	1	0	0	0	0	1	3	2	3	22
20	0	0	0	4	3	1	1	3	7	0	12	14	4	1	1	0	1	0	0	0	2	8	4	4	69
21	0	5	1	15	42	15	4	31	8	12	12	7	3	4	1	4	3	5	3	8	4	1	0	0	188
22	0	0	0	3	0	0	1	0	0	2	0	11	9	13	30	52	22	12	10	9	13	6	7	19	219
23	17	5	0	1	0	0	3	18	36	20	50	62	58	27	8	2	2	2	0	4	4	3	1	1	323
24	1	3	5	2	2	0	0	0	0	0	1	16	37	17	9	3	7	1	0	1	5	11	4	6	128
25	1	0	0	0	0	0	0	0	0	6	17	18	17	15	5	0	0	4	2	1	5	3	0	1	96
26	8	4	8	1	3	2	1	0	0	0	5	7	1	3	2	2	1	1	0	4	1	4	4	1	63
27	1	2	1	4	0	1	3	0	0	0	0	0	9	17	4	0	0	0	0	6	3	4	5	5	67
28	4	2	0	0	0	3	0	0	0	0	3	5	1	1	1	1	1	0	0	0	1	5	2	5	34
29	2	0	2	2	0	6	0	0	0	0	2	1	0	0	1	3	5	15	11	4	0	3	2	3	61
30	4	9	0	4	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	3	1	3	1	4	31
KWh	58	63	34	59	62	38	38	112	96	146	350	527	674	620	399	310	208	144	102	108	85	108	77	89	4506

Nizampur May 2007,2008 **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	7	5	1	9	0	0	1	0	0	0	0	0	0	1	1	2	2	2	0	2	3	0	1	1	38
2	1	0	1	1	3	2	0	0	0	0	0	0	0	3	0	0	0	0	1	5	4	2	0	5	30
3	7	0	0	0	1	5	0	0	0	0	0	0	0	0	0	0	0	9	9	4	1	1	30	108	178
4	168	92	56	4	3	15	11	10	4	4	4	2	1	0	3	4	8	1	4	6	11	12	123	96	642
5	81	66	17	42	25	14	6	7	5	1	1	0	9	9	0	0	7	12	4	3	8	6	0	0	324
6	44	65	72	68	34	16	0	0	0	2	7	13	3	1	0	1	1	0	0	0	1	4	2	3	339
7	0	8	1	0	0	0	3	0	0	0	1	0	0	1	0	0	1	0	29	20	0	0	3	0	67
8	0	0	0	0	1	0	0	0	5	0	0	5	5	2	1	1	89	70	24	1	1	7	0	0	215
9	0	0	1	1	0	0	6	1	3	14	1	9	0	0	1	0	0	4	5	2	0	0	0	0	50
10	0	0	0	5	0	0	0	0	0	0	0	0	1	0	6	11	74	72	13	2	1	0	1	0	188
11	4	5	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1	3	3	20
12	2	0	0	1	7	1	0	0	0	0	0	0	1	3	6	7	3	2	56	29	1	4	0	0	122
13	0	0	0	0	0	0	3	0	0	0	0	2	9	11	12	7	4	6	15	21	0	4	11	1	106
14	3	0	1	2	0	0	0	0	0	0	3	4	0	1	1	0	1	0	3	7	1	0	1	4	34
15	1	0	0	0	0	1	2	0	0	0	0	0	2	2	1	3	103	107	20	9	18	25	0	0	295
16	0	0	7	6	0	0	0	0	0	0	1	2	0	0	3	4	5	4	1	3	2	1	4	2	45
17	3	0	0	1	2	1	0	0	0	0	3	4	0	3	7	4	3	11	51	74	14	16	2	3	202
18	1	1	3	0	0	0	0	0	0	0	0	0	1	2	4	1	1	3	1	0	1	5	2	6	31
19	1	0	0	0	0	2	1	0	0	0	0	0	1	0	3	7	9	8	4	8	28	22	15	24	134
20	6	1	0	0	0	0	0	0	1	1	0	0	0	0	1	1	1	7	29	22	18	8	1	1	97
21	1	0	0	1	0	1	0	0	0	1	1	11	9	15	10	18	26	38	30	18	15	12	7	5	222
22	5	5	0	1	1	3	0	0	0	5	6	9	11	11	10	11	15	63	60	50	50	20	30	63	430
23	30	2	0	0	1	1	0	1	0	10	5	11	8	4	57	74	15	25	111	14	15	2	5	2	394
24	1	10	6	1	1	0	0	0	0	4	4	17	19	20	26	28	100	74	19	0	45	10	0	1	386
25	1	0	0	0	0	0	0	0	2	7	24	35	24	12	63	21	45	48	8	30	22	6	2	1	355
26	0	0	1	0	0	0	0	0	0	4	51	9	4	11	56	44	37	53	8	49	16	34	59	92	529
27	25	1	90	58	18	6	0	0	3	19	23	12	13	13	7	4	2	1	4	4	0	2	11	2	318
28	0	0	0	0	0	1	0	0	0	0	0	0	5	4	14	9	13	4	2	4	2	10	1	0	68
29	3	1	1	3	0	4	0	0	0	2	6	9	13	4	6	5	1	3	14	6	0	0	0	0	79
30	0	0	0	0	0	2	0	0	0	0	1	2	5	11	13	9	10	5	12	5	30	24	2	2	134
31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2
KWh	397	265	259	206	97	75	34	20	24	75	144	157	144	143	313	281	574	631	536	399	311	241	319	427	6072

Nizampur June 2007,2008 **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	4	0	4	10	0	0	0	0	0	0	0	0	3	3	4	5	7	47	27	8	3	47	31	202
2	9	12	18	5	15	3	94	38	50	27	9	22	30	30	55	42	19	50	76	14	0	7	3	3	631
3	12	3	0	1	0	0	0	0	0	5	14	6	8	8	61	42	33	158	159	0	0	3	0	0	511
4	1	1	0	0	0	0	0	0	0	0	0	3	5	8	9	5	11	9	4	13	7	3	0	3	82
5	4	3	0	1	0	0	2	0	0	0	1	0	3	4	8	7	6	1	0	14	22	20	0	0	95
6	0	0	7	0	0	0	0	0	0	0	1	3	1	14	15	21	42	37	40	65	242	6	0	8	502
7	7	0	0	0	0	0	0	0	0	1	0	1	0	3	4	9	19	5	1	179	9	3	6	0	248
8	0	1	0	6	5	3	0	0	3	12	14	17	33	22	26	21	18	13	21	28	9	4	2	1	257
9	4	0	72	1	3	34	3	2	3	19	36	40	34	61	59	56	33	43	24	36	10	11	4	6	595
10	4	0	0	2	4	11	0	1	3	2	12	12	21	5	15	21	14	11	9	21	7	0	0	0	175
11	0	0	1	2	0	0	0	0	0	0	8	9	18	16	17	18	13	40	12	0	2	0	0	0	156
12	14	2	1	3	13	0	9	1	1	9	34	28	1	11	6	0	1	0	0	0	0	0	0	0	135
13	0	0	0	0	3	20	0	1	2	0	0	2	9	40	33	14	11	9	5	2	0	0	0	1	153
14	0	5	12	1	0	0	0	0	0	0	1	11	17	10	41	34	32	40	24	12	0	0	0	0	242
15	1	1	2	0	0	1	0	2	21	28	3	6	18	81	100	97	48	23	14	25	15	25	36	43	590
16	22	11	37	6	5	0	0	0	0	0	0	0	1	0	0	4	5	8	2	2	1	0	0	0	106
17	0	0	0	0	0	0	0	0	5	4	14	5	4	4	18	18	21	25	40	24	19	3	0	0	206
18	0	0	0	0	3	15	12	0	0	3	8	12	16	24	69	64	49	25	12	3	7	8	18	17	365
19	110	10	1	7	4	0	0	0	0	0	23	21	9	9	25	55	34	27	17	21	8	18	13	43	454
20	30	27	15	187	7	3	0	1	0	0	1	13	30	24	13	11	8	13	18	23	17	3	0	0	443
21	2	1	1	0	0	0	0	0	3	2	8	16	24	21	48	35	33	34	30	42	215	10	3	10	536
22	94	55	8	5	0	0	0	0	1	2	4	4	10	17	16	11	17	42	36	27	3	0	0	0	352
23	0	0	0	0	0	0	0	0	1	6	2	12	33	36	37	10	21	20	22	8	33	69	79	84	472
24	1	5	82	12	2	0	3	0	0	7	18	30	30	40	59	47	40	48	27	27	3	0	0	0	479
25	0	0	0	0	0	0	0	0	3	11	13	16	56	55	83	100	88	37	33	12	18	13	14	15	566
26	16	12	0	0	0	0	1	2	2	44	35	40	34	64	107	107	81	64	40	14	9	0	0	0	673
27	0	0	0	106	78	4	40	6	2	2	11	36	47	57	48	51	76	106	0	0	0	3	32	23	727
28	12	61	39	1	0	0	0	0	1	0	1	3	53	53	31	14	15	48	56	43	14	2	0	0	445
29	0	0	0	0	0	0	0	7	3	1	13	8	0	14	27	8	27	29	5	2	5	8	12	1	172
30	0	0	0	0	0	1	0	0	6	0	2	5	9	16	3	9	5	18	0	14	5	0	5	0	100
KWh	342	214	297	349	152	95	165	61	109	188	286	382	551	749	1037	935	825	989	774	697	688	221	274	288	10669

Nizampur July 2007,2008 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	4	7	7	1	0	0	0	2	2	0	0	0	1	15	0	1	4	5	18	27	27	0	0	1	122
2	2	4	0	0	1	0	0	0	0	0	0	3	2	3	9	8	8	3	21	23	19	18	7	0	132
3	0	1	0	0	0	0	0	0	1	4	16	18	27	37	40	40	45	48	60	16	17	11	8	0	388
4	7	9	2	0	4	5	0	10	17	3	14	8	18	14	30	29	32	26	10	18	19	21	10	1	309
5	0	11	9	8	2	5	0	0	10	8	7	11	9	40	110	59	28	12	63	73	25	13	5	0	507
6	0	92	48	7	1	5	0	0	0	1	1	0	15	34	56	48	22	4	10	7	2	0	0	0	352
7	2	21	30	33	2	0	0	0	0	0	0	0	0	2	4	12	40	24	9	1	2	1	0	0	182
8	0	0	10	38	14	0	3	27	8	0	6	28	5	0	2	2	13	8	2	0	0	0	0	0	167
9	0	0	0	0	0	0	0	0	0	0	1	4	8	38	28	7	2	0	1	0	0	0	1	0	89
10	0	0	0	0	0	0	0	0	0	2	9	8	4	0	1	6	13	6	3	16	14	0	0	0	82
11	0	0	0	0	1	0	0	0	0	3	2	12	59	7	27	56	30	13	8	1	0	15	53	30	320
12	45	22	13	45	21	1	0	0	0	0	1	0	0	0	0	0	0	2	6	1	0	0	0	0	157
13	0	0	0	1	0	0	0	0	0	0	0	9	17	9	8	16	14	21	8	5	2	0	11	6	126
14	1	0	1	35	3	1	5	2	11	12	2	2	6	13	16	13	2	2	2	1	0	0	0	0	130
15	0	0	1	0	0	0	0	0	2	1	0	0	2	1	2	8	9	13	16	30	7	0	0	0	90
16	0	0	0	4	11	0	0	24	13	0	0	2	1	1	17	34	30	58	2	0	1	0	0	0	199
17	0	0	0	0	0	0	0	0	0	0	2	4	15	15	15	14	11	7	4	9	9	5	15	14	139
18	18	69	32	94	18	1	6	4	0	0	0	26	17	2	2	2	8	11	9	16	17	0	0	171	522
19	5	9	0	4	5	0	0	0	0	0	0	1	3	6	8	2	0	11	31	18	3	0	0	0	104
20	0	1	27	122	37	2	1	1	0	0	0	0	0	1	3	0	0	0	0	1	5	6	3	11	220
21	4	0	0	0	0	0	0	0	0	27	130	1	0	0	1	6	4	1	6	0	0	0	0	0	182
22	0	0	0	0	0	0	0	0	0	0	0	0	1	2	4	1	92	7	19	8	0	1	7	6	148
23	1	1	5	1	1	4	3	0	0	2	0	0	0	0	0	0	39	77	0	3	3	3	2	1	146
24	3	0	0	0	0	0	0	0	0	0	0	0	6	6	11	2	4	0	7	3	1	2	2	0	46
25	1	6	2	3	0	0	1	0	0	0	0	0	1	2	17	229	228	83	77	61	14	3	0	0	728
26	0	0	7	3	1	5	0	0	0	0	1	1	0	0	0	0	0	0	0	0	2	1	0	0	23
27	0	0	0	0	0	4	1	0	0	0	0	0	0	0	4	0	0	0	3	0	0	1	4	11	28
28	5	0	0	0	4	2	2	0	0	134	3	1	1	1	3	33	3	2	1	0	0	0	0	0	195
29	0	0	0	0	1	0	0	0	0	0	0	0	7	6	4	6	2	0	2	2	6	5	0	0	40
30	0	0	0	0	0	0	0	0	0	0	1	1	2	4	2	7	2	0	0	10	9	0	0	0	40
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
KWh	99	253	195	399	127	37	21	70	65	198	197	139	225	258	422	639	684	443	395	349	203	108	131	254	5912

Nizampur **August 2007,2008** **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	3	7	1	0	3	0	2	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	5	0	2	14	22	26	0	0	74
3	0	0	0	0	0	0	0	0	0	3	11	6	8	137	63	21	5	8	2	1	1	0	10	8	286
4	54	6	27	40	5	1	0	0	3	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	137
5	1	0	0	0	3	0	0	0	0	0	0	0	0	6	8	34	32	0	0	0	0	0	0	0	84
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	4	9	11	3	0	2	0	0	31
7	0	0	1	0	0	0	1	0	1	1	0	0	0	3	5	11	8	4	4	1	3	0	0	0	46
8	0	0	0	0	0	0	0	0	1	0	7	4	17	15	14	21	61	43	48	8	52	10	6	0	307
9	3	0	8	31	2	11	0	1	0	0	0	3	3	1	7	9	1	11	8	1	0	0	0	0	100
10	0	0	0	0	0	0	0	0	0	0	0	2	1	1	1	1	13	31	18	0	0	1	0	0	70
11	0	1	0	0	0	0	0	0	0	0	0	0	1	2	1	11	4	3	9	5	1	3	26	8	76
12	12	40	130	17	5	0	0	0	0	1	0	5	0	0	0	0	3	1	11	17	10	0	0	0	253
13	0	0	0	0	0	0	0	0	0	2	8	7	21	11	17	18	9	3	2	1	0	23	27	17	167
14	11	6	1	0	3	0	0	0	0	0	0	0	0	0	1	2	1	0	0	0	0	0	0	0	25
15	5	27	9	50	24	21	0	22	8	0	0	5	0	2	8	4	1	0	0	0	2	0	0	0	190
16	0	0	25	57	14	3	5	0	0	0	0	0	0	0	2	4	10	3	2	0	0	1	0	0	126
17	0	0	0	0	1	1	0	0	1	72	0	0	1	5	2	0	0	0	24	0	0	1	1	0	108
18	0	1	1	1	1	0	2	0	0	3	0	0	0	0	0	0	0	1	1	2	0	2	0	1	15
19	4	3	1	0	0	0	1	0	0	0	0	1	0	1	5	2	2	2	0	0	3	2	2	1	30
20	0	0	0	3	0	0	2	0	0	0	0	0	0	0	1	4	2	2	0	1	7	0	0	3	25
21	1	0	2	1	2	0	0	0	1	0	0	5	5	4	8	9	12	84	46	46	5	21	1	0	251
22	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	3	7	3	1	0	0	0	17
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	2	9	5	12	19	5	0	54
24	2	0	0	0	1	2	2	0	0	0	0	0	2	3	6	9	4	24	1	0	0	2	2	1	61
25	7	0	0	0	0	0	0	0	0	1	2	6	1	0	0	0	0	0	0	0	0	0	4	2	24
26	2	1	0	0	1	0	0	0	0	0	1	0	0	1	7	5	1	0	193	66	6	2	0	1	287
27	0	0	0	0	0	0	1	0	0	0	0	1	4	4	0	0	3	9	25	5	4	0	4	9	69
28	5	0	0	0	0	0	0	0	0	0	2	1	0	1	0	0	4	13	7	3	4	4	2	0	47
29	13	2	1	9	5	0	1	0	0	1	4	4	0	1	0	0	1	2	5	56	47	5	4	0	161
30	3	7	10	25	3	0	0	0	0	2	1	0	1	2	1	3	15	229	9	5	3	7	0	0	326
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
KWh	124	99	223	238	70	44	15	25	17	87	38	50	67	201	157	176	203	488	444	240	185	131	94	52	3469

Nizampur September 2007,2008 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	1	1	0	0	0	0	0	0	0	0	0	0	1	2	0	2	1	2	4	0	0	0	1	15
2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	4
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	3	0	0	0	0	0	9
4	0	1	0	0	0	0	0	0	0	1	9	1	7	1	0	0	0	0	5	5	7	27	2	4	72
5	0	0	3	1	0	0	0	0	4	90	51	5	6	13	13	5	53	10	4	0	3	3	0	0	263
6	2	4	4	0	2	0	0	0	0	1	0	5	31	12	8	4	3	0	2	0	0	3	1	0	82
7	2	0	0	0	0	1	1	0	0	0	0	7	28	5	1	1	4	4	1	1	1	3	5	0	65
8	1	0	1	0	1	1	0	0	0	0	0	0	2	1	0	0	0	1	0	1	1	1	1	1	11
9	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
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
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
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
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
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
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
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
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	0	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	0	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	0	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	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
22	24	21	6	5	1	0	0	0	1	1	4	3	3	17	14	4	1	0	0	0	0	0	0	2	109
23	0	2	1	0	0	0	0	0	1	2	8	11	1	1	0	3	11	8	0	1	1	2	0	3	57
24	2	1	0	0	0	0	0	0	0	1	8	5	6	7	5	2	1	5	0	1	2	2	1	1	50
25	2	0	0	1	0	3	2	0	0	2	1	0	0	0	0	0	0	0	0	0	2	3	5	5	27
26	0	0	0	0	0	0	0	0	0	0	0	0	2	5	5	2	1	4	9	4	6	5	0	1	44
27	1	0	1	1	0	1	3	2	0	0	0	1	0	2	24	38	22	10	3	17	7	0	3	15	150
28	1	4	0	0	0	1	3	3	0	3	5	4	1	2	10	0	6	0	3	1	2	6	5	5	65
29	0	0	0	6	0	0	0	0	0	0	0	0	0	0	1	0	1	3	0	2	2	1	1	2	20
30	1	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0	0	0	0	4	3	0	0	12
KWh	37	34	19	14	4	8	11	5	6	102	87	43	88	66	82	62	103	51	32	39	40	57	24	42	1056

Nizampur October 2007,2008 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	1	0	0	0	1	1	0	0	0	1	0	1	8	4	5	2	0	0	5	0	3	5	1	41
2	2	0	3	1	0	6	2	0	0	1	0	0	0	1	2	1	1	0	1	0	0	3	3	1	28
3	1	1	0	0	0	0	0	0	0	0	5	3	1	5	4	3	7	6	0	1	4	3	4	5	53
4	1	1	0	2	3	2	0	0	0	1	0	0	0	4	3	2	2	1	1	5	0	2	6	1	36
5	1	0	0	0	1	2	3	0	0	0	1	3	4	8	9	9	11	14	18	7	3	2	2	29	129
6	90	11	5	1	5	2	1	0	0	3	1	1	2	2	2	4	1	0	0	0	0	3	2	2	137
7	0	1	7	9	5	0	0	0	0	1	1	13	13	16	85	137	97	10	6	5	10	6	2	3	429
8	1	1	2	1	0	0	0	0	0	3	5	1	2	5	0	1	5	3	0	3	6	1	1	0	42
9	0	0	0	5	1	4	1	0	0	0	0	0	1	2	5	3	4	1	2	2	2	1	1	1	36
10	0	0	3	1	1	1	0	0	0	0	0	0	1	1	2	0	1	0	3	2	3	2	11	3	37
11	1	2	0	1	3	13	1	0	0	0	1	0	0	0	0	1	0	0	0	5	7	5	2	4	46
12	2	1	2	3	5	3	1	1	0	0	0	1	2	2	0	0	0	0	2	3	1	4	6	2	41
13	0	1	3	5	3	6	3	0	0	0	1	1	0	1	4	3	1	1	0	3	11	11	1	1	61
14	2	5	6	14	15	3	1	0	0	0	1	1	1	0	0	0	2	3	3	2	4	23	8	4	97
15	9	55	9	8	5	29	12	1	0	2	2	0	4	9	11	5	6	4	0	2	5	11	7	0	197
16	1	5	1	0	0	1	0	0	0	0	0	0	0	2	2	2	3	0	1	2	0	3	9	5	36
17	0	0	0	2	1	1	0	0	0	0	0	0	4	7	10	9	11	3	0	1	5	5	3	2	65
18	0	0	0	0	0	3	6	0	0	1	0	0	0	1	1	1	1	0	3	7	2	4	8	6	44
19	1	0	0	5	5	0	0	0	0	0	1	0	0	0	1	2	0	1	5	3	1	2	3	3	34
20	0	2	0	0	0	1	2	0	0	0	1	0	1	1	1	4	6	1	1	1	2	1	0	2	26
21	1	0	5	9	14	5	2	4	0	0	1	0	1	1	0	1	1	2	14	35	12	3	7	7	125
22	1	0	1	1	1	1	1	1	0	0	1	1	0	0	7	4	3	0	1	7	1	3	4	1	40
23	3	2	0	0	1	2	3	0	0	0	0	1	1	0	1	1	1	0	1	5	5	7	3	2	38
24	3	0	1	2	1	0	0	0	0	0	1	0	1	1	0	0	0	0	0	3	1	1	0	2	19
25	4	7	1	1	0	0	0	0	0	0	3	1	0	0	0	0	0	0	1	2	6	6	1	4	38
26	2	1	0	0	0	0	0	0	0	1	4	1	1	7	7	4	2	0	1	3	2	1	3	1	42
27	0	0	1	0	0	0	0	0	0	0	0	2	2	14	23	15	8	2	3	8	9	3	2	4	97
28	2	4	9	2	3	1	3	0	0	0	1	1	1	0	3	1	0	1	2	4	8	8	6	0	58
29	0	1	4	4	1	0	0	0	0	0	0	0	1	1	0	1	0	1	2	24	12	3	2	1	61
30	0	3	1	0	0	2	1	0	0	0	1	1	10	3	5	6	1	0	4	5	8	1	2	1	57
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
KWh	128	107	66	79	78	87	45	10	1	13	32	34	58	99	193	225	175	53	77	156	132	131	113	97	2189

Nizampur November 2007,2008 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	1	4	2	1	0	1	0	0	0	0	1	1	0	4	4	1	0	2	5	3	8	7	3	48
2	1	0	1	3	2	2	1	0	0	0	1	1	1	4	1	1	1	0	5	9	4	5	12	4	58
3	0	0	0	1	3	0	0	0	0	0	1	0	18	26	9	5	0	1	1	1	4	9	4	1	83
4	0	1	0	1	5	1	0	1	0	0	2	2	0	0	1	1	0	0	4	3	7	2	6	2	41
5	0	0	0	3	1	0	2	1	0	0	1	0	1	1	0	0	0	2	7	5	5	4	6	3	42
6	3	3	1	0	1	1	1	3	0	0	0	0	0	1	0	0	0	0	4	3	1	2	1	0	27
7	1	6	2	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	2	5	10	7	4	0	39
8	0	0	1	4	1	0	0	0	0	0	0	0	0	0	1	0	0	2	5	2	2	6	3	1	27
9	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	3	3	1	2	4	3	1	19
10	1	3	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2	2	3	1	3	1	2	19
11	1	2	0	1	1	0	0	1	0	0	0	0	0	1	1	0	0	0	2	1	0	3	5	2	22
12	0	0	0	1	1	2	2	0	0	0	0	0	0	1	1	0	0	0	1	3	1	3	0	1	18
13	26	22	2	24	37	18	3	13	7	7	35	21	28	14	39	29	44	15	35	5	4	5	2	1	435
14	6	15	6	1	26	18	4	4	0	0	1	7	16	14	5	1	0	0	2	1	1	2	0	0	131
15	0	0	0	0	1	0	1	0	0	0	0	0	2	5	8	7	14	2	2	3	1	0	2	0	51
16	0	0	0	2	1	0	0	0	2	2	3	0	6	9	12	8	1	1	1	1	1	3	1	0	56
17	0	0	1	5	1	0	0	0	0	0	0	0	1	1	1	1	2	1	0	5	4	0	1	0	24
18	0	1	2	7	7	1	3	1	1	7	4	6	5	8	3	1	0	0	3	3	3	2	2	0	71
19	0	0	4	5	1	0	0	0	0	0	0	1	0	1	0	0	0	2	7	25	11	24	12	7	101
20	14	0	2	2	1	0	1	0	0	0	0	7	17	21	24	14	1	0	1	1	6	3	3	0	119
21	2	1	2	0	0	0	0	0	0	0	0	1	3	2	2	4	1	1	3	6	3	9	1	1	41
22	6	16	4	1	1	0	0	0	0	0	0	0	0	0	2	1	0	3	5	2	2	4	1	0	48
23	0	1	1	3	2	2	0	0	0	0	0	0	1	0	1	0	0	0	3	4	1	1	5	2	29
24	5	2	4	1	0	0	0	0	0	0	0	0	0	1	1	1	0	1	3	6	1	2	1	2	31
25	0	0	1	1	0	0	0	0	0	0	0	0	1	1	0	0	0	7	5	3	2	2	1	0	26
26	0	0	1	4	2	1	0	1	0	0	0	1	0	0	0	0	0	3	2	1	1	2	1	2	21
27	0	0	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	3	9	3	2	7	3	1	31
28	0	0	0	1	1	1	0	0	0	0	0	1	0	0	0	0	4	1	4	3	1	2	0	0	19
29	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	26	18	5	7	2	1	4	5	0	72
30	0	0	0	0	0	0	0	0	0	2	0	2	11	15	16	6	0	3	5	4	1	4	1	1	72
KWh	68	74	44	70	100	52	21	25	10	18	48	54	112	125	133	112	89	60	133	118	88	132	96	37	1819

Nizampur December 2007,2008 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	11	6	0	0	0	0	0	0	0	0	0	0	18
2	3	9	9	2	4	3	5	10	1	0	0	0	18	47	40	34	8	0	2	5	1	2	0	5	207
3	16	0	0	0	0	0	1	0	0	0	0	1	2	1	6	0	1	0	3	1	0	0	1	0	35
4	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	7	2	6	3	4	0	27
5	0	0	0	2	2	1	0	0	0	0	0	0	0	0	0	0	0	3	2	0	1	6	4	1	23
6	0	1	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	4	1	1	5	3	26
7	3	0	0	0	0	0	1	0	0	0	0	0	1	5	3	1	0	0	5	4	1	1	8	6	39
8	2	1	1	3	5	0	1	0	0	0	0	0	1	2	1	1	0	0	5	1	2	3	6	2	35
9	1	0	1	0	5	0	1	1	0	5	0	0	0	0	1	0	0	3	9	10	6	32	1	0	77
10	0	5	5	0	0	0	0	0	0	0	0	2	16	9	1	0	0	0	0	0	2	5	0	2	48
11	4	6	2	2	0	0	1	1	0	0	0	1	2	0	0	0	0	0	1	4	8	6	5	0	42
12	6	7	0	3	0	0	5	0	3	0	0	0	5	9	2	2	2	0	2	8	5	3	6	2	68
13	1	0	3	1	0	0	1	0	0	0	3	4	22	12	1	2	17	1	1	8	3	3	5	0	86
14	0	0	0	0	4	1	3	0	0	0	0	4	17	48	13	2	1	8	0	0	0	3	6	0	111
15	0	0	0	1	0	1	1	0	0	0	0	0	2	8	2	2	0	0	3	5	0	0	0	0	26
16	1	0	0	0	0	0	0	0	0	0	0	0	0	1	2	1	0	5	9	13	1	4	1	3	42
17	0	5	4	8	3	0	0	0	0	0	0	2	0	1	2	3	0	0	0	0	0	1	6	1	36
18	0	2	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	7	8	0	0	0	0	22
19	0	4	2	1	0	0	0	0	0	0	0	0	0	0	2	1	3	0	0	0	0	1	0	3	16
20	0	0	2	0	1	2	2	9	1	0	0	5	3	0	0	0	0	0	0	0	0	1	0	0	29
21	0	0	0	0	1	0	0	0	0	1	2	12	43	27	61	46	26	31	5	2	3	20	30	0	311
22	0	27	107	73	7	75	29	2	6	18	2	61	115	80	61	48	4	7	1	2	0	0	0	6	730
23	6	3	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	1	0	1	14
24	2	2	1	1	0	0	0	0	0	0	0	0	13	4	1	26	14	1	8	0	1	1	0	0	75
25	0	0	0	0	0	0	0	0	0	0	8	8	4	2	77	45	13	8	3	20	27	53	27	7	303
26	10	8	1	0	1	0	1	0	0	0	0	0	1	4	2	2	0	0	4	3	9	1	9	0	57
27	0	1	2	3	0	1	0	0	0	0	0	1	0	6	2	2	0	3	8	13	2	2	6	6	58
28	0	0	0	2	0	1	1	0	0	0	0	0	0	0	2	4	2	0	9	12	10	8	3	5	61
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	6	17	9	2	10	1	48
30	0	1	0	0	1	1	1	0	0	0	0	0	0	6	22	11	6	0	5	7	0	1	4	0	67
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
KWh	57	84	145	106	34	88	54	26	13	25	16	103	276	278	304	234	96	73	111	149	100	162	148	54	2735