Pakistan Meteorological Department

A STUDY OF WIND POWER POTENTIAL

AT

TALASH-SWAT

Technical Report No. PMD-04/2010
(Final report based on 36 months data)
March 2010

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 project wind data has been collected at 42 sites along the Northern parts of the Country.

In this report the analysis based on *36 months* wind data which has been presented along with the wind generated electric power at ***Talash*** (Swat), NWFP. Wind data with 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 **1.82** m/s during 36 months from *August-2006 to July-2009,* the highest wind speed of **2.68** m/s is observed in the month of March. Seasonal Diurnal Wind variation indicates that maximum wind speed is available in the evening and night time thought-out the whole period. Wind frequency distribution shows that during **7%** of the time wind speed is above 5 m/s.

Sometimes simply wind speed averages do not give the true picture of the wind power optional of an area. For this 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 this report. The average power density of Talash at 50m is **26.59** W/m^2, according to international wind classification this power density categorize Talash as a below marginal site for wind power generation.

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 106,201 kWh which shows the capacity factor of **2%** for Talash. Internationally it is accepted that if any site has a capacity factor of 25% and above than that site is suitable for installation of big economically viable wind power farms. As such Talash and surrounding areas can be classified as non-suitable site for installing 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:

Talash, Bahrain, Kalam, Khawazakhaila, Malamjabba, Fatehpur, Khungipayan, Dir, Tarbela, Nizampur, Warsak, Chitral City, Drosh, Mirkhani, Shagore, Garam Chasma, Khagozi, Reshan, Mastuj, Kalash, Ayun, Astore, Bunji, Chillas, Gilgit, Gupis, Sost, Passu, Aliabad, Shigar, Barapayan, Sermik, Lowaramaina, Ramatkore, ShahidaSir, Danakool, Besham, Moorti Pahari, Rangla, Pedar, Shaheedgali, Dargai.

Talash site is situated in District Lower Dir, K.P. Latitude & Longitude of Talash is:
Latitude = 34.86°, Longitude = 71.79°, 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

$\mathbf{Z_o}$ 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

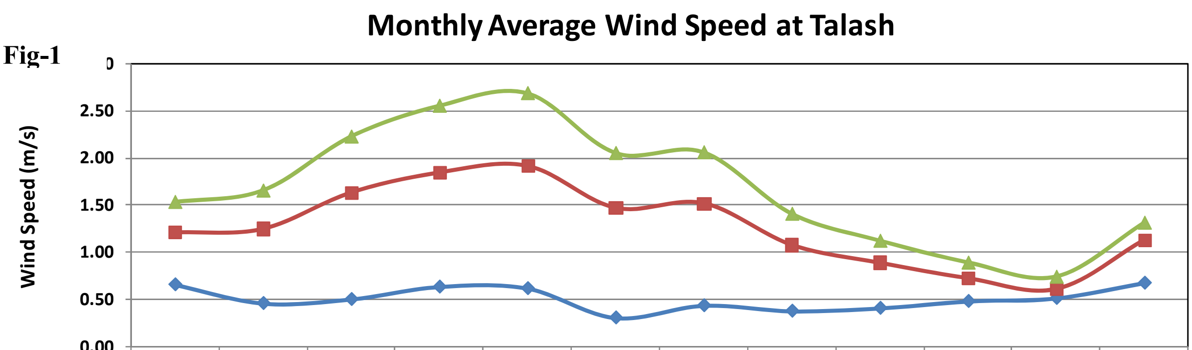
Type of terrain	**Z_0**	**α**
Mud Flats, Ice	10^{-5} to $3x\ 10^{-5}$	
Calm Sea	$2x10^{-4}$ to $3x10^{-4}$	
Sand	$2x10^{-4}$ to 10^{-3}	0.01
Mown Grass	0.001 to 0.01	
Low Grass	0.01 to 0.04	0.13
Fallow Field	0.02 to 0.03	
High Grass	0.04 to 0.1	0.19
Forest and Woodland	0.1 to 1	
Built up area, Suburb	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 1.27 m/s from Aug-06 to Jul-09 where as maximum average wind speed of 1.91 m/s at this height is during July. At 50 meters we have the annual average wind speed of 1.82 m/s from Aug-06 to Jul-09 and maximum average wind speed of 2.68 m/s is in the month of July.

Fig-1



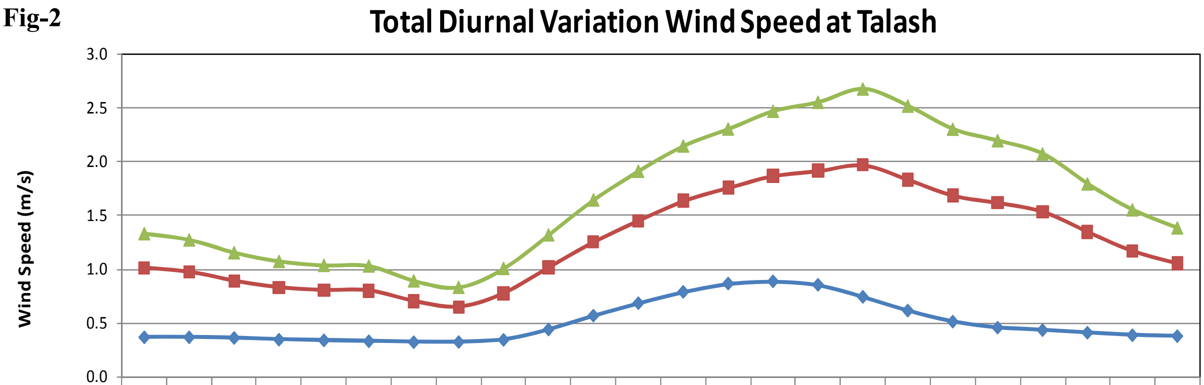
	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
AWS 10m	0.66	0.46	0.50	0.63	0.62	0.31	0.44	0.38	0.41	0.48	0.51	0.68
AWS 30m	1.21	1.24	1.63	1.84	1.91	1.47	1.52	1.08	0.89	0.72	0.61	1.13
AWS 50m	1.53	1.66	2.22	2.55	2.68	2.05	2.06	1.41	1.13	0.90	0.75	1.32

Months

3.3 Diurnal Wind speed Variation:

Fig-2 shows the diurnal wind speed variations at Talash for 36 months (Aug-06 to Jul-09). The wind speed is generally higher during evening & night time as compare to other time. After noon wind speed starts picking up and reaches maximum around 4 p.m. which is around 2.0 m/s and 2.7 m/s at 30 meters and 50 meters height respectively.

Fig-2

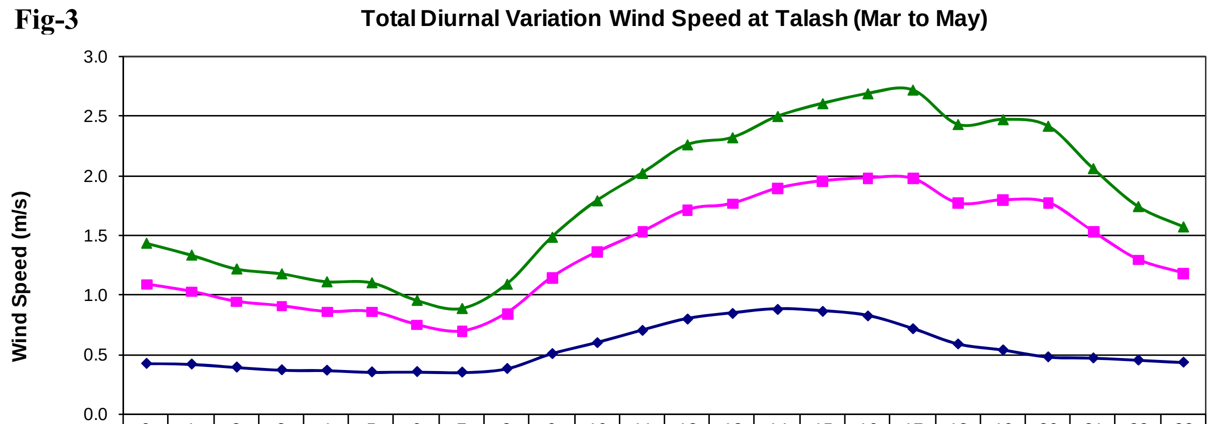


PST (Hours)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
WS 10m	0.4	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.6	0.7	0.8	0.9	0.9	0.9	0.7	0.6	0.5	0.5	0.4	0.4	0.4	0.4
WS 30m	1.0	1.0	0.9	0.8	0.8	0.8	0.7	0.6	0.8	1.0	1.3	1.4	1.6	1.8	1.9	1.9	2.0	1.8	1.7	1.6	1.5	1.3	1.2	1.0
WS 50m	1.3	1.3	1.2	1.1	1.0	1.0	0.9	0.8	1.0	1.3	1.6	1.9	2.1	2.3	2.5	2.6	2.7	2.5	2.3	2.2	2.1	1.8	1.6	1.4

PST (Hours)

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

Fig-3

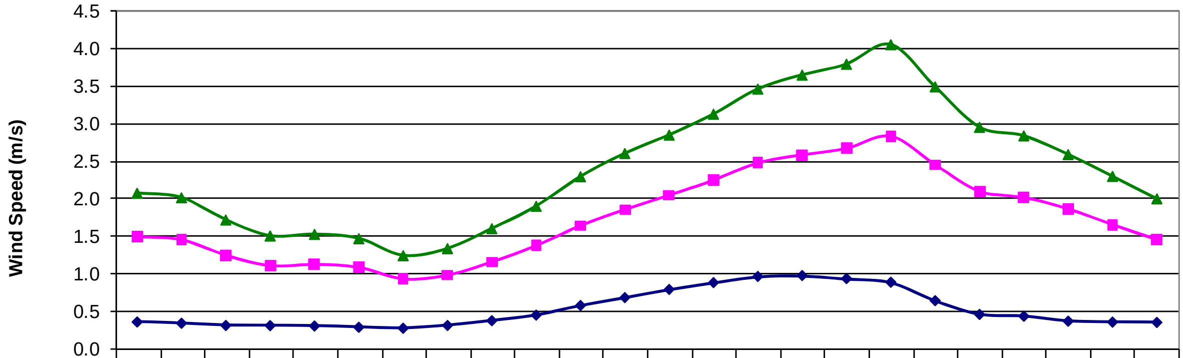


PST (Hours)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
WS 10m	0.4	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.4	0.5	0.6	0.7	0.8	0.8	0.9	0.9	0.8	0.7	0.6	0.5	0.5	0.5	0.4	0.4
WS 30m	1.1	1.0	0.9	0.9	0.9	0.9	0.8	0.7	0.8	1.1	1.4	1.5	1.7	1.8	1.9	2.0	2.0	2.0	1.8	1.8	1.8	1.5	1.3	1.2
WS 50m	1.4	1.3	1.2	1.2	1.1	1.1	1.0	0.9	1.1	1.5	1.8	2.0	2.3	2.3	2.5	2.6	2.7	2.7	2.4	2.5	2.4	2.1	1.7	1.6

PST (Hours)

Fig-4

Total Diurnal Variation Wind Speed at Talash (Jun to Aug)

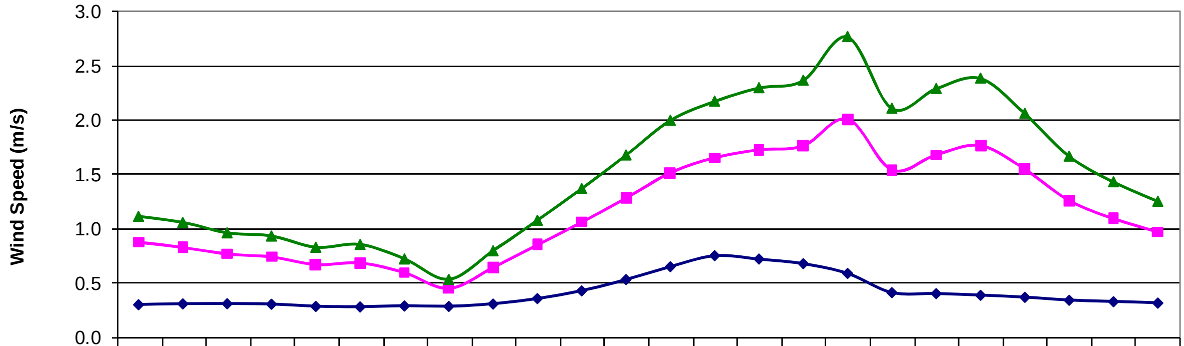


	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
WS 10m	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.6	0.7	0.8	0.9	1.0	1.0	0.9	0.9	0.6	0.5	0.4	0.4	0.4	0.3
WS 30m	1.5	1.4	1.2	1.1	1.1	1.1	0.9	1.0	1.2	1.4	1.6	1.9	2.0	2.2	2.5	2.6	2.7	2.8	2.5	2.1	2.0	1.9	1.7	1.5
WS 50m	2.1	2.0	1.7	1.5	1.5	1.5	1.2	1.3	1.6	1.9	2.3	2.6	2.8	3.1	3.5	3.6	3.8	4.1	3.5	2.9	2.8	2.6	2.3	2.0

PST (Hours)

Fig-5

Total Diurnal Variation Wind Speed at Talash (Sep to Nov)

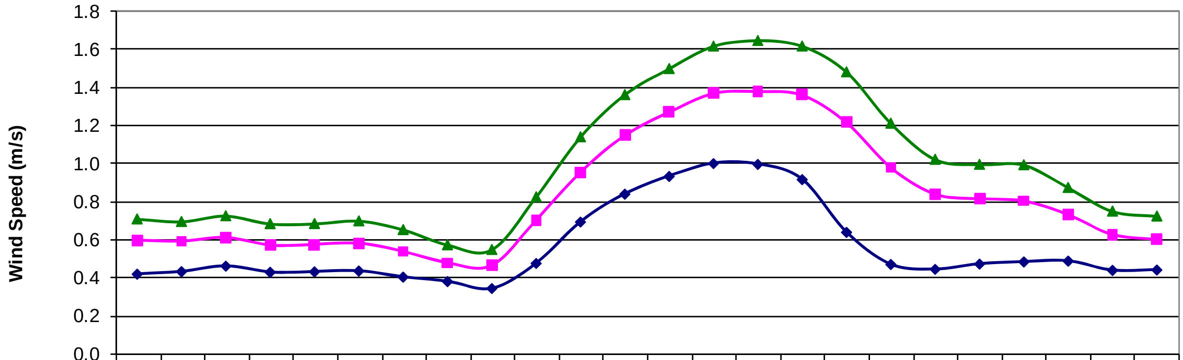


	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
WS 10m	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.5	0.6	0.7	0.7	0.7	0.6	0.4	0.4	0.4	0.4	0.3	0.3	0.3
WS 30m	0.9	0.8	0.8	0.7	0.7	0.7	0.6	0.4	0.6	0.8	1.1	1.3	1.5	1.6	1.7	1.8	2.0	1.5	1.7	1.8	1.5	1.3	1.1	1.0
WS 50m	1.1	1.1	1.0	0.9	0.8	0.9	0.7	0.5	0.8	1.1	1.4	1.7	2.0	2.2	2.3	2.4	2.8	2.1	2.3	2.4	2.1	1.7	1.4	1.3

PST (Hours)

Fig-6

Total Diurnal Variation Wind Speed at Talash (Dec to Feb)



	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	0.4	0.4	0.5	0.4	0.4	0.4	0.4	0.4	0.3	0.5	0.7	0.8	0.9	1.0	1.0	0.9	0.6	0.5	0.4	0.5	0.5	0.5	0.4	0.4
WS 30m	0.6	0.6	0.6	0.6	0.6	0.6	0.5	0.5	0.5	0.7	1.0	1.1	1.3	1.4	1.4	1.4	1.2	1.0	0.8	0.8	0.8	0.7	0.6	0.6
WS 50m	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.5	0.8	1.1	1.4	1.5	1.6	1.6	1.6	1.5	1.2	1.0	1.0	1.0	0.9	0.7	0.7

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:*

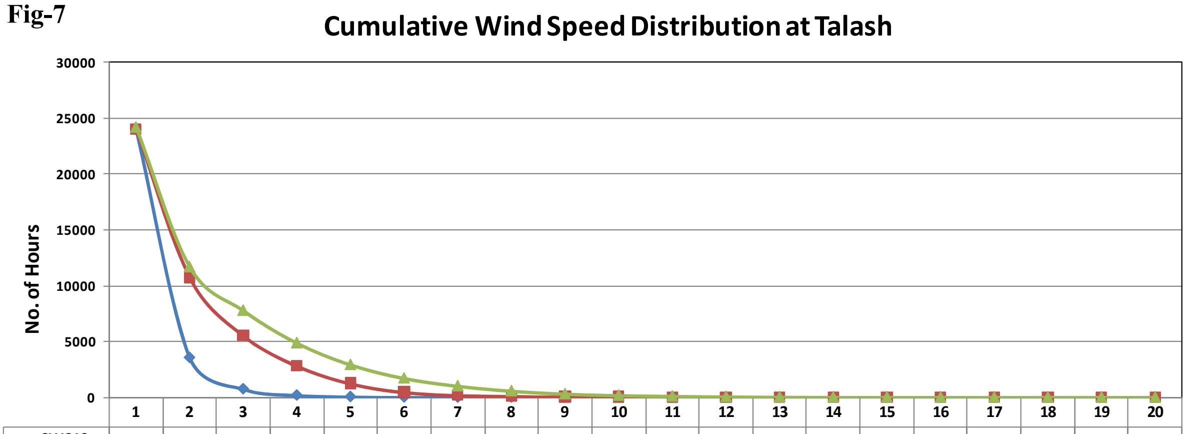
It is proportional wind speed in each bin. It can be viewed as the estimate of probability of given wind speed in the bin. Relative frequency is defined as

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 August 2006 to July 2009 at three heights 10, 30 and 50 meters. The analysis indicate that at a height of 30 meters during 1229 hours the wind speed is greater than or equal to 5 m/s. Whereas at 50 meters, during 2922 hours the wind speed is equal or greater than 5m/s.

Fig-7



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
CWS10m	23972	3550	742	179	46	7	2	1	0	0	0	0	0	0	0	0	0	0	0	0
CWS 30m	23972	10741	5527	2815	1229	443	186	86	40	22	12	7	3	3	2	1	1	1	0	0
CWS 50m	24147	11664	7767	4867	2922	1716	1017	578	311	183	99	61	40	25	17	12	9	7	6	5

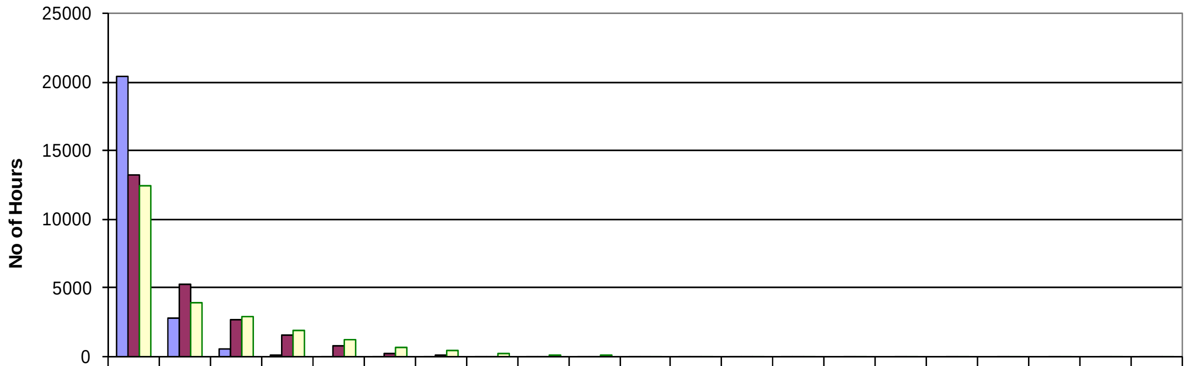
Wind Speed (m/s)

3.4.4 *Wind Frequency Distribution:*

Fig-8 shows the frequency distribution. We can see that at 50 meters during 1206 hours wind speed is 5 m/s, 699 hours speed is 6 m/s, 439 hours speed is 7 m/s, 267 hours speed is 8 m/s and during 128 hours the wind speed is 9m/s and so on. This indicates wind potential in this area.

Fig-8

Wind Frequency Distribution at Talash (All Data)



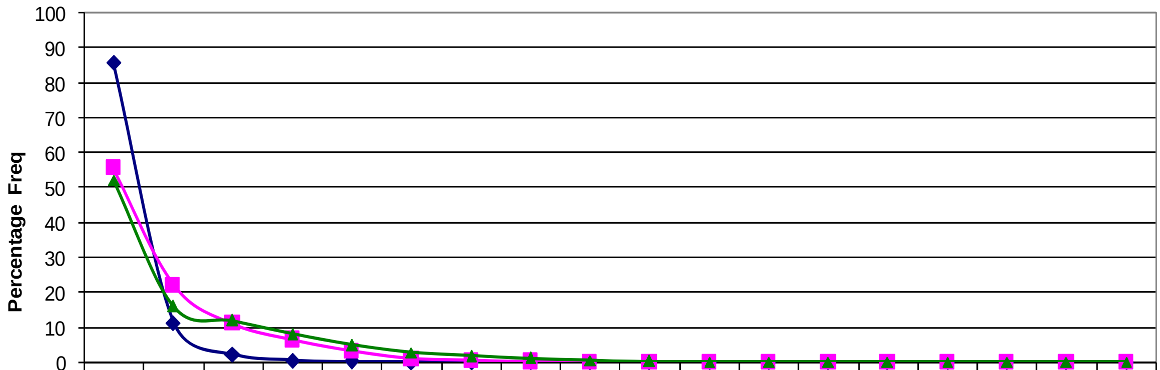
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
WS 10m	20422	2808	563	134	39	5	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
WS 30m	13231	5214	2712	1586	786	256	100	46	18	10	5	3	1	1	1	0	0	0	0	0	0
WS 50m	12482	3898	2900	1945	1206	699	439	267	128	84	38	21	14	8	5	3	2	2	1	1	3

Wind Speed (m/s)

Fig-9 gives this frequency distribution in percentage from Aug-2006 to Jul-2009. At 50 meters we find that during 4.9% of time wind is 5m/s, 2.8% of the time 6m/s and 1.8% of the time it is 7m/s. whereas at 30 meters height we get 3.2% of the time wind speed 5m/s, 1.0% of the times 6m/s and 0.4% of the time 7m/s.

Fig-9

Percentage Wind Frequency Distribution at Talash (All Data)



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
WS 10m	85.8	11.2	2.2	0.5	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
WS 30m	55.6	21.9	11.1	6.4	3.2	1.0	0.4	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WS 50m	52.2	16.0	12.0	8.0	4.9	2.8	1.8	1.1	0.5	0.3	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0

Wind Speed (m/s)

3.4.5 *Seasonal Wind Frequency Distribution:*

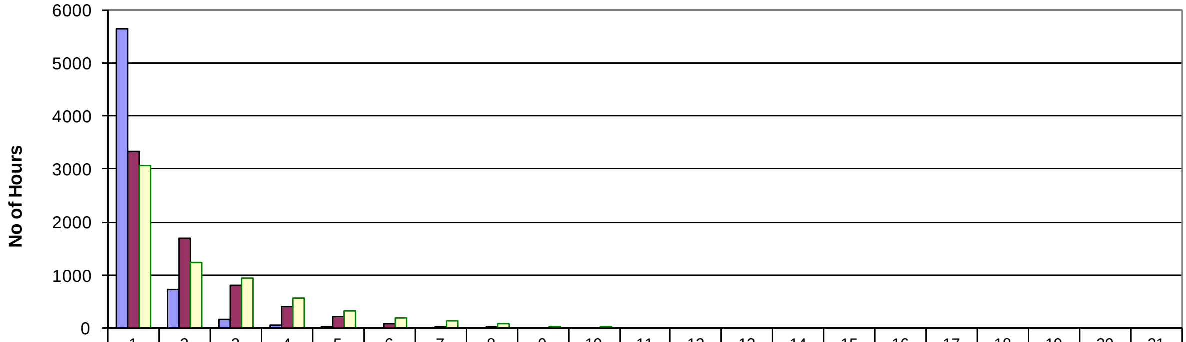
Figures 10–17 gives seasonal wind frequency distribution and percentage wind frequency distribution.

<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 209 hours and 319 hours we get 5m/s respectively.

Fig-10

Wind Frequency Distribution at Talash (Mar-May)



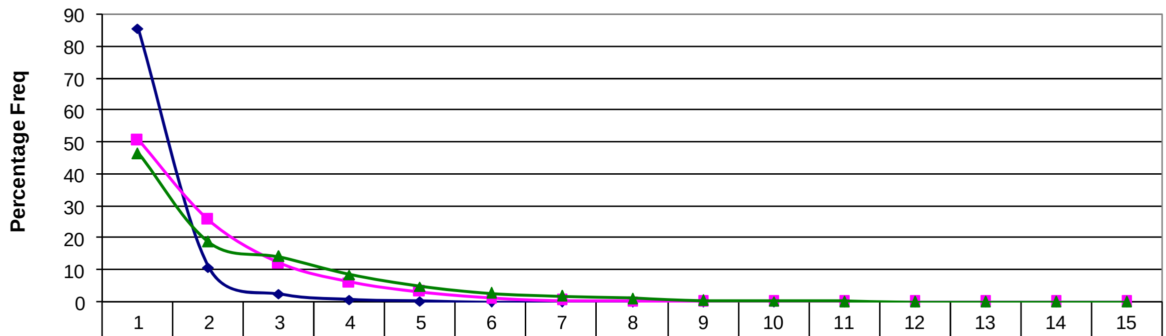
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
WS 10m	5659	719	167	48	19	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WS 30m	3347	1700	804	411	209	77	33	18	8	4	3	2	0	0	0	0	0	0	0	0	0
WS 50m	3073	1241	937	570	319	180	128	72	37	22	12	8	5	4	2	1	1	1	0	1	2

Wind Speed (m/s)

Similarly in Fig-11 shows percentage frequency distribution. At 50 meters we get 4.8% of wind equal to 5m/s, 2.7% of wind equal to 6 m/s and at 30 meter 3.2% wind equal to 5m/s, 1.2% wind equal to 6 m/s respectively.

Fig-11

Percentage Wind Frequency Distribution at Talash (Mar-May)



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
WS 10m	85.6	10.8	2.5	0.7	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WS 30m	50.7	25.7	12.1	6.2	3.2	1.2	0.5	0.3	0.1	0.1	0.0	0.0	0.0	0.0	0.0
WS 50m	46.5	18.7	14.2	8.6	4.8	2.7	1.9	1.1	0.6	0.3	0.2	0.1	0.1	0.1	0.0

Wind Speed (m/s)

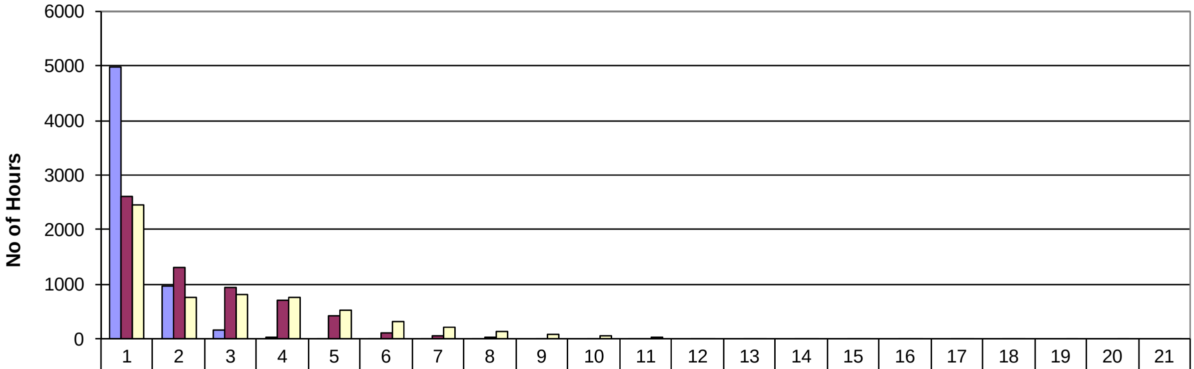
June - August

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 406 hours we get 5m/s, similarly at 50 meters height during 522 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 6.5% and 8.4% we get wind speed of 5m/s at 30m and 50m respectively.

Fig-12

Wind Frequency Distribution at Talash (Jun-Aug)

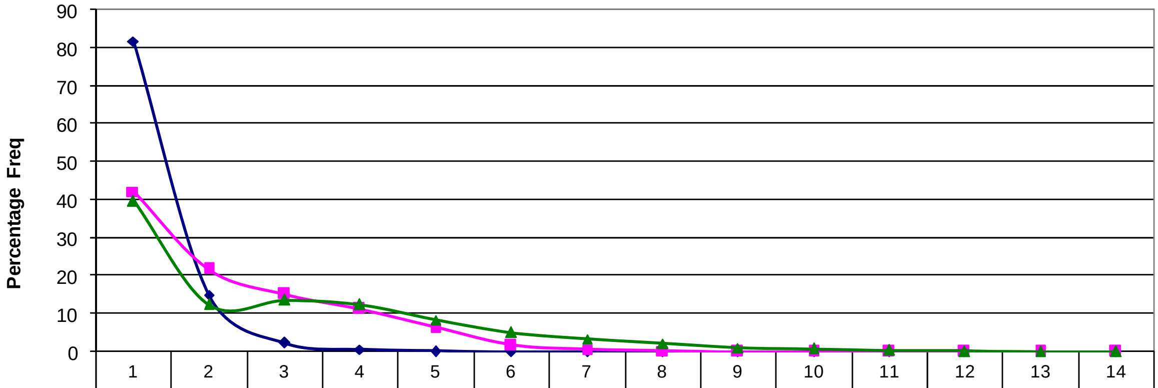


	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
WS 10m	4984	962	151	38	11	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WS 30m	2598	1305	933	711	405	112	46	21	8	5	3	1	0	0	0	0	0	0	0	0	0
WS 50m	2440	769	819	750	522	323	215	142	67	49	22	11	9	4	2	1	1	1	0	1	1

Wind Speed (m/s)

Fig-13

Percentage Wind Frequency Distribution at Talash (Jun-Aug)



	1	2	3	4	5	6	7	8	9	10	11	12	13	14
WS 10m	81.8	15.0	2.3	0.6	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WS 30m	42.1	21.7	15.3	11.4	6.5	1.8	0.7	0.3	0.1	0.1	0.0	0.0	0.0	0.0
WS 50m	39.7	12.5	13.6	12.4	8.4	5.1	3.4	2.2	1.0	0.8	0.3	0.2	0.1	0.1

Wind Speed (m/s)

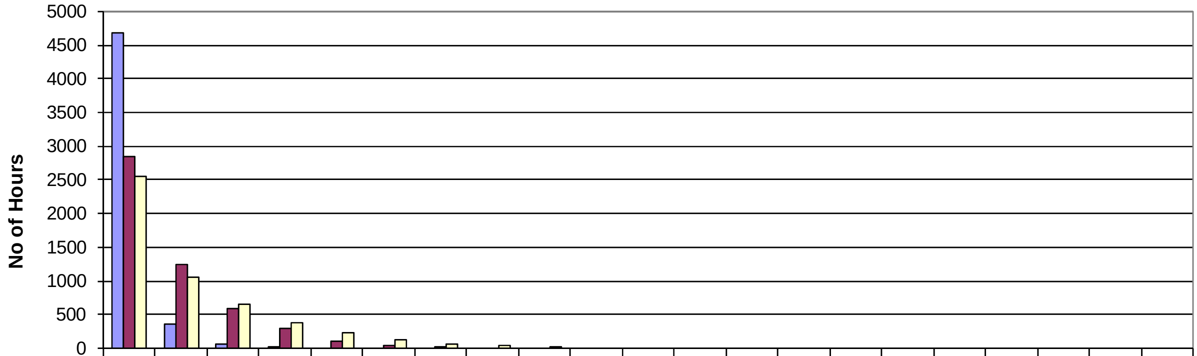
<u>September - November</u>

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 98 hours we get 5m/s, similarly at 50 meters height during 238 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 1.9% and 4.4% we get wind speed of 5m/s at 30m and 50m respectively.

Fig-14

Wind Frequency Distribution at Talash (Sep-Nov)

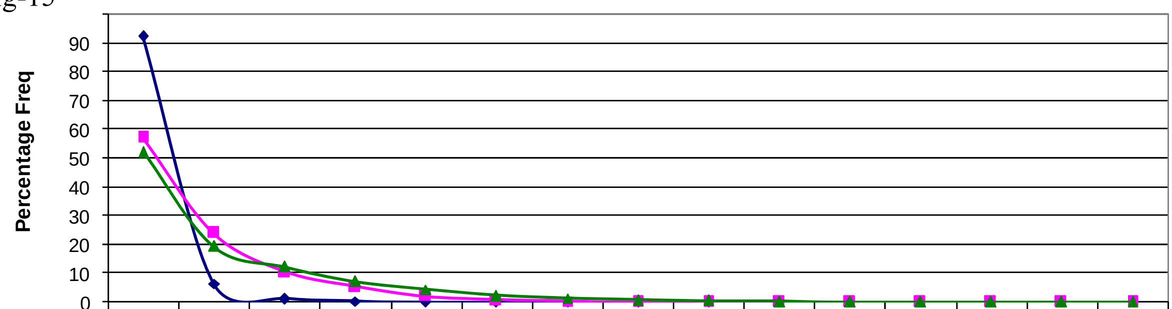


	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
WS 10m	4687	368	69	14	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WS 30m	2850	1246	589	293	98	43	15	5	3	1	0	0	0	0	0	0	0	0	0	0	0
WS 50m	2546	1054	648	387	238	123	66	38	21	10	5	3	1	0	0	0	0	0	0	0	0

Wind Speed (m/s)

Percentage Wind Frequency Distribution at Talash (Sep-Nov)

Fig-15



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
WS 10m	92.1	6.4	1.2	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	57.0	24.0	10.5	5.3	1.9	0.8	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WS 50m	52.1	19.2	12.2	7.2	4.4	2.2	1.2	0.7	0.4	0.2	0.1	0.0	0.0	0.0	0.0

Wind Speed (m/s)

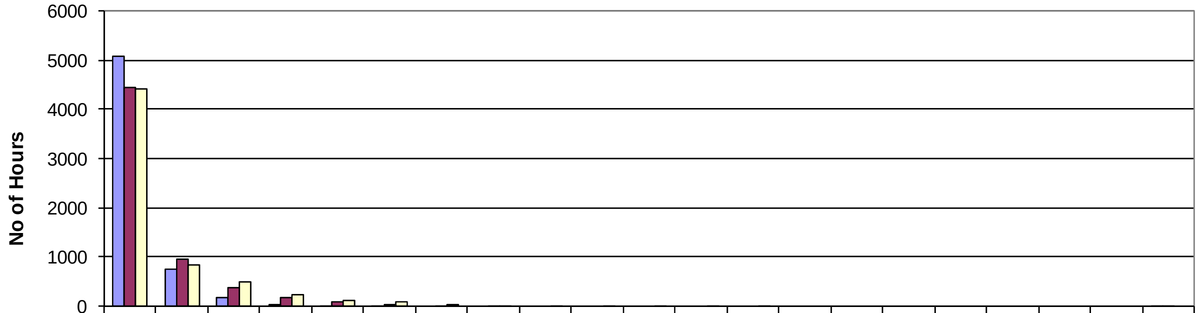
December – February

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 74 hours we get 5m/s, similarly at 50 meters height during 126hours 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 1.2% and 2.1% we get wind speed of 5m/s at 30m and 50m respectively.

Fig-16

Wind Frequency Distribution at Talash (Dec-Feb)

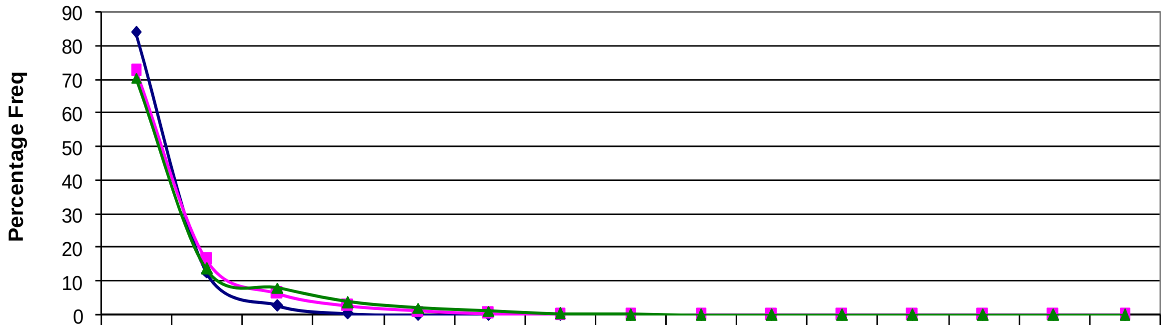


	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
WS 10m	5091	759	176	33	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WS 30m	4436	963	386	172	74	25	6	2	0	0	0	0	0	0	0	0	0	0	0	0	0
WS 50m	4423	833	497	238	126	73	30	14	3	1	0	0	0	0	0	0	0	0	0	0	0

Wind Speed (m/s)

Fig-17

Percentage Wind Frequency Distribution at Talash (Dec-Feb)



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
WS 10m	83.9	12.7	2.8	0.5	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WS 30m	72.5	16.4	6.4	2.9	1.2	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WS 50m	70.3	13.7	8.1	3.9	2.1	1.2	0.5	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0

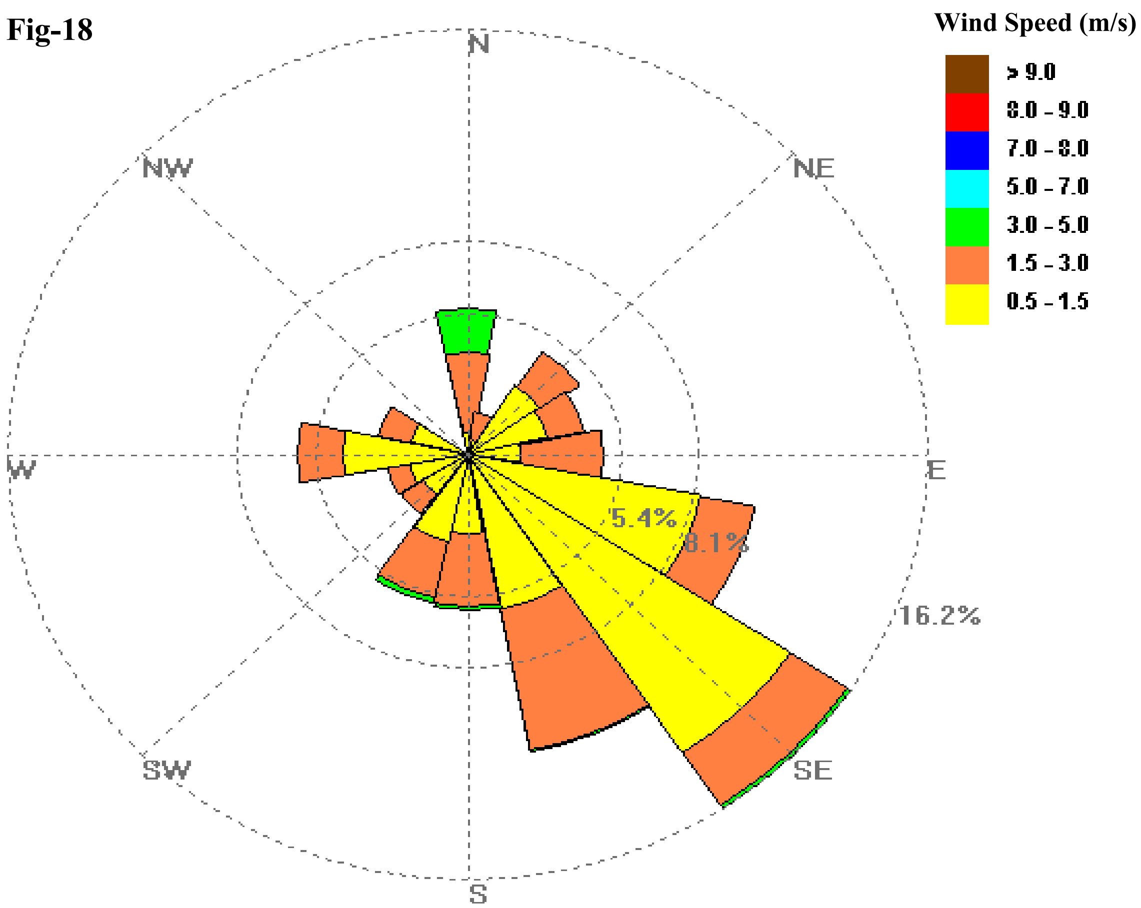
Wind Speed (m/s)

3.5 Wind Rose

Fig-18 shows the Wind Rose based on data from August-2006 to July-2007 (36 months) collected at 30 meters height. Wind Rose indicates that most of the time the wind direction was towards south and south East. The annual average wind speed at 30 meter height is 1.39 m/s and the percentage when wind speed greater than 5 m/s is 2%.

Wind Rose at Talash (30m height)

Fig-18



Average Wind Speed	Wind greater than 5 m/s
1.39 m/s	2%

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

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

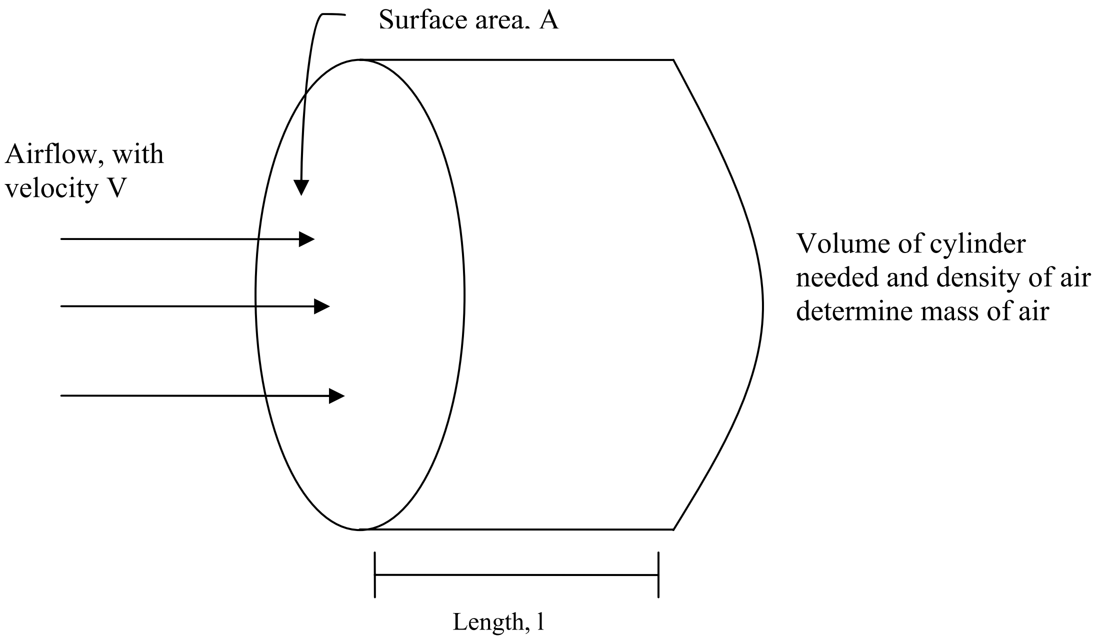
Now mass of wind can be written as

$$M = \varphi Avt$$

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.

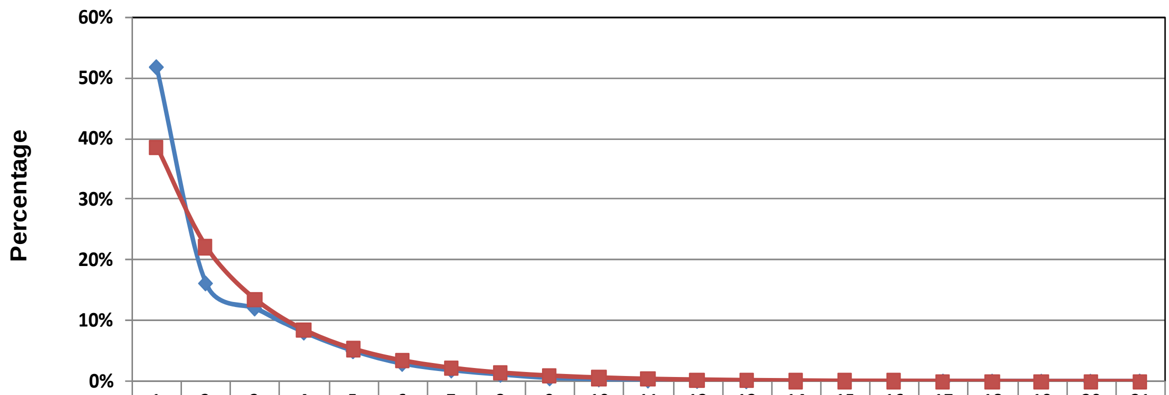
A measure of the confidence of the fit of the Weibull curve to the real data is also returned. Often the Weibull curve is a good fit to the most of the data, but a poor fit to some. If the poor fit is in the low wind speed range, i.e. below cut in it may be possible to ignore the poor fit as this portion 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 **Relative Frequency and Weibull Probability at Talash (50m 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	51.7	16.1	12.0	8.1%	5.0%	2.9%	1.8%	1.1%	0.5%	0.3%	0.2%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Weibull 50m	38.5	22.2	13.5	8.4%	5.3%	3.4%	2.2%	1.4%	0.9%	0.6%	0.4%	0.3%	0.2%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Wind Speed (m/s)

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 wide range from the lowest of 0.91 during January & December to the highest of 1.23 during the month of September with an annual of K being 1.03

The lowest values of the *scale parameter* C 0.97 m/s observed in January while the highest value of 2.92 is obtained in June and with an annual value of 1.88 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 0.69 m/s with Standard deviation of 0.49, at 30 meters this average speed is 1.39 m/s with Standard deviation of 1.21.

At 50 meters the monthly average wind speed varies from the lowest of 0.86 m/s in January to highest of 2.71 m/s during July arch. Whereas the average wind speed is 1.82 m/s with Standard deviation of 1.75.

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 0.22 W/m^2 in October to 1.29 W/m^2 in Februarywith Average of 0.65 W/m^2.

At 30 meters height the power density varies from 1.78 W/m^2 in January to the highest of 17.26 W/m^2 in June and the average values is about 8.32 W/m^2.

At 50 meters height the power density of Talash varies from 4.95 W/m^2 in January to 76.66 W/m^2 in March. The average power density of the area is 26.59 W/m^2.

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

10 m					
	AvgV (m/s)	**St Dev**	**C (m/s)**	**K**	**P/A (w/m^2)**
January	0.67	0.46	0.76	1.52	**0.52**
February	0.82	0.64	0.93	1.32	**1.29**
March	0.78	0.64	0.83	1.23	**1.09**
April	0.64	0.48	0.70	1.37	**0.51**
May	0.67	0.51	0.73	1.36	**0.58**
June	0.78	0.62	0.84	1.28	**1.01**
July	0.77	0.56	0.84	1.42	**0.82**
August	0.64	0.41	0.71	1.61	**0.39**
September	0.69	0.47	0.76	1.51	**0.53**
October	0.57	0.31	0.64	1.95	**0.22**
November	0.60	0.41	0.67	1.53	**0.36**
December	0.64	0.43	0.71	1.54	**0.42**
Average	**0.69**	**0.49**	**0.76**	**1.47**	**0.65**
30 m					
	AvgV (m/s)	**St Dev**	**C (m/s)**	**K**	**P/A (w/m^2)**
January	0.77	0.71	0.87	1.09	**1.78**
February	1.28	1.12	1.44	1.15	**6.91**
March	1.30	1.18	1.35	1.11	**6.25**
April	1.34	1.25	1.38	1.08	**7.43**
May	1.69	1.49	1.78	1.14	**13.07**
June	1.88	1.63	1.99	1.17	**17.26**
July	1.95	1.53	2.11	1.30	**15.60**
August	1.56	1.37	1.64	1.15	**10.03**
September	1.82	1.38	1.99	1.36	**11.87**
October	1.17	1.00	1.24	1.18	**4.04**
November	1.05	0.97	1.08	1.08	**3.49**
December	0.88	0.83	0.90	1.06	**2.13**
Average	**1.39**	**1.21**	**1.48**	**1.16**	**8.32**
50 m					
	AvgV (m/s)	**St Dev**	**C (m/s)**	**K**	**P/A (w/m^2)**
January	0.86	0.94	0.97	0.91	**4.95**
February	1.52	1.42	1.56	1.08	**10.80**
March	1.63	1.60	1.65	1.02	**15.17**
April	1.75	1.83	1.71	0.95	**22.43**
May	2.29	2.26	2.30	1.01	**42.78**
June	2.58	2.47	2.92	1.05	**76.66**
July	2.71	2.37	2.85	1.16	**52.19**
August	2.10	2.04	2.12	1.03	**31.42**
September	2.51	2.07	2.68	1.23	**36.51**
October	1.50	1.47	1.51	1.02	**11.78**
November	1.32	1.36	1.29	0.96	**9.23**
December	1.03	1.12	0.99	0.91	**5.14**
Average	**1.82**	**1.75**	**1.88**	**1.03**	**26.59**

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 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 Talash 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 Talash 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 Talash.

PMD Calculator (using 50M) Aug 2006 to Sep 2008				
Month	**Input W/m^2**	**Output W/m^2**	**C.F.**	**KWh / Month**
January	5	1	0%	1,693
February	11	4	1%	3,833
March	16	5	1%	6,068
April	24	8	2%	8,704
May	45	15	4%	16,942
June	81	25	6%	27,512
July	55	19	5%	21,581
August	33	11	3%	12,820
September	39	14	3%	15,091
October	12	4	1%	4,581
November	10	3	1%	3,384
December	5	2	0%	1,771
Annual	23	8	2%	106,201

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 thirty-six (36) 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.

Cut-in Speed:

Cut-in speed is the minimum wind speed at which the wind turbine will generate usable power. This wind speed is typically between 3 and 5 m/s for most turbines.

Cut-out Speed:

At very high wind speeds, typically between 20 and 35 m/s, most wind turbines cease power generation and shut down. The wind speed at which shut down occurs is called the cut-out speed. Having a cut-out speed is a safety feature which protects the wind turbine from damage.

Figure 20 shows the average diurnal variation of wind generated electric energy output at Talash (Aug 06-Jul-09). The graph shows that the maximum power is produced at 1700; of course, this is the same time when we have the maximum wind speed in 24 hours. Figure 21 and 22 shows the monthly and daily wind generated electric power output. Figure 21 depicts that at Talash the wind have more potential in the month of June as compared to other months. Figure 23 to 34 shows the monthly average diurnal variation of wind generated electric energy output.

Fig 20 Talash: From Aug 2006 to Jul 2009 Annual Average Diurnal Varition Of Wind Generated Electric Powe Output

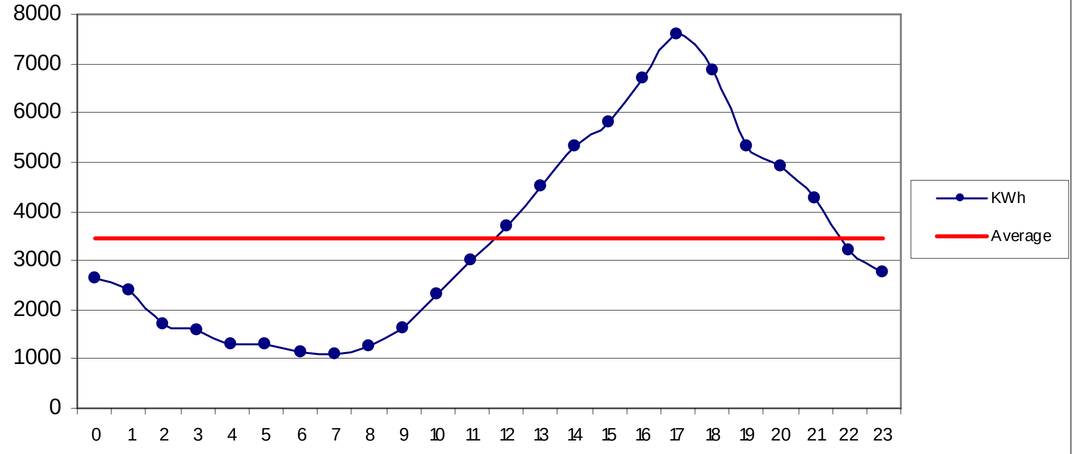


Fig 21 TalashFrom Aug 2006 to Jul 2009 Monthly Average Diurnal Varition Of Wind Generated Electric Powe Output

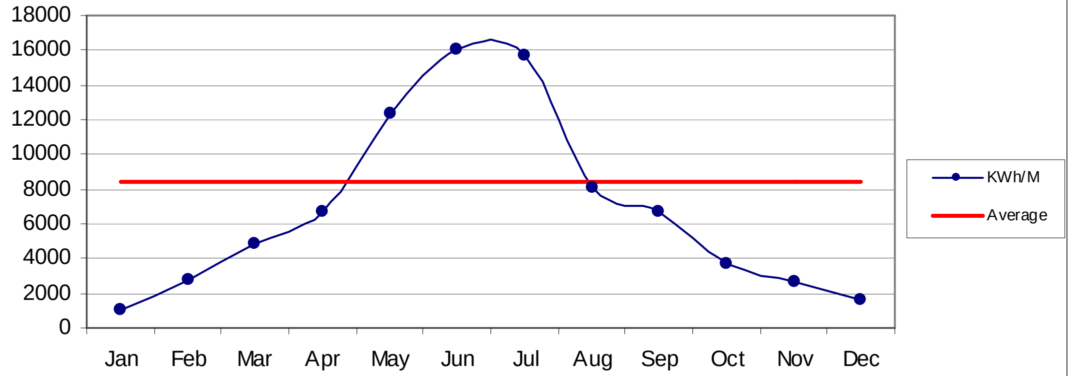


Fig 22 Talash: From Aug 2006 to Jul 2009 Daily Wind Generated Electric Power Output

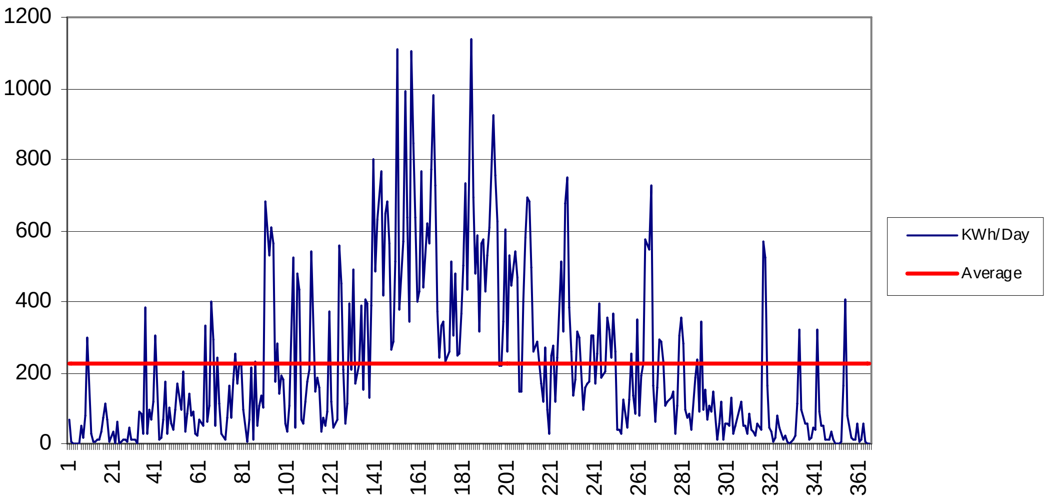


Fig 23 Talash Jan: Diurnal Variation of Wind Genrated Electric Energy Output

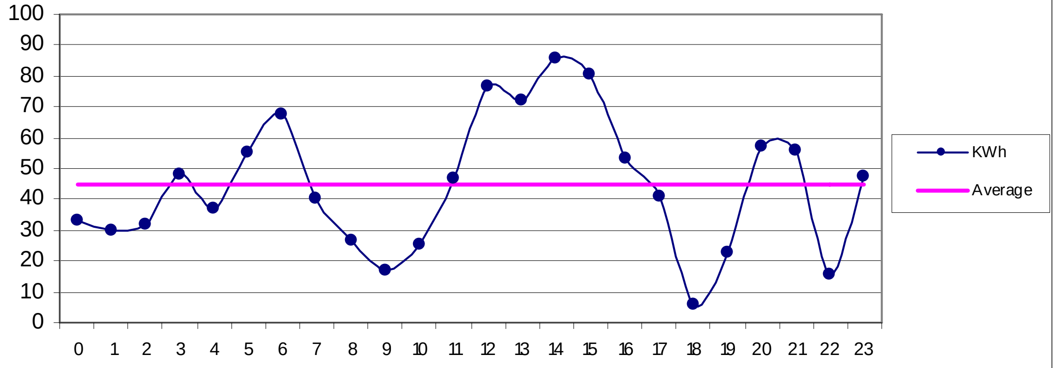
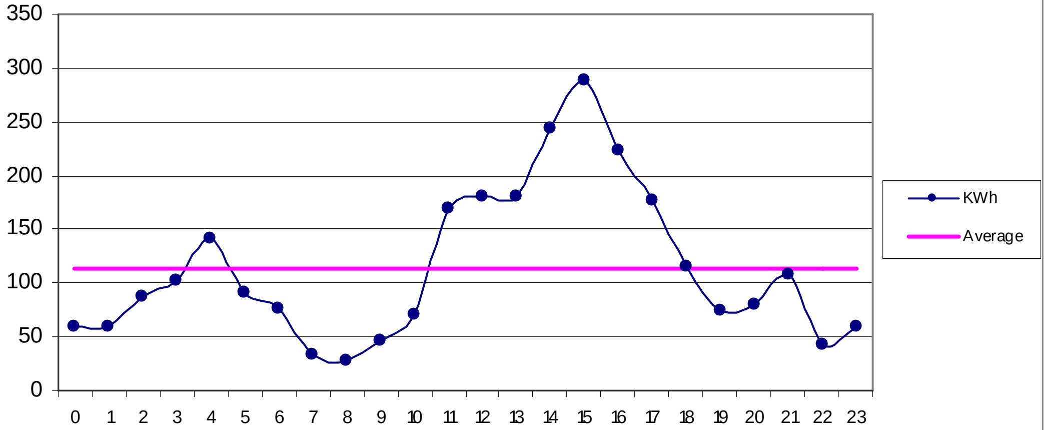
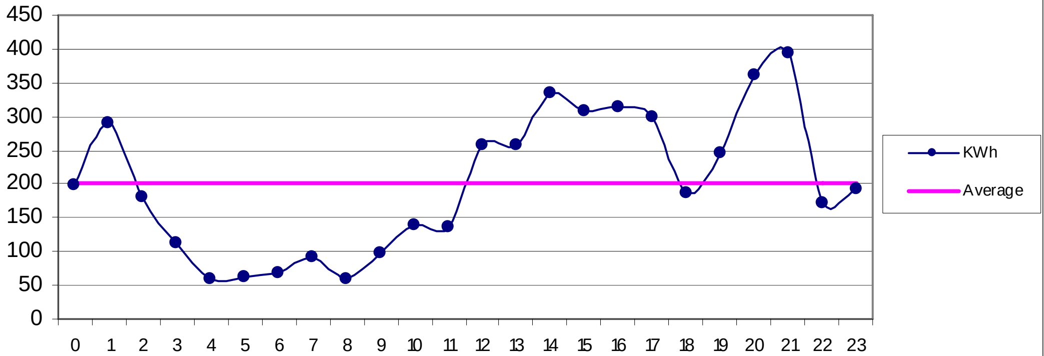


Fig 24 Talash Feb: Diurnal Variation of Wind Genrated Electric Energy Output



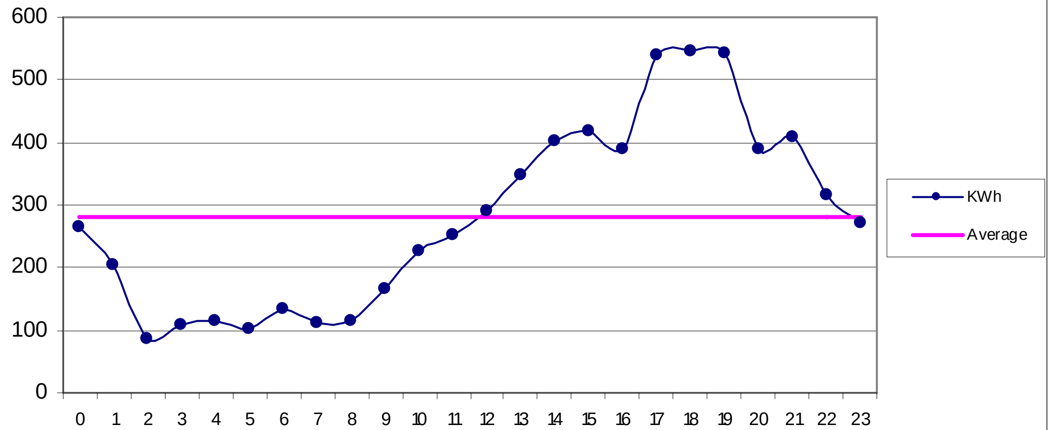
Source: Pakistan Meteorological Department

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



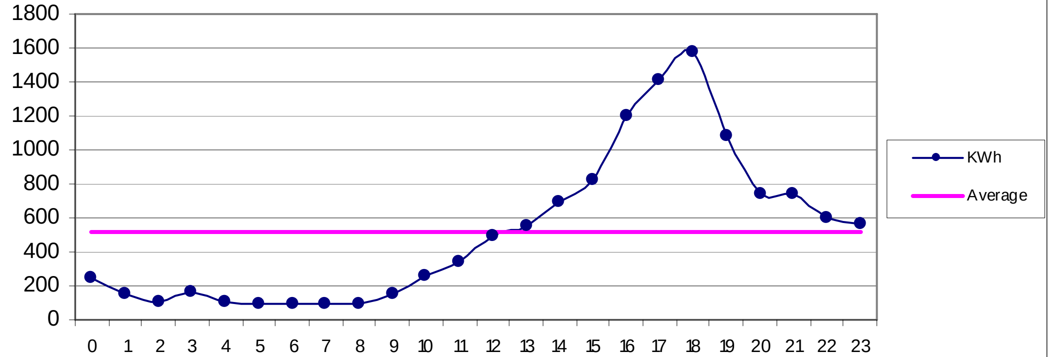
Source: Pakistan Meteorological Department

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



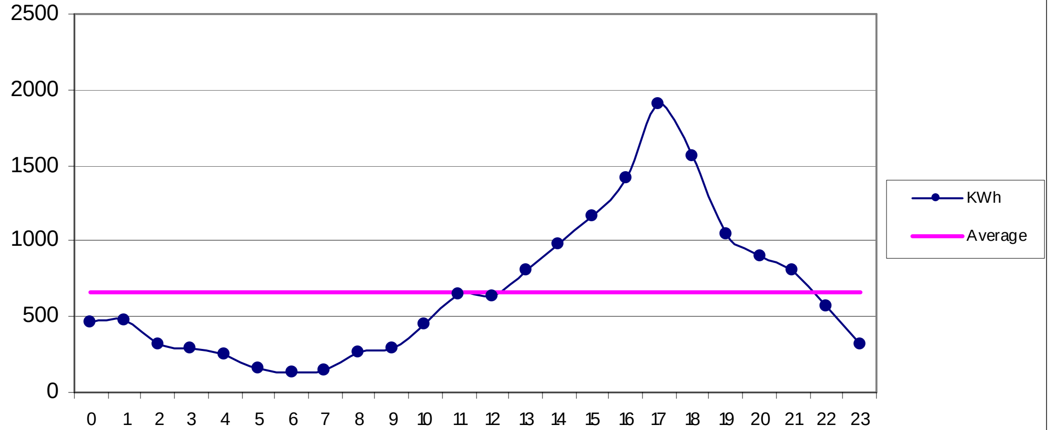
Source: Pakistan Meteorological Department

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



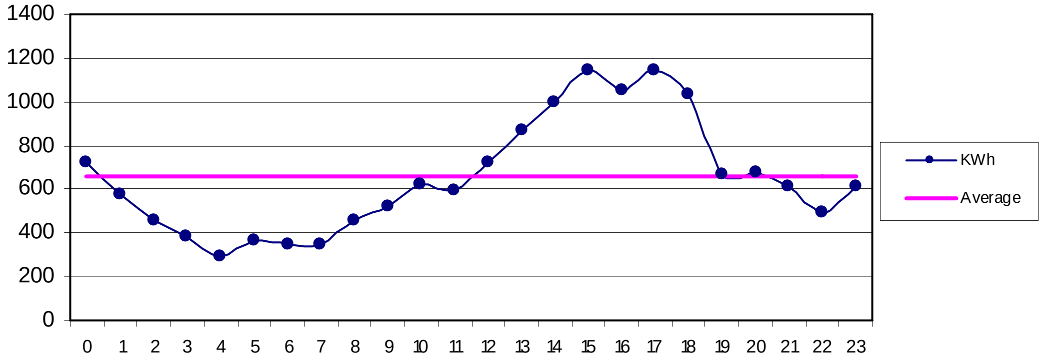
Source: Pakistan Meteorological Department

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



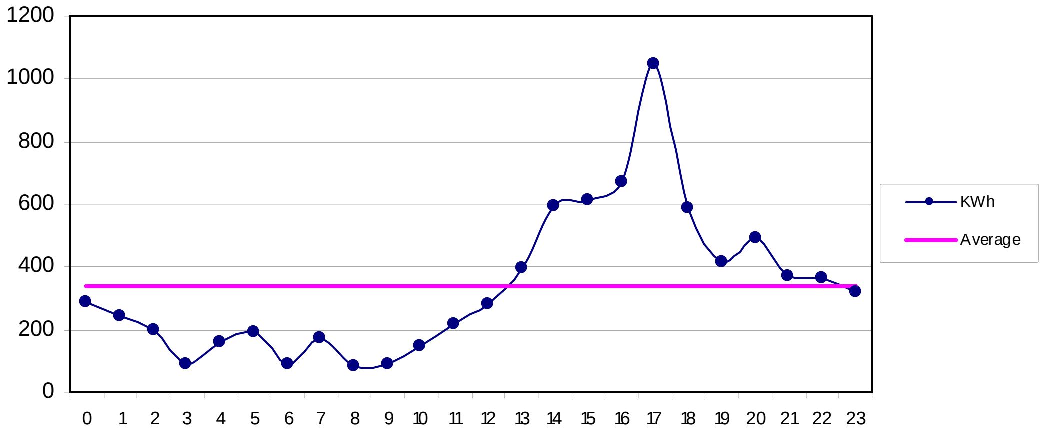
Source: Pakistan Meteorological Department

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



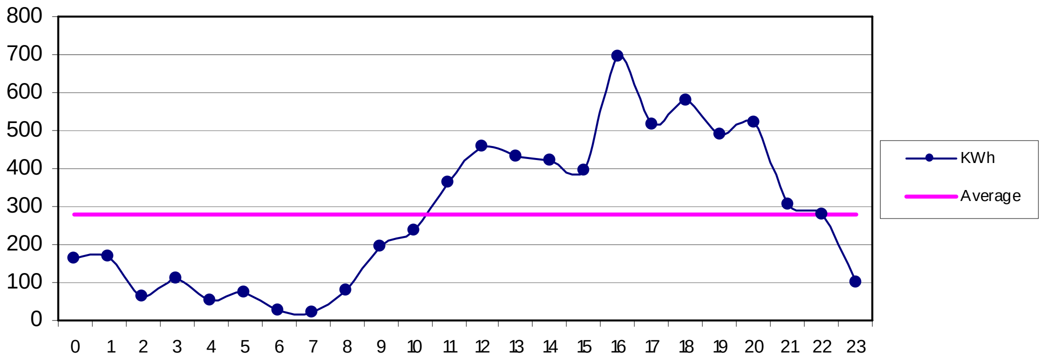
Source: Pakistan Meteorological Department

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



Source: Pakistan Meteorological Department

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



Source: Pakistan Meteorological Department

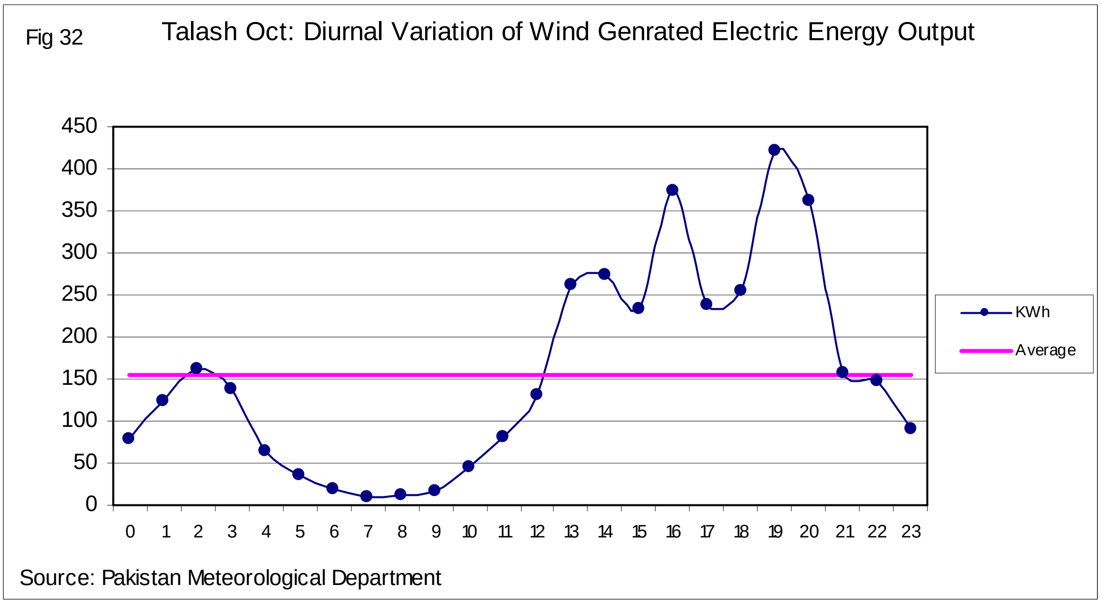


Fig 32
Talash Oct: Diurnal Variation of Wind Genrated Electric Energy Output
450
400
350
300
250
200
150
100
50
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
KWh
Average
Source: Pakistan Meteorological Department

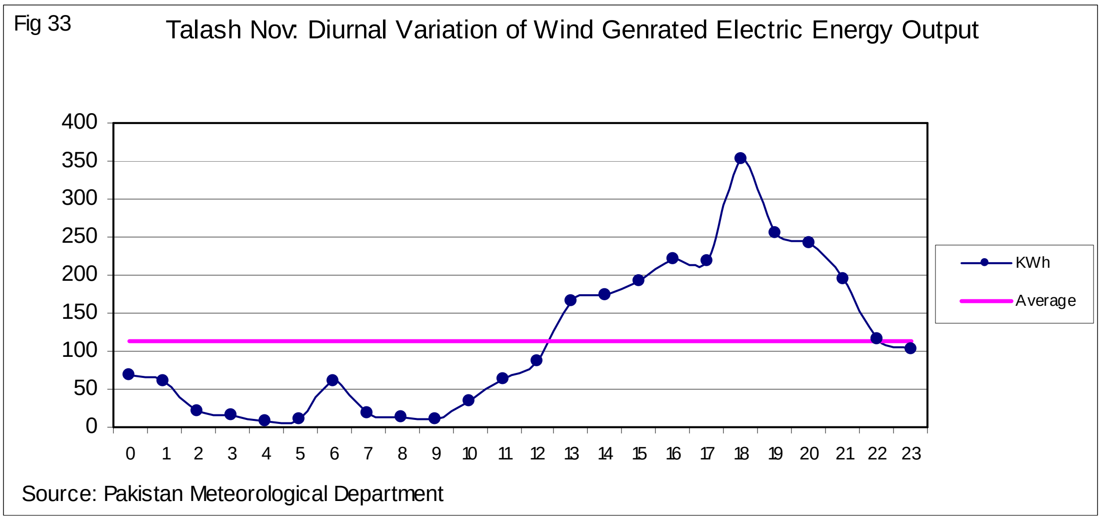


Fig 33
Talash Nov: Diurnal Variation of Wind Genrated Electric Energy Output
400
350
300
250
200
150
100
50
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
KWh
Average
Source: Pakistan Meteorological Department

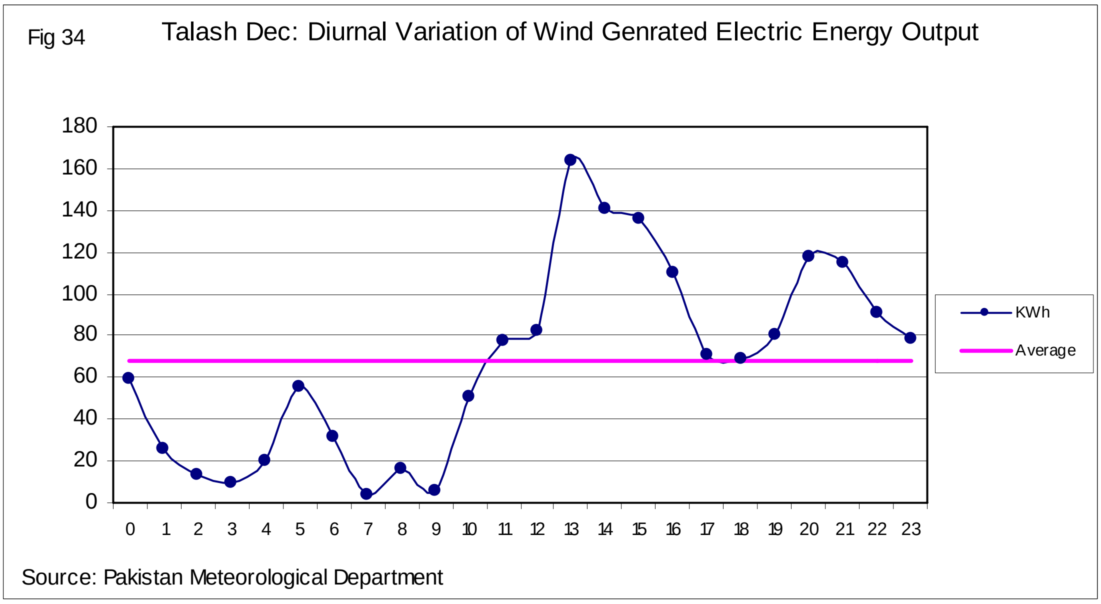
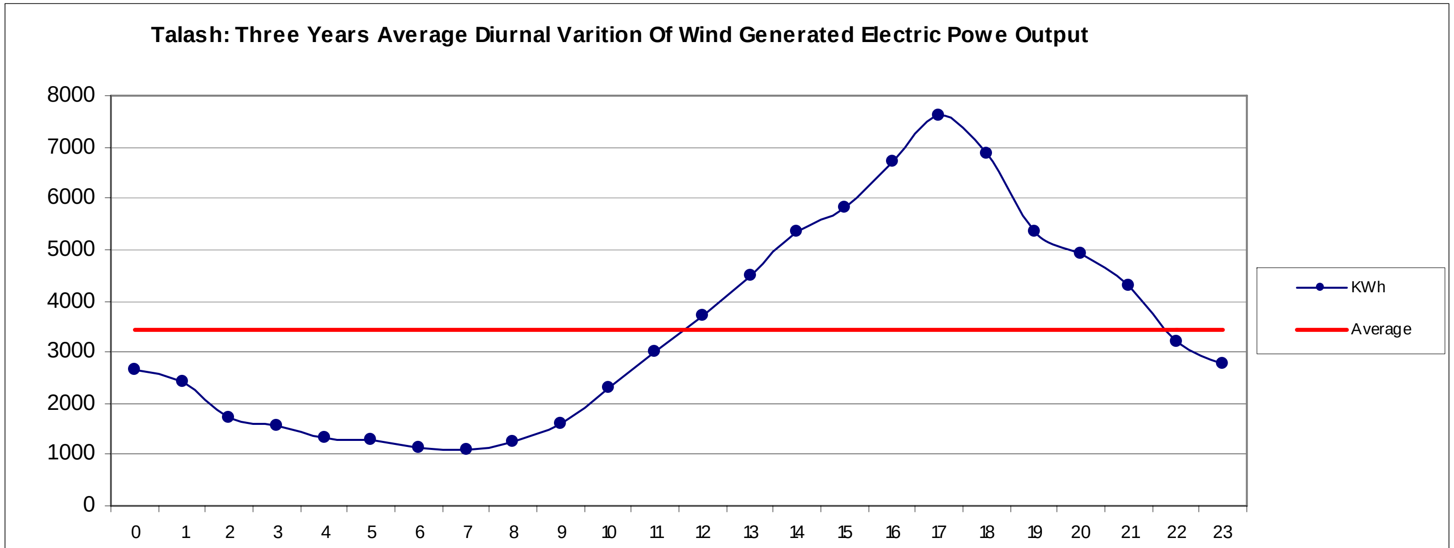


Fig 34
Talash Dec: Diurnal Variation of Wind Genrated Electric Energy Output
180
160
140
120
100
80
60
40
20
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
KWh
Average
Source: Pakistan Meteorological Department

Appendix-I

Talash **Aug 2006 to July 2009** **Wind Power Output of Bonus 600/44 Turbine (36-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	33	30	32	48	37	55	67	40	26	17	25	47	77	72	86	80	53	41	6	23	57	56	16	48	1071
Feb	60	59	87	102	141	91	77	34	28	46	70	170	180	180	243	288	224	177	115	75	80	107	44	59	2735
Mar	198	290	180	112	60	62	68	92	60	98	138	136	258	258	333	308	314	299	185	244	361	393	172	193	4812
Apr	265	204	86	108	116	102	133	111	115	165	227	251	290	348	403	419	390	541	545	542	390	408	317	272	6749
May	249	154	111	163	107	96	92	92	93	154	258	343	496	550	689	826	1198	1411	1579	1079	739	742	595	570	12386
Jun	461	478	311	289	254	162	135	144	268	287	444	652	641	811	985	1163	1415	1909	1557	1042	893	812	570	315	15998
Jul	720	577	456	385	290	369	347	347	458	523	622	596	720	866	997	1144	1048	1141	1033	670	676	614	493	614	15705
Aug	286	240	196	89	161	191	86	172	84	92	147	214	281	394	592	615	671	1048	590	418	494	373	366	320	8120
Sep	164	166	63	110	53	72	25	23	81	196	237	362	457	430	419	395	696	515	581	490	519	306	280	98	6736
Oct	79	123	163	138	64	37	19	9	13	16	46	82	130	261	275	233	373	239	255	420	362	157	148	91	3732
Nov	68	61	20	17	9	12	61	19	13	11	34	63	87	165	173	191	222	218	353	255	241	194	115	102	2702
Dec	59	26	14	10	20	56	32	4	16	6	50	77	82	163	141	136	110	71	69	80	118	115	91	78	1626
KWH	2643	2408	1720	1570	1313	1304	1142	1089	1256	1610	2297	2991	3698	4497	5335	5798	6713	7608	6868	5339	4929	4277	3206	2762	82372
Average	3432	3432	3432	3432	3432	3432	3432	3432	3432	3432	3432	3432	3432	3432	3432	3432	3432	3432	3432	3432	3432	3432	3432	3432	



Source: Pakistan Meteorological Department

Appendix-II

Talash **Jan 07,08,09** **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	3	3	0	0	14	19	10	13	5	1	0	0	0	0	0	0	69
2	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	0	0	0	0	0	0	0	0	0	5
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
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	2
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	2
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
7	0	0	0	0	0	0	0	0	0	0	4	4	2	0	4	0	6	7	0	6	7	1	0	7	48
8	4	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	15
9	0	0	0	0	0	9	16	2	1	8	2	0	1	0	0	0	0	0	0	0	0	0	3	33	77
10	20	19	27	33	29	18	17	15	16	4	3	5	11	9	9	15	1	4	0	0	18	19	4	1	297
11	0	1	1	0	0	0	0	0	0	0	0	0	0	4	8	9	4	0	0	0	0	0	0	0	28
12	0	0	0	0	0	0	0	0	0	1	0	0	0	2	1	2	0	0	0	0	0	0	0	0	6
13	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0	3
14	0	0	0	0	0	0	0	0	0	0	0	1	0	1	6	1	0	0	0	0	0	0	0	0	10
15	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	3	0	0	1	2	11
16	4	0	0	0	0	2	2	22	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	35
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	1	1	0	4	23	32	6	4	76
18	4	0	0	9	0	10	7	0	1	0	12	24	20	2	4	10	8	1	0	0	0	0	0	0	113
19	0	0	3	5	7	13	26	0	0	0	0	1	2	1	1	2	0	0	0	0	3	2	0	0	66
20	0	0	0	0	0	0	0	0	0	0	0	1	3	1	1	0	0	1	0	0	0	0	0	0	7
21	0	0	0	0	0	0	0	0	0	0	0	1	4	8	8	8	2	1	0	0	0	0	0	0	33
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	2
23	0	0	0	0	0	0	0	0	0	0	1	3	12	15	10	5	10	0	1	2	1	0	0	0	61
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
25	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2	0	0	0	0	0	0	0	6
26	0	0	0	0	0	0	0	0	0	0	1	2	3	2	1	1	0	1	0	0	0	1	0	0	13
27	0	0	1	0	0	3	0	0	0	0	0	0	0	1	0	2	1	1	0	0	0	0	0	0	10
28	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	1	0	1	0	0	0	0	0	5
29	0	0	0	0	0	0	0	0	0	0	0	0	0	2	14	5	3	14	2	3	2	0	0	1	46
30	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	4	0	1	0	0	0	0	14
31	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	3	4	0	0	0	0	0	0	9
KWh	33	30	32	48	37	55	67	40	26	17	25	47	77	72	86	80	53	41	6	23	57	56	16	48	1071

Talash **Feb 07,08,09** **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	1	0	0	0	0	0	0	3
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	3	5	5	19	23	15	9	3	90
3	4	6	0	6	8	8	9	0	0	0	0	0	0	0	1	6	15	19	3	0	0	0	0	0	84
4	0	0	0	0	0	0	0	0	0	1	0	0	0	4	1	1	0	0	0	0	1	6	0	14	30
5	3	24	21	17	36	38	41	30	7	15	0	0	0	6	12	4	13	11	32	12	6	49	10	0	385
6	0	1	0	0	0	0	0	0	0	0	0	1	1	3	4	3	9	2	1	1	0	0	0	0	26
7	0	1	15	11	7	0	0	0	0	0	9	13	14	13	2	6	3	0	1	1	0	0	0	0	98
8	0	0	0	12	5	12	8	1	2	2	1	0	1	2	1	4	2	3	3	4	1	0	1	0	67
9	0	0	0	0	0	0	0	0	0	0	7	7	15	25	29	14	3	1	0	0	0	2	0	16	118
10	26	10	42	40	51	18	0	0	0	3	5	9	13	17	23	22	18	3	1	0	0	0	0	0	302
11	0	0	0	0	0	0	0	0	0	0	1	0	2	2	2	2	2	2	0	0	0	0	0	0	14
12	0	0	0	0	0	0	0	0	0	0	1	1	6	7	0	3	1	1	0	0	0	0	0	0	20
13	0	0	0	0	0	0	0	0	0	2	3	3	7	9	12	15	3	0	5	1	0	0	3	1	66
14	5	0	4	11	0	0	16	1	0	0	0	4	10	4	12	24	26	14	26	9	3	4	0	0	174
15	0	0	1	0	0	0	0	0	0	0	2	1	3	4	5	7	1	1	3	0	1	0	0	0	29
16	0	0	0	0	0	0	0	1	0	1	13	4	11	10	14	16	23	5	0	0	0	0	0	0	99
17	0	0	0	0	0	0	0	0	0	2	1	2	5	2	15	17	11	1	0	0	0	0	1	0	57
18	0	0	0	0	0	0	0	0	0	0	2	0	2	5	11	7	2	8	0	0	0	0	0	0	37
19	0	0	0	0	0	0	0	0	0	0	1	1	1	0	5	24	16	39	1	3	2	0	0	0	93
20	6	2	0	2	27	11	2	0	19	16	19	8	5	4	1	1	1	9	8	3	3	16	6	4	170
21	6	4	0	2	0	0	0	0	0	0	2	14	5	1	8	4	3	10	2	2	8	6	4	14	96
22	4	3	0	0	0	0	0	0	0	2	4	18	19	19	17	51	35	23	8	0	0	0	0	0	204
23	0	0	0	0	0	0	0	0	0	0	0	4	5	5	3	5	2	1	0	2	1	0	3	0	33
24	0	0	0	0	0	0	1	0	0	0	0	27	13	1	3	1	1	3	6	8	17	3	0	0	85
25	1	1	0	0	0	0	0	0	0	0	0	45	32	23	15	13	4	1	1	1	3	1	1	0	143
26	1	0	0	0	0	0	0	0	0	0	1	3	7	10	24	16	12	0	0	1	1	0	1	0	80
27	2	4	3	0	5	1	0	0	0	0	0	3	2	5	17	18	13	2	4	5	5	1	0	0	91
28	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	7	3	12	3	1	1	0	0	0	30
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	2	5	7	7	22
KWh	60	59	87	102	141	91	77	34	28	46	70	170	180	180	243	288	224	177	115	75	80	107	44	59	2735

Talash **March 07,08,09** **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	6	13	2	0	0	0	0	2	0	0	0	0	0	0	1	19	12	2	5	3	0	0	0	0	67
2	0	0	0	1	0	0	0	0	0	0	0	0	0	2	0	0	4	11	4	10	3	0	6	5	49
3	0	0	0	0	3	5	43	37	12	9	6	20	31	42	25	34	36	6	2	10	10	1	0	0	332
4	0	1	0	0	2	0	0	0	0	0	1	1	4	6	11	7	8	8	6	5	2	2	0	0	64
5	0	1	0	0	0	0	0	0	0	0	1	2	2	3	4	20	18	7	12	3	12	2	3	14	105
6	8	0	2	2	0	0	0	0	8	1	1	9	76	35	9	4	15	1	0	8	20	140	28	36	402
7	6	72	48	15	26	35	5	0	1	4	12	17	5	16	19	8	0	4	0	0	0	0	0	0	294
8	0	0	0	0	0	0	0	0	0	0	1	1	3	7	3	1	3	1	0	4	3	1	4	16	48
9	9	0	7	49	8	14	8	1	1	4	21	21	43	23	14	6	1	2	4	2	0	3	1	0	242
10	0	0	0	0	0	1	0	0	0	0	0	9	10	7	8	2	19	12	28	4	10	0	2	1	114
11	0	0	2	0	0	0	0	1	1	0	0	0	0	3	3	1	0	2	4	3	4	2	2	1	27
12	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1	0	2	2	0	4	0	1	0	14
13	0	1	0	1	0	2	0	7	4	5	7	2	0	2	2	9	6	4	4	2	4	2	1	10	75
14	37	27	19	10	1	2	0	0	0	0	1	1	0	1	4	4	10	10	2	7	19	9	0	0	166
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	1	7	22	7	16	17	75
16	13	14	1	0	0	0	0	0	0	0	1	1	3	3	6	6	11	17	13	28	33	22	6	2	181
17	41	1	5	1	0	0	0	13	0	0	0	0	1	1	1	6	8	96	33	14	25	2	0	1	252
18	1	1	4	4	1	0	0	18	3	1	0	1	18	33	44	14	3	2	0	1	0	0	11	5	167
19	0	0	0	0	0	0	0	0	13	36	11	8	1	3	12	15	15	19	15	40	11	8	1	18	225
20	10	18	9	0	8	1	1	0	0	25	55	20	4	5	15	11	26	9	0	0	0	0	0	0	218
21	0	0	0	0	0	0	0	11	5	2	4	6	8	13	24	16	3	2	2	0	0	0	0	0	97
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	5
23	0	1	0	0	0	0	0	0	0	0	1	4	1	5	6	2	5	3	1	5	2	8	17	5	67
24	16	44	9	6	3	0	0	2	9	6	6	4	11	17	23	26	23	1	1	0	1	1	3	2	215
25	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	8
26	18	14	13	3	0	0	0	0	0	0	1	1	4	2	53	56	27	25	6	2	1	1	2	1	230
27	2	1	1	0	0	0	2	0	3	0	3	2	4	2	1	1	7	7	2	2	4	5	0	1	51
28	1	1	2	0	1	1	0	0	0	0	0	1	1	0	0	3	5	10	5	24	30	15	7	0	107
29	0	3	5	0	0	1	5	0	0	1	0	0	10	17	15	15	18	9	8	4	16	4	2	0	135
30	3	1	2	0	1	0	1	0	0	0	1	0	10	2	1	2	13	10	1	1	12	16	22	5	104
31	22	72	48	16	4	0	0	0	1	1	2	5	4	9	26	17	15	13	26	56	111	142	37	52	680
KWh	198	290	180	112	60	62	68	92	60	98	138	136	258	258	333	308	314	299	185	244	361	393	172	193	4812

Talash **April 07,08,09** **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	111	61	31	21	16	1	3	1	7	2	7	9	13	17	17	17	19	21	8	1	0	64	33	49	531
2	45	53	18	12	8	1	0	9	52	57	46	33	29	28	46	52	25	15	18	31	18	5	1	6	610
3	4	22	0	0	0	1	0	0	0	3	23	29	42	83	76	58	32	108	10	31	27	16	0	0	564
4	0	0	0	0	0	0	0	0	1	3	19	26	12	14	13	17	9	11	2	25	1	10	2	7	173
5	9	17	16	16	3	2	16	14	14	8	16	27	7	13	37	18	17	8	2	2	6	4	4	7	282
6	3	0	0	0	14	9	3	2	0	0	5	0	6	1	1	3	0	2	0	1	17	51	21	3	143
7	3	7	4	1	6	13	17	5	4	20	16	17	12	5	20	11	8	6	3	6	5	0	1	0	192
8	3	13	3	19	13	21	22	21	5	0	0	1	2	0	0	7	12	6	0	1	1	7	20	3	183
9	0	0	0	0	0	0	0	0	0	1	1	1	2	8	17	5	3	7	6	0	3	3	0	0	57
10	2	1	0	1	0	0	0	0	0	2	1	1	1	1	2	1	2	2	6	4	1	1	3	0	34
11	0	0	0	1	0	0	0	0	0	1	2	3	1	11	11	5	6	0	2	10	7	2	4	41	108
12	9	8	1	1	0	0	2	0	0	0	1	4	3	1	2	4	89	87	31	34	20	121	93	14	524
13	4	0	0	0	0	0	0	0	2	2	1	1	3	0	1	1	1	1	1	13	10	3	2	1	47
14	0	0	0	0	7	5	17	3	0	25	29	22	14	54	41	42	71	32	33	31	19	23	10	0	478
15	5	1	1	0	0	5	2	50	25	22	17	19	42	23	22	15	9	22	93	39	16	3	2	0	433
16	0	0	0	0	0	0	0	0	3	6	7	13	13	7	5	0	0	1	1	4	4	0	0	1	65
17	0	0	0	0	10	1	1	0	0	0	2	4	1	1	7	2	1	0	1	2	13	5	4	0	54
18	0	3	2	0	0	0	0	0	0	8	15	15	8	8	10	17	6	6	7	3	5	7	0	0	121
19	0	0	0	1	1	1	1	0	0	1	6	3	1	0	2	76	20	26	11	4	4	8	7	1	175
20	3	1	0	15	30	29	49	7	1	0	6	7	14	11	2	2	9	3	1	1	3	8	5	2	208
21	0	1	2	0	0	0	0	0	0	0	0	1	29	23	23	19	10	58	123	117	97	24	11	3	542
22	1	1	1	0	0	1	0	0	0	0	0	2	7	9	12	17	9	2	8	43	18	6	2	7	148
23	4	0	0	0	0	0	0	0	0	0	2	4	3	10	5	10	6	3	77	30	13	11	5	1	185
24	3	0	0	1	0	1	0	0	0	0	1	2	5	7	14	7	14	32	34	5	10	5	7	5	155
25	3	0	0	1	1	1	0	0	0	0	0	0	2	1	1	1	0	0	2	9	4	2	2	2	31
26	3	1	1	0	0	1	1	0	0	0	0	2	17	6	7	6	0	0	0	3	16	7	1	2	74
27	20	4	0	0	0	0	0	0	0	0	3	0	0	1	1	0	5	0	0	9	4	1	0	0	50
28	28	0	1	13	0	0	0	0	0	0	0	0	0	3	4	4	5	4	0	6	4	2	9	5	91
29	0	1	0	0	0	1	0	0	0	0	0	0	0	2	4	2	1	63	57	58	16	2	63	102	374
30	0	9	4	4	3	5	0	0	0	0	0	2	0	0	0	1	0	15	8	18	27	9	2	8	117
KWh	265	204	86	108	116	102	133	111	115	165	227	251	290	348	403	419	390	541	545	542	390	408	317	272	6749

Talash **May 07,08,09** **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	4	6	1	3	0	0	0	1	1	0	0	0	0	0	0	0	0	11	9	1	4	1	48
2	0	0	2	1	0	0	0	0	0	0	0	0	0	1	26	8	1	0	2	4	6	12	3	0	69
3	1	3	0	37	42	5	2	1	1	10	16	16	10	57	19	27	22	9	4	42	43	93	72	25	559
4	12	8	35	49	3	12	17	3	0	13	29	9	25	22	56	4	33	13	14	16	12	28	20	14	448
5	37	26	22	10	0	5	0	0	0	3	2	1	7	9	5	4	12	48	6	0	4	4	0	0	206
6	0	0	0	0	0	0	0	0	1	2	2	5	6	1	2	9	5	10	3	1	4	4	0	0	56
7	0	0	0	0	0	0	0	0	0	0	1	2	6	7	8	4	7	9	1	1	2	6	20	39	112
8	43	11	14	3	5	0	0	0	0	4	17	5	2	3	4	8	53	43	104	53	19	3	1	0	394
9	0	0	0	0	0	0	0	0	0	1	2	0	4	3	1	1	6	15	57	41	14	31	9	22	207
10	5	0	1	29	26	41	0	0	0	0	1	1	7	4	4	17	50	60	133	68	30	3	2	5	488
11	4	2	3	1	0	0	0	0	0	0	2	9	10	18	26	26	10	4	7	10	13	8	13	0	167
12	1	1	2	2	0	1	0	0	0	0	7	2	8	17	28	23	13	20	22	30	22	21	5	5	227
13	50	36	0	0	1	1	0	0	0	1	12	20	11	2	5	14	32	63	108	8	10	4	6	2	388
14	1	2	0	2	1	0	0	0	0	0	1	0	4	7	13	9	12	14	7	16	36	24	2	2	155
15	0	0	1	0	0	2	0	0	0	1	0	1	14	16	23	38	39	43	101	82	11	4	7	22	404
16	25	12	2	1	4	2	23	21	7	3	0	1	6	5	17	26	26	8	21	15	7	37	70	54	392
17	7	3	1	1	1	0	0	0	1	2	1	1	3	1	1	2	14	18	28	19	19	5	1	0	129
18	3	2	3	2	1	2	0	0	0	0	1	4	17	15	19	62	24	103	45	69	11	3	3	0	389
19	2	18	3	2	3	0	2	0	1	10	17	14	13	14	31	92	40	60	253	130	54	26	11	5	801
20	0	4	0	0	0	0	1	9	20	15	5	4	6	8	21	17	35	31	20	59	9	3	105	111	482
21	27	2	2	0	0	3	0	0	0	1	4	6	18	44	42	74	148	88	46	60	29	3	14	21	631
22	1	0	8	1	12	8	9	1	1	10	17	11	11	18	43	34	125	110	30	16	49	156	68	26	764
23	1	17	0	7	1	0	23	31	15	7	11	32	34	33	32	10	13	50	56	20	12	9	3	2	420
24	0	1	1	2	0	1	0	0	0	4	24	21	46	44	59	38	56	170	76	26	26	15	18	21	649
25	5	0	0	0	0	3	6	20	24	8	25	74	101	93	69	50	65	39	38	33	14	10	1	0	681
26	3	0	0	4	5	1	4	5	4	12	0	2	9	20	19	57	161	149	73	11	9	3	2	8	562
27	2	0	3	1	0	0	0	0	2	2	5	6	7	14	22	50	47	31	22	13	22	17	0	0	266
28	1	0	0	0	0	1	0	0	1	3	11	20	13	14	9	15	35	55	54	23	22	8	1	2	289
29	0	0	0	0	0	0	0	0	1	2	20	21	21	16	50	66	54	48	89	84	19	11	4	5	512
30	0	1	1	0	1	3	2	0	2	24	15	39	54	33	17	29	49	74	142	112	184	139	112	77	1111
31	17	1	1	0	0	0	0	0	13	13	10	16	21	11	21	12	12	24	16	6	18	50	15	101	379
KWh	249	154	111	163	107	96	92	92	93	154	258	343	496	550	689	826	1198	1411	1579	1079	739	742	595	570	12386

Talash **June 07,08,09** **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	74	6	1	1	1	4	0	0	1	9	23	29	27	13	21	36	12	15	64	25	124	13	47	21	568
2	39	35	34	25	1	1	0	8	22	17	25	41	31	23	61	100	217	120	97	45	34	1	6	10	994
3	13	22	0	22	23	20	15	4	1	5	8	37	17	12	1	15	15	100	160	135	4	1	2	1	635
4	0	2	9	13	1	0	0	9	35	22	23	18	19	15	18	3	24	27	13	13	1	6	1	71	345
5	46	72	69	43	12	0	0	0	1	5	8	14	14	10	37	30	9	166	92	173	165	39	73	25	1103
6	7	60	8	5	0	0	4	11	13	15	27	46	11	5	10	20	41	104	99	68	73	140	65	14	847
7	0	0	0	0	0	0	0	0	0	0	4	2	7	18	18	88	78	111	133	41	65	41	25	3	636
8	9	8	6	7	5	0	11	13	20	13	18	21	24	17	41	59	47	44	15	2	5	12	0	3	400
9	2	0	5	17	19	5	18	21	34	19	8	15	27	60	63	67	16	8	10	1	2	7	0	4	429
10	0	1	3	0	2	2	0	0	0	0	1	0	5	6	8	27	81	109	108	36	80	201	76	21	767
11	67	23	20	1	9	0	0	2	1	1	1	11	13	8	26	20	35	83	55	16	14	13	14	7	439
12	6	3	6	3	21	1	0	0	14	10	30	45	49	51	54	49	60	85	32	9	15	14	31	31	619
13	31	7	0	6	6	15	10	0	0	0	9	17	20	40	51	43	54	58	103	29	10	9	27	21	565
14	27	24	7	10	0	2	6	12	7	2	11	20	13	52	86	57	61	154	85	47	39	32	16	5	774
15	31	75	50	35	31	8	6	10	15	11	7	38	80	109	117	96	101	53	26	16	12	30	21	4	982
16	42	19	16	14	22	7	2	4	17	24	77	64	81	72	56	56	39	44	21	12	9	14	14	0	727
17	27	25	3	1	0	4	6	1	0	12	13	15	12	26	27	16	25	47	43	38	15	8	1	4	370
18	0	6	1	4	0	0	2	2	1	0	3	3	7	16	13	7	38	28	13	96	2	1	0	0	242
19	1	0	0	0	0	0	0	0	0	1	1	1	8	18	13	48	67	30	82	8	14	21	3	11	330
20	11	5	0	0	2	1	1	1	1	7	7	11	16	9	11	10	15	42	88	46	23	23	7	6	344
21	0	0	0	0	0	0	1	0	0	11	14	20	27	16	17	24	30	19	9	9	8	5	19	2	230
22	2	17	2	4	4	4	8	13	8	2	2	3	3	3	4	7	8	7	15	6	39	55	23	22	260
23	4	13	28	43	33	27	24	11	18	26	19	72	22	22	23	37	30	25	6	8	6	3	5	6	510
24	11	7	11	6	8	6	3	4	2	2	2	3	5	8	18	32	40	100	11	3	5	5	7	6	305
25	3	1	4	12	6	4	4	2	43	29	39	28	17	13	23	15	27	66	47	45	17	3	27	4	479
26	1	16	14	4	12	17	4	0	0	0	0	1	5	15	21	36	20	25	25	12	1	10	6	0	245
27	3	3	1	0	9	13	7	7	4	5	6	7	6	7	6	21	20	60	51	9	1	4	1	0	252
28	0	0	0	2	2	2	0	7	7	2	19	27	34	27	25	59	60	61	4	5	8	4	6	2	365
29	0	3	0	0	0	0	0	0	2	18	15	23	24	63	58	30	70	78	17	5	18	36	34	9	504
30	2	22	13	11	24	17	0	0	1	18	26	22	19	57	59	55	75	39	33	83	82	62	11	1	732
KWh	461	478	311	289	254	162	135	144	268	287	444	652	641	811	985	1163	1415	1909	1557	1042	893	812	570	315	15998

Talash July 07,08,09 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	2	0	0	0	0	1	1	4	20	40	46	34	62	82	38	56	18	16	10	431
2	7	0	8	90	21	9	0	11	27	23	26	31	75	114	103	122	76	161	148	48	7	17	15	1	1141
3	1	1	0	0	1	14	9	1	1	1	19	34	28	40	37	54	59	53	82	64	54	58	59	23	691
4	8	1	10	4	7	9	11	34	48	67	68	39	22	21	20	34	13	19	17	8	3	1	10	2	477
5	4	6	12	24	24	18	15	15	21	24	44	28	16	30	25	35	23	30	76	16	21	24	22	35	587
6	57	28	7	0	0	0	0	0	5	15	10	13	20	15	12	15	11	12	8	5	6	4	0	70	315
7	40	25	16	0	0	0	28	38	7	18	49	51	38	32	38	45	38	47	27	14	5	4	2	2	566
8	6	25	36	24	4	4	12	6	24	39	38	31	33	30	35	27	23	29	22	16	25	36	27	26	577
9	22	0	6	8	24	35	16	26	38	19	19	20	4	0	1	5	43	16	13	13	37	36	20	8	428
10	44	18	17	3	0	11	6	15	4	8	20	20	48	28	43	36	32	38	27	14	17	33	30	20	532
11	34	16	13	1	2	7	3	6	17	30	15	10	15	19	35	48	56	36	36	29	39	48	37	61	611
12	40	59	39	33	19	21	26	12	28	11	19	19	36	58	59	48	41	62	76	41	61	25	56	39	926
13	46	38	21	21	8	38	25	15	18	17	21	24	32	40	36	45	58	73	62	41	36	12	11	17	755
14	106	100	64	49	36	1	0	0	3	4	15	18	24	27	33	25	8	7	32	25	2	25	15	8	627
15	6	3	20	14	3	0	0	0	0	0	0	2	9	4	12	25	19	22	14	12	10	7	4	34	222
16	22	34	13	5	2	10	7	4	0	2	3	3	6	5	20	24	24	10	6	5	7	4	5	1	220
17	0	4	0	2	2	26	4	0	8	17	14	16	20	54	50	28	29	28	9	10	6	9	6	1	345
18	7	11	22	3	36	31	46	36	47	81	44	18	5	17	17	32	25	27	15	19	21	23	10	14	604
19	1	4	5	11	0	0	0	0	0	3	6	14	18	23	29	30	19	15	21	21	20	8	4	2	258
20	47	24	10	10	13	13	9	9	12	29	33	32	30	36	43	37	20	25	7	1	40	11	13	29	531
21	32	2	9	5	5	4	0	8	5	13	39	33	27	16	35	13	19	38	26	26	44	32	11	3	446
22	1	4	5	0	11	23	44	24	14	3	16	15	24	36	31	23	31	17	25	48	27	57	42	17	540
23	4	35	1	3	24	29	35	5	17	6	4	9	17	20	33	35	53	80	29	12	12	3	1	0	466
24	0	2	0	0	0	0	0	3	0	0	0	0	2	5	27	27	14	16	27	15	6	4	0	0	148
25	0	0	0	0	0	0	0	0	0	0	1	3	6	6	19	15	24	13	9	9	15	23	7	0	149
26	4	6	13	7	5	2	5	8	9	7	10	12	16	7	17	78	91	18	18	11	21	12	7	14	401
27	7	6	27	14	7	25	17	18	29	33	24	24	29	24	37	18	27	23	20	29	14	25	29	75	579
28	102	49	10	1	2	5	1	8	20	7	2	16	55	71	50	114	43	46	34	17	11	8	4	16	691
29	20	26	27	32	22	25	19	21	27	18	30	26	29	36	25	17	47	49	35	30	25	13	8	73	683
30	47	47	34	11	10	4	9	25	29	12	11	13	18	15	20	33	37	49	12	20	20	18	1	4	498
31	4	4	10	9	0	0	0	0	0	16	23	18	15	17	15	12	11	20	18	12	7	15	22	10	259
KWh	720	577	456	385	290	369	347	347	458	523	622	596	720	866	997	1144	1048	1141	1033	670	676	614	493	614	15705

Talash **August 06,07,08** **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	1	20	7	16	29	7	8	7	6	8	3	7	16	12	27	43	61	6	3	2	0	0	0	0	290
2	0	0	0	0	2	0	0	0	0	4	16	13	21	15	18	11	6	20	24	14	56	2	2	4	228
3	19	10	0	4	7	13	1	3	15	10	3	2	10	8	2	1	6	6	8	5	9	14	10	3	168
4	12	3	0	0	2	2	2	1	0	0	1	8	4	4	6	11	10	4	10	21	4	6	6	0	117
5	4	11	15	3	12	8	4	0	0	0	0	1	2	3	6	7	12	138	36	4	5	0	0	0	270
6	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	16	29	25	15	5	1	0	0	2	97
7	0	0	0	0	0	0	0	0	0	0	0	5	6	4	3	3	3	2	1	0	0	1	0	0	30
8	1	0	0	0	0	0	0	0	0	0	6	0	0	2	2	5	8	9	6	7	22	49	31	99	247
9	46	19	13	15	16	22	11	5	4	8	4	1	9	0	12	7	9	13	21	4	11	14	5	4	274
10	11	10	7	2	3	2	0	0	0	0	0	0	0	2	3	3	6	12	7	14	12	9	10	9	120
11	3	2	0	0	10	4	4	5	4	5	0	2	2	2	2	5	17	25	14	8	17	20	51	36	240
12	9	6	11	3	43	7	11	19	0	0	0	7	18	32	43	25	39	26	33	27	62	42	44	6	515
13	8	6	5	2	1	2	3	0	1	1	3	14	14	24	31	50	18	46	9	15	6	28	29	1	316
14	1	51	61	4	5	1	14	4	6	8	12	32	29	53	85	57	31	32	28	17	27	50	42	23	674
15	7	21	13	2	14	70	1	1	0	0	7	26	29	65	92	65	59	108	35	48	38	23	8	18	749
16	7	22	3	1	0	4	7	1	0	0	1	9	14	28	33	32	31	52	44	37	36	11	5	3	381
17	7	5	0	1	3	0	0	110	16	2	15	8	1	2	1	5	22	33	11	5	1	4	2	0	257
18	1	3	0	0	0	0	0	6	0	0	0	0	0	3	12	46	23	16	4	1	2	7	8	1	135
19	0	1	3	0	0	0	0	0	9	1	0	1	1	4	10	15	26	13	15	21	15	13	9	25	182
20	54	6	8	3	4	5	6	6	6	14	23	31	21	10	2	6	10	46	8	20	20	4	1	3	315
21	0	0	0	0	0	0	0	0	0	0	2	5	13	4	14	27	16	150	33	21	8	2	1	4	300
22	3	4	1	0	1	2	2	0	0	2	4	7	4	2	6	8	9	6	2	13	18	3	1	0	97
23	0	0	0	0	0	0	0	0	0	0	0	0	1	5	12	29	37	24	14	25	4	6	3	0	160
24	1	1	0	0	0	1	6	0	0	1	2	3	4	12	10	11	13	5	64	10	13	2	3	8	171
25	6	1	0	0	0	0	0	0	0	0	5	8	10	18	27	20	10	8	21	14	14	13	1	1	177
26	1	1	0	0	0	0	0	0	0	0	0	1	0	1	4	11	58	147	43	4	3	8	9	15	305
27	11	0	0	2	2	5	1	0	3	5	7	6	16	32	47	45	38	43	29	7	0	7	0	0	306
28	1	0	0	0	0	0	0	0	0	2	7	2	10	12	15	15	24	4	5	22	28	11	8	1	167
29	38	1	4	0	0	0	0	0	0	0	0	3	11	13	15	12	17	11	19	16	17	18	44	17	256
30	26	27	32	31	7	36	6	3	9	19	23	12	13	10	10	8	13	10	3	6	44	4	35	8	395
31	8	10	13	0	0	0	0	0	2	0	0	0	0	12	39	20	10	8	27	3	0	1	0	29	184
KWh	286	240	196	89	161	191	86	172	84	92	147	214	281	394	592	615	671	1048	590	418	494	373	366	320	8120

Talash **September 06,07,08** **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	42	11	4	0	10	9	0	0	0	0	0	1	6	8	12	6	15	18	15	21	15	3	10	0	204
2	0	9	3	0	1	32	13	2	22	31	28	10	25	11	4	6	14	13	83	5	16	20	1	4	354
3	5	1	0	0	0	0	0	0	0	1	17	16	11	17	13	4	4	9	9	20	101	42	46	5	322
4	0	0	0	0	0	0	0	0	1	3	3	10	31	39	21	18	9	3	51	18	5	1	30	0	243
5	0	0	4	0	0	0	1	16	4	24	59	32	33	26	36	45	4	12	4	29	28	8	0	0	366
6	0	0	0	0	1	2	0	1	7	0	0	4	29	47	25	5	11	38	51	21	10	3	0	0	257
7	0	0	0	0	0	0	0	0	0	0	0	10	1	1	1	0	5	12	1	10	1	0	0	0	42
8	0	0	0	0	0	0	0	0	0	0	0	1	5	5	2	5	8	1	1	7	5	0	1	0	41
9	0	0	0	0	0	0	0	0	0	1	1	4	1	0	0	1	3	8	2	2	2	0	1	0	28
10	1	0	0	0	1	0	0	0	0	1	3	5	15	18	23	16	13	4	2	4	7	11	0	0	125
11	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	4	1	4	2	6	5	6	10	7	47
12	9	5	12	10	1	0	0	0	0	0	0	1	1	0	0	1	8	17	14	7	14	26	0	1	126
13	2	6	8	5	4	2	2	0	3	9	22	24	12	19	18	14	8	10	10	7	49	13	2	2	251
14	2	2	1	0	2	1	0	0	1	9	11	16	15	8	6	15	18	10	8	2	3	2	2	1	135
15	6	2	0	0	0	0	0	0	0	1	2	1	2	3	6	9	8	4	7	13	16	0	1	2	83
16	2	0	0	0	0	0	0	0	1	56	7	52	41	13	5	12	122	12	9	1	3	11	1	0	347
17	0	0	0	0	0	0	0	0	0	0	2	10	2	2	9	1	22	10	2	6	5	0	3	1	77
18	0	3	0	0	0	0	0	0	0	0	0	0	1	1	4	5	63	38	68	7	0	0	1	0	193
19	0	0	0	0	0	0	0	0	0	1	4	22	78	16	65	6	3	1	2	11	12	2	1	1	225
20	1	29	5	1	0	4	1	2	9	49	48	61	56	59	39	51	41	22	20	23	25	23	2	8	577
21	14	1	8	12	0	9	4	0	0	7	12	25	21	19	35	42	91	19	23	42	23	27	92	24	548
22	40	86	15	78	30	10	2	2	33	1	15	36	26	49	26	24	35	24	53	52	36	14	30	12	728
23	1	1	0	0	0	0	0	0	0	0	0	2	4	13	12	5	2	21	19	43	14	14	6	4	162
24	5	0	0	0	0	0	0	0	0	0	0	1	5	2	1	1	4	4	1	15	12	3	0	7	61
25	0	0	0	0	0	1	0	0	0	0	1	0	0	0	1	4	17	41	13	26	12	24	11	4	156
26	25	3	1	1	1	0	0	0	0	0	0	3	1	4	6	9	61	57	31	35	30	7	6	12	293
27	0	0	0	0	0	0	0	0	0	2	2	1	20	35	14	10	22	41	59	15	35	24	7	0	287
28	0	0	1	0	0	0	0	0	0	0	0	12	9	4	15	48	46	34	18	32	8	0	3	0	230
29	7	6	0	0	0	1	0	0	0	0	0	0	7	4	13	16	5	17	2	8	11	5	5	1	108
30	1	0	0	1	1	0	0	0	0	0	0	0	1	5	9	11	34	10	2	2	18	14	7	3	120
KWh	41	36	30	22	9	13	8	21	54	144	170	302	332	356	332	338	590	395	464	456	363	193	126	60	4854

Talash **October 06,07,08** **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	2	0	1	0	0	0	0	0	0	0	0	2	4	7	22	16	13	8	4	14	15	12	2	5	127
2	0	0	0	0	0	0	0	0	0	0	0	0	4	7	8	4	1	56	22	15	18	3	5	1	146
3	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	3	2	1	5	10	5	0	0	29
4	0	0	0	0	0	1	1	0	0	0	0	0	1	7	13	9	17	20	19	6	3	9	3	0	108
5	0	0	0	0	0	1	1	0	0	0	15	6	5	15	17	15	34	22	14	20	116	21	3	0	303
6	0	0	0	0	2	1	0	0	0	0	0	29	38	25	36	29	44	46	38	60	5	3	0	0	357
7	0	10	0	1	0	4	10	1	11	7	1	8	23	106	53	32	3	1	3	5	1	0	0	0	281
8	0	0	0	0	0	0	0	0	0	0	0	0	6	21	21	18	15	4	0	7	1	0	0	1	96
9	1	0	0	0	0	0	0	0	0	0	1	0	1	0	1	2	27	6	3	9	14	3	3	1	72
10	2	5	2	0	0	0	0	0	0	0	0	0	4	2	2	8	23	4	6	20	8	0	0	0	87
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	1	1	4	7	9	10	1	0	37
12	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	2	8	2	6	12	19	4	83	43	184
13	58	65	18	19	3	0	2	1	0	0	0	0	0	3	3	4	23	6	1	2	6	22	1	0	238
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	9	8	22	19	15	1	2	10	91
15	3	24	81	53	42	15	0	5	0	5	14	1	4	4	8	5	5	9	6	26	17	7	9	0	344
16	0	0	0	2	0	0	0	0	0	0	0	4	9	4	8	13	6	6	5	15	14	6	2	0	94
17	1	1	0	0	0	0	0	0	0	0	6	17	15	37	12	11	16	2	8	12	6	3	2	0	149
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	6	7	4	9	6	6	21	5	0	68
19	1	0	0	0	0	0	0	0	0	0	0	0	4	5	5	18	10	12	26	11	5	0	0	4	105
20	1	0	2	6	8	12	4	1	0	1	5	1	3	4	5	1	7	3	6	8	3	0	10	3	92
21	0	16	41	22	3	0	0	0	0	0	0	3	1	0	1	4	12	1	5	13	19	2	3	3	148
22	3	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	0	1	2	1	0	0	0	12
23	0	0	0	0	0	0	0	0	0	0	0	1	1	3	6	4	33	2	1	4	0	1	0	0	56
24	0	0	0	0	0	0	0	0	0	0	1	0	0	1	2	6	17	4	4	54	17	8	5	0	121
25	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	1	5	0	1	0	0	12
26	0	0	15	17	0	0	0	0	0	0	0	1	2	1	0	1	7	1	2	2	2	1	0	0	54
27	0	1	1	15	5	2	0	0	0	0	0	0	1	0	0	2	10	1	1	8	5	0	0	0	54
28	0	0	0	0	0	0	0	0	0	0	0	0	0	3	35	2	3	1	2	3	2	2	0	0	52
29	0	0	0	1	0	0	0	0	1	1	1	1	0	0	1	1	8	1	21	37	24	11	8	15	132
30	4	0	1	0	0	0	0	0	0	1	0	1	2	1	2	4	6	1	1	4	1	0	0	0	30
31	0	0	0	0	0	0	0	0	0	0	0	2	1	2	7	6	1	4	14	9	0	0	1	2	51
KWh	79	123	163	138	64	37	19	9	13	16	46	82	130	261	275	233	373	239	255	420	362	157	148	91	3732

Talash **November 06,07,08** **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	5	3	10	18	14	25	19	1	0	2	0	98
2	0	0	0	0	0	0	0	0	0	0	1	0	6	14	16	15	21	15	10	10	5	0	2	3	120
3	0	0	0	0	2	1	0	0	0	0	0	0	1	0	1	4	14	3	8	3	5	9	2	0	53
4	0	0	0	0	0	0	0	0	0	0	1	1	1	5	3	1	6	19	5	4	1	0	0	0	48
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	4	1	4	4	1	1	2	3	26
6	2	4	0	0	0	0	0	0	0	0	0	0	0	2	5	2	9	7	25	14	5	4	2	3	85
7	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	3	7	9	1	11	4	0	1	39
8	0	0	0	0	0	0	0	0	0	0	0	0	0	7	12	3	0	3	3	2	1	2	1	1	35
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	13	1	0	1	2	0	23
10	0	0	0	0	0	0	0	11	1	0	0	0	0	5	0	2	1	11	3	2	8	9	0	2	54
11	0	0	0	0	0	0	0	0	0	0	0	0	0	3	10	8	1	0	5	1	1	3	0	5	38
12	3	0	0	0	0	0	0	0	0	3	6	8	28	38	27	39	36	36	57	52	102	67	39	26	568
13	34	19	5	0	0	9	60	5	0	0	0	6	3	3	1	9	24	51	50	81	57	50	29	25	522
14	4	0	0	0	0	0	0	0	0	0	6	20	9	5	3	8	9	10	29	14	3	13	13	17	163
15	6	2	4	0	0	0	0	0	0	0	0	4	2	2	1	1	1	2	4	4	4	4	0	0	43
16	1	0	0	0	0	0	0	0	0	0	0	0	2	1	3	4	0	1	10	4	1	0	1	2	33
17	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	2	0	0	0	8
18	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	3	5	0	0	0	0	0	0	2	14
19	1	0	0	0	0	0	0	0	0	0	0	0	0	10	27	21	9	0	0	0	4	7	2	0	81
20	0	24	1	4	0	0	0	0	0	1	0	0	2	3	1	1	1	0	3	1	1	0	2	0	46
21	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0	0	1	5	4	1	0	0	0	14
22	3	2	0	0	0	0	0	0	0	0	5	0	0	2	2	1	1	1	3	1	0	0	0	0	20
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	4
24	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	2
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	1	0	0	4
26	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	3	1	2	2	1	0	1	0	1	13
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	8	1	7	1	0	0	0	1	23
28	0	0	0	0	0	0	0	1	11	5	12	19	26	14	14	1	1	0	0	0	1	0	2	2	110
29	1	6	2	0	1	0	0	0	0	0	0	0	1	42	36	23	24	30	68	29	27	16	12	5	322
30	12	4	7	12	4	0	0	2	1	0	0	0	2	1	1	24	15	3	1	2	0	0	0	1	94
KWh	68	61	20	17	9	12	61	19	13	11	34	63	87	165	173	191	222	218	353	255	241	194	115	102	2702

Talash **December 06,07,08** **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	1	0	1	1	4	10	5	10	6	3	5	8	0	0	1	0	57
2	0	0	0	0	0	0	0	0	0	0	1	1	0	34	9	6	2	1	1	1	0	0	0	0	55
3	0	0	0	0	0	2	0	0	1	0	0	1	1	3	1	0	1	0	2	0	0	0	0	0	13
4	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	0	5	1	3	0	0	0	0	0	15
5	0	0	0	0	9	2	14	0	0	0	0	0	0	1	0	0	1	3	5	2	3	0	0	0	43
6	0	0	0	0	0	0	0	1	2	1	3	0	0	1	1	1	8	7	0	0	6	7	0	1	39
7	0	0	0	0	1	3	2	0	0	0	0	3	3	30	43	33	17	18	16	17	32	23	40	39	323
8	41	18	3	0	5	1	0	0	0	0	0	2	1	1	2	1	8	1	1	3	3	0	0	0	90
9	0	0	0	0	0	0	0	0	0	1	3	0	2	14	5	15	8	0	0	0	0	0	0	0	49
10	0	0	0	0	0	0	1	0	0	0	0	0	6	15	15	3	3	4	2	0	0	0	0	0	49
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	4	4	0	1	11
12	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	2	8	0	0	0	0	14
13	0	0	0	0	0	0	0	1	12	2	8	4	1	0	2	0	1	1	0	0	0	0	0	0	34
14	0	0	0	0	0	0	0	0	0	0	0	1	1	4	3	1	1	0	0	0	0	0	0	0	11
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	1
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
17	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	4
19	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	13	8	4	7	9	53	37	8	21	162
20	8	0	1	3	0	47	13	0	0	0	28	45	39	16	24	29	21	3	4	23	7	41	36	16	406
21	9	0	0	0	1	0	1	0	1	0	2	12	11	18	13	4	2	0	0	0	0	0	0	0	76
22	0	0	0	0	0	0	0	0	0	0	0	1	2	6	3	1	3	0	0	0	0	0	0	0	17
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	2	0	1	0	0	0	0	0	9
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	3	2	1	3	0	0	0	0	12
25	0	6	5	6	4	0	0	0	0	0	0	5	7	4	5	4	2	2	0	0	2	0	0	0	54
26	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	2	1	0	0	0	2	0	0	0	8
27	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	1	0	1	0	0	0	0	0	10
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	5	20	16	5	4	0	0	0	54
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	5
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
31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	3
KWh	59	26	14	10	20	56	32	4	16	6	50	77	82	163	141	136	110	71	69	80	118	115	91	78	1626