Pakistan Meteorological Department

A STUDY OF

WIND POWER POTENTIAL AT

GILGIT

Technical Report No. PMD-08/2010
(Final report based on 36 months data)
May 2010

Executive Summary

Pakistan Meteorological Department (PMD) conducted a Wind Power Potential survey of the Northern Areas of Pakistan. Funding for this project has been 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 ***Gilgit***. 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 **2.35** m/s during 36 months from *May-2007 to April-2010* the highest of 3.10 m/s is observed in March. Seasonal Diurnal Wind variation indicates that maximum wind speed is available in the evening time thought-out the whole period. Wind frequency distribution shows that during 16% 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 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 Gilgit at 50m is **59.05** W/m^2 according to international wind classification, this power density categorize Gilgit 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 235,517 kWh which shows the capacity factor of 4% for Gilgit. 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 Gilgit and surrounding areas can be classified as non-suitable site for installing big economically viable wind farms.

1. Introduction:

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

A steady supply of reasonably strong wind is necessary requirement for utilizing the power in the wind. Development of wind energy depends upon a clear understanding of wind resources. Site location, turbine performance and physical effects of turbulence and energy extraction represent a few of the issues that must be addressed by anyone interested in developing wind energy.

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

1.1 Characteristic of wind:

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

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

2.0 Wind Mapping Project of Pakistan Meteorological Department:

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

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

2.1 Study Area:

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

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

Fatehpur, Bahrain, Kalam, Khawazakhaila, Malamjabba, Talash, 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.

Gilgit site is situated in Gilgit city (Gilgit-Baltistan). Latitude & Longitude of Gilgit is:
Lat = 35.92°, Long = 74.33°, Elevation = 4819 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

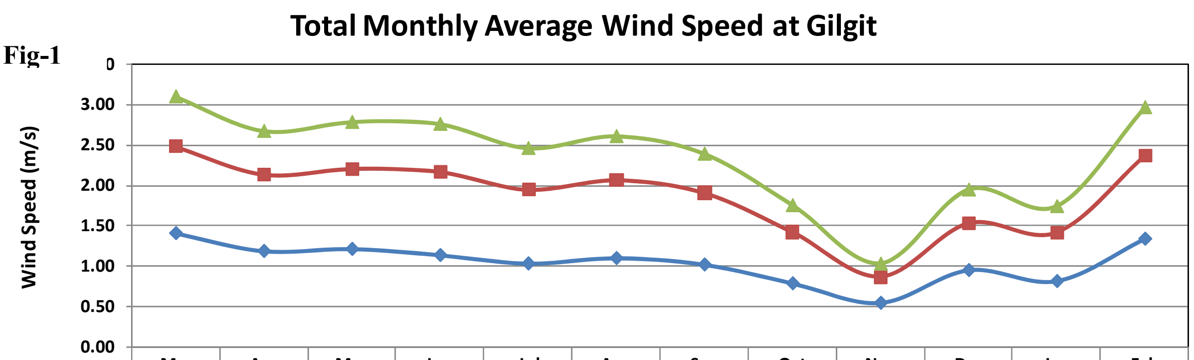
Type of terrain	Z_0	α
Mud Flats, Ice	10^{-5} to 3x 10^{-5}	
Calm Sea	2×10^{-4} to 3×10^{-4}	
Sand	2×10^{-4} to 10^{-3}	0.01
Mown Grass	0.001 to 0.01	
Low Grass	0.01 to 0.04	0.13
Fallow Field	0.02 to 0.03	
High Grass	0.04 to 0.1	0.19
Forest and Woodland	0.1 to 1	
Built up area, Suburb	1 to 2	0.32
City	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 1.87 m/s from May-2007 to April-2010 where as maximum average wind speed of 2.47 m/s at this height is during March. At 50 meters we have the annual average wind speed of 2.35 m/s during three years and maximum average wind speed of 3.10 m/s is in the month of March.

Fig-1



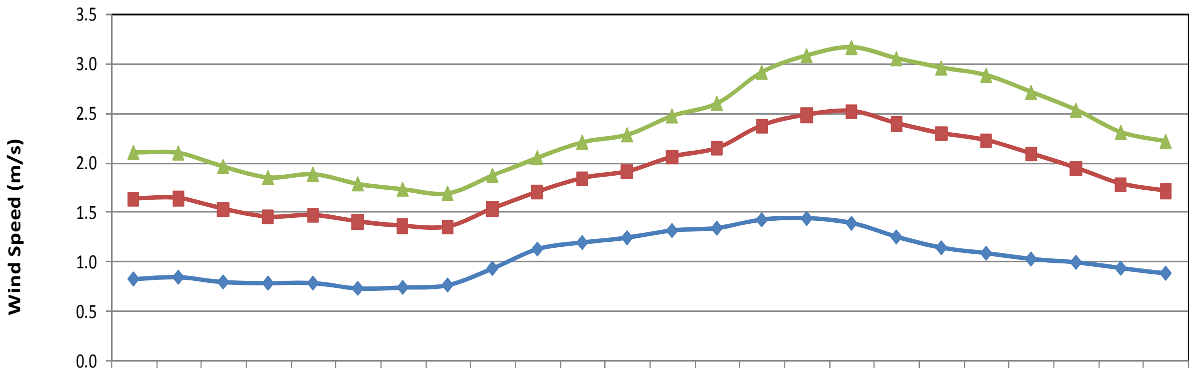
	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
AWS 10m	1.40	1.19	1.21	1.14	1.03	1.10	1.02	0.79	0.55	0.95	0.82	1.33
AWS 30m	2.47	2.13	2.20	2.16	1.94	2.06	1.90	1.42	0.87	1.53	1.42	2.36
AWS 50m	3.10	2.68	2.79	2.76	2.46	2.61	2.39	1.76	1.04	1.95	1.75	2.97

Months

3.3 Diurnal Wind speed Variation:

Fig-2 shows the diurnal wind speed variations at Gilgit for 36 months (May-07 to April-10). The wind speed is generally higher during day as compare to night time. After sunrise wind speed starts picking up and reaches maximum around 4 p.m. which is around 2.5 m/s and 3.2 m/s at 30 meters and 50 meters height respectively.

Fig-2

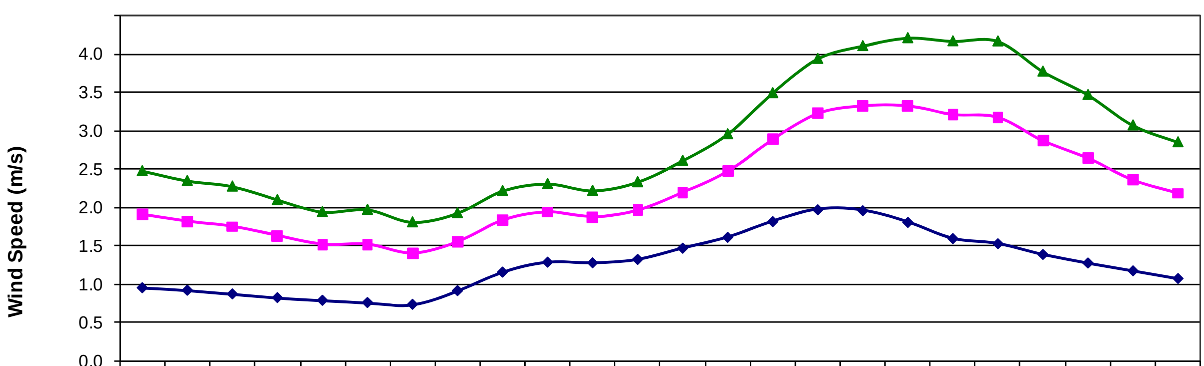


	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
WS 10m	0.8	0.8	0.8	0.8	0.8	0.7	0.7	0.8	0.9	1.1	1.2	1.2	1.3	1.3	1.4	1.4	1.4	1.3	1.1	1.1	1.0	1.0	0.9	0.9
WS 30m	1.64	1.64	1.5	1.5	1.5	1.4	1.4	1.4	1.5	1.7	1.8	1.9	2.1	2.1	2.4	2.5	2.5	2.4	2.3	2.2	2.1	1.9	1.8	1.7
WS 50m	2.11	2.10	2.0	1.9	1.9	1.8	1.7	1.7	1.9	2.1	2.2	2.3	2.5	2.6	2.9	3.1	3.2	3.1	3.0	2.9	2.7	2.5	2.3	2.2

PST (Hours)

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

Fig-3

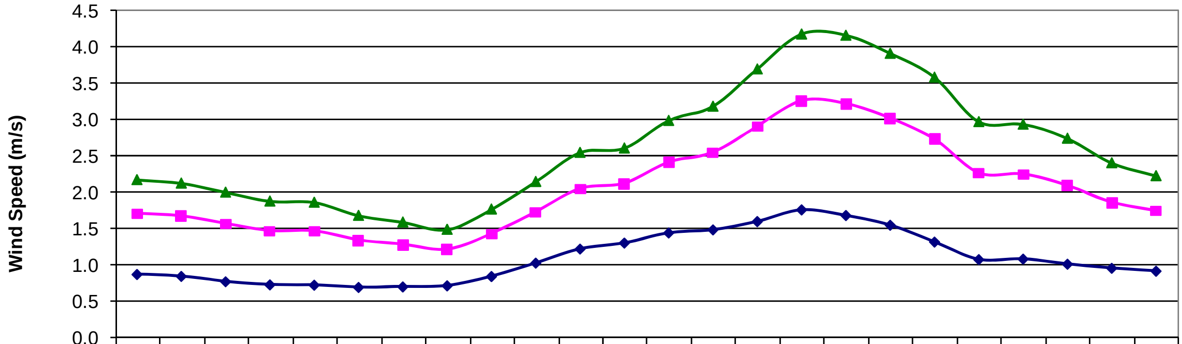


	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
WS 10m	0.9	0.9	0.9	0.8	0.8	0.8	0.7	0.9	1.2	1.3	1.3	1.3	1.5	1.6	1.8	2.0	2.0	1.8	1.6	1.5	1.4	1.3	1.2	1.1
WS 30m	1.9	1.8	1.8	1.6	1.5	1.5	1.4	1.6	1.8	1.9	1.9	2.0	2.2	2.5	2.9	3.2	3.3	3.3	3.2	3.2	2.9	2.6	2.4	2.2
WS 50m	2.5	2.3	2.3	2.1	1.9	2.0	1.8	1.9	2.2	2.3	2.2	2.3	2.6	2.9	3.5	3.9	4.1	4.2	4.2	4.2	3.8	3.5	3.1	2.8

PST (Hours)

Fig-4

Diurnal Variation Wind Speed at Gilgit (Jun to Aug)

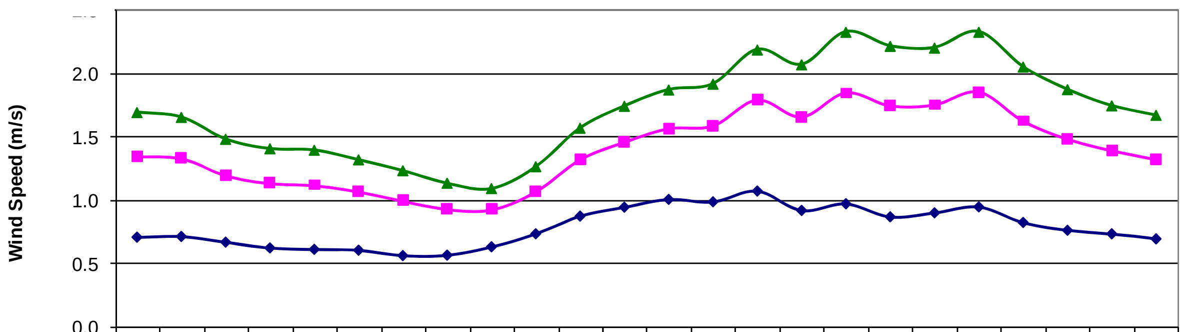


PST (Hours)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
WS 10m	0.9	0.8	0.8	0.7	0.7	0.7	0.7	0.7	0.8	1.0	1.2	1.3	1.4	1.5	1.6	1.8	1.7	1.5	1.3	1.1	1.1	1.0	0.9	0.9
WS 30m	1.7	1.7	1.6	1.5	1.5	1.3	1.3	1.2	1.4	1.7	2.0	2.1	2.4	2.6	2.9	3.3	3.2	3.0	2.7	2.3	2.2	2.1	1.9	1.7
WS 50m	2.2	2.1	2.0	1.9	1.9	1.7	1.6	1.5	1.8	2.1	2.5	2.6	3.0	3.2	3.7	4.2	4.2	3.9	3.6	3.0	2.9	2.7	2.4	2.2

PST (Hours)

Diurnal Variation Wind Speed at Gilgit (Sep to Nov)

Fig-5

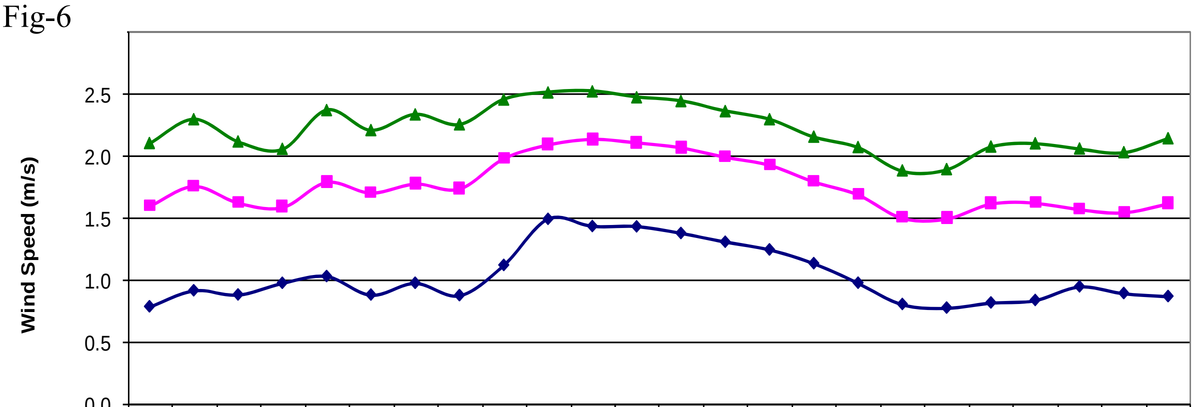


PST (Hours)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
WS 10m	0.7	0.7	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.9	0.9	1.0	1.0	1.1	0.9	1.0	0.9	0.9	0.9	0.8	0.8	0.7	0.7
WS 30m	1.3	1.3	1.2	1.1	1.1	1.1	1.0	0.9	0.9	1.1	1.3	1.5	1.6	1.6	1.8	1.7	1.8	1.7	1.8	1.9	1.6	1.5	1.4	1.3
WS 50m	1.7	1.7	1.5	1.4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

PST (Hours)

Diurnal Variation Wind Speed at Gilgit (Dec to Feb)

Fig-6



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	1.0	0.9	1.0	0.9	1.1	1.5	1.4	1.4	1.4	1.3	1.2	1.1	1.0	0.8	0.8	0.8	0.8	1.0	0.9	0.9
WS 30m	1.6	1.8	1.6	1.6	1.8	1.7	1.8	1.7	2.0	2.1	2.1	2.1	2.1	2.0	1.9	1.8	1.7	1.5	1.5	1.6	1.6	1.6	1.6	1.6
WS 50m	2.1	2.3	2.1	2.1	2.4	2.2	2.3	2.3	2.5	2.5	2.5	2.5	2.4	2.4	2.3	2.2	2.1	1.9	1.9	2.1	2.1	2.1	2.0	2.1

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

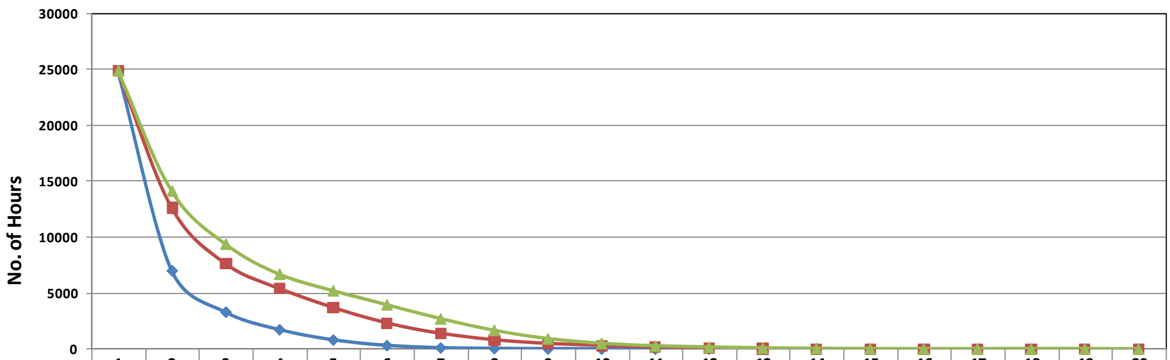
R .F = probability P (V_i) = Frequency of given wind speed / Total period

3.4.3 *Annual Cumulative Wind Frequency:*

Fig-7 shows the Cumulative Wind Frequency distribution from May-07 to April-10 at three heights 10, 30 and 50 meters. The analysis indicate that at a height of 30 meters during 3726 hours the wind speed is greater than or equal to 5 m/s. Whereas at 50 meters, during 5216 hours the wind speed is equal or greater than 5m/s.

Fig-7

Cumulative Wind Speed Distribution at Gilgit



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
CWS10m	24861	7007	3297	1728	812	314	108	43	18	10	8	7	7	7	7	7	7	7	7	7
CWS 30m	24861	12635	7637	5399	3726	2318	1400	817	489	310	183	91	42	18	9	7	7	6	6	6
CWS 50m	24861	14124	9388	6697	5216	3958	2711	1671	924	506	277	160	100	60	37	22	15	12	10	10

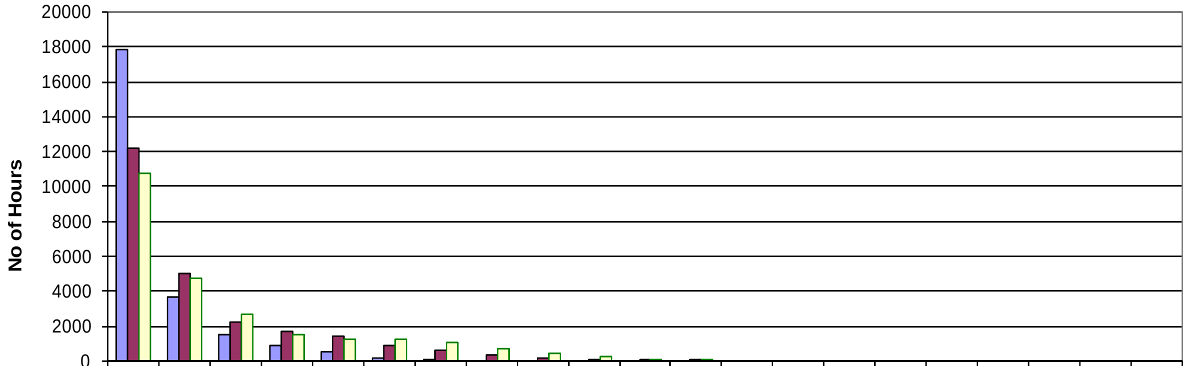
Wind Speed (m/s)

3.4.4 *Wind Frequency Distribution:*

Fig-8 shows the frequency distribution. We can see that at 50 meters during 1258 hours wind speed is 5 m/s, 1247 hours speed is 6 m/s, 1040 hours speed is 7 m/s, 747 hours speed is 8 m/s and during 418 hours the wind speed is 9m/s and so on. This indicates wind potential in this area.

Fig-8

Wind Frequency Distribution at Gilgit (All Data)



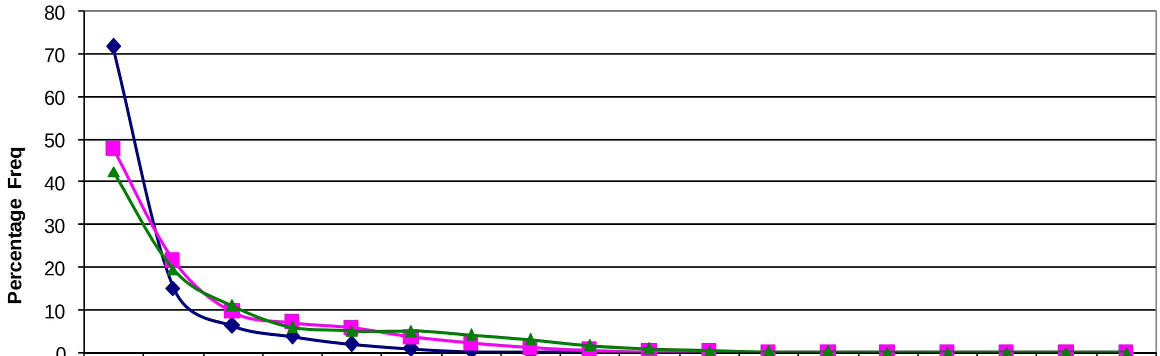
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
WS 10m	17853	3710	1569	916	498	207	65	25	7	2	1	0	0	0	0	0	0	0	0	0	7
WS 30m	12226	4998	2238	1673	1408	918	583	328	179	127	93	48	24	9	2	1	1	0	0	0	6
WS 50m	10737	4736	2691	1480	1258	1247	1040	747	418	228	118	60	40	23	15	8	3	1	1	0	9

Wind Speed (m/s)

Fig-9 gives this frequency distribution in percentage from May-07 to April-10. At 50 meters we find that during 5.1% of time wind is 5m/s, 5.0% of the time 6m/s and 4.2% of the time it is 7m/s. whereas at 30 meters height we get 5.8% of the time wind speed 5m/s, 3.7% of the times 6m/s and 2.2% of the time 7m/s.

Fig-9

Percentage Wind Frequency Distribution at Gilgit (All Data)



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
WS 10m	71.6	15.1	6.3	3.7	2.0	0.8	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WS 30m	47.7	21.6	9.6	7.1	5.8	3.7	2.2	1.2	0.6	0.3	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
WS 50m	42.5	19.4	11.0	6.0	5.1	5.0	4.2	3.0	1.7	0.9	0.5	0.2	0.2	0.1	0.1	0.0	0.0	0.0

Wind Speed (m/s)

3.4.5 *Seasonal Wind Frequency Distribution:*

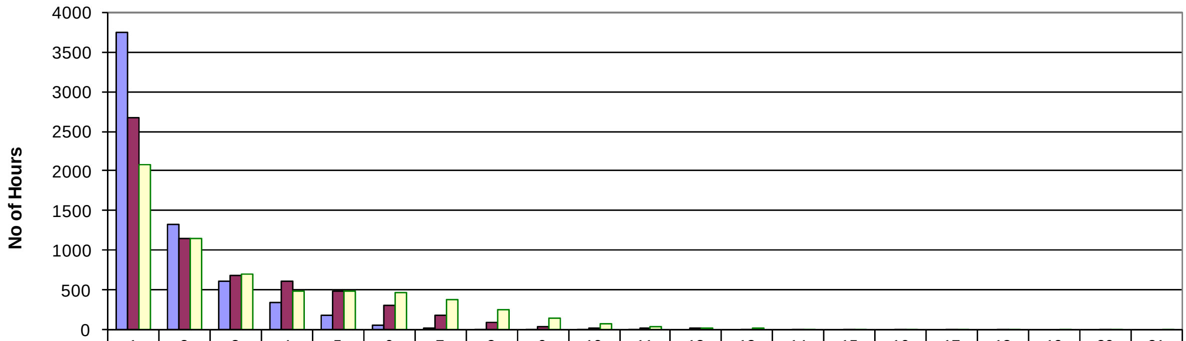
Figures 10–17 gives seasonal wind frequency distribution and percentage wind frequency distribution.

<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 483 hours and 487 hours we get 5m/s respectively.

Fig-10

Wind Frequency Distribution at Gilgit (Mar-May)



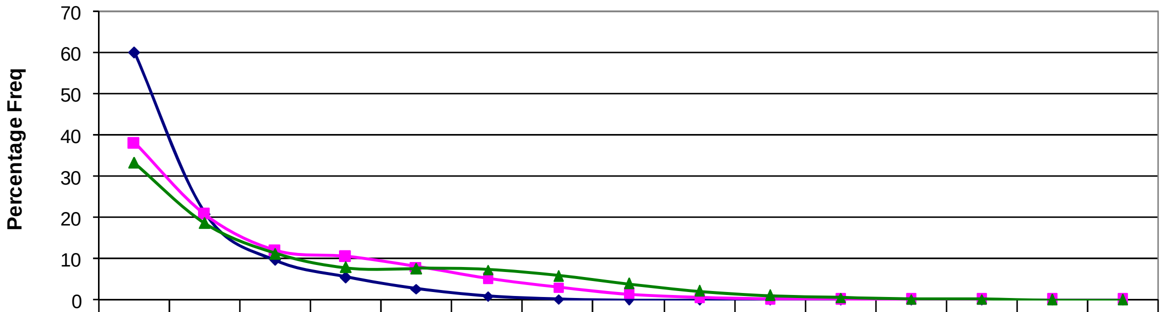
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
WS 10m	3749	1319	610	348	174	59	16	5	1	1	0	0	0	0	0	0	0	0	0	0	0
WS 30m	2680	1149	676	612	483	303	183	85	35	24	24	17	7	3	1	0	0	0	0	0	0
WS 50m	2079	1157	698	493	487	470	374	249	136	71	32	16	10	5	3	1	1	0	0	0	1

Wind Speed (m/s)

Similarly in Fig-11 shows percentage frequency distribution. At 50 meters we get 7.6% of wind equal to 5m/s, 7.3% of wind equal to 6 m/s and at 30 meter 8.1% wind equal to 5m/s, 5.1% wind equal to 6 m/s respectively.

Fig-11

Percentage Wind Frequency Distribution at Gilgit (Mar-May)



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
WS 10m	60.0	20.9	9.6	5.5	2.7	0.9	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WS 30m	37.9	20.7	11.9	10.5	8.1	5.1	3.1	1.5	0.6	0.3	0.1	0.1	0.0	0.0	0.0
WS 50m	33.3	18.6	11.2	7.8	7.6	7.3	5.8	3.9	2.2	1.1	0.5	0.3	0.2	0.1	0.0

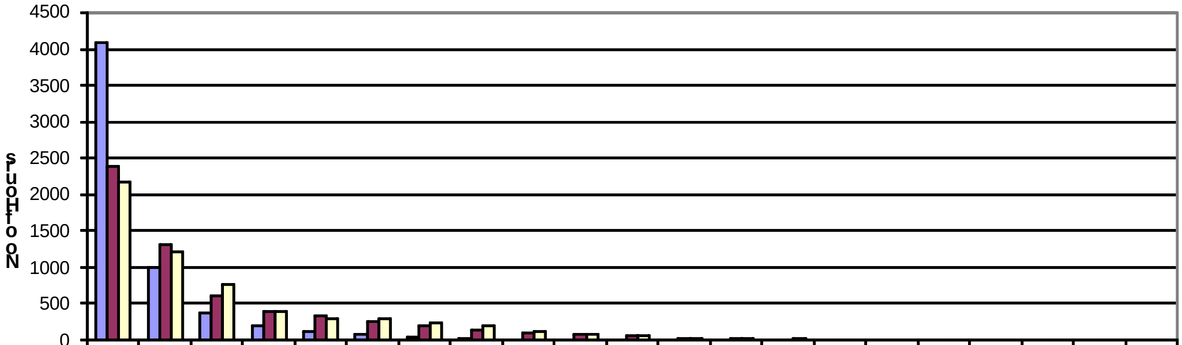
Wind Speed (m/s)

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 338 hours we get 5m/s, similarly at 50 meters height during 288 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 5.7% and 4.9% we get wind speed of 5m/s at 30m and 50m respectively.

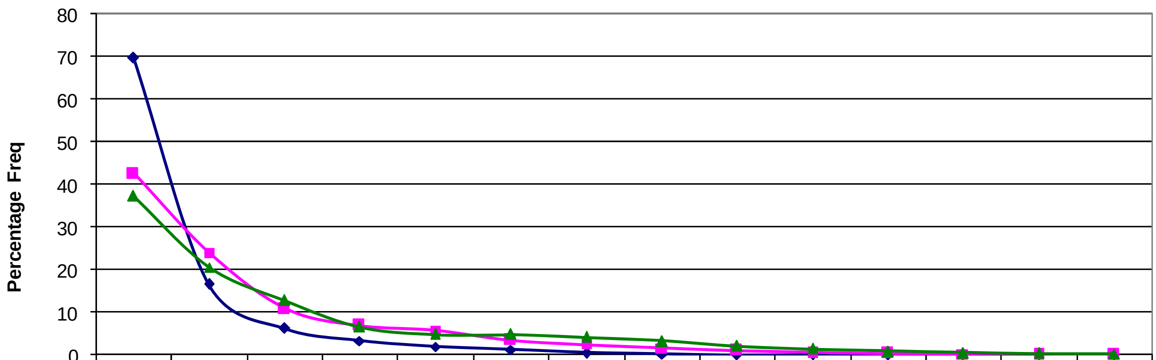
Fig-12 **Wind Frequency Distribution at Gilgit (Jun-Aug)**



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
WS 10m	4088	991	367	194	118	73	30	14	4	1	0	0	0	0	0	0	0	0	0	0	0
WS 30m	2384	1305	597	383	338	246	193	143	100	86	59	26	16	6	1	0	0	0	0	0	0
WS 50m	2174	1212	760	390	288	284	240	191	126	85	52	29	19	13	9	5	2	1	0	0	0

Wind Speed (m/s)

Fig-13 **Percentage Wind Frequency Distribution at Gilgit (Jun-Aug)**



	1	2	3	4	5	6	7	8	9	10	11	12	13	14
WS 10m	69.7	16.7	6.2	3.3	2.0	1.3	0.5	0.2	0.1	0.0	0.0	0.0	0.0	0.0
WS 30m	42.6	24.0	10.9	7.0	5.7	3.5	2.5	1.6	1.0	0.5	0.3	0.2	0.1	0.0
WS 50m	37.3	20.6	12.7	6.5	4.9	4.8	4.1	3.3	2.2	1.5	0.9	0.5	0.3	0.2

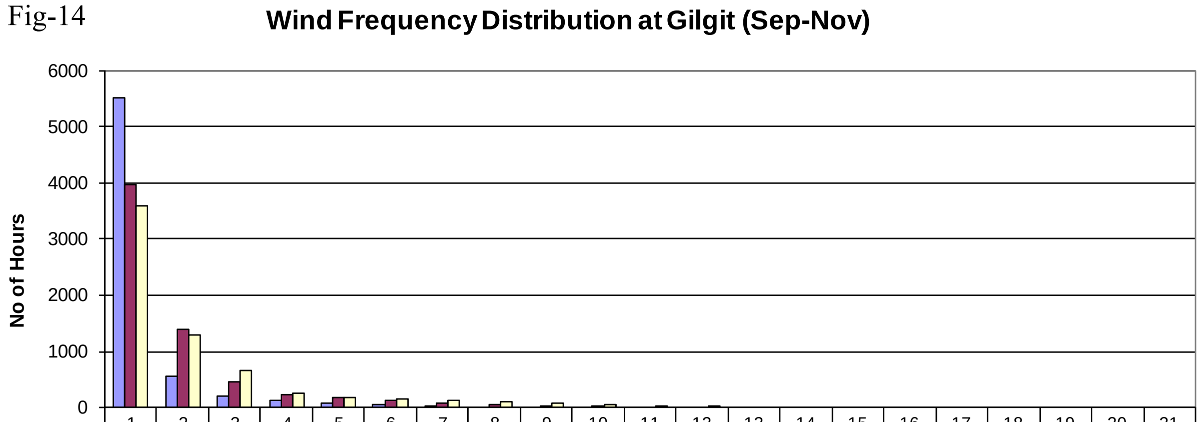
Wind Speed (m/s)

September - November

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 177 hours we get 5m/s, similarly at 50 meters height during 167 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 2.6% and 2.5% we get wind speed of 5m/s at 30m and 50m respectively.

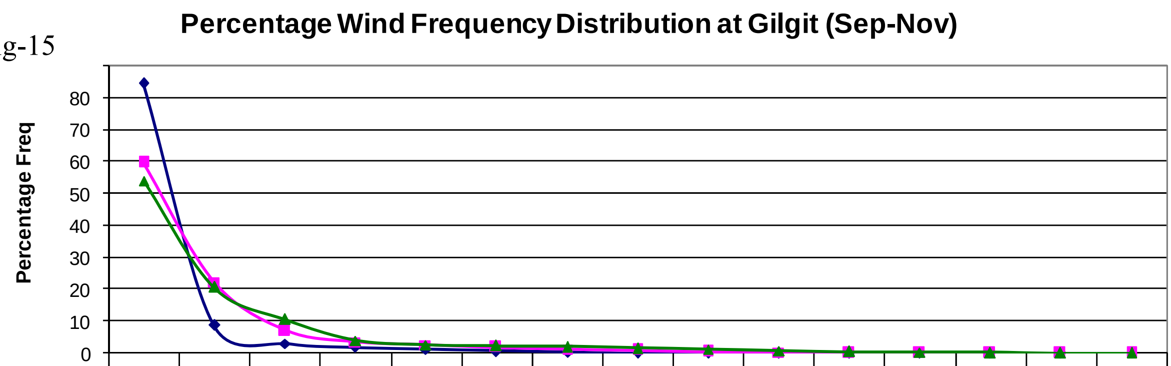
Fig-14



Wind Speed (m/s)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
WS 10m	5519	550	207	125	74	41	17	7	2	0	0	0	0	0	0	0	0	0	0	0	0
WS 30m	3973	1389	446	229	177	125	80	57	35	16	9	5	1	1	0	0	0	0	0	0	0
WS 50m	3604	1291	649	254	167	156	135	104	73	48	28	15	10	5	3	1	0	0	0	0	0

Wind Speed (m/s)

Fig-15



Wind Speed (m/s)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
WS 10m	84.2	8.7	3.0	1.9	1.1	0.6	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WS 30m	59.6	22.3	7.0	3.5	2.6	1.9	1.2	0.9	0.5	0.2	0.1	0.1	0.0	0.0	0.0
WS 50m	53.8	20.6	10.5	3.9	2.5	2.3	2.0	1.5	1.1	0.7	0.4	0.2	0.2	0.1	0.0

Wind Speed (m/s)

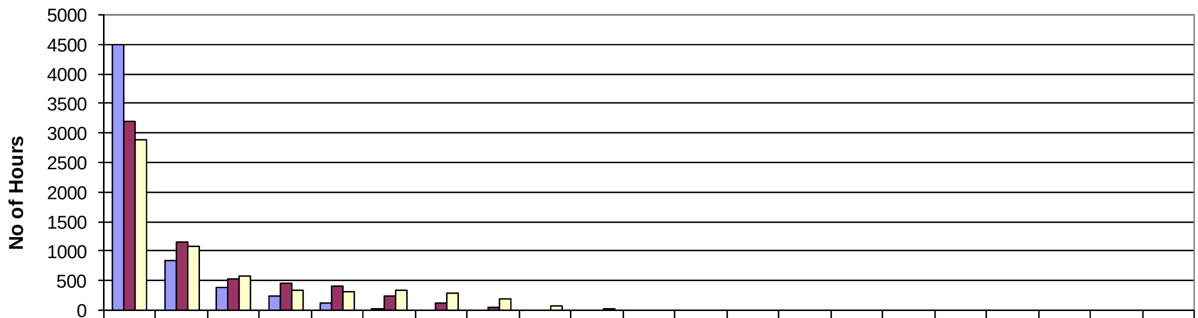
December – February

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 411 hours we get 5m/s, similarly at 50 meters height during 317 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 6.8% and 5.2% we get wind speed of 5m/s at 30m and 50m respectively.

Fig-16

Wind Frequency Distribution at Gilgit (Dec-Feb)

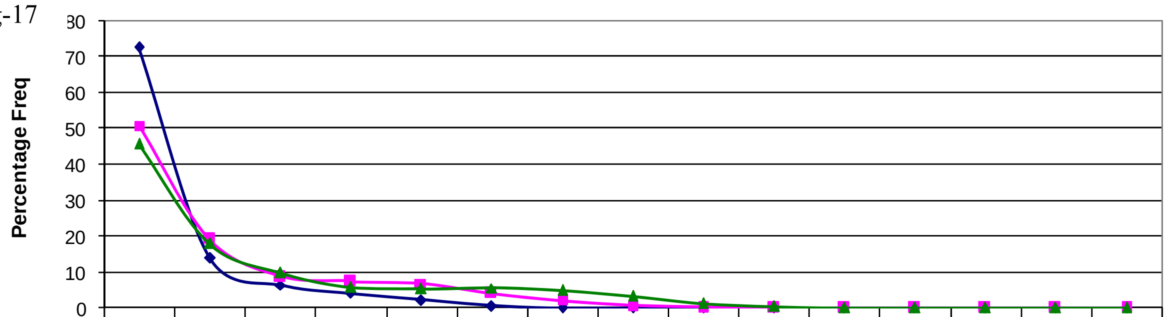


	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
WS 10m	4497	850	385	249	132	33	2	0	0	0	0	0	0	0	0	0	0	0	0	0	7
WS 30m	3190	1156	519	449	411	244	128	43	10	1	0	0	0	0	0	0	0	0	0	0	6
WS 50m	2880	1076	584	344	317	337	292	203	84	25	5	0	0	0	0	0	0	0	0	0	9

Wind Speed (m/s)

Percentage Wind Frequency Distribution at Gilgit (Dec-Feb)

Fig-17



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
WS 10m	72.5	14.0	6.4	4.2	2.2	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WS 30m	50.7	19.2	8.7	7.4	6.8	4.1	2.1	0.7	0.1	0.0	0.0	0.0	0.0	0.0	0.0
WS 50m	45.6	17.9	9.7	5.8	5.2	5.6	4.9	3.4	1.4	0.4	0.1	0.0	0.0	0.0	0.0

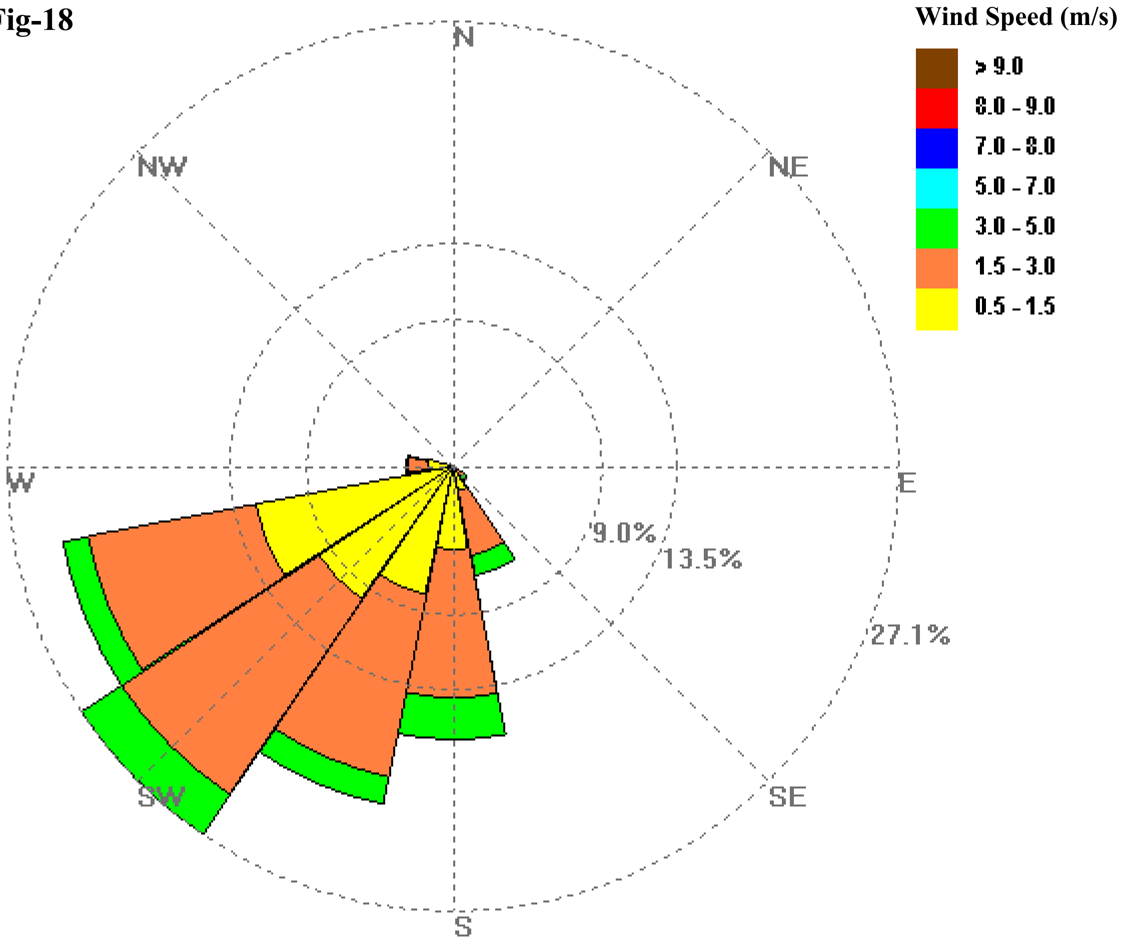
Wind Speed (m/s)

3.5 Wind Rose

Fig-18 shows the Wind Rose based on data from May-07 to April-10 (36 months) collected at 30 meters height. Wind Rose indicates that most of the time the wind direction was towards South West. The annual average wind speed at 30 meter height is 1.87 m/s and the percentage when wind speed greater than 5m/s is 8%.

03 Years Wind Rose at Gilgit (30m height)

Fig-18



Average Wind Speed	Wind greater than 5 m/s
1.87m/s	8%

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 dm/dt is the mass of air following time.

From fluid dynamics, it can be proved that

$$dm/dt = \varphi AV$$

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

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

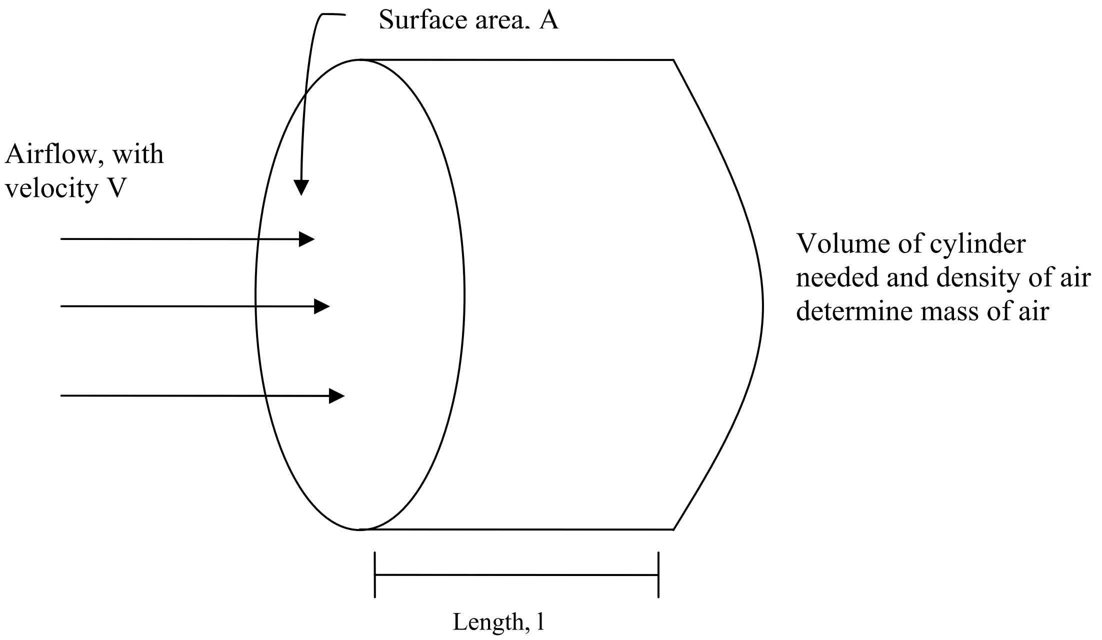
Now mass of wind can be written as

$$M = \varphi Avt$$

Differentiating

$$dm/dt = \varphi AV \, d/dt(t) = \varphi AV$$

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.

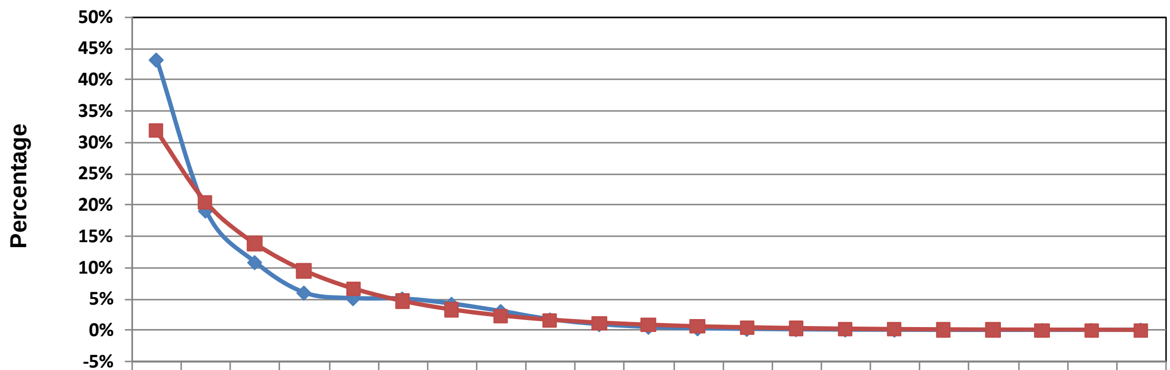
A measure of the confidence of the fit of the Weibull curve to the real data is also returned. Often the Weibull curve is a good fit to the most of the data, but a poor fit to some. If the poor fit is in the low wind speed range, i.e. below cut in it may be possible to ignore the poor fit as this portion 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 Gilgit (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	43.2	19.1	10.8	6.0%	5.1%	5.0%	4.2%	3.0%	1.7%	0.9%	0.5%	0.2%	0.2%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Weibull 50m	31.8	20.4	13.8	9.5%	6.6%	4.7%	3.3%	2.3%	1.7%	1.2%	0.8%	0.6%	0.4%	0.3%	0.2%	0.2%	0.1%	0.1%	0.1%	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 wind range from the lowest of 0.79 during December to the highest of 1.26 during the month of March with an annual of K being 0.99

The lowest values of the *scale parameter* C 1.02 m/s observed in November while the highest value of 3.33 is obtained in March and with an annual value of 2.39 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 1.07, at 30 meters this average speed is 1.91 m/s with Standard deviation of 1.93.

At 50 meters the monthly average wind speed varies from the lowest of 1.04 m/s in November to highest of 3.09 m/s during March. Whereas the average wind speed is 2.35 m/s with Standard deviation of 2.37.

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 0.28 W/m^2 in November to 12.80 W/m^2 in December with Average of 5.77 W/m^2.

At 30 meters height the power density varies from 1.98 W/m^2 in November to the highest of 99.82 W/m^2 in June and the average values is about 33.78 W/m^2.

At 50 meters height the power density of Gilgit varies from 4.83 W/m^2 in November to 100.93 W/m^2 in June. The average power density of the area is 59.09 W/m^2.

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

10 m					
	AvgV (m/s)	St Dev	C (m/s)	K	P/A (w/m^2)
January	0.87	0.89	0.98	0.98	**3.78**
February	1.32	1.19	1.49	1.12	**8.37**
March	1.38	1.19	1.46	1.18	**6.73**
April	1.17	1.10	1.20	1.07	**5.02**
May	1.18	1.19	1.18	0.99	**6.22**
June	1.11	1.10	1.12	1.02	**4.86**
July	1.06	1.15	1.02	0.92	**5.48**
August	1.09	1.25	1.01	0.86	**7.11**
September	1.02	1.18	0.94	0.85	**6.07**
October	0.81	0.88	0.78	0.92	**2.49**
November	0.59	0.36	0.66	1.71	**0.28**
December	0.88	1.37	0.61	0.62	**12.80**
Average	**1.04**	**1.07**	**1.04**	**1.02**	**5.77**
30 m					
	AvgV (m/s)	St Dev	C (m/s)	K	P/A (w/m^2)
January	1.45	1.52	1.64	0.95	**19.73**
February	2.33	1.94	2.63	1.22	**35.39**
March	2.44	1.94	2.63	1.28	**31.41**
April	2.12	1.89	2.21	1.13	**26.27**
May	1.96	2.46	1.70	0.78	**57.17**
June	3.07	3.00	3.10	1.03	**99.82**
July	1.95	2.02	1.91	0.96	**30.18**
August	2.03	2.15	1.96	0.94	**36.29**
September	1.87	2.05	1.78	0.91	**31.31**
October	1.41	1.59	1.32	0.87	**14.81**
November	0.87	0.80	0.90	1.09	**1.98**
December	1.46	1.78	1.30	0.81	**21.05**
Average	**1.91**	**1.93**	**1.92**	**1.00**	**33.78**
50 m					
	AvgV (m/s)	St Dev	C (m/s)	K	P/A (w/m^2)
January	1.81	1.97	2.04	0.91	**45.75**
February	2.96	2.50	3.15	1.20	**63.37**
March	3.09	2.50	3.33	1.26	**66.15**
April	2.69	2.46	2.79	1.10	**57.07**
May	2.77	2.77	2.77	1.00	**77.77**
June	2.75	2.69	3.11	1.02	**100.93**
July	2.50	2.63	2.43	0.94	**66.32**
August	2.60	2.78	2.51	0.93	**77.92**
September	2.39	2.65	2.26	0.89	**67.41**
October	1.76	2.08	1.60	0.83	**33.52**
November	1.04	1.10	1.02	0.94	**4.83**
December	1.86	2.33	1.62	0.79	**48.06**
Average	**2.35**	**2.37**	**2.39**	**0.99**	**59.09**

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 Gilgit 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 Gilgit 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 Gilgit.

PMD Calculator (using 50M) Aug 2006 to Sep 2008				
Month	**Input W/m^2**	**Output W/m^2**	**C.F.**	**KWh / Month**
January	48	15	4%	16,808
February	67	23	6%	24,454
March	70	25	6%	27,706
April	60	20	5%	22,098
May	82	25	6%	27,732
June	106	31	8%	33,383
July	70	21	5%	23,364
August	82	23	6%	26,120
September	71	20	5%	21,834
October	35	11	3%	12,117
November	5	1	0%	1,557
December	50	14	3%	15,356
Annual	**56**	**18**	**4%**	**235,517**

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 Gilgit (May-07 to April-10). The graph shows that the maximum power is produced at about 1600; 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 Gilgit the wind have more potential in the month of March & August as compared to other months. Figure 23 to 34 shows the monthly average diurnal variation of wind generated electric energy output.

Fig 20 **Gilgit: From May 2007 to April 2010 Annual Average Diurnal Varition Of Wind Generated Electric Powe Output**

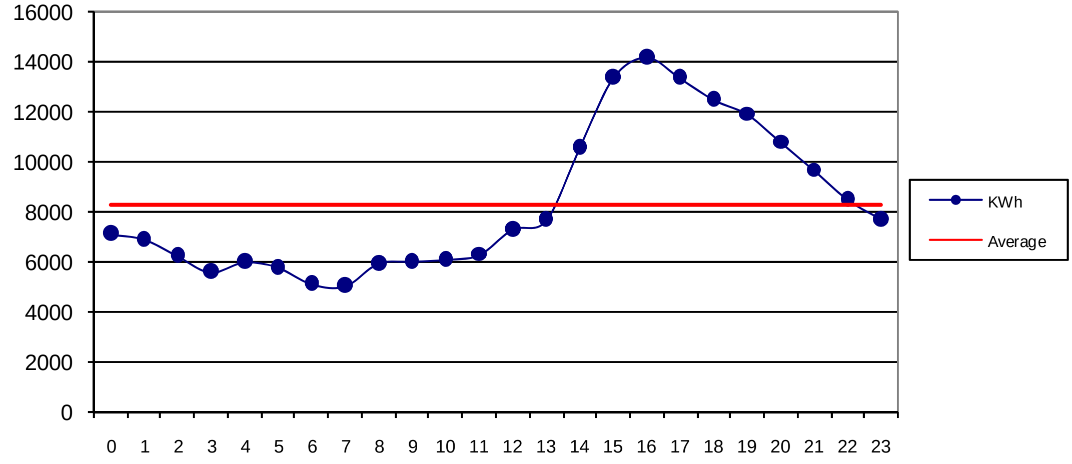


Fig 21 **Gilgit: From May 2007 to April 2010 Monthly Average Diurnal Varition Of Wind Generated Electric Powe Output**

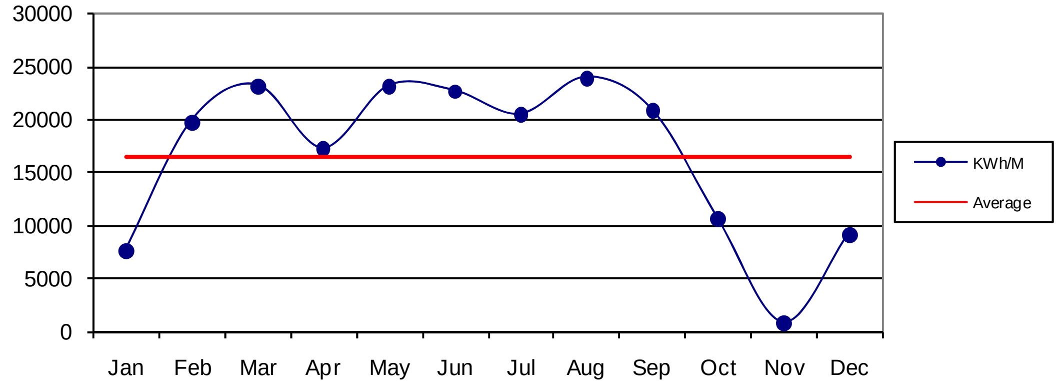


Fig 22 **Gilgit : From May 2007 to April 2010 Daily Wind Generated Electric Power Output**

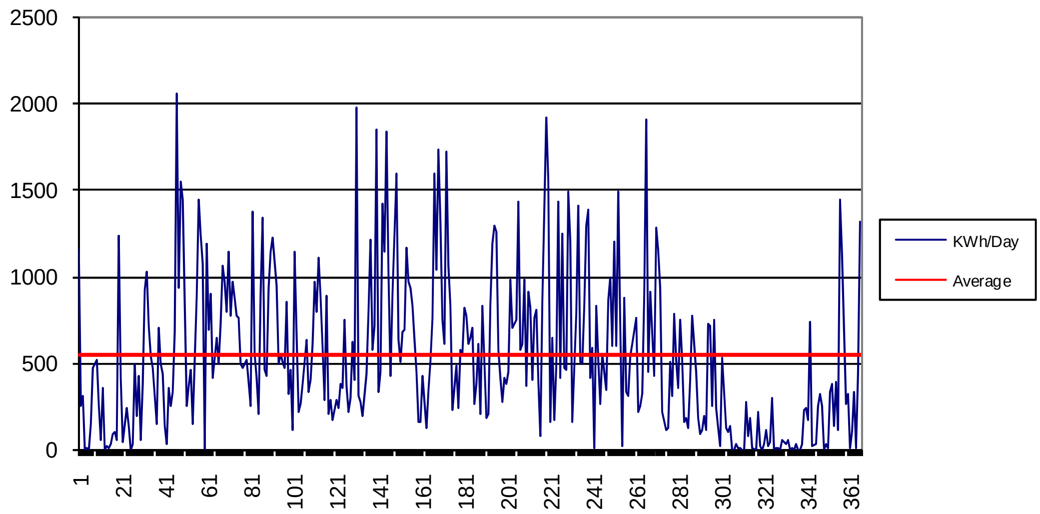


Fig 23 **Gilgit** Jan: Diurnal Variation of Wind Genrated Electric Energy Output

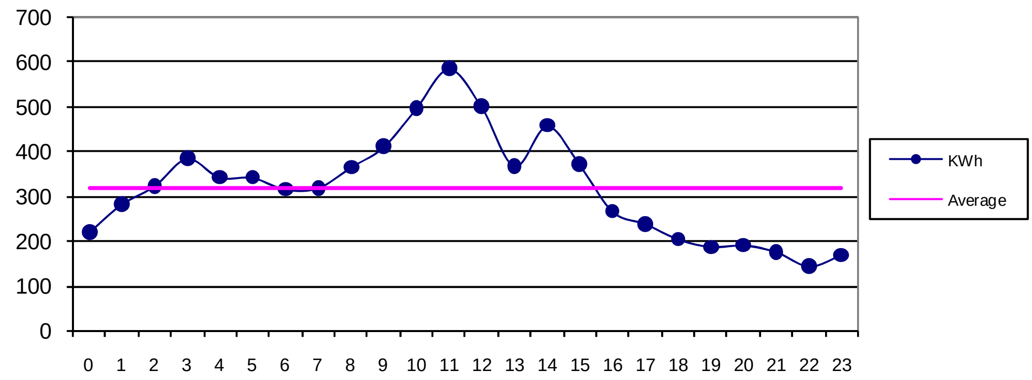
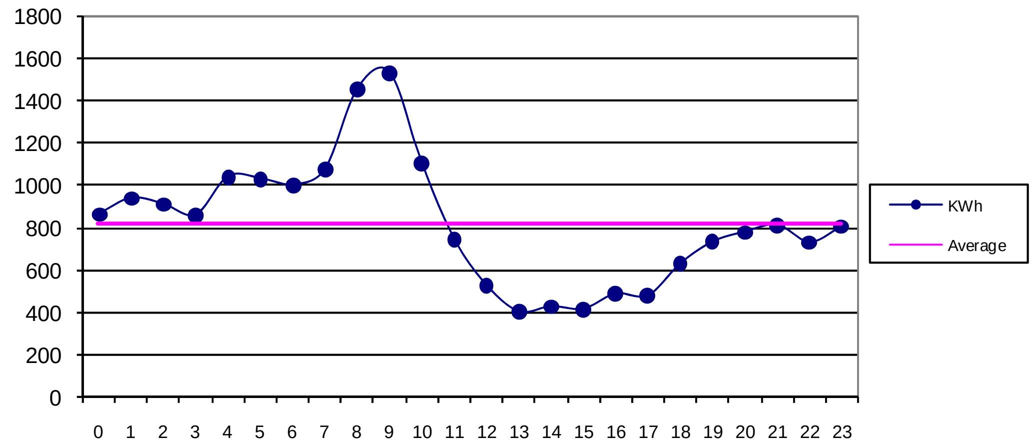
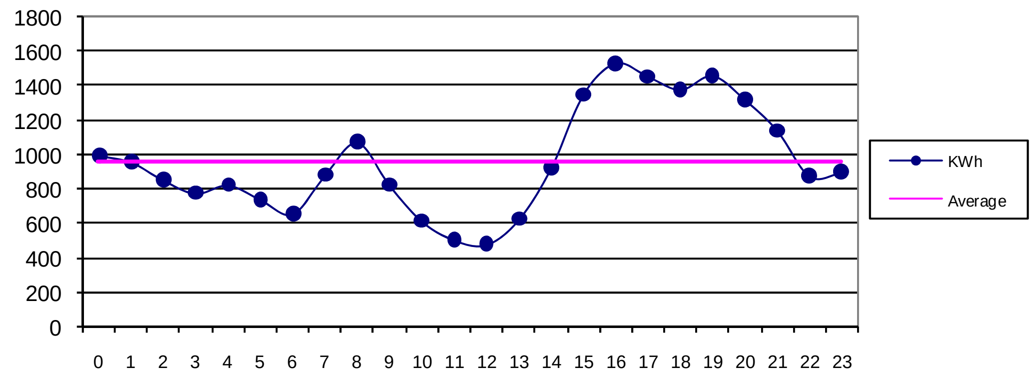


Fig 24 **Gilgit** Feb: Diurnal Variation of Wind Genrated Electric Energy Output



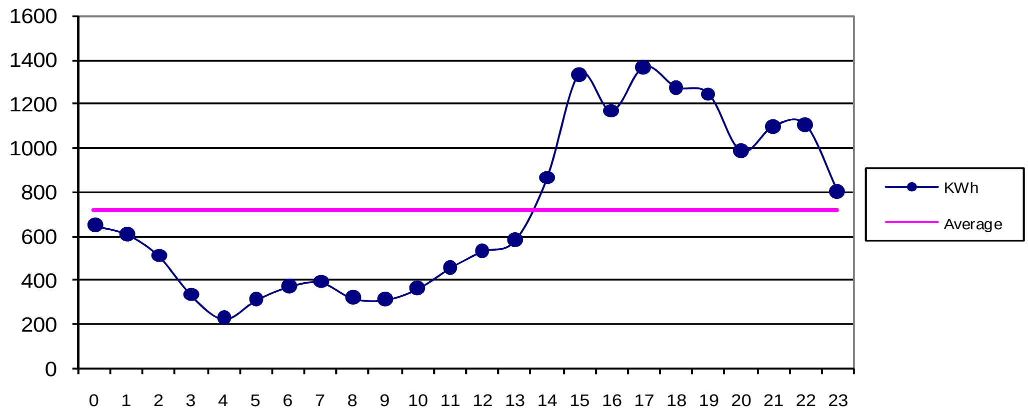
Source: Pakistan Meteorological Department

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



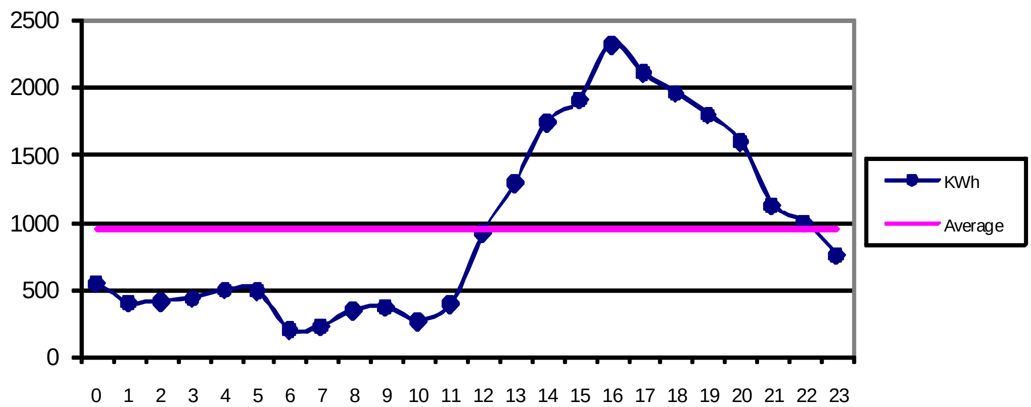
Source: Pakistan Meteorological Department

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



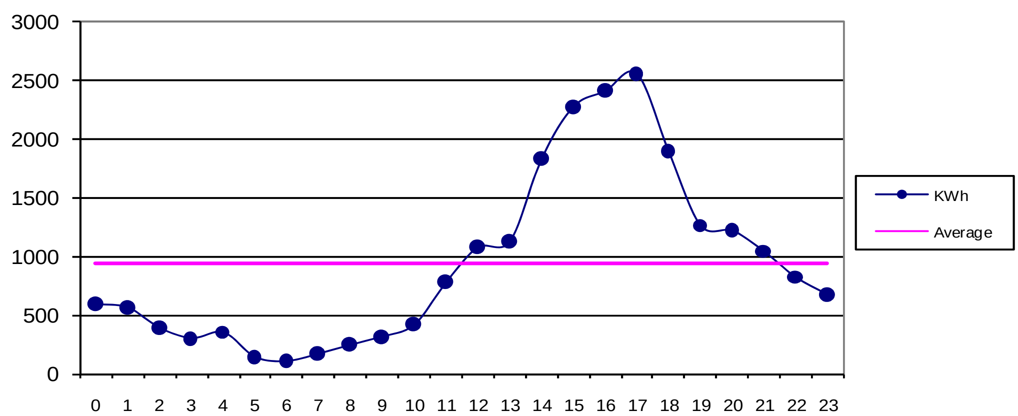
Source: Pakistan Meteorological Department

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



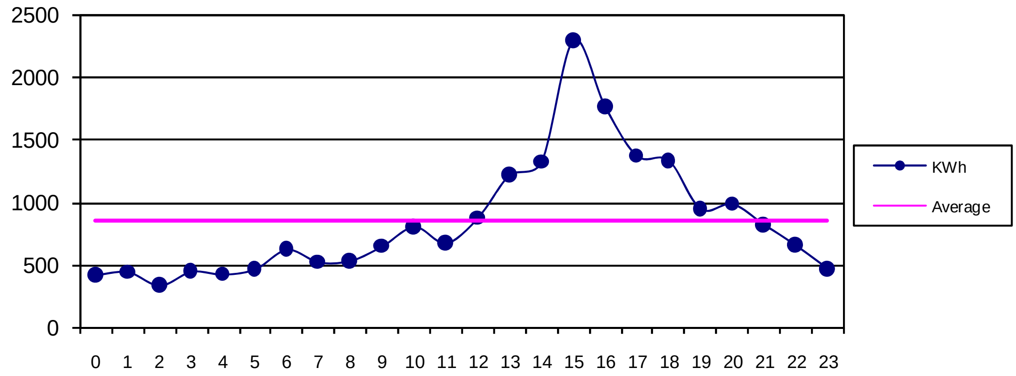
Source: Pakistan Meteorological Department

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



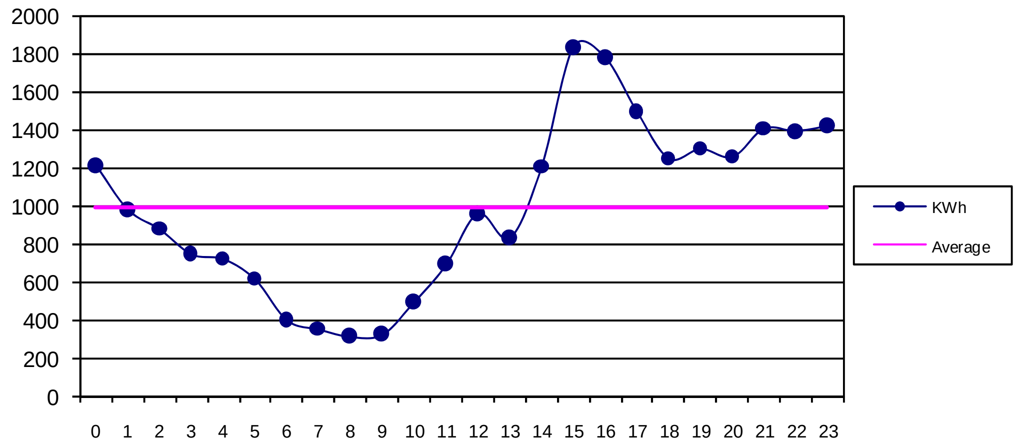
Source: Pakistan Meteorological Department

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



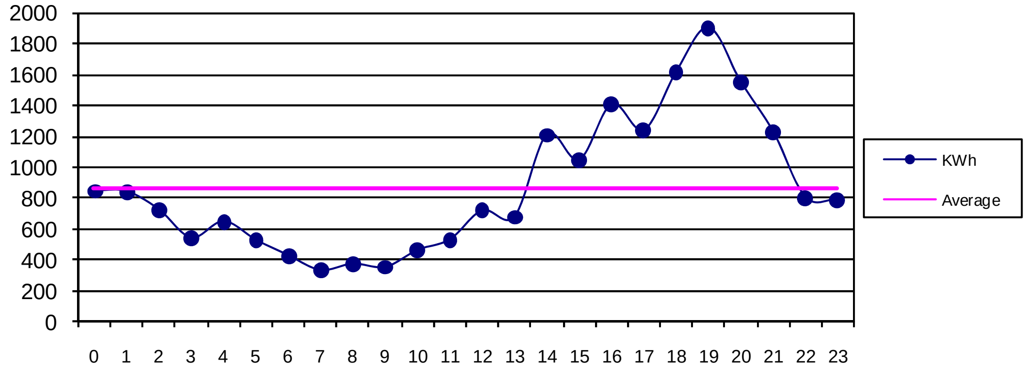
Source: Pakistan Meteorological Department

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



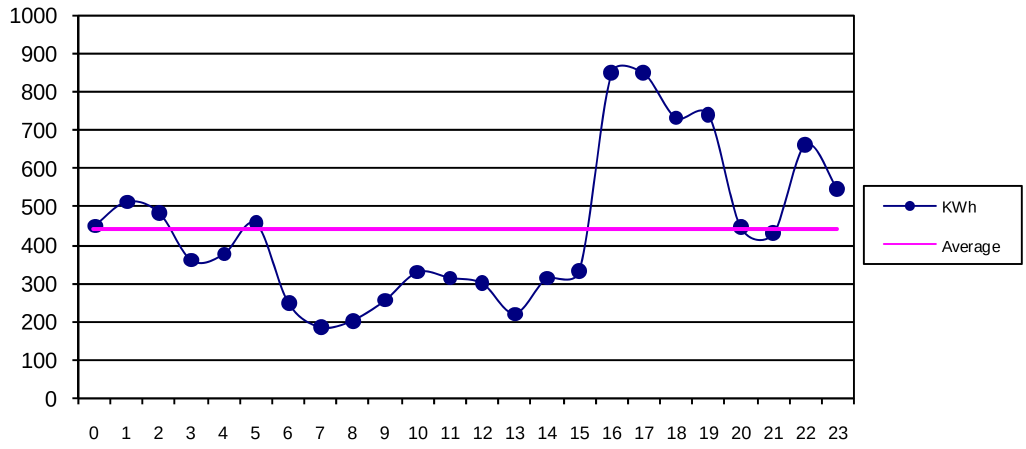
Source: Pakistan Meteorological Department

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



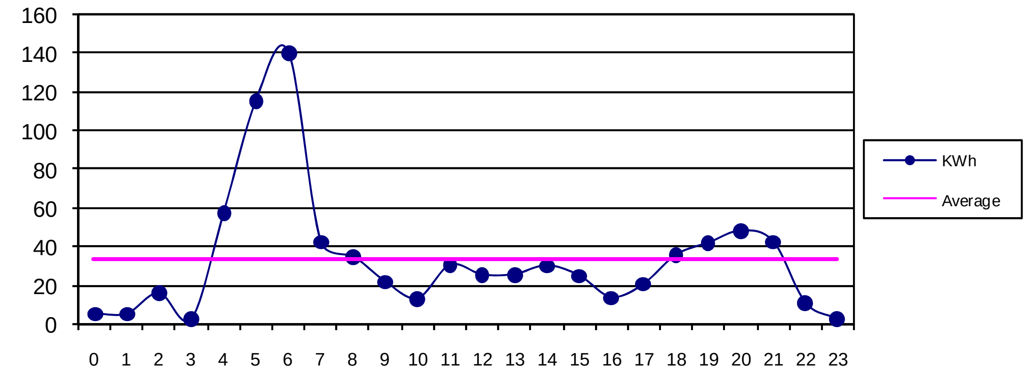
Source: Pakistan Meteorological Department

Fig 32 **Gilgit** Oct: Diurnal Variation of Wind Genrated Electric Energy Output



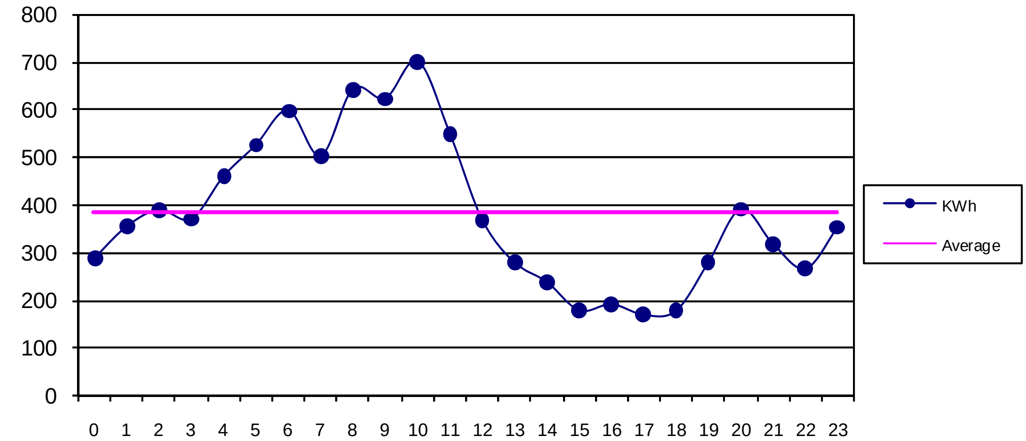
Source: Pakistan Meteorological Department

Fig 33 **Gilgit** Nov: Diurnal Variation of Wind Genrated Electric Energy Output



Source: Pakistan Meteorological Department

Fig 34 **Gilgit** Dec: Diurnal Variation of Wind Genrated Electric Energy Output

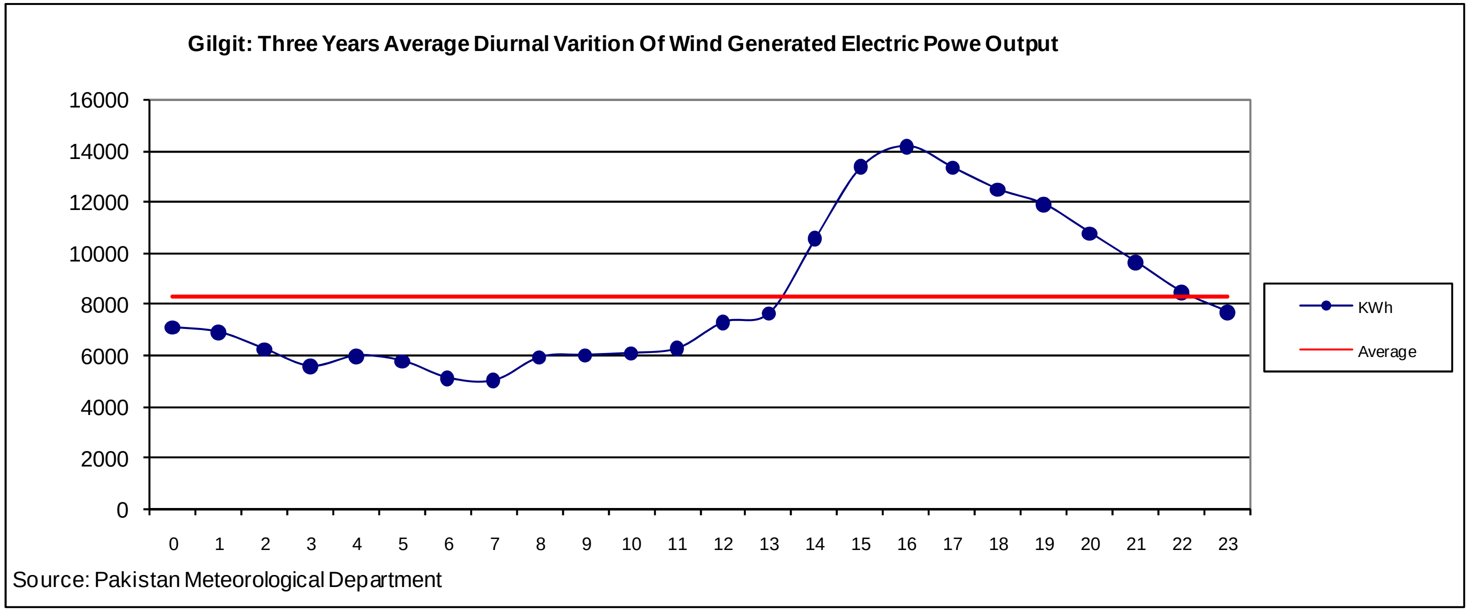


Source: Pakistan Meteorological Department

Appendix-I

Gilgit **May 2007 to April 2010** **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	217	280	321	383	341	341	315	317	364	409	496	585	499	366	456	369	264	237	202	185	188	173	141	167	7618
Feb	863	939	910	860	1040	1031	1002	1075	1454	1531	1103	744	527	403	427	416	486	479	629	732	779	811	730	805	19775
Mar	997	959	854	778	826	743	659	883	1073	826	617	508	481	627	924	1351	1533	1456	1380	1460	1321	1141	877	900	23173
Apr	648	610	510	333	225	310	371	392	319	312	362	456	532	579	864	1337	1168	1370	1277	1247	987	1099	1106	803	17219
May	545	403	415	434	498	487	200	229	350	369	267	396	921	1290	1742	1906	2318	2102	1954	1793	1592	1125	994	756	23087
Jun	597	568	395	308	356	147	114	177	252	322	423	782	1081	1127	1830	2274	2407	2553	1891	1264	1221	1043	824	677	22634
Jul	422	443	337	447	425	467	623	523	535	651	805	677	877	1221	1326	2296	1764	1373	1335	951	988	822	657	470	20433
Aug	1212	983	880	749	725	618	405	357	318	330	501	695	964	835	1207	1835	1778	1494	1251	1301	1260	1407	1395	1420	23919
Sep	850	846	727	547	653	533	433	338	379	358	467	536	723	684	1212	1048	1407	1240	1616	1902	1550	1228	808	795	20881
Oct	452	514	486	362	378	458	251	187	205	258	331	316	301	222	315	333	851	849	733	741	447	431	664	546	10629
Nov	6	5	16	3	58	116	141	43	35	22	13	31	26	26	30	25	14	21	36	42	48	43	11	3	814
Dec	287	354	389	369	459	525	598	502	643	623	702	549	367	278	237	177	190	168	177	279	390	317	265	353	9195
KWH	7094	6903	6241	5574	5984	5775	5111	5021	5927	6013	6086	6274	7298	7657	10572	13365	14181	13341	12480	11897	10772	9641	8472	7696	**199377**
Average	217	280	321	383	341	341	315	317	364	409	496	585	499	366	456	369	264	237	202	185	188	173	141	167	7618



Gilgit **Jan 08,09,10** **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	41	73	78	78	74	75	69	68	74	84	110	76	46	32	29	20	14	24	20	15	16	14	14	17	1159
2	12	11	0	0	0	6	5	0	0	15	54	67	42	15	6	9	1	0	0	0	1	4	1	2	251
3	0	0	0	0	0	0	0	2	1	0	1	0	1	1	28	42	64	68	36	28	28	13	2	0	315
4	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	3
5	0	0	0	0	0	0	0	0	0	0	0	0	1	9	2	1	2	1	0	0	0	0	0	0	16
6	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	3
7	0	0	0	1	6	7	4	3	16	26	12	13	5	6	12	6	3	1	0	0	0	5	14	13	156
8	17	22	22	22	31	31	30	33	38	52	54	47	32	8	2	8	11	3	2	1	0	0	1	8	476
9	15	0	13	13	12	9	11	7	13	28	30	38	33	25	37	55	31	26	32	23	19	18	15	15	520
10	21	36	33	44	30	23	21	7	0	0	8	0	0	2	19	12	2	0	0	0	0	0	0	1	260
11	0	2	2	1	16	0	0	0	0	3	0	0	0	0	1	0	1	0	0	1	6	17	1	2	56
12	8	2	6	19	22	27	15	24	8	0	2	35	72	45	36	26	14	3	1	1	0	0	0	0	364
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	2
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	6	11	3	0	0	21
15	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3	1	0	0	0	0	0	0	0	2	9
16	1	0	0	0	0	0	0	0	0	2	1	0	4	6	4	0	6	4	0	0	1	3	1	0	34
17	0	4	0	7	1	1	0	0	0	0	0	7	10	11	8	0	6	1	0	2	0	4	6	20	90
18	9	6	5	4	6	3	0	0	0	0	4	0	7	17	27	2	2	0	0	0	0	0	1	9	103
19	0	0	0	0	0	0	0	0	0	4	2	15	9	1	4	9	2	0	0	5	1	0	0	2	55
20	25	33	48	71	68	76	44	64	94	59	68	72	59	45	64	36	28	41	51	44	39	41	36	33	1238
21	38	38	33	27	22	20	17	16	27	27	27	33	31	23	9	9	2	5	6	7	4	0	1	0	422
22	0	0	0	0	0	0	0	0	0	0	0	6	17	12	2	10	3	0	0	2	0	0	0	0	52
23	0	10	45	67	22	6	0	0	0	0	0	16	34	26	7	7	6	2	0	0	0	0	0	0	248
24	0	0	0	0	0	1	4	2	0	0	0	0	0	11	16	25	43	34	8	0	0	0	0	0	146
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
26	0	0	0	0	0	0	0	0	0	0	0	2	1	0	1	0	0	0	6	1	1	4	9	15	40
27	15	27	30	28	30	48	55	48	59	56	44	24	18	5	1	0	0	0	0	2	0	3	8	3	505
28	12	15	6	0	0	0	24	33	22	8	3	0	0	0	0	0	0	0	0	8	27	22	12	6	197
29	1	0	0	0	0	0	0	1	1	0	11	97	41	41	132	81	12	1	7	5	0	0	0	0	432
30	1	0	0	0	1	7	12	10	11	4	0	0	0	1	1	1	1	0	0	2	4	1	0	1	59
31	0	0	0	0	0	0	0	0	0	40	63	35	32	22	4	7	10	21	32	34	29	20	18	16	386
KWh	217	280	321	383	341	341	315	317	364	409	496	585	499	366	456	369	264	237	202	185	188	173	141	167	7618

Gilgit **Feb 08,09,10** **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	26	16	20	27	36	33	51	73	77	80	66	46	18	11	19	26	29	23	46	47	44	32	43	39	929
2	23	20	23	39	45	46	38	51	71	56	56	58	52	32	38	46	40	27	22	28	45	61	47	71	1035
3	86	60	0	33	76	84	59	43	39	44	47	35	9	3	9	5	3	0	0	0	14	11	21	34	716
4	5	13	11	29	63	45	36	33	64	42	36	14	9	0	2	2	1	0	21	40	41	19	16	8	550
5	24	24	15	27	41	36	37	24	46	23	9	5	7	17	21	18	39	22	8	10	10	12	2	3	482
6	0	2	1	0	2	2	1	0	2	1	0	0	6	10	71	31	9	13	2	0	2	0	0	0	154
7	0	1	3	2	26	31	51	40	55	51	48	55	44	43	37	16	11	41	33	23	25	26	26	19	706
8	24	23	24	23	22	24	26	36	32	56	47	30	22	14	5	11	20	10	9	0	6	7	6	19	496
9	41	0	57	44	54	33	31	24	12	2	1	1	2	20	25	18	25	6	17	11	7	3	5	5	442
10	36	1	0	0	0	0	1	0	1	20	5	0	0	2	5	5	3	7	10	22	13	1	0	2	136
11	0	0	2	0	0	1	1	0	0	14	13	1	1	1	1	2	0	1	1	2	0	0	0	1	42
12	1	1	0	0	4	16	30	45	72	46	25	7	2	1	2	2	1	1	3	17	25	20	12	24	358
13	12	9	7	10	12	6	11	19	40	29	14	2	1	0	0	1	3	5	24	27	9	0	3	16	259
14	3	22	8	0	13	31	3	11	8	8	6	20	27	15	8	5	24	24	1	0	12	42	21	28	337
15	60	29	15	0	8	21	9	17	34	38	27	13	4	5	2	1	2	24	38	51	63	68	64	87	681
16	85	119	156	127	159	141	102	103	159	139	90	63	42	31	26	31	39	39	45	55	46	83	84	101	2064
17	73	59	60	53	73	87	43	40	53	84	45	32	24	27	19	32	27	9	11	24	26	18	9	13	941
18	17	28	42	44	67	88	92	120	180	224	171	103	44	21	7	4	16	24	39	43	37	40	47	56	1556
19	64	58	46	88	88	66	70	85	151	163	136	75	53	23	20	16	11	12	24	39	46	47	42	28	1450
20	22	34	51	41	13	1	18	23	7	3	3	0	0	0	11	9	6	4	5	5	3	1	0	0	261
21	0	0	32	32	6	8	28	28	18	21	1	1	2	1	7	2	11	7	7	26	25	64	33	12	372
22	12	13	20	3	9	1	0	1	5	0	12	9	5	2	2	1	2	14	58	60	91	79	39	26	465
23	26	11	3	0	0	0	0	0	0	0	0	2	2	6	18	33	23	15	7	8	0	0	0	0	153
24	0	31	12	4	2	16	30	21	29	38	17	6	0	0	0	15	43	67	60	41	13	13	34	28	521
25	72	161	111	47	12	18	0	1	15	27	4	1	26	13	1	14	36	45	64	50	40	33	38	63	893
26	66	75	65	88	72	79	80	82	106	113	89	67	43	22	15	23	27	20	32	32	57	71	70	57	1451
27	58	95	90	64	74	69	90	94	124	133	68	51	48	51	20	12	5	0	4	19	22	18	15	15	1238
28	28	31	36	35	63	48	64	60	54	77	67	47	33	33	33	36	30	17	36	50	56	43	55	50	1081
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	2	0	0	0	0	0	5
KWh	863	939	910	860	1040	1031	1002	1075	1454	1531	1103	744	527	403	427	416	486	479	629	732	779	811	730	805	19775

Gilgit **March 08,09,10** **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	62	39	34	70	47	41	50	69	48	60	67	40	32	7	32	16	47	79	89	73	34	48	45	63	1191
2	72	59	72	55	49	20	14	33	33	27	32	15	7	13	34	10	6	21	13	42	40	13	8	3	691
3	8	0	0	10	135	76	23	4	2	10	3	44	71	106	115	117	62	22	12	22	8	1	23	33	906
4	28	12	13	3	0	7	9	55	30	9	6	6	21	14	6	1	11	29	31	40	72	15	0	0	417
5	0	0	0	0	0	0	0	0	6	5	2	1	0	0	88	146	116	83	54	65	18	20	13	28	646
6	5	1	0	1	7	0	0	0	8	16	15	2	1	0	0	75	76	57	51	25	28	48	49	31	495
7	36	34	64	33	18	12	31	51	78	81	34	7	1	0	21	7	2	0	16	33	54	56	31	31	729
8	34	24	30	39	41	48	41	63	73	91	108	73	38	17	2	12	8	12	32	47	68	51	56	55	1062
9	34	0	30	41	36	28	40	48	38	33	12	9	33	37	47	71	62	64	68	79	65	45	26	29	977
10	77	23	31	29	4	0	4	13	65	44	21	2	7	3	74	45	47	18	24	41	51	54	58	59	796
11	82	138	106	98	119	94	95	98	85	55	22	2	0	9	29	8	1	5	5	18	31	27	11	5	1143
12	1	8	12	20	33	28	28	42	64	63	58	20	14	4	2	11	17	24	59	61	55	70	39	42	776
13	57	65	68	94	87	68	56	54	69	54	58	32	6	1	10	59	34	3	6	9	24	18	20	16	970
14	31	48	35	36	41	39	51	64	83	51	39	16	1	0	1	0	7	12	31	51	63	62	60	58	878
15	58	67	48	50	43	38	34	42	73	36	1	1	3	0	0	0	5	10	24	39	68	65	44	33	782
16	42	33	27	27	38	138	67	43	41	10	0	1	0	0	1	4	15	26	24	28	74	56	26	43	765
17	29	23	21	16	22	13	9	3	6	0	7	24	3	18	29	22	41	28	32	21	25	21	54	26	495
18	19	18	22	12	0	0	0	28	24	10	6	0	2	1	41	11	7	24	16	64	43	44	42	38	473
19	44	42	50	21	17	2	0	4	17	12	0	1	0	0	0	1	84	38	18	34	42	37	27	29	522
20	17	10	3	6	8	4	0	0	1	0	0	0	0	1	4	24	21	38	75	64	62	27	21	12	396
21	5	2	3	17	2	0	0	0	3	0	2	10	8	8	19	42	23	31	39	15	1	6	12	8	256
22	13	8	7	12	14	30	40	51	73	59	48	119	127	152	119	104	58	54	25	80	81	36	10	65	1383
23	21	32	17	39	18	0	0	0	4	2	0	0	1	1	17	17	16	16	40	82	68	54	67	49	560
24	36	52	51	18	9	1	0	8	19	3	0	1	10	66	10	17	33	11	10	18	17	12	10	6	418
25	2	0	0	0	0	0	0	0	0	0	0	0	1	0	2	24	32	24	38	42	10	15	8	5	206
26	4	15	25	1	0	0	0	0	0	1	3	21	20	18	34	55	158	203	71	53	57	54	66	46	906
27	42	60	68	29	38	44	51	59	78	64	60	53	54	65	50	80	64	71	130	74	46	34	9	17	1343
28	0	0	0	0	0	0	0	1	1	1	1	0	5	2	2	21	91	127	108	63	41	4	0	0	470
29	6	11	0	0	0	0	0	0	1	3	0	3	2	65	43	62	71	47	22	60	20	10	0	2	430
30	2	0	0	0	0	0	0	7	21	9	0	0	0	3	76	201	158	144	77	54	24	109	16	38	938
31	132	135	17	0	0	11	15	40	29	17	10	4	12	15	16	87	163	134	140	61	31	26	26	33	1153
KWh	997	959	854	778	826	743	659	883	1073	826	617	508	481	627	924	1351	1533	1456	1380	1460	1321	1141	877	900	23173

Gilgit April 08,09,10 **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	44	22	24	26	31	76	37	70	72	47	41	31	17	58	36	57	49	76	43	60	89	84	68	73	1230
2	76	77	37	22	16	0	0	0	2	0	6	28	12	27	45	158	161	55	73	29	25	63	20	16	951
3	1	0	0	0	0	0	0	4	0	6	1	0	17	34	83	68	82	67	26	20	41	45	3	2	501
4	1	0	8	17	2	8	0	0	0	4	16	41	19	38	28	5	22	122	55	32	50	68	10	8	555
5	8	9	15	4	0	0	0	1	1	1	45	25	7	19	29	32	42	55	45	63	13	20	51	21	506
6	6	1	4	4	27	31	32	27	15	4	9	60	25	15	33	15	11	21	34	31	21	13	11	31	480
7	16	21	27	18	5	55	17	60	65	78	48	60	60	64	72	50	35	64	15	2	0	6	6	18	861
8	0	0	0	0	0	0	0	0	0	3	3	4	0	1	91	68	16	53	49	8	8	8	11	5	330
9	1	0	5	10	2	2	0	4	0	9	4	2	7	5	19	56	77	74	80	52	38	11	2	4	464
10	3	1	0	0	0	0	0	0	0	0	0	3	0	0	2	2	0	10	44	18	9	12	12	0	117
11	0	0	3	2	1	2	3	0	5	14	51	42	12	0	1	15	19	59	122	139	132	214	195	115	1146
12	108	74	55	23	3	10	79	25	1	0	0	14	31	8	20	6	2	125	26	2	0	17	29	0	660
13	0	11	0	0	7	0	0	0	0	0	1	0	3	4	18	11	12	31	30	47	29	8	1	7	223
14	11	14	0	0	0	0	0	0	0	0	5	27	20	16	21	2	21	28	14	10	18	27	24	12	268
15	8	0	0	0	0	0	0	0	0	0	7	6	4	7	26	39	21	44	42	49	39	32	36	28	390
16	13	51	45	48	45	56	59	64	13	4	10	1	0	2	7	22	27	47	49	59	9	4	0	0	635
17	0	1	2	0	0	1	0	2	1	0	0	1	2	1	2	17	40	40	19	34	47	61	52	12	333
18	0	0	1	1	0	0	9	21	45	46	28	20	13	3	2	10	8	14	29	32	17	26	34	47	406
19	38	36	29	10	31	8	20	23	26	9	6	8	90	46	7	16	19	38	42	48	34	16	4	8	611
20	34	45	42	22	14	23	20	22	2	13	22	4	86	54	91	216	149	53	36	8	1	0	11	8	977
21	60	106	81	36	3	0	0	0	0	2	3	9	1	9	7	56	16	11	27	94	72	38	62	112	805
22	95	46	27	23	11	2	10	3	0	0	0	5	32	13	63	149	33	21	55	52	46	145	194	93	1120
23	12	0	36	24	0	0	0	0	0	0	0	0	7	49	44	108	174	93	110	93	81	5	42	15	894
24	5	0	2	0	0	8	6	17	28	22	26	13	4	23	34	5	2	17	29	52	9	101	118	69	592
25	33	9	0	0	0	0	0	0	3	13	2	41	27	23	18	24	23	13	22	21	12	7	0	0	291
26	17	68	63	33	26	24	36	33	24	28	23	6	34	53	44	120	92	76	58	32	6	0	0	0	896
27	0	0	0	0	0	0	1	0	0	0	0	0	0	1	16	7	10	3	19	70	59	9	8	6	209
28	12	7	2	0	0	3	34	1	0	0	0	4	0	1	1	0	0	11	18	20	21	18	65	78	297
29	45	9	0	0	0	0	0	0	0	0	0	0	0	3	2	0	3	15	15	10	20	25	22	7	178
30	0	0	1	9	0	0	8	15	14	9	3	0	1	2	0	3	2	33	53	59	41	17	17	5	293
KWh	648	610	510	333	225	310	371	392	319	312	362	456	532	579	864	1337	1168	1370	1277	1247	987	1099	1106	803	17219

Gilgit **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	1	0	0	1	0	0	0	3	16	0	0	0	0	0	2	13	12	29	62	62	17	13	15	5	250
2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	13	5	12	35	131	67	76	21	17	8	386
3	0	0	0	0	0	0	0	0	1	1	1	7	30	28	16	7	15	38	43	60	88	27	0	0	364
4	0	0	1	1	0	3	0	0	53	23	0	1	26	7	9	17	220	174	30	54	80	31	0	25	755
5	9	11	10	0	0	42	12	0	0	0	0	4	8	21	7	34	15	77	49	51	2	0	5	13	370
6	2	2	0	31	39	34	19	14	2	4	0	0	3	22	9	26	14	4	0	0	0	0	2	0	226
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	96	40	62	56	40	306
8	35	10	5	1	6	76	16	15	2	0	0	1	1	1	53	106	65	11	31	24	22	22	73	55	631
9	64	0	43	8	0	0	0	0	0	0	0	1	76	20	18	43	26	22	33	16	11	10	8	9	409
10	4	49	12	15	77	43	50	27	22	40	55	93	152	143	260	259	189	188	132	69	53	31	16	0	1981
11	0	0	0	0	0	0	0	0	2	2	1	0	0	16	60	93	49	22	8	4	14	24	19	0	314
12	1	1	0	0	0	0	0	0	1	0	0	0	0	8	13	57	56	35	50	45	5	7	5	0	283
13	0	0	1	1	0	0	0	0	0	2	1	3	8	17	19	33	31	5	26	31	10	1	8	2	198
14	0	0	0	0	0	3	0	0	1	1	0	0	0	19	30	48	44	78	126	30	19	16	22	0	438
15	1	14	26	4	6	1	0	0	8	19	36	80	124	103	151	88	76	50	15	0	0	0	0	0	802
16	0	0	54	79	106	53	2	0	0	1	1	1	8	40	64	98	153	77	55	11	144	96	151	23	1217
17	35	21	28	26	22	26	12	22	25	27	16	2	5	0	0	2	24	34	45	62	73	32	22	16	577
18	16	16	11	8	6	2	11	2	10	15	8	3	2	58	121	15	37	59	73	48	34	60	92	11	717
19	0	0	0	0	0	0	0	1	4	11	1	0	1	27	120	116	158	261	338	283	215	151	138	31	1857
20	9	0	0	0	0	0	0	0	0	2	1	5	29	8	84	23	86	27	2	6	15	12	12	14	338
21	0	2	0	0	0	0	2	0	3	59	25	2	12	108	38	37	70	14	6	0	38	26	8	3	455
22	0	0	0	102	106	61	47	62	68	24	2	0	2	7	33	114	93	98	78	140	119	79	81	112	1428
23	82	80	42	13	30	101	1	8	55	38	6	10	4	18	37	97	53	102	43	52	76	78	19	99	1146
24	114	16	31	19	19	13	19	66	63	81	90	78	91	170	198	84	201	167	148	123	19	8	6	17	1840
25	4	1	11	27	23	0	1	3	0	2	0	18	161	190	60	17	99	89	64	50	99	56	12	26	1015
26	3	4	0	0	0	0	0	0	0	3	5	0	23	8	18	46	36	30	19	15	73	37	45	68	433
27	3	0	0	0	0	0	0	1	4	0	0	63	25	9	66	125	89	106	97	102	82	64	49	27	911
28	11	52	52	43	19	9	0	0	1	4	11	20	87	178	197	233	253	185	74	59	42	30	18	25	1603
29	17	15	10	9	12	13	9	5	4	8	6	2	12	12	1	1	10	28	128	163	57	50	54	13	639
30	2	0	0	0	2	0	0	0	4	2	0	0	0	0	11	19	34	31	35	69	70	80	39	113	513
31	132	107	75	48	26	5	0	0	1	1	1	1	30	51	33	49	97	27	1	0	0	0	0	0	686
KWh	545	403	415	434	498	487	200	229	350	369	267	396	921	1290	1742	1906	2318	2102	1954	1793	1592	1125	994	756	23087

Gilgit **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	0	0	0	1	2	0	1	0	4	3	4	5	0	69	50	28	69	56	14	3	112	73	105	95	695
2	55	46	32	1	1	0	0	0	0	1	0	0	4	3	58	91	109	131	192	195	107	63	34	46	1168
3	19	31	0	41	12	1	0	1	14	1	21	71	59	39	94	151	96	105	6	1	43	54	64	53	977
4	48	44	48	38	23	8	0	2	0	0	0	1	5	19	41	56	160	208	202	27	3	6	2	0	942
5	0	0	3	15	62	32	0	0	0	0	1	16	10	9	12	83	79	141	81	8	30	77	128	51	837
6	4	0	0	1	0	1	0	1	3	15	22	0	4	7	5	23	51	69	32	79	127	99	69	22	634
7	7	0	0	2	2	0	0	1	3	1	4	10	46	61	39	66	110	27	3	0	10	38	19	2	450
8	0	0	2	0	0	0	0	0	2	8	1	0	0	14	19	25	27	35	13	6	3	3	0	0	158
9	0	0	1	0	0	0	0	0	0	3	1	0	2	24	16	57	10	12	25	6	1	0	0	0	158
10	0	0	1	0	0	0	0	0	1	8	1	2	9	12	58	135	29	2	60	79	28	10	0	0	435
11	0	0	0	4	0	0	0	0	0	2	3	1	27	17	11	3	0	7	7	0	21	22	8	0	134
12	0	0	0	1	0	0	0	0	0	0	2	8	15	8	20	35	52	39	52	28	39	28	5	16	351
13	0	0	0	0	0	2	0	0	3	7	4	3	1	1	112	73	34	37	37	32	17	27	68	55	513
14	55	37	15	11	7	5	3	2	0	3	1	6	93	154	138	30	7	5	0	33	118	44	1	0	770
15	20	1	0	0	0	1	0	0	0	4	37	49	70	69	68	203	213	314	164	80	77	83	60	82	1597
16	47	11	0	0	0	0	24	24	1	56	139	123	149	126	66	16	42	40	17	22	34	21	31	52	1042
17	122	167	131	64	34	2	0	14	17	6	14	31	177	111	205	195	155	74	60	39	36	42	32	15	1743
18	3	4	0	7	13	7	19	14	37	31	26	82	136	230	223	179	127	62	46	37	32	3	0	1	1322
19	0	0	0	0	0	0	0	58	53	17	15	6	3	3	61	22	96	86	84	153	54	10	10	26	760
20	42	47	41	25	8	15	42	41	41	8	1	1	3	10	9	19	46	70	118	20	1	6	3	0	617
21	0	1	0	0	0	0	8	4	15	26	9	94	144	23	60	203	296	236	178	116	103	84	59	64	1724
22	68	63	36	24	26	19	4	7	2	5	1	0	2	14	114	183	165	162	108	31	16	3	0	9	1065
23	24	0	0	0	1	1	0	0	2	43	15	16	18	7	140	149	94	108	148	62	6	0	0	2	838
24	9	18	22	8	8	1	0	0	3	8	2	0	1	0	6	16	8	10	6	0	1	1	45	59	233
25	55	36	22	23	16	8	3	0	1	1	2	3	1	3	8	27	22	129	11	22	24	72	5	0	492
26	4	5	2	0	1	20	0	0	10	10	4	2	1	2	8	35	50	46	18	8	9	0	1	1	239
27	1	0	3	0	3	5	0	0	2	10	36	97	19	26	30	18	29	7	15	75	71	66	52	14	580
28	12	51	28	6	1	0	0	1	25	29	20	12	21	38	24	21	38	87	75	50	1	11	8	0	558
29	0	3	0	0	55	18	6	6	10	12	1	0	26	17	34	46	164	188	79	15	65	71	1	7	826
30	0	0	5	33	80	0	0	1	1	3	36	142	33	9	103	84	31	63	38	35	32	28	14	4	776
KWh	597	568	395	308	356	147	114	177	252	322	423	782	1081	1127	1830	2274	2407	2553	1891	1264	1221	1043	824	677	22634

Gilgit 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	25	19	34	42	121	116	72	20	3	12	10	3	40	33	37	18	4	2	1	0	0	0	1	614
2	0	0	0	0	0	1	0	4	16	8	12	20	6	71	36	56	50	33	2	1	172	114	17	30	650
3	44	44	0	43	27	9	64	26	9	7	1	15	103	98	38	5	16	25	25	0	0	7	33	76	713
4	20	1	1	0	0	0	0	0	2	3	6	2	3	6	22	105	61	27	13	1	0	0	0	0	273
5	0	0	0	0	0	0	0	0	0	1	4	2	5	23	14	0	34	15	66	56	45	85	36	0	388
6	0	0	1	0	0	0	0	0	2	104	137	10	1	5	65	194	50	26	11	1	1	0	0	0	610
7	0	2	8	14	9	0	3	0	0	7	1	0	13	45	6	25	14	9	31	10	0	0	0	11	210
8	37	98	28	115	89	44	6	2	47	53	23	17	9	6	18	39	21	27	81	35	17	9	12	0	832
9	2	0	10	28	3	0	0	0	1	1	0	0	4	1	4	42	40	14	18	1	9	9	0	0	188
10	0	0	2	0	0	0	0	0	0	0	3	28	45	48	26	37	13	0	7	1	0	0	0	0	211
11	1	0	0	1	0	0	0	0	0	3	7	4	14	6	64	160	192	178	69	34	47	44	22	0	848
12	1	0	0	0	0	0	0	0	3	11	7	7	12	40	67	257	207	116	133	157	78	26	52	19	1194
13	7	2	14	5	102	148	187	151	116	69	30	13	19	36	25	87	47	64	76	48	22	18	15	1	1303
14	2	1	0	1	2	0	43	98	127	92	129	113	106	101	133	131	61	50	33	20	16	4	0	0	1263
15	31	167	155	62	4	0	1	1	14	11	7	2	8	10	17	17	28	26	19	3	0	0	0	0	583
16	0	0	0	0	0	0	0	0	3	8	6	28	6	5	11	77	49	69	39	44	36	6	33	0	421
17	0	0	0	0	0	1	0	0	1	1	1	1	1	15	54	30	18	25	90	29	6	3	0	0	276
18	1	0	0	1	0	0	0	0	0	0	1	6	9	20	122	186	27	31	16	0	0	0	0	1	421
19	0	0	0	0	0	8	44	8	0	3	10	8	25	45	34	34	67	53	32	1	0	0	0	9	382
20	27	2	23	34	4	7	38	26	6	19	15	22	15	27	15	14	36	19	14	4	9	2	46	28	448
21	27	1	0	20	17	7	0	0	0	0	19	18	0	17	33	144	184	116	94	130	77	48	22	15	990
22	5	0	0	13	8	0	0	0	0	0	9	33	177	190	9	69	14	105	65	8	2	3	0	0	711
23	3	1	6	1	1	7	19	10	0	1	5	8	2	0	0	5	48	55	58	22	57	70	204	176	757
24	76	20	17	6	85	93	94	107	94	111	169	156	126	58	48	48	39	25	10	8	16	27	8	1	1439
25	1	0	0	0	0	0	0	0	0	3	2	27	89	96	165	102	63	23	5	2	0	0	0	0	579
26	0	0	0	0	0	1	1	1	0	61	154	108	28	14	16	75	19	2	70	58	6	2	0	0	617
27	0	0	8	19	17	15	4	8	12	12	1	0	13	24	21	31	74	87	102	89	144	136	98	76	991
28	30	20	19	7	0	1	0	0	0	1	0	0	0	12	12	40	36	32	33	49	27	20	17	17	374
29	91	55	25	39	9	0	1	8	53	40	27	18	34	59	59	68	59	63	68	45	56	31	11	0	923
30	0	0	0	0	0	0	0	0	3	5	5	0	0	54	59	161	134	27	41	70	87	140	30	7	822
31	15	3	0	3	4	1	0	0	7	13	2	0	0	48	101	19	48	27	14	24	57	16	0	0	403
KWh	422	443	337	447	425	467	623	523	535	651	805	677	877	1221	1326	2296	1764	1373	1335	951	988	822	657	470	20433

Gilgit **August 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	2	3	0	0	0	0	0	1	1	31	152	145	86	15	26	54	6	4	85	21	62	53	17	765
2	9	4	2	0	0	0	0	2	2	8	13	15	34	47	71	85	57	112	79	77	53	55	47	41	813
3	33	20	0	4	7	1	0	0	3	8	5	4	3	0	9	80	60	16	9	46	39	28	17	4	396
4	2	0	0	0	0	0	1	0	11	4	5	3	7	14	12	0	2	0	0	0	0	0	5	14	80
5	15	3	6	22	24	22	4	1	74	11	0	15	10	4	6	22	87	91	90	91	68	59	56	89	872
6	159	160	173	152	130	129	77	93	58	28	10	5	26	7	2	0	8	1	49	39	66	195	166	190	1923
7	199	138	197	191	175	187	96	48	1	0	2	20	11	9	83	25	1	15	53	33	12	22	21	27	1566
8	7	0	0	0	0	0	0	0	10	6	1	2	7	13	13	12	46	24	22	1	0	0	1	1	165
9	1	0	0	0	0	0	0	0	0	3	2	3	7	11	3	48	72	218	138	76	39	22	2	0	645
10	0	0	0	0	0	0	1	0	0	4	8	3	25	20	10	7	20	20	17	21	12	0	0	0	170
11	3	6	0	0	0	0	2	0	1	1	2	4	20	9	0	38	116	13	2	0	0	2	44	230	494
12	240	221	206	168	145	72	55	17	1	16	15	8	7	5	1	151	37	5	1	0	14	35	22	0	1443
13	0	0	3	15	1	2	1	6	2	10	7	4	5	11	17	26	31	59	0	59	89	27	24	15	414
14	14	0	1	1	23	64	34	22	36	94	125	21	20	28	46	174	99	12	14	14	14	48	177	166	1248
15	52	13	11	6	5	4	1	1	1	0	18	10	11	10	22	2	29	95	40	27	20	77	18	0	474
16	1	9	0	0	1	2	0	0	0	0	11	2	117	61	41	53	38	20	0	0	6	51	33	24	470
17	47	76	123	57	87	17	17	21	8	41	48	33	7	22	136	118	41	40	68	104	76	106	134	65	1492
18	49	29	41	81	85	60	96	120	72	41	24	51	60	113	115	17	48	52	37	10	3	0	0	0	1205
19	0	2	1	10	15	15	0	0	1	5	3	2	4	3	7	62	31	3	0	0	1	0	0	1	168
20	0	0	0	0	0	0	0	0	1	2	3	0	0	1	11	9	68	50	58	76	95	166	141	103	785
21	89	65	2	0	1	10	0	0	24	19	43	138	124	23	72	149	81	119	182	102	36	40	34	55	1410
22	28	25	31	34	1	0	0	0	3	0	0	0	20	13	4	16	27	61	55	53	79	33	8	16	507
23	23	26	9	0	0	0	0	0	4	8	18	25	11	46	46	88	73	36	37	16	16	16	4	0	501
24	0	0	0	0	0	1	0	0	0	0	1	1	8	53	11	5	23	4	9	152	155	185	140	89	837
25	33	49	15	0	1	0	0	0	0	1	10	7	34	31	17	9	128	178	154	155	135	65	115	157	1295
26	150	130	55	4	2	3	1	0	0	0	15	38	28	130	196	265	113	36	11	49	125	24	21	0	1396
27	15	0	0	0	0	0	0	0	0	0	2	44	107	26	14	18	8	89	89	8	0	0	0	0	421
28	1	0	0	1	18	28	1	0	0	8	64	11	0	4	100	168	114	50	22	0	0	0	0	0	591
29	1	0	0	0	3	0	0	0	0	0	1	2	0	0	0	3	0	0	1	0	1	0	0	0	12
30	1	0	0	0	0	0	0	0	0	0	2	1	1	11	101	140	250	56	0	2	42	37	76	115	837
31	42	4	0	0	0	0	17	25	4	11	13	70	104	22	26	19	17	15	7	1	42	49	36	0	524
KWh	1212	983	880	749	725	618	405	357	318	330	501	695	964	835	1207	1835	1778	1494	1251	1301	1260	1407	1395	1420	23919

Gilgit **September 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	1	0	0	0	0	0	0	0	0	7	12	3	3	8	21	3	9	2	11	0	4	98	42	46	272
2	94	20	4	0	0	0	0	0	0	6	9	2	4	7	144	146	46	20	1	2	1	24	2	24	554
3	17	23	0	1	0	0	0	27	87	39	6	4	5	3	6	27	76	19	0	0	0	0	0	4	346
4	77	112	19	44	89	145	64	10	4	2	9	22	20	20	6	25	53	29	20	24	24	37	15	1	873
5	2	2	0	1	0	0	0	0	0	2	3	10	36	34	146	67	26	25	37	196	211	114	69	21	1001
6	13	12	1	0	17	7	8	3	20	31	26	7	28	46	77	41	37	21	8	29	62	62	39	15	607
7	20	14	30	36	31	6	0	0	0	11	9	13	21	32	8	39	127	109	85	119	148	128	98	123	1207
8	80	68	45	30	16	1	3	8	1	3	2	18	1	3	21	49	35	5	49	106	12	6	7	38	607
9	89	0	119	51	14	6	7	6	0	0	2	2	32	6	113	105	34	1	171	178	175	119	157	111	1498
10	64	55	64	67	72	55	56	44	53	39	20	26	1	2	4	1	10	2	7	18	58	2	0	0	719
11	0	7	3	5	9	0	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	28
12	1	0	0	0	0	1	6	1	0	0	16	158	150	136	115	87	38	45	64	48	18	1	0	0	883
13	0	0	0	0	0	0	0	0	0	0	0	0	12	16	16	47	79	70	13	18	42	25	0	0	339
14	0	1	0	0	0	0	0	0	0	0	0	0	1	1	112	16	132	14	20	18	2	0	0	0	318
15	0	1	0	0	0	0	0	0	0	0	2	0	1	0	4	3	68	112	177	126	42	9	0	0	545
16	0	0	0	0	0	0	0	0	1	0	6	28	39	8	11	32	137	159	82	23	40	27	9	20	621
17	15	5	11	9	1	0	0	0	0	1	0	0	8	17	45	17	25	24	133	240	147	61	2	0	763
18	0	0	0	0	0	0	0	0	0	3	4	1	2	30	5	9	35	11	0	2	33	34	26	27	221
19	9	2	0	0	0	0	0	4	11	3	0	0	0	19	81	9	14	95	11	0	0	0	0	0	259
20	0	41	49	19	0	0	0	0	0	0	0	0	1	16	99	82	5	12	0	1	1	0	0	0	326
21	1	4	22	17	13	1	1	8	33	72	119	35	29	0	0	6	74	41	24	119	184	64	2	33	903
22	43	72	89	111	119	119	178	125	94	65	45	52	115	145	62	42	48	100	137	98	18	17	2	15	1908
23	30	0	0	0	0	1	0	0	0	0	0	5	106	58	45	34	26	7	5	4	1	1	41	85	450
24	98	115	72	33	41	18	10	16	5	16	12	12	11	12	4	19	41	80	72	60	46	35	55	36	918
25	30	28	24	15	9	9	3	5	1	0	0	0	0	0	0	3	0	0	139	158	113	90	37	14	678
26	6	3	8	1	60	58	23	4	0	0	0	0	6	25	12	14	26	41	9	8	20	87	20	2	429
27	30	36	17	18	6	0	0	0	0	0	2	2	9	0	7	78	194	170	180	106	8	141	156	127	1288
28	64	125	67	4	87	38	13	0	0	3	119	111	59	4	11	4	4	16	96	169	93	21	12	42	1163
29	51	90	63	76	55	64	57	78	69	57	48	25	24	36	34	44	9	1	1	2	15	19	13	10	941
30	15	11	19	8	12	2	0	0	0	0	0	0	0	0	0	1	0	8	64	32	34	9	0	0	216
KWh	850	846	727	547	653	533	433	338	379	358	467	536	723	684	1212	1048	1407	1240	1616	1902	1550	1228	808	795	20881

Gilgit October 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	2	0	0	0	0	1	0	0	9	9	12	1	37	52	123
2	32	0	0	0	0	0	0	0	0	0	0	0	0	0	29	1	0	1	0	26	37	3	0	1	132
3	3	31	0	38	34	20	20	19	6	0	0	0	1	0	0	0	0	33	31	141	10	51	62	7	507
4	3	8	0	2	1	0	0	1	0	0	0	10	29	15	20	18	6	1	110	31	7	2	22	28	316
5	29	12	12	38	8	0	0	0	0	0	0	1	2	14	13	17	28	63	74	59	89	109	121	95	784
6	31	14	1	1	0	0	0	1	0	0	1	8	15	27	19	34	155	136	54	20	1	0	0	0	522
7	0	0	47	17	1	0	0	0	0	0	0	7	8	9	1	7	19	60	12	18	49	39	41	28	363
8	28	31	26	36	22	18	26	28	27	20	1	2	3	2	0	12	196	158	81	26	0	0	9	1	753
9	28	0	25	24	152	135	42	34	8	0	3	5	15	10	4	10	0	17	6	0	1	5	1	2	528
10	0	0	0	0	0	1	0	0	0	0	0	1	0	0	6	1	1	2	0	115	37	1	0	0	167
11	0	1	0	0	0	1	0	0	0	0	0	0	0	0	12	9	2	0	0	6	14	59	57	30	192
12	25	24	15	10	10	1	0	0	0	0	3	1	0	0	0	0	11	18	4	1	0	0	0	0	123
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	32	20	24	85	111	55	47	29	5	2	409
14	24	85	166	47	3	0	0	0	0	4	23	12	1	0	23	26	121	30	6	2	0	45	103	51	773
15	39	112	13	1	0	101	5	0	10	0	0	1	2	2	27	55	49	35	0	2	0	1	0	0	455
16	0	0	4	7	18	11	1	0	0	0	0	0	0	1	1	0	0	0	0	0	19	45	45	30	182
17	13	0	2	21	8	7	0	0	0	0	0	0	4	2	1	5	24	0	1	6	1	2	0	0	97
18	2	2	40	8	0	15	15	1	17	5	0	0	0	0	1	0	0	6	1	0	0	0	0	0	115
19	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	3	0	21	81	77	6	0	0	1	194
20	0	0	0	0	0	0	0	0	0	0	0	0	0	4	26	5	0	2	2	0	2	4	21	51	121
21	25	0	0	1	12	24	62	13	0	27	112	152	123	61	3	3	1	3	2	17	28	15	19	32	735
22	33	42	38	31	38	29	0	0	24	72	93	72	72	21	8	17	89	25	8	4	5	0	0	0	722
23	5	23	4	6	12	6	6	10	10	22	7	0	0	0	7	0	1	1	6	1	0	0	34	89	253
24	68	106	85	68	46	41	26	36	64	46	20	12	2	0	0	5	5	0	1	59	41	1	0	18	752
25	48	14	1	0	0	0	0	0	0	0	0	0	0	0	6	2	2	1	2	31	30	18	80	11	247
26	0	0	0	0	0	0	0	0	0	3	0	3	13	20	33	35	9	9	0	0	0	0	0	0	128
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	3	13	19
28	14	8	4	2	9	3	3	2	0	27	47	10	4	26	38	21	28	121	128	33	4	0	0	0	534
29	0	0	0	2	2	0	0	0	0	0	1	0	1	0	1	24	80	17	0	0	0	0	0	0	128
30	0	0	0	0	0	42	41	21	0	0	0	0	0	0	0	0	0	0	2	2	2	0	0	0	110
31	0	0	0	0	0	0	3	19	40	28	17	18	6	7	1	1	0	0	0	1	3	0	0	0	144
KWh	452	514	486	362	378	458	251	187	205	258	331	316	301	222	315	333	851	849	733	741	447	431	664	546	10629

Gilgit **November 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	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	3
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	3
3	0	0	0	0	0	1	0	0	0	0	6	10	1	0	1	14	3	0	0	0	0	0	1	0	38
4	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	8
5	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	2	3	0	0	10
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	3
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
8	0	0	0	0	0	0	0	5	0	19	34	2	31	17	30	31	23	53	24	7	5	0	1	0	282
9	0	0	7	7	0	0	10	18	6	7	0	1	19	5	0	0	5	0	0	1	0	0	0	0	87
10	0	0	0	0	0	0	0	0	0	2	11	8	22	18	33	22	13	5	0	0	21	29	5	0	190
11	0	1	13	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	18
12	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	4
13	0	1	1	0	4	7	11	26	34	21	5	17	9	8	7	6	8	14	11	11	19	7	0	0	227
14	1	3	1	0	0	0	0	0	0	0	0	0	0	5	7	0	0	0	0	0	0	0	0	0	19
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	3
16	1	0	0	0	0	0	0	3	0	1	0	0	6	5	1	0	0	0	1	0	0	2	16	1	37
17	2	12	0	0	0	0	0	0	0	0	0	0	0	4	7	16	42	19	6	2	0	1	2	1	114
18	0	0	0	16	2	0	0	0	0	0	0	0	0	0	0	2	0	0	1	0	0	0	0	0	22
19	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1	5	17	21	0	0	0	0	46
20	1	0	0	1	50	106	127	16	0	0	0	2	2	0	0	0	0	0	1	0	0	0	0	0	307
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	3
22	0	0	0	0	0	0	1	0	1	0	0	0	0	0	4	0	0	0	1	2	0	0	1	0	11
23	0	0	0	0	0	0	0	0	0	0	0	2	2	0	1	1	0	0	0	1	1	0	0	0	9
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	1	0	4
25	0	0	1	1	0	0	0	0	0	5	4	8	2	2	1	0	0	0	1	3	0	7	2	19	57
26	32	3	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	40
27	0	0	0	0	0	0	0	0	1	0	0	0	0	3	0	0	0	0	12	32	11	0	0	0	62
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2
29	0	0	0	0	0	0	0	0	0	0	4	2	7	2	0	0	0	0	0	0	0	0	0	0	15
30	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	3
KWh	6	5	16	3	58	116	141	43	35	22	13	31	26	26	30	25	14	21	36	42	48	43	11	3	814

Gilgit **December 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	5	12	12	3	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2	0	1	0	39
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	3
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	1	0	2	0	6
4	0	2	0	0	1	1	0	0	0	0	1	18	7	1	1	0	0	0	0	0	0	0	0	0	36
5	0	1	0	0	0	0	1	0	0	0	6	4	0	2	0	12	49	25	1	22	23	4	13	77	239
6	60	51	57	15	21	17	20	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	244
7	0	0	0	0	1	0	0	0	0	0	0	0	3	8	6	7	2	10	22	26	26	20	19	19	171
8	23	27	30	33	62	93	91	63	55	77	69	60	36	12	5	2	1	0	0	2	0	0	0	1	742
9	0	0	0	2	3	0	0	0	0	0	8	7	1	3	0	2	0	0	0	0	0	0	0	0	28
10	0	0	0	0	0	0	0	0	0	0	1	0	0	2	1	2	0	3	1	9	18	3	0	0	40
11	2	0	0	0	1	3	41	51	80	8	0	0	13	28	24	6	0	0	0	0	0	0	0	0	259
12	0	1	1	0	0	0	0	9	36	41	41	27	18	17	19	6	4	9	8	19	16	19	15	20	323
13	12	14	14	18	34	34	33	10	13	12	12	20	12	12	2	0	0	0	0	0	0	0	0	0	252
14	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
15	0	0	0	0	4	0	8	9	8	3	0	0	0	0	0	1	0	0	0	0	0	0	0	0	34
16	0	0	0	0	0	0	0	0	0	0	0	0	0	9	2	0	0	0	0	0	0	1	0	0	13
17	0	0	0	0	4	0	16	22	31	48	51	37	15	1	0	0	0	0	0	15	22	22	29	28	343
18	38	38	38	39	31	26	28	24	28	31	22	15	6	7	2	0	5	0	0	1	0	0	0	0	380
19	0	0	0	2	11	22	22	19	2	15	27	11	4	1	1	0	0	0	0	0	0	0	0	0	137
20	0	0	0	0	0	2	8	12	12	19	32	19	8	2	5	21	26	29	36	51	67	27	11	12	400
21	10	40	27	11	2	0	4	0	0	8	3	3	0	0	1	2	1	4	2	0	1	1	0	0	121
22	14	58	69	74	80	90	65	65	90	111	144	112	75	72	53	30	18	15	21	28	32	39	40	58	1452
23	42	47	31	44	77	72	72	85	119	98	89	38	26	29	15	26	24	19	26	26	36	30	31	26	1129
24	20	23	32	16	24	23	10	0	1	4	2	3	1	1	32	21	18	0	0	0	0	32	0	4	267
25	10	2	12	24	24	25	31	24	20	17	27	31	25	16	3	0	0	2	0	0	27	0	0	0	322
26	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	3	1	1	0	8
27	0	0	0	0	0	0	0	0	0	0	0	0	1	4	2	3	0	0	3	9	17	20	18	26	105
28	22	19	17	17	19	30	36	24	41	15	28	17	19	14	7	6	0	0	1	0	0	0	0	0	332
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	1	0	0	0	0	0	0	0	1	8
30	0	0	0	0	0	27	51	17	22	40	23	15	10	3	8	0	2	19	26	26	34	45	39	30	437
31	31	26	48	62	59	58	61	65	82	75	113	109	85	32	40	26	37	32	29	42	65	52	44	49	1322
KWh	287	354	389	369	459	525	598	502	643	623	702	549	367	278	237	177	190	168	177	279	390	317	265	353	9195