

ZENI WIND POWER (PVT) LTD.

SITE SELECTION STUDY

FOR

50 MW WIND FARM

Submitted by:



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EXECUTIVE SUMMARY

INTRODUCTION

Zeni Power intends to set up a 50MW wind farm in the Wind Corridor near Karachi. As a first step, they want to identify the suitable site location for the wind farm from amongst the Nooriabad / Jhimpir / Dhabejee and Gharo areas. This Report addresses the results of the study for which several visits were undertaken to various Sites offered by landowners (to Zeni Power) in these areas.

The wind farm is proposed to be set up by installing 1.5 MW turbines, which are typically installed at 80 m heights.

This Report addresses the following key considerations for each site and the recommendations are based accordingly:

- Quality of wind and Energy yield.
- Proximity to transmission line and rehabilitation / upgrade of existing lines.
- Terrain and Access to site.
- Site orientation to prevailing wind direction.
- Soil conditions / Civil works costs.

SITES VISITED

Upon identification of various sites (by Zeni Power), visits to these sites were undertaken. In total 5 Nos. of sites were visited, 3 Nos. in Nooriabad area, with one each in Dhabejee & Gharo.

The aim & purpose of this exercise was to generally review the terrain & access roads, leading to these sites. Co-ordinates were collected for the purpose of marking the plot area onto Google earth.

This collection of information was necessary for the following reasons:

- AEDB has to confirm, the plot falls within the wind corridor, for wind guarantee confirmation.
- Turbine Suppliers would require this, for micro-siting of wind turbines, in the plot area.

Details of sites visited are hereunder:

S. No.	Site	Location	Date Visited
1.	Site No. 1	Nooriabad/Jhampir *	11 th October, 2008
2.	Site No. 2	Nooriabad/Jhampir *	27 th October, 2008
3.	Site No. 3	Nooriabad/Jhampir *	27 th October, 2008
4.	Site No. 4	Gharo (Coastal) **	5 th November, 2008
5.	Site No. 5	Dhabejee (within Nooriabad/Jhampir *)	12 th November, 2008

* Nooriabad/Jhampir/Dhabejee are considered the same areas, with reference to Benchmark wind speeds.

** Gharo/Khuttikun/Bhambore are considered the same areas, with reference to Benchmark wind speed.

- **Site No. 1 & 2**

Visit to Site No. 1 area (identified by Zeni Wind Power) was conducted on the 11th of October 2008 to acquire coordinates (four corners) of the plot of land owned by a local landowner. The measured area works out to be around 1200 acres.

The Site No. 2 measures around 800 acres and the landowner has offered additional 400 acres, required for the wind farm.

The plot is adjacent to Site No. 1, and can be accessed from the same pathway leading to Site No. 1.

See Figure-1, for site location.

- **Quality of Wind and Energy Yield**

These two sites are within the Jhampir area, and the applicable Benchmark wind speed from AEDB.

Estimated energy yield is in the range of 130-135 GWhr/year, for a 50 MW Wind Power Farm.

- **Proximity to Transmission Lines**

Both sites can be connected to 132 KV transmission line. The distance appear to be within limits (50 Km) defined in NEPRA's Grid Code.

The lines are reportedly in good order.

- **Terrain and Access to Site**

Generally the area (Site No. 1 & 2) is flat but will require clearing and grubbing of the localized bushes and scattered mounds. Agriculture plots were also present within the site, thus, indicating the fertile nature of the area.

The site is approximately 140 km from the city of Karachi. It is close to the Nooriabad industrial area, which is located on the super highway. From the highway the site is 23 Km southwards, 17 Km of which consist of asphalt road and 6 Km is a jeepable track.

- **Soil Conditions / Civil Works Cost**

Soil conditions at Site No. 1 & 2 are good from strength point of view and will result in reasonable cost for miscellaneous civil works.

- **Site No. 3**

The coordinates of this site were provided by Zeni Power. The plot is behind what is called Essa Cement Factory located on the main super highway approximately 10 km away from the Nooriabad link road to Site No. 1 & 2.

A continuous series of hills stand between the prevailing wind direction (southwesterly) and the plot area. The site, therefore, is not considered for locating Zeni Power Plant. Hence, is not being considered for any further analysis.

- **Site No. 4**

The site located in Gharo area, measuring 1400 acres, and is generally considered (by AEDB) to be the most suitable area, considering the Benchmark wind speeds (on average wind speeds are higher by 5% from 30 meters to 67 meters).

See Figure-1, for site location.

- **Quality of Wind and Energy Yield**

This site falls within the Khuttikun/Bhambore, and the applicable Benchmark wind speed from AEDB.

The Benchmark Wind Speed (Wind Guarantee) by AEDB is given at 30 meters, 50 meters, 60 meters, 67 meters & 80 meters.

The increased wind speeds for Gharo are higher by 10% at 30 meters, 6% at 50 meters, 4.5% at 60 meters & 3% at 67 meters. The wind speed remains the same at 80 meters, i.e. 7.3 meters/sec.

Comparison of Benchmark wind speeds provided for Jhimpir/Nooriabad and Gharo areas, show that the latter appears to have an edge over Jhimpir. However, for turbines in the range of 1.5 MW installed at 80m height, there will be no difference as the wind speed remains the same.

Estimated energy yield is in the range of 130-135 GWhr/year, for a 50 MW Wind Power Farm, since the Benchmark wind speeds are the same at 80 meters, for both Jhimpir & Gharo.

A brief study has been carried out by ZEL, to compare Energy yields by considering installation of smaller wind turbine (250 KW, with hub height of 30 meters). The results indicate much lower Energy yield of around 80-85 GWhr./year compared to 130-135 GWhr./year for 1.5 MW turbines. Total capacity for both being 50 MW.

▪ **Proximity to Transmission Lines**

Power from Site No. 4 can be connected to 132 KV transmission lines, which falls within the limits given in NEPRA Code, which is 50 Km, for 132 KV line.

This line is reportedly in a poor condition and requires rehabilitation & upgradation. The operator of the line (HESCO) has plans to undertake this work.

▪ **Terrain and Access to Site**

The area is generally leveled and provides flat terrain in the vicinity of the wind farm. This will require minimal area preparation works. However, since the land is located very near to the coastal area, wind turbines area protections shall be required to avoid flooding during high tides. Existing site condition is such that it is influenced by the tidal fluctuations. Small agriculture plots were also present within the site.

The visited site is located approx. 95 Km from Karachi. The route to the site consists of approximately 62 Km along the National highway. A link road on the right side of highway goes to Mirpur Sakro. Access to the site lies approximately 12 Km on this link road. There is a 9 Km long single track asphalt road, followed by an 11 Km jeep able track. This track will require leveling and compaction for the access and transportation purposes.

▪ **Soil Conditions / Civil Works Cost**

Soil conditions at this site are quite weak and will require pile foundations for wind turbine and other miscellaneous civil facilities. Civil works will therefore be quite high at this site.

FIGURE-1



LOCATION OF SITES

- **Site No. 5**

The site is located in Dhabejee, measuring around 500 acres and the landowner has promised to provide the additional 700 acres. The terrain is generally rough and is not flat.

See Figure-1, for site location.

- **Quality of Wind and Energy Yield**

This site is within the Jhimpir area, and the applicable Benchmark wind speed .

Estimated energy yield is in the range of 130-135 GWhr/year, for a 50 MW Wind Power Farm.

- **Proximity to Transmission Lines**

Dhabejee is close to the National Highway. Several transmission lines were seen, when this side was visited. The distance between these lines from the Dhabejee site is within limits.

The size of transmission lines would be confirmed in the Detailed Feasibility Report.

- **Terrain and Access to Site**

The area is not leveled and has scattered hilly locations that will require land terracing of the wind farm, since a common finish grade will require expensive efforts in terms of cost and time. The terrain can be described as a rugged one with rock outcrops. This may pose problems for area clearing and grubbing. Small agriculture plots were also present within the site.

The visited site is located approx. 54 Km from Karachi and lies on the left side of National highway. From the highway, the site is 6 Km away which consist of a jeepable track. This track will require leveling and compaction for the access and transportation purposes. There is an overhead railway bridge, approximately 3 Km away from the highway.

- **Soil Conditions / Civil Works Cost**

Soil conditions at this site is quite similar to Site No. 1 & 2 in terms of strength. Civil costs will therefore be same as that for Site No. 1 & 2.

ESTIMATED ANNUAL GROSS REVENUES

Gross annual revenue, at 13¢/KWhr (latest levelized tariff for wind power plant) comes out to be in the region of USD 17.5 Million.

More accurate estimates of gross revenues will be worked out when main feasibility work is undertaken.

CIVIL WORKS COST BASIS & DETAILS

Since soil conditions and length of access roads are similar for Jhimpir and Dhabejee, therefore, for civil works cost comparison, these sites are grouped in one category. The cost is generally driven by the soil conditions, however, site proximity and access roads also contribute, but to a lesser extent. Cost of civil works is based on 33 Nos., 1.5 MW wind turbines laid out in 1200 acres area. For foundations, bearing capacities at Jhimpir/Dhabejee have been considered in the range of 2-2.5 Ton/Sq.ft, while for pile foundation 90 Tons (compression) and 30 Tons (tension) capacities have been used. Based on these assumptions, cost of civil works at Gharo is US\$ 18.09 Million and US\$ 10.34 Million at Jhimpir/Dhabejee. Cost at Gharo is 75% higher than Jhimpir/Dhabejee due to weak soil conditions, coastal environment and remote location of site.

RECOMMENDATIONS

As the wind speed is the same at 80m height for both the Gharo and Jhimpir/Dhabejee/Nooriabad areas, the energy generation is the same. Therefore, the cost of civil works, accessibility, proximity to grid system etc. will be the governing criteria. From these standpoints the recommended sites in the order of preference are:

- Dhabejee Site, provided the selected plot is relatively flat like the Nooriabad sites, the proposed plot is a rough terrain in general with many rocky outcrops. The advantage over the Nooriabad sites is its proximity to Karachi.
- Jhimpir/Nooriabad Sites, the area is very similar to Dhabejee in terms of Soil Characteristics and wind quality.
- Gharo Site, this site will incur high civil works costs while the energy generation will remain the same for the 1.5 MW turbines being considered.

A brief study has been carried out by ZEL, to compare Energy yields at Gharo by considering installation of smaller wind turbine (200 Nos., 250 KW, with hub height of 30 meters). The results indicate much lower Energy yield of around 80-85 GWhr./year compared to 130-135 GWhr./year for 33 Nos., 1.5 MW turbines. Gross capacity for both being 50 MW. Moreover, the cost of civil works for 200 Nos. small capacity wind turbines may go up compared with 33 Nos. higher capacity turbines as at Gharo, extensive amount of piling work is anticipated resulting in higher cost.

Hence, smaller turbines appear to be not suitable for Gharo site.

Final approval of site must be obtained from AEDB, confirming that the location falls within the applicable wind corridor and the benchmark wind speeds.

It is recommended that installation of wind must be considered by Zeni Power after approval from AEDB.