

# Wind Resource Mapping in Pakistan IMPLEMENTATION PLAN

MARCH 2016



This report was prepared by [3E](#), under contract to [The World Bank](#).

It is one of several outputs from the wind **resource mapping component of the activity “Renewable Energy Resource Mapping and Geospatial Planning – Pakistan”** [Project ID: P146140]. This activity is funded and supported by the Energy Sector Management Assistance Program (ESMAP), a multi-donor trust fund administered by The World Bank, under a global initiative on Renewable Energy Resource Mapping. Further details on the initiative can be obtained from the [ESMAP website](#).

This report is an interim output from the above-mentioned project. Users are strongly advised to exercise caution when utilizing the information and data contained, as this has not been subject to validation using ground measurement data or peer review. The final output from this project will be a validated Pakistan Wind Atlas, which will be published once the project is completed.

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**ESMAP WIND MAPPING PROJECT  
PAKISTAN**

IMPLEMENTATION PLAN 20150601



## ESMAP WIND MAPPING PROJECT PAKISTAN

IMPLEMENTATION PLAN 20150601

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## DOCUMENT REVIEW HISTORY

Version #	Version date	Author (Company and/or name)	Summary of changes
V1	20150214	LDW (3E), Areeb Hussain (SES), NGU (3E), GDV (3E)	First draft
V2	20150601	Guillaume De Volder (3E)	Final draft

## 1 INTRODUCTION

In the framework of the wind mapping exercise for Pakistan, a mesoscale wind map has been calculated by the technical university of Denmark (DTU) (cf. Figure 1).

The latest methodology developed at DTU Wind Energy uses the Weather Research and Forecasting (WRF) model in a dynamical downscaling mode to produce mesoscale analysis. It is this method that is employed in this project.

Based on this preliminary wind mapping, areas for ground based wind measurements for validation purposes have been identified.

DTU identified 10 interesting areas where a mast would be useful for the validation (cf. Figure 1, blue areas). In parallel, AEDB identified potential areas for wind energy projects based on a previous wind map generated in 2006 by NREL (Figure 1, white areas).

Although the old NREL map is not as accurate as the new preliminary DTU map, we have observed that the areas identified by AEDB are most often overlapping with the areas from DTU, so that no compromise should be needed between the areas.

AEDB also insisted that there is budget for additional masts, which should be used in the framework of this study. 3E has therefore identified a long list of potential sites. A site visit mission has been carried out, in order to identify the 12 best sites for the installation of the masts (short list).

The present report details the selected sites for implantation of met mast and the implementation plan for the measurement campaigns (land leases and permits, mast and instruments specifications, maintenance plan, ownership, insurance, planning and costs).

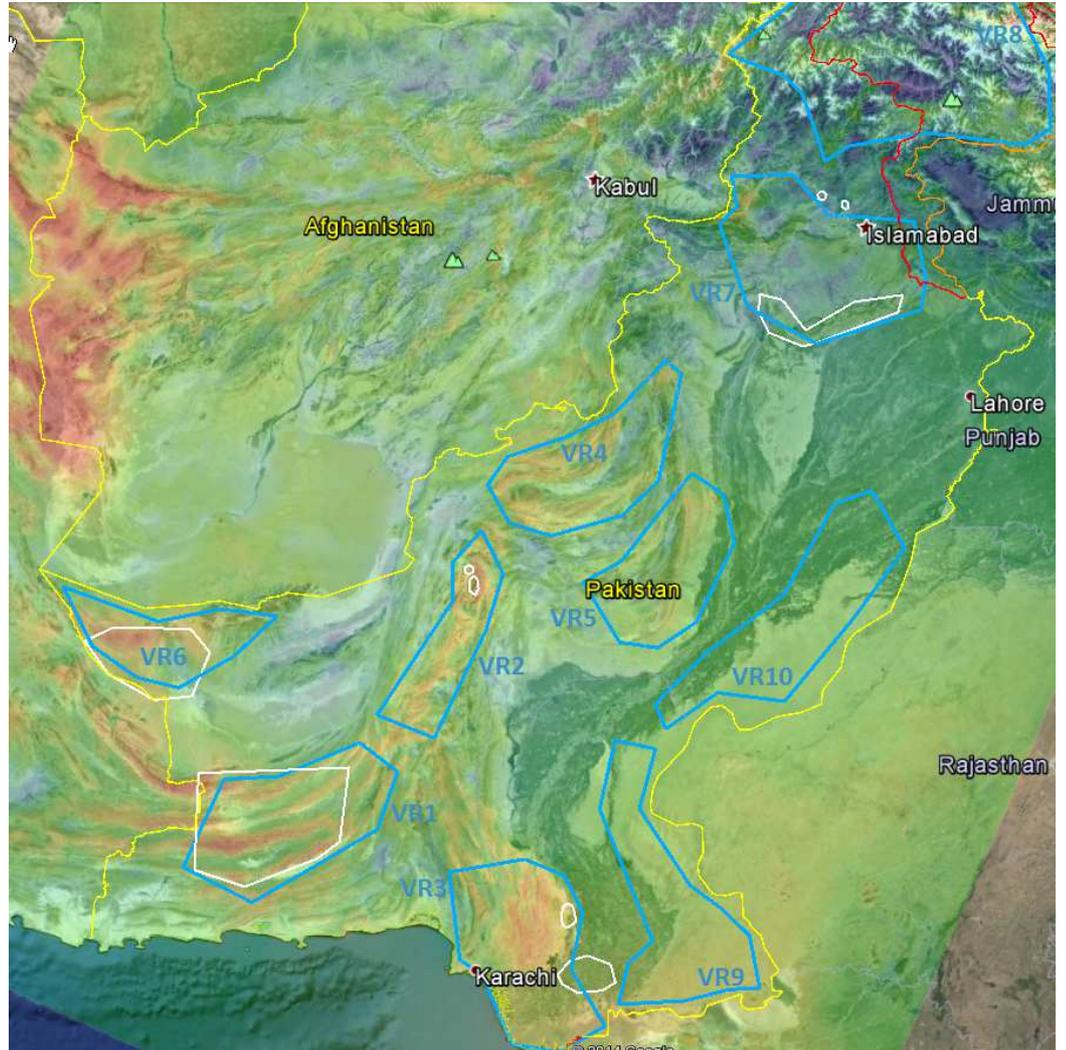


Figure 1: Verification areas as proposed by DTU for validation of the meso-scale wind map (blue areas named VR1 to VR10), and zones suggested by AEDB based on 2006 NREL map (white areas)

## 2 LONG LIST OF SITES

DTU identified 10 interesting areas (VR1 to VR10), where ground-based measurements could serve for the validation of their mesoscale model. 3E first carried out a desktop study in order to identify potential sites for mast locations inside each of these zones, to be further assessed based on site visits.

Unfortunately, it was not possible to work this way as finding available land with clear ownership is a difficult task throughout Pakistan. The local authorities were thus approached to help the team identify suitable available land within the land owned by the government. This will also reduce the costs for land lease as government land will be free of use for met mast installation within the context of this World Bank Project.

In most cases, the team had to meet the local authorities in their offices, explain the reason of their visit and the purpose of the study. After this, the local authorities would take the team to potential areas that were assessed in view of mast installation.

Many places in tribal areas and in Balochistan Province could also not be envisaged due to potential security problems at the time of the study.

### SITE VISITS

Contact has been made with the local authorities in order to enquire for public land and site visits were then organised. An expert from 3E joined the first site visits. For safety reasons, 3E could only visit sites located in the province of Punjab, the rest of the sites being visited by the local partner SESI.

Each of the sites was technically evaluated against the following relevant criteria set by 3E and SESI:

- The area around the mast is homogeneous in terms of terrain elevation and roughness,
- The site is easily accessible for long trucks and heavy duty,
- The site is located close to dwellings in order to properly secure the equipment,
- The site is located inside or close to a region of interest for wind energy development:
  - High to moderate wind area
  - Close to electricity network and consumption centre (electrical load)

Based on these criteria, 44 sites have eventually been selected in the long list presented below. Each site was also assessed in terms of the above-mentioned criteria and a ranking of the sites helped identify the best sites for the short list presented further below (Cf. table in ANNEX A).

The details and pictures for each of the visited sites can be found in the separate site visit reports.

**Table 1: Selected sites for the long list**

Province	Site
Khyber Pakhtunkhwa	UET Jalozai Campus
Khyber Pakhtunkhwa	Preimer Sugar Mill, Mardan
Khyber Pakhtunkhwa	Misri Banda Village, Nowshera
Khyber Pakhtunkhwa	Do Nali, Haripur
Punjab	Q A Solar Park, Bahawalpur

Punjab	Gath Bairi, RYK
Punjab	Chakri, Chakwal
Punjab	Quaidabad, Khushab
Punjab	Mpur,BMP Post, Rajanpur
Punjab	Pull Chak Shakari, Rajanpur
Punjab	Karari Wala Rest House, Muzafargarh
Punjab	Anari, Near Bahria Town, DGK
Punjab	Kot Chajji, Jand, Attock
Punjab	Taunsa Barage
Punjab	Kala Gojran, Jehlum
Punjab	Solar Park NUST, Islamabad
Punjab	UET Balkasar, Chakwal
Punjab	Rakh Warhal Forest, Chakwal
Punjab	Wild life Check Post, Chakwal
Punjab	Khar Cho Daf, Ground, DGK
Punjab	BMP Post, DGK
Punjab	Near Rest House, Islamabad
Punjab	Shahbaz Pur, Pindigheb, Attock
Punjab	Water Storage, Islamabad
Punjab	Hill Top, Islamabad
Punjab	Public Park, Islamabad
Sindh	Shahabad, Thatta
Sindh	Tandu Ghulam Ali, Badin
Sindh	Mataru Khan Village, Mirpur Khas
Sindh	Zahidabad, Mirpur Khas
Sindh	Sataar Goth, Umarmkot
Sindh	Site 1, Kandhari, Sangharh
Sindh	Site 2, Kandhari, Sangharh
Sindh	30 km SuperHighway
Sindh	Farm 2, Mirpur Khas
Sindh	Jati, Thatta
Sindh	Location1, Farm 1, Mirpur Khas
Sindh	Location 2, Farm 1, Mirpur Khas
Sindh	PMA, Karachi
Baluchistan	BUIITEMS, Quetta
Baluchistan	Watra, Harnai

Baluchistan	Allah Dad, Kachh, Ziarat
Baluchistan	Kaust, Harnai
Baluchistan	Khur. Kachh, Ziarat



### 3 SHORT LIST OF 12 PROPOSED SITES

During the consultative meeting of stakeholders in Islamabad early April 2015, the site visit work was presented and it was agreed that the following 12 sites are selected for mast installation:

Table 2: Selected sites for the short list (approved)

Sr. No.	Site Name	Province
1	UET Jallozai Campus, Cherat	Khyber Pakhtunkhwa
2	Do Nali, Haripur	Khyber Pakhtunkhwa
3	Saroba, Chakri	Punjab
4	Quaidabad, Khushab	Punjab
5	QA Solar Park, Bahawalpur	Punjab
6	Gath Bairi, Rahim Yar Khan	Punjab
7	BUIITEMS, Quetta	Baluchistan
8	Kandiari, Sanghar	Sindh
9	Sataar Goth, Umarkot	Sindh
10	Tandu Ghulam Ali, Badin	Sindh
11	30 km Karachi – Hyderabad Super Highway	Sindh
12	Shahabad, Thatta	Sindh

For each of these sites, a short site description is given below with a representative picture of the site, together with the calculated wind roses (both in terms of frequency and energy) from a micro-siting exercise based on the LIB files calculated by DTU.

The locations of the 12 sites across Pakistan are presented in the image below.

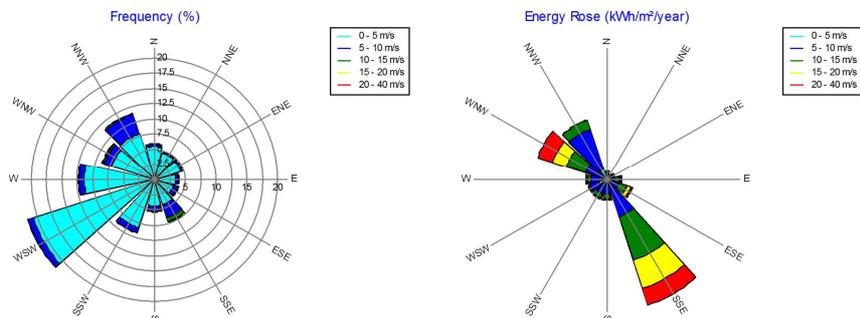


Figure 2: 12 selected sites for mast installation across Pakistan

### 3.1 UET JALLOZAI CAMPUS, CHERAT

Name of Site	UET Jallozai Campus, District Nowshehra
Coordinates	N 33°55'2.97", E 71°47'39.81"
Elevation	401 m
Terrain	Flat
Area	100 acres (404,686 sq. m)
Accessibility	Easily accessible by road

This site is located within the University of Engineering and Technology (UET) Peshawar, Jallozai Campus. The campus is newly constructed and very recently became operational. The site selected for wind mast installation is located at the western end of the campus near the boundary wall. The land here is flat, currently unused and no construction planned for at least 2 years. It is located about 400 m away from the nearest academic block. The soil type is muddy, with grass grown over it. There are scattered rocks that will not cause any problems for foundation preparation. The site is secure as it is located within campus boundary. The hills of Cherat, visible towards the South are about 15 km away.

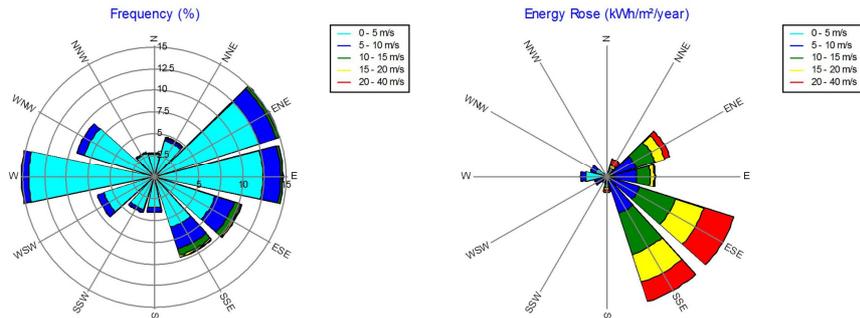


### 3.2 DO NALI, HARIPUR

Name of Site	Do Nali, District Haripur
Coordinates	N 33°58'41.68", E 73° 1'43.20"
Elevation	490m
Terrain	Flat
Area	15 acres (81,000 m <sup>2</sup> , approx.)
Accessibility	Easily accessible by road

This site is located on privately owned land mainly being used for fruit and vegetable farming. The mast installation location selected is about 70 m away from the access road. Some fruit trees of 5-7 m height are located about 150 m towards East. The terrain is completely flat and the soil is soft and muddy, suitable for foundation preparation. A storage barn is the only nearby construction located about 150 m towards South West. The area is safe from a security point of view and the houses of land owners are located about 300 m towards North of site.

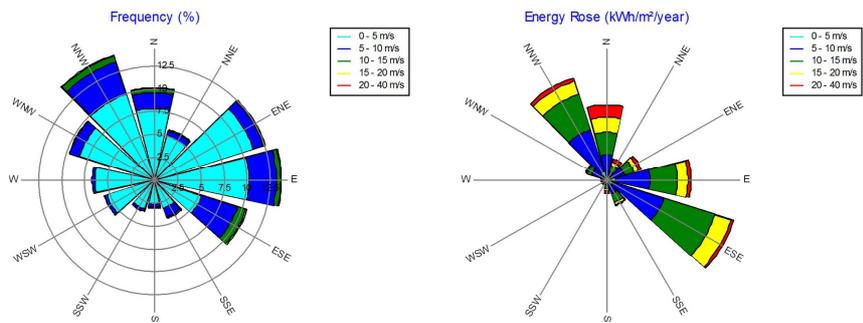
The team arrived at the site after dark therefore pictures could not be taken. Photographs of site will be taken on the next visit.



### 3.3 SAROBA, CHAKRI

Name of Site	Saroba, Tehsil Chakri, District Chakwal, Punjab
Coordinates	N 33°20'5.70", E 72°48'10.38"
Elevation	376 m
Terrain	Flat land With few trees
Area	3,775,998 square meters
Accessibility	Easily accessible by road

Large unused area of privately owned land located in Chakri. The land is enclosed by boundary walls and a security guard is present at all times at the site, making it safe and secure for wind mast installation. The terrain here is slightly uneven, but there are patches of flat land. A flat patch of about 100 m by 100 m, located 200 m away from the guard house, is suitable for mast installation. The soil type in this patch of land is of clay and is suitable for foundation preparation. A grid station is located about 350 m away from the site and the nearest population is about 2 km away. All factors considered, the site is suitable for wind mast installation.



### 3.4 QUAIDABAD, KHUSHAB

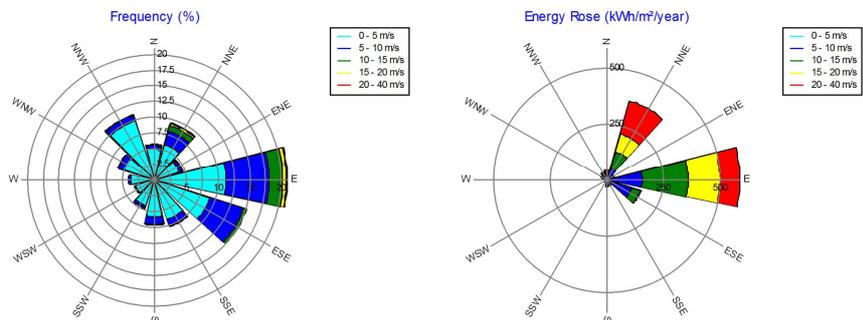
Name of Site	Block#6 Stadium, Tehsil Quaidabad, District Khushab
Coordinates	N 32°20'50.19", E 71°53'42.72"
Elevation	192 m
Terrain	Flat with no construction around.
Area	359 Kanals (3.6 km <sup>2</sup> )
Accessibility	Very easy by road

The Punjab Government owns very large land area here which they have marked for potential wind/solar projects development, although it is currently unused and there is no development foreseen in the near future.

The land has large flat area. It is also ideal for preparation of foundation as the soil is of clay type and will be easy to dig.

There is no construction nearby, with the nearest being a 132kV grid station 250m away.

A flat patch, 100 m away from the road was selected and shortlisted as suitable for wind mast installation.

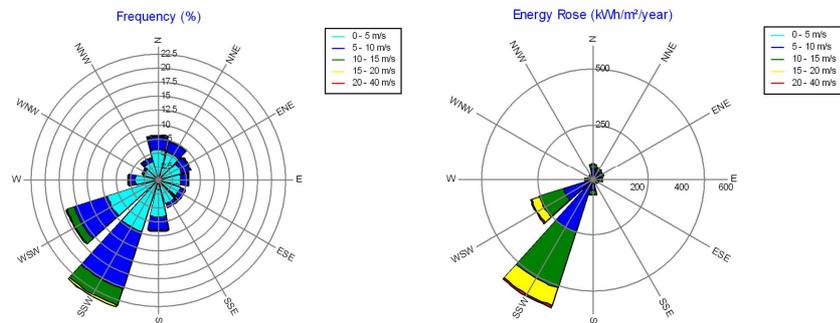


### 3.5 QA SOLAR PARK, BAHAWALPUR

Name of Site	QA Solar Park, District Bahawalpur
Coordinates	N 29°19'37.43"; E 71°49'5.26"
Elevation	119m
Terrain	Flat, desert land
Area	2 km x 0.5 km
Accessibility	Easily accessible because road has already been developed for Solar project

Over 15,000 acres of land has been dedicated for Solar PV Park construction by the Punjab Government. The park is named Quaid-e-Azam (QA) solar park. The park management has set up an on-site camp and towards the north of the camp there is a stretch of land about 2 km by 0.5 km which is marked as 'service area'. There is no construction on this stretch and no construction is foreseen in the near future.

The terrain here is flat desert land. Since it is located within the QA solar park premises, it is also secure. Site is therefore suitable for wind mast installation.



### 3.6 GATH BAIRI, SADIQABAD, RYK

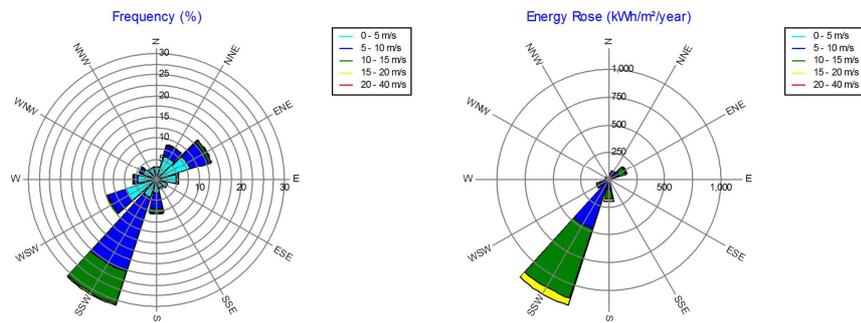
Name of Site	Gath Bairi (Army Camp) District Rahim Yar Khan
Coordinates	N 27°58'30"; E 70°7'56"
Elevation	73m
Terrain	Flat, desert land
Area	more than 2000 acres
Accessibility	Accessible by a 4x4 vehicle as there is about a 9 km path made through the desert which is not a proper road. Accessibility by truck will be a bit challenging but can be managed.

The site is located within the Cholistan desert, which is owned by the Punjab Government. The terrain is that of a typical desert, largely flat sandy soil with a few sand dunes.

The Pakistan Army has set up a camp within the desert at a location known as Gath Bairi. The army is pumping salty ground water from the surrounding areas of Rahim Yar Khan and Bahawalpur into a dried up river bed at this location. This operation serves the dual purpose of reclaiming the land being damaged by salt water and creating a defense against the Indian army as this water storage will prevent them from bringing in tanks from across the border. The operation has been going on for the last 18 years and the army has now managed to create a water reservoir about 104 km long.

A site located about 300 m away from the army camp and the edge of the water reservoir was deemed suitable for wind mast installation. The maximum width of the water reservoir is about 1 km. At the time of the visits there was very strong wind blowing in the area and the army personnel stationed there informed that this is normal and in fact wind speeds go higher than this. The army Colonel in charge of the site also volunteered security provisions for the wind mast.

The Punjab Energy Department representative, Mr. Iftikhar Randhawa also accompanying the team on this visit expressed great interest in setting up a wind farm development, similar to the solar park in Bahawalpur. He also informed that across the border, the Indian government has utilized the same desert land for wind farms and has already set up several thousand MWs.

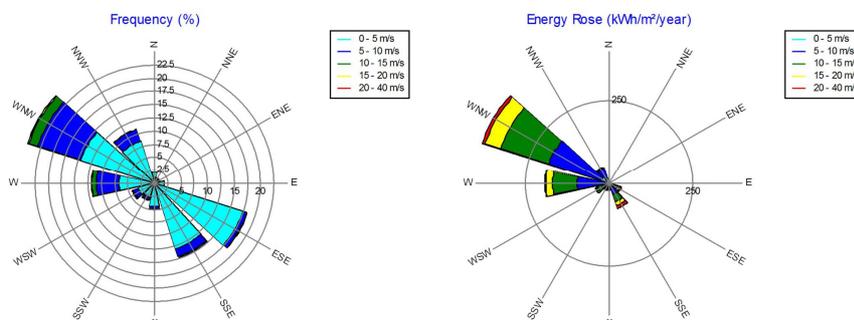


### 3.7 BUIITEMS, QUETTA

Name of Site	Baluchistan University of Information Technology Engineering & Management Sciences (BUIITEMS), Baleli Road, Quetta
Coordinates	N 30°16'15.91"; E 66°56'12.09"
Elevation	1580 m
Terrain	Flat with ridges more than 5 km away
Area	10 acres (404,686 sq. m)
Accessibility	Easily accessible by car or truck

This site is located within the campus of Baluchistan University of Information Technology Engineering & Management Sciences (BUIITEMS). The terrain is flat and soil type is clay with stones and pebbles, which is suitable for foundation and mast erection. Ridges are observed in several directions around the site but at distances of more than 5 km. There is a water tank about 30 m high located about 150 m away from probable mast location. More area is available to move the mast further away from the water tank, though the tank is located towards the Eastern end of the site and wind in the region generally flows from West to East, so it will not have too much effect on measurements. Academic blocks/buildings are located about 250 m away from the site.

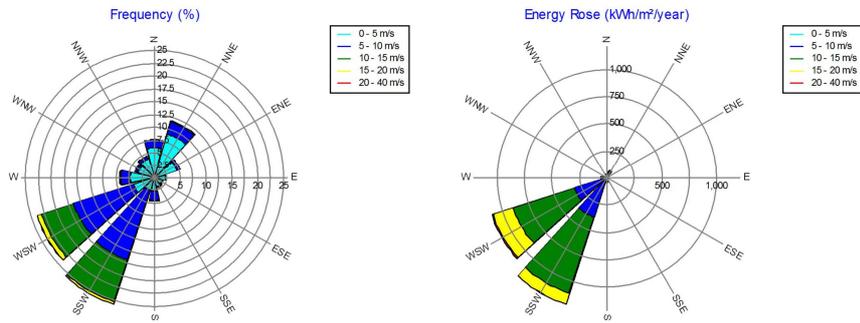
The site is secure as it is located within campus premises. Management on the University is keen on having mast installed in their campus for academic reasons. Considering all factors, the site is suitable for installation of wind mast.



### 3.8 KANDIARI, SANGHAR

Name of Site	Kandiari Site 1 (Village Khan Ghulam Qadir Narejo), Tehsil & District Sanghar
Coordinates	25°48.770'N 69°2.091'E
Elevation	28 m
Terrain	Flat
Area	2400 acres (9,712,455 sq. m)
Accessibility	Easily accessible by road

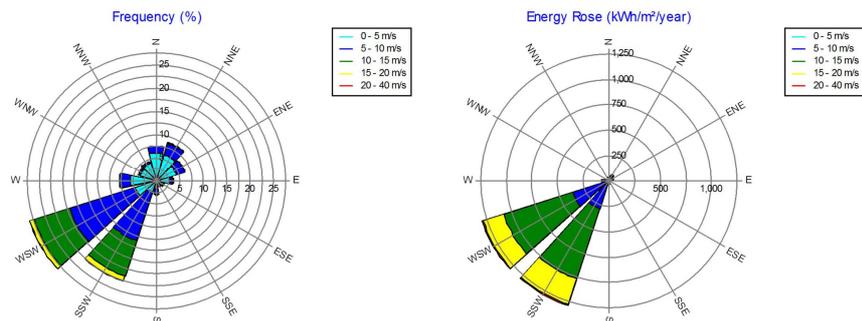
Privately owned land about 2400 acres in area. Flat terrain, easily accessible by road. Soil type is muddy, suitable for foundations. Nearby community at a distance of about 1 km. There is a group of trees 150 m towards South which are approximately 5-6 ft. (2 m) high, which is an acceptable distance.



### 3.9 SATAAR GOTH, UMARKOT

Name of Site	Sataar goth Chhachhro road, District Umar kot
Coordinates	25°20'56.22"N 69°45'39.12"E
Elevation	45 m
Terrain	Flat
Area	40 acres (161,874 sq. m)
Accessibility	Easily accessible by road

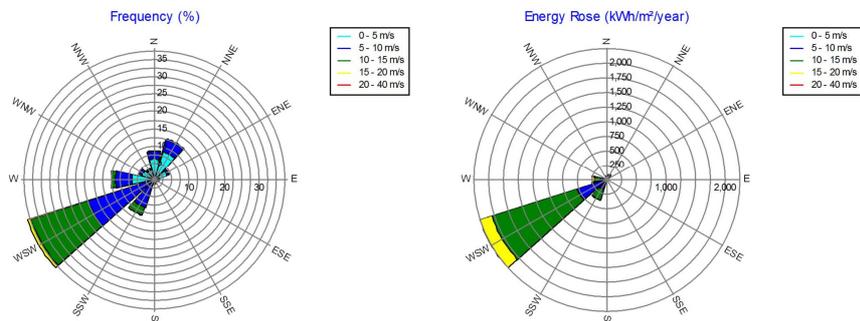
This site is located in the Thar desert, on privately owned land. The area available is sufficient for wind mast installation. The soil is sandy, typical of a desert, convenient for foundation preparation. There are two nearby houses about 150 m away from site. 11kV transmission lines are about 200 m away from site. The site is accessible by road about 200 m away.



### 3.10 TANDU GHULAM ALI, BADIN

Name of Site	Tandu Ghulam Ali City, Tehsil Matli, District Badin
Coordinates	25° 7'8.82"N 68°52'21.84"E
Elevation	16 m
Terrain	Flat
Area	100 acres (404,686 sq. m)
Accessibility	Easily accessible by road

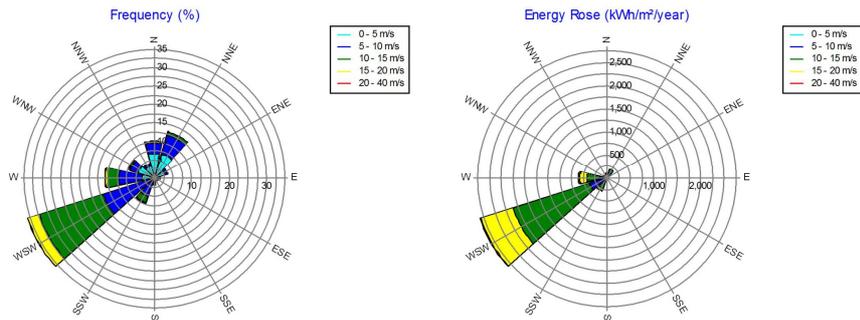
Privately owned, about 100 acres of flat land. There is no construction on the land; most of it is used for agriculture. The location selected for mast installation is unused, about 150 m away from the road. There is very little traffic on the road as it is within the private property, mainly used by the land owners. Soil type is muddy, suitable for foundation preparation. There are some trees about 5-7 m high, 500 m towards the South. The site is therefore suitable for installation of wind mast.



### 3.11 30 KM KARACHI, HYDERABAD SUPER HIGHWAY

Name of Site	Super Highway, Hyderabad
Coordinates	25° 18.084'N 68°04.644'E
Elevation	63 m
Terrain	Flat
Area	1000 acres (4,047,000 sq. m)
Accessibility	Easily accessible by road

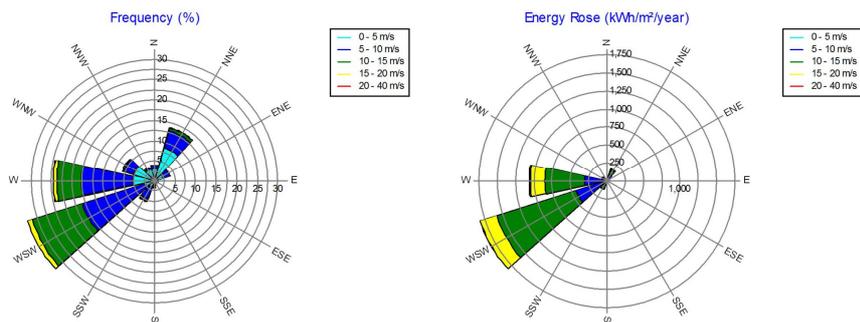
Site located about 30 km West of Hyderabad, along the Karachi – Hyderabad Super Highway. Privately owned land, flat terrain, the selected potential mast installation point is about 300 m away from the highway; however, this distance can be increased if needed as there is no restriction of land availability. Soil type is muddy, suitable for foundations. Site is suitable for installation of wind mast.



### 3.12 SHAHABAD THATTA

Name of Site	Shah Abad Village, Tehsil Sajawal, District Thatta
Coordinates	N 24°30'56.04" E68°11'19.14"
Elevation	17m
Terrain	Flat
Area	1200 acres (4,856,228 sq. m)
Accessibility	Easily accessible by car or truck

The site is located on a privately owned land. The land area is quite large; however the owner has identified an area of 1200 acres which is suitable for wind mast installation. The area is flat, easily accessible by road and soil type is mixture of sand and clay, which is suitable for foundation preparation. The land is not being utilized currently and there is no development foreseen. A farm house is located 250 meters away and a nearby community is about 2 km away. All things considered, the site is suitable for installation of wind mast.



#### **4 LAND LEASE OF SITES AND PERMITTING**

After securing the No Objection Certificate (NOC) for each shortlisted site, a formal agreement will be drafted, shared and negotiated with land owner (whether land ownership is private or governmental). Lease agreement will cover clauses including;

- The wind mast location detail including name of site, district, and exact coordinates
- Total area required for wind mast
- Initial duration of monitoring period
- Liability, if any
- Insurance
- Title to data and equipment
- Access to premises
- Payment detail (if applicable) with payment schedule.

## 5 MAST AND INSTRUMENTS SPECIFICATIONS

### 5.1 GENERAL OVERVIEW

The 80m high climbable meteorological guyed lattice tower and instrument assembly will comply with the IEC standard. The design of mast will be in accordance with ANSI/TIA/EIA-222 G or latest edition. The equipment will be installed according to the recommendation of latest IEC standards (IEC 61400-12-1).

5 Anemometers are foreseen on each mast: one at 20m, one at 40m, one at 60m, and two at 80m above ground level (a.g.l) and equipment will be MEASNET calibrated (calibration certificates to be shipped together with equipment).

Mast painting and lighting will comply with ICAO regulation (Annex 14). The masts will be adequately protected against lightening with a 2 m length rod extending above the main body of the mast, a bare copper cable of 70mm<sup>2</sup> running outside a mast leg and an adequate Earthing system for the mast and its guy wire anchoring. This will better protect the sensors against lightning.

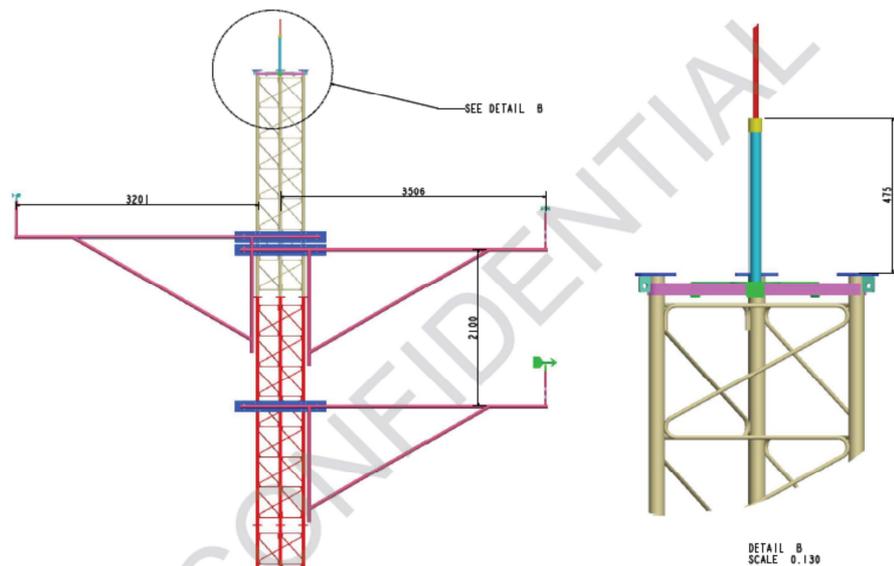
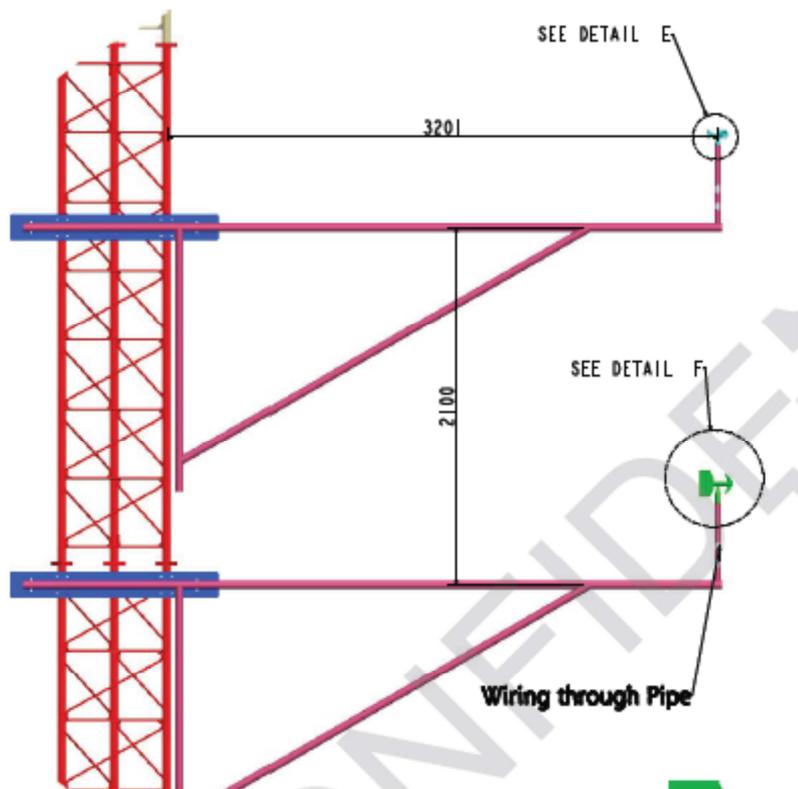


Figure 3 : Tower top arrangement for lightning protection

The tower and instrument assembly, booms and instrument spacing and mounting will be carried out in accordance with IEC 61400-12-1 standards.



**Figure 4: Boom arrangement**

Temperature, barometric pressure and humidity will be measured using calibrated instruments located at 3m to 5m a.g.l. A second calibrated temperature sensor will be installed and located close to the top of the mast, in order to identify the stratification of the wind profile that occurs on the terrain.

The masts will be powered by solar panels and have sufficient battery capacity for operation of the mast instrumentation and its aviation lights throughout the measurement campaign. An adequate local data storage capacity for at least one month of data will be foreseen. Data will be encrypted.

Anemometers are calibrated before the measuring campaign. They are calibrated according to the MEASNET Standards. All anemometers will be supplied with an individual calibration certificate. Data will be transmitted electronically through a cell phone connection [GPRS], or satellite connection (if cell phone coverage is inadequate) from each mast.

A separate Internet modem enables the data logger to connect to an internet service provider and to transfer a copy of the data by e-mail. The system will be tested after installation and before leaving the site and will work automatically.

The data are sent directly from the logger to an e-mail account and integrated in an online monitoring tool. The raw files and cleaned data (automated process) will be uploaded to the web site.

The online monitoring tool has a web interface that will be accessible by the authorized persons (to be decided by World Bank and Client).

Data measured at 1 Hz frequency will be averaged over 10-minute time intervals. For each anemometer, 10-minute mean wind speed, standard deviation, maximum and minimum will be collected.

## 5.2 EQUIPMENT SPECIFICATIONS

Each mast will be equipped with the following measurement equipment:

- 5 first class advanced anemometers
- 2 first class wind vanes
- 1 humidity sensor
- 2 temperature sensors
- 1 pressure sensor
- 1 Data logger
- 1 GSM/GPRS communication kit (modem)
- 1 Solar power supply

The selected data logger is Ammonit type "DL 16 Pro", or "Meteo 40" which will be powered by a PV panel.

**Table 3: Equipment specifications**

### First class advanced anemometers

- Wind transmitter first class advanced
- Meas. range: 0...75 m/s without heat.
- Cup star anemometer with optoelectrical scanner
- Acc. to MEASNET, CLASSCUP and IEC recommendation.
- Frequency output: 1082 hz / 50 m/s
- Starting value: 0,3 m/s
- Max. Load: 85 m/s
- Linearity: > 0,99997
- Delay distance: < 3 m
- Power supply: 3,3 V-42 VDC, type: 0,3 mA / 3,3 VSC
- According to the requirements, the two top anemometers will be of a different brand (one Thies First Class Advanced and one Vector First Class).

### Wind vanes

- Wind direction sensor first class
- Opto-el. Transmitter, classified as Class 1

### Humidity measuring sensor

- Hygro-thermo transmitter - compact
- Output: 0...1v/pt 100
- Rel. Humidity:
- Meas. range: 0...100 % rel. Hum.
- Output: 0...1 v = 0...100 %
- Meas. Element: capacitive sensor
- Deviation: +/- 2 % (Meas. range 5...95 % rel. hum. / 23 deg. C/1 m/s)

- Temperature:
- Meas. element: PT100 acc. DIN EN 60751
- 1/3 DIN class B

#### Temperature measuring sensor

- Temperature-transmitter-compact
- Output: PT 100
- PT 100 acc. DIN EN 60751 1/3 DIN class B
- Accuracy: +/- 0,15 k

#### Pressure measuring sensor AB100

- Piezoelectric, 600 .. 1100 hPa (0 ..5 V),
- protection IP64 when connector is looked,
- incl.installation in steel cabinet

#### Data logger dl 16 pro or Meteo 40

- Data logger DL16 Pro or Meteo 40
- The logger is equipped with Ethernet 10MB Interface for web and ftp use.
- The data communication and control can be done via Integrated usb - and / or Ethernet interface.
- Further RS422/485/232 interfaces can be used to add. sensors which serve serial interfacing. A comfortable 4 line LCD display together with a rotary switch serves for easy manual handling. An integrated SD card interface (fat 16), allows PC independing data transmission.

#### GSM/GPRS communication

- GSM modem socket for DL16 Pro or Meteo 40 incl. mounting kit
- GSM antenna / MC0114021 with reflector and adapter
- Coaxial cable 5 m, for connection M20 and DC antenna
- Traverse short, compact for mast diameter 48-102 mm

#### Solar power supply

- Solar panel 12V / 51W incl. mast mounting material 15,6 V / 3,28 A

### 5.3 INSTALLATION REPORT

An installation report will be provided for each measurement mast, including, but not be limited to:

- Exact location details, including coordinate system and Datum info. GPS readings at each anchor point or 4 points taken 25 m N, E, S and W of mast. All references will be according to geographical North rather than Magnetic North.
- Configuration drawing of the mast, including mounting height of each instrument above ground, length of booms, clearances etc.
- Layout of the mast showing alignment of each boom, the North arrow and expected main wind direction
- List of instruments including brand, model and serial numbers

- Useful pictures of mounting details of each instrument (picture from close of anemometer on mounting boom, showing the serial number of anemometer and a writing board or paper close by, on which the position of the anemometer on the mast is written (e.g."80m, NE"))
- Picture of data logger and logger cabinet
- At least two pictures of the mast during uplift
- Directional pictures of the area looking out from the mast position in 30° angles, starting from straight North (0°) and moving clockwise, to be taken after mast erection
- Picture of the fully erected mast including exact coordinates from where picture is taken
- Picture of the mast from the bottom looking upward with North at the top
- Calibration certificates for each instrument
- All data logger settings

## 6 MAINTENANCE PLAN

### 6.1 DATA MONITORING

#### *Data back-up*

An automated monitoring system will automatically collect the data on its dedicated and protected server. The data is stored on a secured on designated server.

The advantages are:

- A secure storage of all data
- Immediate check of data errors
- Immediate alarms to the client in case of problems
- Immediate access to all selected parties

#### *Quality check*

Collected data by the monitoring system will be automatically processed and analysed in detail using specific data filters and quality control points. The following control and verification will be done per mast for each measurement sensor:

- Data availability (capture rate);
- Data consistency (comparison of sensors at various heights, flat line, etc...);
- Data logger battery voltage condition (if available);
- Synchronisation with chosen time (i.e.: GMT0);

In case of data failure detected by the monitoring system, an e-mail will be automatically sent to 3E project manager with the following information:

- Errors description: sensors affected, duration, link to error detail.

### 6.2 DATA ANALYSIS AND REPORTING

A report will be prepared, summarising and documenting the measurement and terrain conditions at the measurement stations after installation of the masts. This site visit will take place after at least 3 months of operation of the measurement stations in order to allow for an initial data assessment exercise for identification of possible issues prior to the site visit.

The measured data of each mast is transferred by e-mail. Data will be stored in a wind database and uploaded on the web site. The measured data of the site will be processed and analysed, resulting in the following statistics:

- Data availability,
- Wind rose at the different measuring levels over the duration of the measuring period in sectors of 30 deg. (total 12 sectors)
- Average wind speed at the different measuring levels over the duration of the measuring period
- Wind speeds frequency distribution by sector (Weibull parameters)
- Diagram of the distribution of the wind speed frequency
- Diagram of cumulative probability
- Wind energy density at the different measuring levels over the duration of the measuring period

- Vertical wind profile on the basis of the measuring data
- Seasonal and diurnal variations in wind characteristics.
- Turbulence intensity as a function of the wind speed and wind direction at the different measuring levels and in sectors of 30 degrees
- Wind rose of energy content
- Encountered problems.

The measurement period for each site starts when the first valid data - as approved by World Bank- is received online on the required web site from all required measurement instruments on each site.

A measurement progress report will be delivered every 6 months, for 2 years.

The measurement will be considered complete if following conditions are fulfilled:

- Data recovery rate from each of the anemometers on each mast and wind vanes is above 95% over the measurement period (2 years).
- Data losses are seasonally dispersed. Lost data intervals above 12 consecutive days are not acceptable for any instrument.

If the data recovery rate of 95% is not fulfilled, the measurements will continue until the data coverage is considered being satisfactory using reasonable bankability considerations.

At end of the 24-month measurement period, one of the top anemometers on each mast will be recalibrated and the new calibration certificate will be provided, upon written agreement with the Client and acceptance of the extra cost involved..

### 6.3 MAINTENANCE AND INSPECTIONS

Maintenance of the mast and its equipment is foreseen throughout the entire measurement campaign. An inspection of the masts will be realized regularly to verify and adjust guy wire tensioning as necessary as well as the correct mounting and functioning of the instrumentation, notably in relation to the required data recovery rate and continuous compliance with the IEC 61400-12-1 standard. Timer settings are set to local standard time, and will be verified during inspections.

Situations will likely arise in which additional inspections are necessary. These unscheduled events are important, as they are usually in response to data loss. Examples include suspected sensor malfunctions found during the data validation process or an investigative response from site threatening weather-related events, such as gale-force winds or severe ice loading. To minimize potential data loss, these functions need to be carried out within 72 hours or at the earliest convenience (weather permitting). At least one unscheduled operation and maintenance visit may be anticipated for each wind mast site per year.

All maintenance undertaken, date and reason for replacement of instruments, etc. will be documented in a log report, which will be available online through the web site. The client will be informed by e-mail before and after all maintenance visits. The updated historical log report will be forwarded to the client and uploaded to the web site within 7 days of the visit. An inventory of spare parts will be available for e.g. instrument replacement at short notice taking into account the large distance and difficult access to the sites, especially in winter times. The instrument taken down will be replaced with an instrument with the same specifications.

The following checks will be carried out.

## *Tower Structure, Supports, and Grounding*

### Anchor Condition

- Check for signs of rust or damage.
- Assess movement of the anchors over time.
- Verify the integrity of the anchor connections; for example, the anchor resistance may have changed if an animal has burrowed near the connection point.

### Guy Wire Condition

- Check that the guy wires are properly tensioned in accordance with the manufacturer's guidelines. Tension the guy wires if necessary.
- Inspect the wires and connection points for signs of rust or corrosion.
- Ensure that the appropriate numbers of wire clips were used to secure the wires and that the clips are in good condition.

### Tower Condition

- Check for signs of rust or damage.
- Confirm that the tower is plumb and straight.
- For tubular towers, examine the tower for signs of flaring at the connection points between tower sections.
- Inspect the base plate or foundation to ensure that it is not sinking or distorted and is otherwise free from damage.

### Grounding System

- Verify that the grounding system is connected properly and the electrical contacts are in good condition.

## *Instruments and Data Acquisition System*

### Sensors

- Inspect the sensor booms and instrument pillars to make sure they are level or plumb and in good condition.
- Booms are known to slip or rotate; confirm that all booms are at the correct heights and point in the correct directions.
- Replace any sensors that data analysis shows may be deteriorating or may have failed
- To ensure continuity of the data record, replace only one of a pair of sensors at the same height in a single visit.
- If any doubts arise concerning the stability of an anemometer's calibration, it may be advisable to have the anemometer removed and recalibrated. Comparing the pre- and post-deployment calibration coefficients allows any significant drift in the anemometer response to be detected.

### Data Acquisition System

- Inspect the logger and the enclosure for signs of corrosion, damage, moisture, and the presence of rodents or insects.
- Check the wiring panel to ensure a good connection to the sensors.
- Check battery voltage and replace batteries as needed.

- If the batteries are charged by a solar system, the solar panels should be cleaned and their alignment checked and the panels, wiring, and electrical connections should be examined for cracks and water resistance.

#### 6.4 SPARE PARTS INVENTORY

Projected operation and maintenance functions must anticipate potential equipment malfunction and breakage. To minimize downtime, an adequate spare parts inventory needs to be maintained and included with all site visits. The basic inventory should consist of all items necessary to outfit one monitoring station:

- 1 spare logger and cabinet
- 4 Thies Clima first class Advanced anemometers
- 1 Vector anemometer
- 2 first class wind vanes
- 1 temperature, 1 pressure and 1 humidity sensor
- 3 solar panels

## **7 OWNERSHIP & SUBCONTRACTING**

As per the terms of the contract, SESI will take ownership of installation and maintenance for two years of all wind masts within the budget specified in the financial proposal. For this purpose, SESI has allocated the required resources for fabrication and installation of masts in accordance with the design specifications and within the time frame specified and agreed with the client. The turnkey contract by SESI will ensure in maintaining high quality of equipment and services coupled with taking responsibility of maintaining the wind masts for two year project life in challenging and difficult environment, which no other firm would be able to offer.

SESI has already established a dedicated project office for this project in Islamabad and its local presence will be helpful in taking required ownership and responsibility necessary for successful completion of the project. SESI has an experienced and committed team to ensure completion of the project with guaranteed satisfaction of the Client.

In order to speed up the process, SESI will be responsible for installation and maintenance of the masts.

SESI's wind energy capabilities are based on its comprehensive regional and international experience in wind projects.

SESI's project team in Pakistan also possesses prior experience of wind mast installation in several regions of the country. For the purpose of this project, SESI has completed the comprehensive technical design of the wind masts in conformity with the prevalent standards and international best practices. Additionally, this design has been subjected to FEA analysis and simulation under various stress scenarios to ensure its quality and robustness. The mast drawings and specifications are enclosed.

## **8 INSURANCE**

The insurance cost will cover comprehensive insurance cover including fire, theft; terrorism etc. and the insurance contract will need to be revised each year.

## 9 PLANNING

The implementation schedule for phase-2 was provided in the beginning of phase-2 in Gantt chart format and is shown below.

12 candidate sites have been identified for mast installation and procurement process is under way for all of them in parallel.

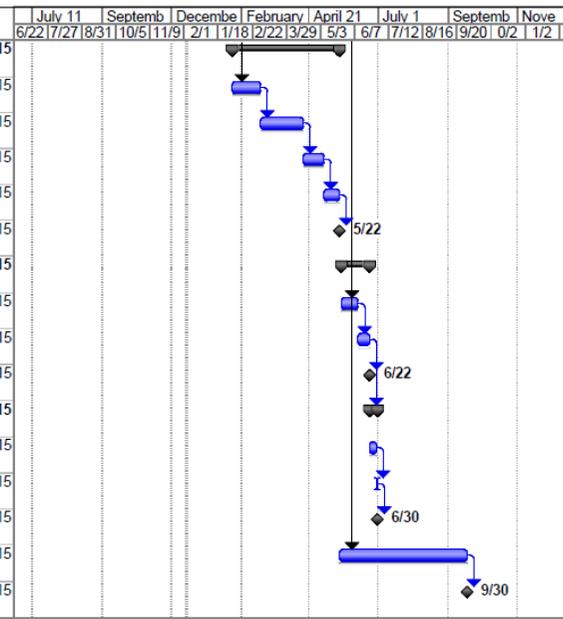
No Objection Certificates (NOCs) have already been asked to the authorities, in line with the project planning.

The team is confident that all 12 mast installations will be completed by the end of September 2015. According to the project planning, this is in line with the date that was originally foreseen for the installation of 10 masts.

ID	Task Name	Duration	Start	Finish	Gantt Chart											
					July 11	Septemb	Decembe	February	April 21	July 1	Septemb	Nov				
1	Preparation of long list of sites	98 days	Mon 8/11/14	Wed 12/24/14	[Gantt bar from 8/11/14 to 12/24/14]											
2	Identification of regions based on preliminary modelling	56 days	Mon 8/11/14	Mon 10/27/14	[Gantt bar from 8/11/14 to 10/27/14]											
3	Identification of government land/private land in selected regions	22 days	Tue 10/28/14	Wed 11/26/14	[Gantt bar from 10/28/14 to 11/26/14]											
4	Preparation of long list of prospective sites	19 days	Thu 11/27/14	Tue 12/23/14	[Gantt bar from 11/27/14 to 12/23/14]											
5	Long list prepared	1 day	Wed 12/24/14	Wed 12/24/14	[Gantt bar at 12/24/14]											
6	Site Visits	69 days	Thu 12/25/14	Tue 3/31/15	[Gantt bar from 12/25/14 to 3/31/15]											
7	Identification of suitable sites for visit by foreign personnel	5 days	Thu 12/25/14	Wed 12/31/14	[Gantt bar from 12/25/14 to 12/31/14]											
8	Obtaining required security clearances of foreign personnel for selected sites	11 days	Thu 1/1/15	Thu 1/15/15	[Gantt bar from 1/1/15 to 1/15/15]											
9	Site visits and evaluation	51 days	Fri 1/16/15	Fri 3/27/15	[Gantt bar from 1/16/15 to 3/27/15]											
10	Consultative meeting of stakeholders for finalization of sites	1 day	Tue 3/31/15	Tue 3/31/15	[Gantt bar at 3/31/15]											
11	Final list of sites prepared	0 days	Tue 3/31/15	Tue 3/31/15	[Gantt bar at 3/31/15]											
12	Land Acquisition/ permits	38 days	Wed 4/1/15	Fri 5/22/15	[Gantt bar from 4/1/15 to 5/22/15]											
13	Obtaining permits/NOCs for shortlisted sites (in batches of 5)	38 days	Wed 4/1/15	Fri 5/22/15	[Gantt bar from 4/1/15 to 5/22/15]											
14	Land lease agreements for private land	28 days	Wed 4/15/15	Fri 5/22/15	[Gantt bar from 4/15/15 to 5/22/15]											
15	Sites acquired	0 days	Fri 5/22/15	Fri 5/22/15	[Gantt bar at 5/22/15]											
16	Design, Analysis of Mast and Preparation of Engineering Drawings	54 days	Mon 11/17/14	Thu 1/29/15	[Gantt bar from 11/17/14 to 1/29/15]											
17	Conceptual Design, Analysis and preparation of drawings for Tower	41 days	Mon 11/17/14	Mon 1/12/15	[Gantt bar from 11/17/14 to 1/12/15]											
18	Review and Finalization of design and engineering drawings	12 days	Tue 1/13/15	Wed 1/28/15	[Gantt bar from 1/13/15 to 1/28/15]											
19	Final design drawing prepared (including BoQ for instruments and selection of vendors)	1 day	Thu 1/29/15	Thu 1/29/15	[Gantt bar at 1/29/15]											
20	Finalization of equipment, procurement or equipment and material for tower	94 days?	Tue 1/13/15	Fri 5/22/15	[Gantt bar from 1/13/15 to 5/22/15]											
21	Preparation of BoQ	5 days	Tue 1/13/15	Mon 1/19/15	[Gantt bar from 1/13/15 to 1/19/15]											
22	Request for quotation from suppliers	5 days	Tue 1/20/15	Mon 1/26/15	[Gantt bar from 1/20/15 to 1/26/15]											
23	Receipt for advance payment for equipment and tower	5 days	Tue 1/20/15	Mon 1/26/15	[Gantt bar from 1/20/15 to 1/26/15]											
24	Placement of order for recommended equipment and shipment to Islamabad	65 days	Fri 1/30/15	Thu 4/30/15	[Gantt bar from 1/30/15 to 4/30/15]											
25	Custom Clearance	10 days	Fri 5/1/15	Thu 5/14/15	[Gantt bar from 5/1/15 to 5/14/15]											
26	Transportation to site	6 days	Fri 5/15/15	Fri 5/22/15	[Gantt bar from 5/15/15 to 5/22/15]											
27	Instruments available at site	0 days?	Fri 5/22/15	Fri 5/22/15	[Gantt bar at 5/22/15]											



ID	Task Name	Duration	Start	Finish	July 11	Septemb	Decembe	February	April 21	July 1	Septemb	Nov			
					6/22	7/27	8/31	10/5	11/9	2/1	1/18	2/22	3/29	5/3	6/7
28	Fabrication of Towers	80 days	Mon 2/2/15	Fri 5/22/15											
29	Testing and Procurement of material for masts	21 days	Mon 2/2/15	Mon 3/2/15											
30	Fabrication and assembly of sections	32 days	Tue 3/3/15	Wed 4/15/15											
31	Galvanizing and painting of towers	15 days	Thu 4/16/15	Wed 5/6/15											
32	Transportation of tower to site	12 days	Thu 5/7/15	Fri 5/22/15											
33	Mast available at site for erection	0 days	Fri 5/22/15	Fri 5/22/15											
34	Civil work and installation of Towers	21 days	Mon 5/25/15	Mon 6/22/15											
35	Excavation and foundation works	13 days	Mon 5/25/15	Wed 6/10/15											
36	Installation of towers, guy wires and instruments	8 days	Thu 6/11/15	Mon 6/22/15											
37	Installation complete	0 days	Mon 6/22/15	Mon 6/22/15											
38	Commissioning of Mast	6 days	Tue 6/23/15	Tue 6/30/15											
39	Commissioning of all instruments	5 days	Tue 6/23/15	Mon 6/29/15											
40	Final inspection	1 day	Tue 6/30/15	Tue 6/30/15											
41	Mast installed and commissioned	0 days	Tue 6/30/15	Tue 6/30/15											
42	Installation and commissioning of all masts	94 days	Sat 5/23/15	Wed 9/30/15											
43	All masts installed and operational	0 days	Wed 9/30/15	Wed 9/30/15											



Project: Wind Mapping & Measuremen Date: Tue 12/16/14	Task		Milestone		External Tasks	
	Split		Summary		External Milestone	
	Progress		Project Summary		Deadline	



## 10 COSTS

In addition to the lump sum fees, the following included and excluded costs need to be allocated in accordance with the proposal.

### 10.1 INCLUDED COSTS

BREAKDOWN OF INCLUDED COSTS	
Component	Cost (\$) for 10 Masts
Lattice tower, foundations, anchoring, grounding, security/warning features	230,000
Mast instrumentation, cables, logger, communications system[1], power supply, other BoS components	230,000
Spare parts, wear parts and consumables inventory	26,000
Shipping costs DDU Pakistan entry port	14,000
*Online data communication through GSM	
<b>TOTAL</b>	<b>500,000</b>

## 10.2 EXCLUDED COSTS

		SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6	SITE 7	SITE 8	SITE 9	SITE 10	SITE 11	SITE 12
Name		UET Jallozai Campus, KPK	Do Nali, Haripur, KPK	Saroba, Chakri, Punjab	Quaidabad, Khushab, Punjab	QA Solar Park, Bahawalpur, Punjab	Gath Bairi, RYK, Punjab	BUIITEMS, Quetta, Baluchistan	Kandiari, Sanghar, Sindh	Sataar Goth, Umarnot, Sindh	Tandu Ghulam Ali, Badin, Sindh	Super Highway, Hyderabad, Sindh	Shahabad, Thatta, Sindh
X		33°55'2.97" N	33°58'45.51" N	33°20'5.70" N	32°20'50.19" N	29°19'37.43" N	27°58'30" N	30°16'15.91" N	25°48'46.20" N	25°20'56.22" N	25° 7'8.82" N	25°18'5.05" N	24°30'56.04" N
Y		71°47'39.81" E	73° 1'35.34" E	72°48'10.38" E	71°53'42.72" E	71°49'5.26" E	70°7'56" E	66°56'12.09" E	69° 2'5.44" E	69°45'39.12" E	68°52'21.84" E	68° 4'38.65" E	68°11'19.14" E
Altitude		401 m	490 m	376 m	192 m	119 m	73 m	1580 m	28 m	45 m	16 m	63 m	17 m
transport to the site		USD 700	USD 600	USD 550	USD 500	USD 600	USD 1,000	USD 1,100	USD 900	USD 1,000	USD 900	USD 900	USD 975
storage		USD 100	USD 100	USD 100	USD 100	USD 100	USD 100	USD 100	USD 100	USD 100	USD 100	USD 100	USD 100
foundations		USD 8,500	USD 8,500	USD 8,500	USD 8,500	USD 9,000	USD 9,000	USD 9,100	USD 9,000	USD 9,000	USD 9,000	USD 8,700	USD 8,700
fencing		USD 800	USD 800	USD 800	USD 800	USD 800	USD 800	USD 900	USD 800	USD 800	USD 800	USD 800	USD 800
guardhouse		USD 700	USD 700	USD 700	USD 700	USD 700	USD 700	USD 700	USD 700	USD 700	USD 700	USD 700	USD 700
facilities for guard (GSM) (year 1)		USD 500	USD 500	USD 500	USD 500	USD 500	USD 500	USD 500	USD 500	USD 500	USD 500	USD 500	USD 500
facilities for guard (GSM) (year 2)		USD 500	USD 500	USD 500	USD 500	USD 500	USD 500	USD 500	USD 500	USD 500	USD 500	USD 500	USD 500
facilities for guard (GSM) for extra 3 Months		USD 125	USD 125	USD 125	USD 125	USD 125	USD 125	USD 125	USD 125	USD 125	USD 125	USD 125	USD 125
GSM/GPRS communication cost year 1		USD 400	USD 400	USD 400	USD 400	USD 400	USD 400	USD 400	USD 400	USD 400	USD 400	USD 400	USD 400
GSM/GPRS communication cost year 2		USD 400	USD 400	USD 400	USD 400	USD 400	USD 400	USD 400	USD 400	USD 400	USD 400	USD 400	USD 400
GPRS Communication for extra 3 months		USD 100	USD 100	USD 100	USD 100	USD 100	USD 100	USD 100	USD 100	USD 100	USD 100	USD 100	USD 100
guard 1 (year 1)		USD 3,600	USD 3,600	USD 3,600	USD 3,600	USD 3,600	USD 3,600	USD 3,600	USD 3,600	USD 3,600	USD 3,600	USD 3,600	USD 3,600
guard 2 (year1)		USD 3,600	USD 3,600	USD 3,600	USD 3,600	USD 3,600	USD 3,600	USD 3,600	USD 3,600	USD 3,600	USD 3,600	USD 3,600	USD 3,600
guard 1 (year 2)		USD 3,600	USD 3,600	USD 3,600	USD 3,600	USD 3,600	USD 3,600	USD 3,600	USD 3,600	USD 3,600	USD 3,600	USD 3,600	USD 3,600
guard 2 (year2)		USD 3,600	USD 3,600	USD 3,600	USD 3,600	USD 3,600	USD 3,600	USD 3,600	USD 3,600	USD 3,600	USD 3,600	USD 3,600	USD 3,600
2 guards for extra 3 months		USD 1,800	USD 1,800	USD 1,800	USD 1,800	USD 1,800	USD 1,800	USD 1,800	USD 1,800	USD 1,800	USD 1,800	USD 1,800	USD 1,800
taxes on import of equipment	35%	USD 8,750	USD 8,750	USD 8,750	USD 8,750	USD 8,750	USD 8,750	USD 8,750	USD 8,750	USD 8,750	USD 8,750	USD 8,750	USD 8,750
permits		USD 350	USD 350	USD 350	USD 350	USD 400	USD 400	USD 400	USD 400	USD 400	USD 400	USD 400	USD 400
installation		USD 2,500	USD 2,500	USD 2,500	USD 2,500	USD 2,500	USD 2,500	USD 2,500	USD 2,500	USD 2,500	USD 2,500	USD 2,500	USD 2,500
land rent (per year 1)		Govt. Land	USD 5,400	USD 4,800	Govt. Land	Govt. Land	Govt. Land	Govt. Land	USD 4,800	USD 4,800	USD 4,800	USD 4,800	USD 4,800
land rent (per year 2)		Govt. Land	USD 5,400	USD 4,800	Govt. Land	Govt. Land	Govt. Land	Govt. Land	USD 4,800	USD 4,800	USD 4,800	USD 4,800	USD 4,800
land rent for extra 3 months		Govt. Land	USD 1,350	USD 1,200	Govt. Land	Govt. Land	Govt. Land	Govt. Land	USD 1,200	USD 1,200	USD 1,200	USD 1,200	USD 1,200
maintenance year 1		USD 6,000	USD 6,000	USD 5,000	USD 6,500	USD 7,000	USD 9,000	USD 9,000	USD 7,500	USD 8,000	USD 8,000	USD 7,000	USD 8,000
maintenance year 2		USD 6,000	USD 6,000	USD 5,000	USD 6,500	USD 7,000	USD 9,000	USD 9,000	USD 7,500	USD 8,000	USD 8,000	USD 7,000	USD 8,000
maintenance for extra 3 months		USD 1,500	USD 1,500	USD 1,250	USD 1,625	USD 1,750	USD 2,250	USD 2,250	USD 1,875	USD 2,000	USD 2,000	USD 1,750	USD 2,000
Insurance (year 1)		USD 750	USD 750	USD 750	USD 750	USD 750	USD 750	USD 750	USD 750	USD 750	USD 750	USD 750	USD 750
Insurance (year 2)		USD 750	USD 750	USD 750	USD 750	USD 750	USD 750	USD 750	USD 750	USD 750	USD 750	USD 750	USD 750
insurance for extra 3 months		USD 187.50	USD 187.50	USD 187.50	USD 187.50	USD 187.50	USD 187.50	USD 187.50	USD 187.50	USD 187.50	USD 187.50	USD 187.50	USD 187.50
Uninsurable losses and contingencies	10%	USD 5,581.25	USD 6,786.25	USD 6,421.25	USD 5,723.75	USD 5,851.25	USD 6,341.25	USD 6,371.25	USD 7,073.75	USD 7,196.25	USD 7,186.25	USD 6,931.25	USD 7,163.75
Admin Fee	7%	USD 3,906.88	USD 4,750.38	USD 4,494.88	USD 4,006.63	USD 4,095.88	USD 4,438.88	USD 4,459.88	USD 4,951.63	USD 5,037.38	USD 5,030.38	USD 4,851.88	USD 5,014.63
<b>Total</b>		<b>USD 65,301</b>	<b>USD 79,399</b>	<b>USD 75,129</b>	<b>USD 66,968</b>	<b>USD 68,460</b>	<b>USD 74,193</b>	<b>USD 74,544</b>	<b>USD 82,763</b>	<b>USD 84,196</b>	<b>USD 84,079</b>	<b>USD 81,096</b>	<b>USD 83,816</b>
<i>Potential extra costs</i>													
Calibration of cup anemometer (per unit)		USD 230	USD 230	USD 230	USD 230	USD 230	USD 230	USD 230	USD 230	USD 230	USD 230	USD 230	USD 230
Calibration of wind vane (per unit)		USD 200	USD 200	USD 200	USD 200	USD 200	USD 200	USD 200	USD 200	USD 200	USD 200	USD 200	USD 200
Dismantling + transportation to Measnet calibration center and back to Pakistan	First item of a mast	USD 1,500	USD 1,500	USD 1,500	USD 1,500	USD 1,500	USD 1,500	USD 1,500	USD 1,500	USD 1,500	USD 1,500	USD 1,500	USD 1,500
	Each extra item	USD 500	USD 500	USD 500	USD 500	USD 500	USD 500	USD 500	USD 500	USD 500	USD 500	USD 500	USD 500
Re-installation	First item of a mast	USD 1,000	USD 1,000	USD 1,000	USD 1,000	USD 1,000	USD 1,000	USD 1,000	USD 1,000	USD 1,000	USD 1,000	USD 1,000	USD 1,000
	Each extra item	USD 400	USD 400	USD 400	USD 400	USD 400	USD 400	USD 400	USD 400	USD 400	USD 400	USD 400	USD 400



## ANNEX A SITE SELECTION MATRIX

Each of the 44 visited sites is given a grade between 1 and 3 for a list of 7 criteria as presented in the tables below. Each criterion is given a weightage between 10% and 20% of the total.

Grade	Remarks	
1	Bad	Absent
2	Fair	
3	Good	Present

Criteria	Site #	1	2	3	4	5	6
	District	Attock		Chakwal			
	Weightage	Kot Chajji, Attock	Shahbaz Pur, Attock	Rakh Warhal Forest, Kallar Kahar	Wild life Check Post, Kallar Kahar	Saroba, Chakri	UET Balkasar, Chakwal
Site accessibility	15	3	1	3	3	3	2
Land Availability/ Terrain & Soil Condition	20	2	1	1	1	3	2
GPRS Network coverage	10	3	3	3	3	3	3
Security	15	2	2	1	2	3	3
Representative of region	15	3	2	2	2	3	3
Wind Flow & Govt. Preference	10	2	1	2	1	1	1
Construction/Population/Trees /Water bodies (1 km radius)	15	3	1	3	1	3	2
	<b>100</b>	255	150	205	180	280	230
Score	%	85.00	50.00	68.33	60.00	93.33	76.67

7	8	9	10	11	12	13	14	15	16	17
Jhelum	Khushab	NUST, Islamabad		Rawal Dam, Islamabad			Rahim Yar K	Bahawalpur	Muzaffargarh	
Kala Gojran, Jhelum	Quaidabad, Khushab	NUST Islamabad, Water Tank, Site 1	NUST Islamabad, Solar Park, Site 2	Rawal Dam, Hill Top, Islamabad	Rawal Dam, Public Park, Islamabad	Rawal Dam, Rest House, Islamabad	Gath Bairi, Sadiqabad, RYK	Q A Solar Park, Bahawalpur	Taunsa Barage, Muzaffargarh	Karari Wala Rest House, Muzaffargarh
3	3	1	3	2	2	1	2	3	2	3
3	3	1	2	1	1	1	3	3	3	3
3	3	3	3	3	3	3	3	3	3	3
3	2	3	3	2	2	2	3	3	2	2
2	3	1	2	1	1	1	3	3	2	2
1	2	1	1	1	1	1	3	2	3	2
1	3	1	2	1	1	3	3	3	2	2
235	275	150	230	150	150	165	285	290	240	245
78.33	91.67	50.00	76.67	50.00	50.00	55.00	95.00	96.67	80.00	81.67

18	19	20	21	22	23	24	25	26	27	28	29	30
DG Khan, Fort Monoe			RajanPur		Thatta		Badin	Mirpur Khas				
Khar Cho Daf, Ground, Fort Monroe, DG Khan	BMP Post, Fort Monroe, DG Khan	Anari, Near Bahria Town, Fort Monroe, DG Khan	Muhammad pur Gam Wala, Rajanpur	Pull Chak Shakari, Rajanpur	Shahabad, Thatta	Jati, Thatta	Tandu Ghulam Ali, Badin	Mirwah Gorchani Farm 1, 1st site, Mirpur Khas	Mirwah Gorchani Farm 1, 2nd site, Mirpur Khas	Mataru Khan Village, Mirpur Khas	Mirwah Gorchani Farm 2, Mirpur Khas	Zahidabad Village, Mirpur Khas
3	3	3	3	3	3	2	3	3	3	3	3	3
1	1	3	3	3	3	3	3	1	1	3	3	3
3	3	3	3	3	3	3	3	3	3	3	3	3
1	2	2	2	2	2	2	2	2	2	2	2	2
1	1	2	3	3	3	3	3	2	2	3	2	3
2	1	2	2	2	2	2	2	2	2	2	2	2
2	1	2	3	3	3	3	3	3	3	3	3	3
175	165	245	275	275	275	260	275	220	220	275	260	275
58.33	55.00	81.67	91.67	91.67	91.67	86.67	91.67	73.33	73.33	91.67	86.67	91.67

31	32	33	34	35	36	37	38	39	40	41	42	43	44	
Umarkot	Sanghar		Hyderabad	Karachi	Mardan	Noshera		Quetta	Ziarat	Harnai	Harnai	Ziarat	Haripur, KPK	
Sataar Goth, Umar kot	Kandiari, 1st site, Sanghar	Kandiari, 2nd site, Sanghar	30 km Karachi - Hyderabad SuperHigh way, Hyderabad	Pakistan Marine Academy, Karachi	Preimer Sugar Mill, Mardan	UET Jalojai Campus, Nowshera	Misri Banda Village, Nowshera	BUITEMS, Quetta	Allah Dad, Kachh, Ziarat	Watra, Harnai	Kaust, Harnai	Khur. Kachh, Ziarat	Do Nali, Haripur, KPK	
3	3	3	3	3	3	3	2	3	2	3	1	2	3	
3	3	3	3	3	1	1	3	1	2	3	2	2	1	3
3	3	3	3	3	3	3	3	3	1	2	1	1	3	
2	2	2	2	3	3	3	1	3	2	2	2	1	3	
3	3	3	2	1	1	3	1	2	3	2	2	1	2	
2	2	2	3	1	1	1	1	2	2	2	2	1	2	
3	3	3	3	1	1	3	2	3	1	2	1	1	2	
275	275	275	270	180	180	280	150	255	210	215	160	115	260	
91.67	91.67	91.67	90.00	60.00	60.00	93.33	50.00	85.00	70.00	71.67	53.33	38.33	86.67	

## QUALITY INFORMATION

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