Hartford Alternative Energy (Pvt) Ltd.
Head Office : Plot 4 & 8, Sector 25, Korangi Industrial Area, Karachi-74400

August 28, 2015

THE REGISTRAR
National Electric Power Regulatory Authority,
NEPRA Tower, Attaturk Avenue (East)
G-5/1,
Islamabad

SUBJECT: **APPLICATION FOR THE GRANT OF A GENERATION LICENSE ON BEHALF OF HARTFORD ALTERNATIVE ENERGY (PRIVATE) LIMITED IN RELATION TO ITS 49.3 MW WIND POWER GENERATION PROJECT TO BE LOCATED AT JHIMPIR, DISTRICT THATTA, PROVINCE OF SINDH**

I, **RAFIQUE KHANANI,** being the duly authorized representative of HARTFORD ALTERNATIVE ENERGY (PRIVATE) LIMITED (a company incorporated under the laws of Pakistan with its registered office located at Karachi) hereby, certify that the revised Generation License Application dated August 28, 2015 and the documents in support thereof have been prepared and submitted in conformity with the provisions of the National Electric Power Regulatory Authority Licensing (Generation) Rules 2000, and I undertake to abide by the terms and provisions of the same.

I further undertake and confirm that the information provided in the attached documents in support is true and correct to the best of my knowledge and belief.

Sincerely,
For and on behalf of
HARTFORD ALTERNATIVE ENERGY (PRIVATE) LIMITED

.....
RAFIQUE KHANANI
AUTHORISED REPRESENTATIVE

Hartford Alternative Energy (Pvt) Ltd

Phones : (92 21) 111 26 36 46 Fax : (92 21) 3507 5446. Email : corporate@artisticmillners.com

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BOARD RESOLUTION

The following resolutions were discussed in detail by the Board and approved unanimously on 13th of July, 2015:

"RESOLVED THAT Hartford Alternative Energy (Private) Limited (a company incorporated under the laws of Pakistan with its registered office located at Plot No 4 & 8, Sector 25, Korangi Industrial Area, Karachi, Pakistan) (the Company) be and is hereby authorized to application for Generation License (including any subsequent modifications) for submission to National Electric Power Regulatory Authority for grant of Generation License for in respect of its 49.5 MW wind power generation project to be located at Jhampir, Province of Sindh, Pakistan (the Project) and in relation thereto, enter into and execute all required documents, make all filings and pay all applicable fees, in each case, of any nature whatsoever, as required."

"FURTHER RESOLVED THAT in respect of filing of application for Generation License (including any subsequent modifications) for submission to National Electric Power Regulatory Authority, **MR. RAFIQUE KHANANI** (Chief Financial Officer) be empowered and authorized for and on behalf of the Company to:

(i) review, execute, submit, and deliver the application for Generation License (including any subsequent modifications) and any related documentation required by National Electric Power Regulator Authority for the determination of the reference to application for generation license, including any contact, documents, power of attorney, affidavits, statements, letters, forms, applications, deeds, guarantees, undertakings, approvals, memoranda, amendments, letters, communications, notices, certificates, requests, statements and any other instruments of any nature whatsoever;

(ii) represent the Company in all negotiations. Representations, presentations, hearings, conferences and /or meetings of any nature whatsoever with any entity (including, but in no manner limited to National Electric Power Regulatory Authority, any private parties, companies, partnerships, individuals, governmental and/or semi-governmental authorities and agencies, ministries, boards, departments, regulatory authorities and/or any other entity if any nature whatsoever);

(iii) sign and execute the necessary documentation, pay the necessary fees, appear before the National Electric Power Regulatory Authority as needed, and do all acts necessary for completion and processing of the application for Generation License including any modifications;

(iv) appoint or nominate any one or more officers of the Company or any other person or persons, singly or jointly, in their discretion to communicate with, make presentations to and attend the National Electric Power Regulatory Authority hearings;

(v) do all such acts, matters and things as may be necessary for carrying out the purposes aforesaid and giving full effect to the above resolutions/resolution.

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"AND FURTHER RESOLVED THAT MR. RAFIQUE KHANANI (Chief Financial Officer), be and is hereby authorized to delegate all or any of the above powers in respect of the forgoing to any other officials of the Company as deemed appropriate.

IN WITNESS THEREOF, I hereunder set my hands as such Secretary/Chief Financial Officer and affixed the corporate seal of said company.

Company Secretary

PROSPECTUS

The Applicant obtained the Letter of Intent (LOI) from AEDB in 13th July 2012 for the wind power project for capacity of 50 MW (the "**Project**"). The land for the Project has been allocated and provided by the Government of Sindh ("**GOS**") through a "Lease Agreement".

The Project site is located near the Village Jhimpir, District Thatta, Karachi; a city of the southern province Sindh. The direct distance between the Project site and Karachi is about 84 km. The distance between Project site and the coastal line of Arabian Sea is approximately 80 km. The site is located in a strong and partly rocky area at 49m to 78m above sea level. The size of the whole wind farm is 320 acres. The north latitude of the site is 24.98 N, and the east longitude is 67.83 E. The altitude of the site is 49m~78m m above sea level. The monsoon from the Indian Ocean, which is stable in its direction and high in quality brings rich wind energy resource to the site.

The complete feasibility study was submitted to AEDB on 12th March 2013 for approval. The Annual Power Production Estimate has been approved by AEDB.

The Electrical and Grid Interconnection Studies were submitted to the National Transmission & Despatch Company Limited "**NTDC**" on 21st October 2013. So far, there are no comments from CPPA / NTDC on the Grid Study Report.

Initial Environmental Examination (IEE) Report was submitted to Sindh Environmental Protection Agency (SEPA) in Nov, 2013 and a No Objection Certificate (NOC) was granted in May, 2015

The Project shall have an installed capacity of 49.5 MW with 33 wind turbine generators (WTG) of 1.5 MW each. There shall be a substation of 132 KV, which shall dispatch electricity to Hyderabad Electric Supply Company Limited grid at a station in Jhimpir, which is to the southeast of the Project site; or at a station in Nooriabad, which is 20 km away to the northwest of the Project site.

The Project has applied for the tariff simultaneously with this application. Upon issuance of the Generation License and determination of tariff, the applicant would execute Energy Purchase Agreements with the power purchaser and aims to reach financial close by the end of 2015. The expected commercial operation date of the Project is June, 2017.

This document is submitted pursuant to Section - 5 of Article - 3 of NEPRA Licensing (Application & Modification Procedure) Regulation, 1999 (the "**Regulations**"); and list of documents required are attached as Annexure as mentioned in Document Structure.

Annexure-I:
PROJECT INFORMATION

Project Background

Since the issuance of the LOI, the Applicant conducted various studies to assess the feasibility of the Project. These studies included the wind resource assessment, geo technical investigation, digital topographic map, initial environmental examination and grid interconnection study. The complete feasibility study was submitted by the Applicant to AEDB for its review.

In order to select EPC and O&M contractors for the Project, the Applicant carried out a bidding process by circulating RFPs to the EPC contractors for awarding the turnkey EPC contracts for development of the Project and following submitted the bids:

- Descon Engineering Limited
- Power China Huadong Engineering Corporation Limited
- Vestas Asia Pacific Wind Technology Pte Ltd

After an extensive technical, financial and commercial evaluation process, the Applicant selected "Power China Huadong Engineering Corporation Limited" as Engineering, Procurement & Construction (EPC) Contractor.

Project Site

The site proposed for the implementation of the Project has been selected by considering

i. Location in the wind corridor
ii. Wind conditions at the site
iii. Topographic conditions
iv. Site accessibility
v. Location of the grid with reference to the site for interconnection-The site is located within the wind corridor identified by AEDB and the land has been obtained from AEDB in this regard.

The site is located in Jhimpir; District Thatta, Sindh, which is one of the most promising areas where wind power projects can be viably installed. The HAEPL wind farm site is located 145 km from Port Qasim Karachi in the East direction with easy road access. Nooriabad Industrial Estate (situated on the M9 motorway connecting Karachi and Hyderabad) is 09 Km from the Wind Farm.

Land Description of the Project Site

Total Land Area: 320 Acres		
	Geodetic Coordinates	
Point No.	Latitude (N)	Longitude (E)
Boundary 1	24.98883379	[illegible]
Boundary 2	24.98799224	[illegible]
Boundary 3	24.93716576	[illegible]
Boundary 4	24.94609095	[illegible]
Boundary 5	24.95509961	[illegible]
Boundary 6	24.95430218	[illegible]
Boundary 7	24.9454292	[illegible]
Boundary 8	24.93856389	[illegible]

The Project site is exposed to very strong south westerly winds; wind data analysis of the area suggests that, 80% wind blows from the south west direction. The terrain of the area is flat with small change in altitude. The proposed site lies under roughness class 1.5 as there is low vegetation. The site is easily accessible through metallic roads. The ground is hard and rocky; the subsurface soil also includes clay and silt.

The proposed wind farms lies on a flat inland area with hard and rocky ground conditions. The site would be categorized as inland wind development as opposed to offshore/coastal wind project development (which is more difficult to develop due to tides and soft subsoil clay). The general terrain at the site can be described as simple and flat terrain. Internal access roads are the roads connecting the single wind turbine locations with each other and the external access roads and grid station would be constructed during the civil works of the wind farm.

The proposed site area lies in an arid zone with very little annual precipitation. The result is that there is hardly any natural vegetation in the area. Some hardy tree species are visible scattered far and wide in the area. The area is rocky with some rock outcrops towards the Super Highway. There are small rock outcrops and hillocks left over by the wind and flash flood erosions in the middle of the project land. The terrain at the site and surrounding area is generally flat with elevations varying between 50m in the southeast of the site to 110m in the northwest.

The proposed site is located about 145 km from Port Qasim Karachi. Karachi borders on the Arabian Sea and the weather belongs to tropical monsoon climate. Rainfall is scarce with about 200 mm for a whole year and most of this is concentrated in July and August. The temperature in winter from November to February is temperate, but it is hot with high temperature in summer from April to August as the highest temperature has reached 44.02°C.

Wind Farms Layout at Project Site

The wind farms site is in long and narrow in shape, the topography is relatively flat and the elevation above sea level is approximately 57-70m. There is little vegetation at the wind farm site. Wind Turbines will have an 80m hub height. See figure below for the sketch map for the WTG towers location setting parameters for the project.

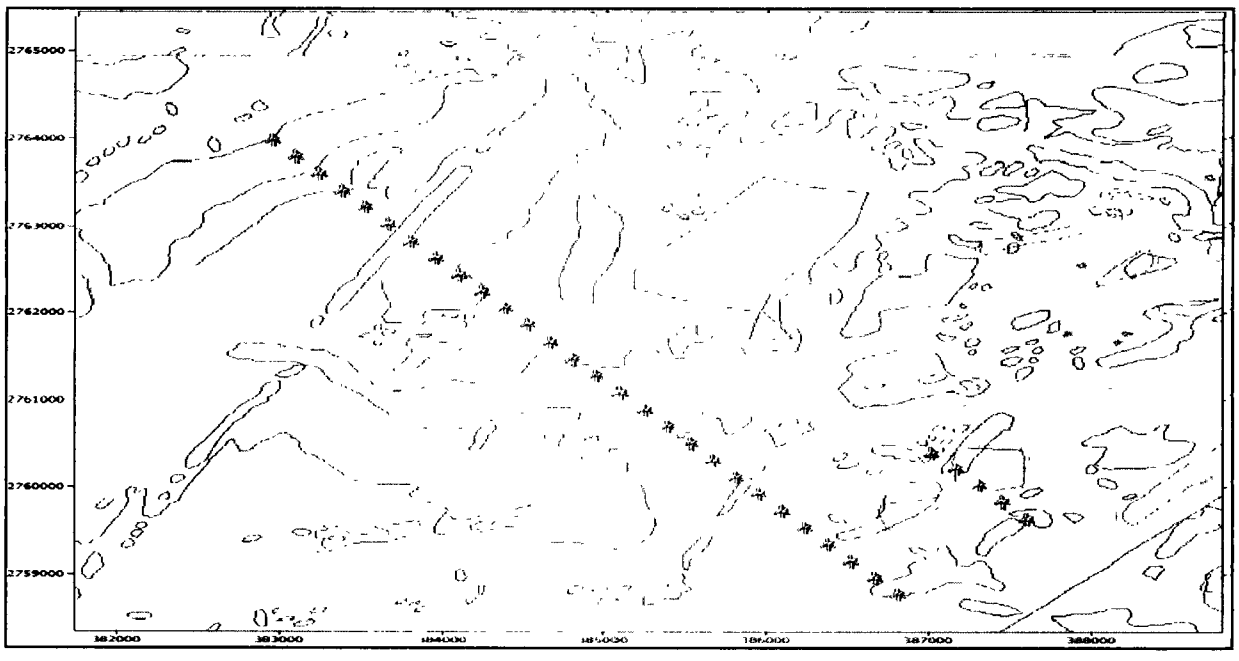


Figure: Micrositing for the HAEPL project

Topographical and Geological Conditions at Project Site

Topographical conditions

The Project site is on a plain area at an elevation of 57-70m, which is generally flat, but a bit higher on the west and lower on the east. The landform at wind farm sites is mainly of pediment and the vegetation there is less developed.

Geological conditions

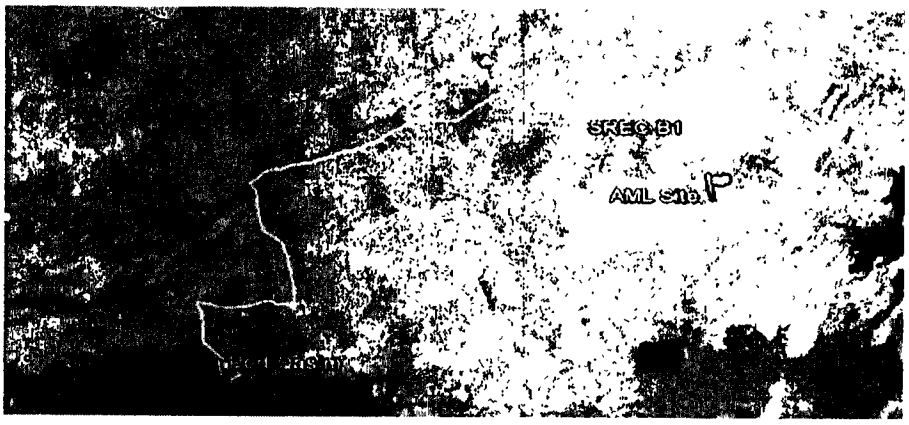
The planned wind farm sites are covered mainly by marine alluvium of Holocene and recent weathered deposit, and underlain mainly by Tertiary limestone. The bedrock in the site is generally outcropped. As the WTG is a high-rise structure, it has a high gravity center and should sustain high loads, large horizontal wind force and overturning moments. WTGs are designed to withstand these forces.

Hydrology

According to the regional hydrological data available, the Project site is in a dry area, where the water table is deeply underground, and the surface water and water in the shallow surface layers is weakly to slightly corrosive to the concrete and is corrosive to the rebars in the concrete which has been immerged in water for a long-time or alternatively in wet and dry conditions. Corrosion prevention measures will be adopted in the design and implementation of the wind farm.

Site Accessibility

The Project is located on Thatta-Bannu Khan Road heading towards Jhimpir from M-9 Khi-Hyd highway. The machinery for the Project will be routed from Port Qasim Karachi which is on the eastern edge of the city and closer to the Project site, for which the transporter has to travel to Jhimpir from Karachi port through populated areas. The distance of Project site from Karachi is 84 km. The proposed route to the Project site is given in the below Illustration.



Telecommunication at project site

Close to the site, there is wire based telecommunication available in the village Jhimpir. Cellular phone suppliers, Warid Telecom Ltd, and Pakistan Telecommunication Mobile Ltd (Ufone) are offering services at the site. GPRS services are also available in the region.

For the SCADA system of the wind farm, a wire based telecommunication infrastructure has to be installed. Land line network will be arranged from the nearby village Jhimpir once civil work starts at the site.

Availability of Semi-Skilled and Skilled Labor

There is a dearth of wind project specific skilled labor in the area, however unskilled and semi-skilled labor is available in the area and the Project will be a source of employment for these individuals.

Project Site Security

The Applicant is quite cognizant of the fact that security situation in the country is unsatisfactory. The Applicant has plans to use the infrastructure at Jhimpir in the most efficient manner to provide seamless security at offices, accommodation and site.

Grid Connectivity

Artistic Milliners Wind Power Plant would be connected by a double circuit of 132kV looping in-out with a sub cluster also connecting Fina, Tapal, Titan and Sunec WPPs to Jhimpir New 132 kV collector substation.

Annual Energy Production

The Annual Energy Production of 177.78 GWh. The tables below show key details relating to power generation from the Project.

Installed Gross ISO Capacity of HAEPL	50MW
Annual Energy Generation	147 GWh
Capacity Factor	38.9%

WTG Technology & EPC Bidding Process

The Applicant, in order to get the right companies involved in the procurement and construction of the project conducted a bidding process. Technical Consultants of the Applicant developed a prequalification criteria for this purpose which including the following:

- Vendor should be active in Pakistan
- Machines should be available in hot climate version
- Vendors should have local presence as well as local commitment
- Should not be in litigation over completion liability issues in the region
- Should have been viable financial entity for at least last three years
- Should have successfully completed works of similar sizes in last three years
- Suitable population of the proposed machine installed and working in the market.

Based on the pre qualifications attributes set aside by the Applicant's Technical Management and its follow up with the EPC vendors, the RFPs were sent out to vendors fulfilling the criteria.

The Applicant received interest from various international WTG suppliers and EPC contractors despite certain suppliers did not respond to the RFP well within time. After considerable effort and receipt of proposals from many suppliers, the Applicant took this input as a starting point and started negotiations with the vendors for EPC proposals.

Based on its thorough due diligence and following an intense negotiations process with the various suppliers and contractors, the Applicant selected "**Power China Huadong Engineering Corporation Limited**" and GE 1.5xle as the technology for its wind farm of the Project with a fixed price and fixed COD.

General Electric – The WTG manufacturer

GE has long been known as one of the most innovative companies on the planet. Product evolution is one of our core competencies and GE is continuing this tradition by developing the next generation of wind energy. GE wind turbines are another chapter in storied power generation history, which spans over a century. With proven performance, reliability, and availability, GE offers increased value to the customers.

GE Renewable Energy is one of the world's leading wind turbine suppliers. GE's current product portfolio includes turbines with rated capacities from 1.5 MW to 3.2 MW. Additionally, GE offers support services that cover everything from development assistance to operations and maintenance.

The 1.XMW platform selected for the project has more than 20,000 installed units in the world, which is a remarkable market size.
Today, GE continues to lead the global wind industry with mature manufacturing capabilities and innovative product line. The specifications of 1.5 MW **GE 1.5 xle** turbine is as follows:

-1	Total Installed/Gross ISO Capacity (MW)	49.5
-2	Total Annual Full Load Hours	2969.7
-3	Average Wind Turbine Generator(WTG) Availability	95%
-4	Total Gross Generation of the Generation Facility/Wind Farm (in GWh)	180.3
-5	Array & Miscellaneous Losses (GWh)	20.52
-6	Availability Losses(GWh)	8.55
-7	Balance of Plant Losses (GWh)	4.28
-8	Annual Energy Generation (20 year equivalent Net AEP) GWh	147.00
-9	Net Capacity Factor	33.90%

EPC Contractor

The details of Applicant selected for the EPC Contractor are as follows:

EPC contractor; Power China Huadong Engineering Corporation Limited (HDEC)

Power China Huadong Engineering Corporation Limited (HDEC) was founded in 1954. It is a multi-specialized, interdisciplinary and comprehensive international engineering corporation. It is a state-owned corporation under Power Construction Corporation of China (POWERCHINA). POWERCHINA is ranked 313th among the world Top 500 enterprises in 2014. Headquartered in Hangzhou, HDEC has its branches in Sichuan, Chongqing, Fujian, Guangdong, Jiangxi and Yunnan, as well as its overseas branches and subsidiaries, such as in Vietnam, Thailand, Indonesia, Pakistan, Turkey, Ethiopia, Kenya, Nigeria and Costa Rica etc. The Large Dam Safety Supervision Center under National Energy Administration is set in HDEC.

HDEC operates in both domestic and international target markets, devoting itself to three main engineering fields (hydropower and renewable energy, urban construction and environmental engineering, dams and infrastructure safety), and three main business (design& consultancy, EPC contracting and investment). HDEC possesses the capability of providing systematic solutions to the whole industry chains throughout the resource identification, planning and design, investment and financing, procurement management, construction management, and

operations management, etc., and has the modern management structure compatible to its undertakings. HDEC is now staffed with over 4000 employees who are mostly state registered engineers, in addition to their subject technical specializations, for construction supervision, cost estimation, quality assurance, consultancy as well as architectural, structural and civil engineering, etc. A large number of model workers at the state, ministry and provincial levels emerge from this super-excellent team. The strong technical resources and professionals of all necessary disciplines make HDEC gain comprehensive and multi-specialized capability.

Meanwhile, HDEC has established long-term stable technical cooperation with top ranking scientific research institutions and famous universities, and retains a large number of famous Chinese specialists and scholars as its consultants.

Annexure –II
Certificate of Incorporation

SECURITIES AND EXCHANGE COMMISSION OF PAKISTAN

1st Floor SLIC Building No.7, Blue Area,
Islamabad

CERTIFICATE OF INCORPORATION

[Under Section 32 of the Companies Ordinance, 1984 (XLVII of 1984)

Corporate Universal Identification No. **0087898**

I hereby certify that **HARTFORD ALTERNATIVE ENERGY (PRIVATE) LIMITED** is this day incorporated under the Companies Ordinance, 1984 (XLVII of 1984) and that the company is **limited by shares.**

Given under my hand at Islamabad this 17th day of April, Two Thousand and Fourteen.

Fee Rs. **5,000/-**

(Shaukat Hussain)
Additional Registrar of Companies

No. ADI 70535
Dated 17/4/14

Annexure-III
MEMORANDUM AND ARTICLES OF ASSOCIATION

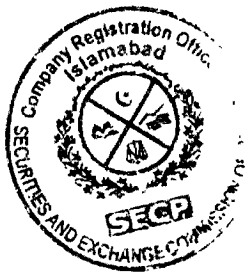
THE COMPANIES ORDINANCE, 1984

(COMPANY LIMITED BY SHARES)

MEMORANDUM OF ASSOCIATION

of

HARTFORD ALTERNATIVE ENERGY (PRIVATE) LIMITED



I. The name of the Company is **HARTFORD ALTERNATIVE ENERGY (PRIVATE) LIMITED.**

II. The Registered Office of the Company will be situated in Islamabad Capital Territory

III The objects for which the Company is established are all or any of the following:-

1. To carry on all or any of the businesses of generating, purchasing, importing, transforming, converting, distributing, supplying, exporting and dealing in electricity and all other forms of energy and products or services associated therewith and of promoting the conservation and efficient use of electricity and to perform all other acts which are necessary or incidental to the business of electricity generation, transmission, distribution and supply.

2. To locate, establish, construct, equip, operate, use, manage and maintain thermal power plants and coal fired power plants, solar powered plants, power grid station, transforming, switching, conversion, and transmission facilities, grid stations, cables, overhead lines, sub-stations, switching stations, tunnels, cable bridges, link boxes, heat pumps, plant and equipment for combined heat and power schemes, offices, computer centres, shops, dispensing machines for pre-payment cards and other devices, showrooms, depots, factories, workshops, plants, printing facilities, warehouses and other storage facilities.

3. To carry on all or any of the businesses of wholesalers, retailers, traders, importers, exporters, suppliers, distributors, designers, developers, manufacturers, installer, filters, testers, repairers, maintainers, contractors,

constructors, operators, users, inspectors, reconditioners, improvers, alterers, protectors, removers, hirers, replacers, importers and exporters of and dealers in, electrical appliances, systems, products and services used for energy conservation, equipments, machinery, materials and installations, including but not limited to cables, wires, meters, pylons, tracks, rails, pipelines and any other plant, apparatus equipment, systems and things incidental to the efficient generation, procurement, transformation, supply and distribution of electricity.

4. To ascertain the tariff for bulk supply that will secure recovery of operating costs, interest charges and depreciation of assets, redemption at due time of loans other than those covered by depreciation, expansion projects, payment of taxes, and reasonable return on investment, to quote the tariff to bulk purchasers of electrical power, and to prefer petition to the appropriate authority for approval of the schedule of tariff and of adjustments or increases in its bulk supply tariff, where desirable or necessary.

5. For the purposes of achieving the above objects, the company is authorized:-

a) to purchase/import raw materials and allied items required in connection thereto in any manner the company may think fit;

b) to do and perform all other acts and things as are incidental or conducive to the attainment of the objects of the company;

c) to own, establish or have and maintain shops, branches and agencies all over Pakistan or elsewhere for sale and distribution of cables, wires, meters, pylons, tracks, rails, pipelines and any other plant, apparatus equipment, systems and things incidental to the efficient generation, procurement, transformation, supply and distribution of electricity;

d) to make known and give publicity to the business and products of the company by such means as the company may think fit;

e) to purchase, acquire, protect, renew, improve, use and sell, whether in Pakistan or elsewhere any patent, right, invention, license, protection or concession which may appear advantageous or useful to the company for running the business;

f) to pay all costs, charges and expenses, if any, incidental to the promotion, formation, registration and establishment of the company;

g) to borrow and arrange the repayment of money from banks/financial institutions or any lawful sources whether in Pakistan or elsewhere and in such manner as the company may think fit, including the issue of debentures, preference shares, bonds, perpetual or otherwise charged upon the whole or any part of the company's property or assets, whether present or future, and to purchase, redeem or payoff such securities,

h) to purchase, hold and get redeemed shares, debentures, bonds of any business, company, financial institution or any Government institutions;

i) to guarantee the performance of contracts, agreements, obligations or discharge of any debt of the company or on behalf of any company or person in relation to the payment of any financial facility including but not limited to loans, advances, letters of credit or other obligations through creation of any or all types of mortgages, charges, pledges, hypothecations, on execution of the usual banking documents or instruments or otherwise encumbrance on any or all of the movable and immovable properties of the company, either present or future or both and issuance of any other securities or sureties by any other means in favour of banks, Non-Banking Finance Companies (NBFCs) or any financial institutions and to borrow money for purpose of the company on such terms and conditions as may be considered proper.

6. Notwithstanding anything stated in any object clause the company shall obtain such other approval or license from competent authority as may be required under any law for the time being enforced to undertake a particular business

7 It is declared that notwithstanding anything contained in the foregoing object clauses of this Memorandum of Association nothing contained therein shall be construed as empowering the Company to undertake or to indulge in business of payment systems, Electronic funds transfers in and outside Pakistan, deposit taking from general public, network marketing, referral marketing & direct selling banking company, leasing, investment, managing agency, insurance business, any of the NBFC business, multi-level marketing (MLM), Pyramid

and Ponzi Scheme, commodity, future contract or share trading business locally or internationally, directly or indirectly as restricted under the law or any unlawful operation.

IV The liability of the members is limited.

V The Authorized Share Capital of the Company is Rs. 100,000/- (Rupees One Hundred Thousands Only) divided into 10,000 (Ten Thousands Only) ordinary shares of Rs. 10 (Rupees Ten) each with powers to the company from time to time to increase and reduce its capital subject to any permission required under the law.

We the several persons, whose names and addresses are subscribed below are desirous of being formed into a Company in pursuance of the Memorandum of Association and we respectively agree to take the number of shares in the capital of the Company set opposite our respective names:-

Name and surname (present & former) in full (in Block Letters)	CNIC No. (in case of foreigner, Passport No)	Father's/ Husband's Name in full	Nationality with any former Nationality	Occupation	Residential Address in full	Number of shares taken by each subscriber	Signatures
Vajih Aslam Khan	42301-0652499-9	Aslam R Khan	PAKISTANI	Business	122/1, Khayaban-e-Ghazi, Phase 6, DHA, South Karachi	6,000	
Dost Muhammad Qureshi	42101-1845205-3	Sultan Muhammad Qureshi	Pakistan	Business	House No. D-159, Block-B, Haidri North Nazimabad, Karachi	1,000	
Hamid Hassan Khan	61101-4968730-9	Shafaat Ahmad Khan	PAKISTANI	Business	House No. 10, Street No. 80, G-6/4, Islamabad	1,000	
Moiz us Samad Khan	42201-2511144-7	Muhammad Abdul Haleem Khan	PAKISTANI	Business	Flat No A-4, Universal Heights, Gulistan-e-Johar, Block-16, Karachi	1,000	
Tanvir Muhammad Qureshi	42000-3019279-1	Dost Muhammad Qureshi	PAKISTANI	Business	House No. D-159, Block-B, Haidri North Nazimabad, Karachi	1,000	

Total number of shares taken 10,000
(Ten Thousands Only)

Dated the 11th day of April 2014

CERTIFIED TO BE TRUE COPY

Witness to above signatures

National Institutional Facilitation Technologies (Pvt) Ltd
5th Floor, AWT Plaza I.I. Chundrigar Road,
Karachi, Pakistan

Deputy Registrar
Company Registration Office Islamabad

Company Registration Office Islamabad
SECURITIES AND EXCHANGE

9/3/15

No. ADI-216
Dated 23/2/15

THE COMPANIES ORDINANCE, 1984

(COMPANY LIMITED BY SHARES)

ARTICLES OF ASSOCIATION

Of

HARTFORD ALTERNATIVE ENERGY (PRIVATE) LIMITED

1. The regulations contained in Table "A" in the First Schedule to The Companies Ordinance, 1984 shall not apply to the Company except in so far as the same are expressly made applicable by the said Ordinance, or these Articles. The regulation for management of the Company, and for the observance thereof by the members of the Company, and their representatives shall, subject as aforesaid and to any exercise of the statutory power of the Company in reference to the repeal or alteration of or addition to its regulations by Special Resolution as prescribed by the said Ordinance; be such as are contained in these Articles.

INTERPRETATION

2. In the interpretation of these Articles the following expressions shall have the following meanings, unless repugnant to or inconsistent with the subject Articles.

"Articles" means these Articles of Association as originally framed or as may be amended from time to time.

"Board" means the Board of Directors of the Company, for the time being.

"Commission" means Securities and Exchange Commission of Pakistan

"Chairman" means the Chairman of the Company, from time to time, duly under the provisions of these presents.

"Chief Executive" means the Chief Executive, for the time being, of the Company.

"Directors" means the Directors, for the time being, of the Company.

"Government" means the Government of the Islamic Republic of Pakistan.

"Memorandum" means the Memorandum of Association of the Company as originally framed or as may be altered from time to time in accordance with the provisions of the Ordinance.

"Month" means a calendar month according to Gregorian calendar;

"Ordinance" means the Companies Ordinance, 1984 or any statutory modification or re-enactment thereof for the time being enforced.

"Ordinary Resolution" means a resolution passed at a general meeting when the vote cast (Whether on a show of hands or poll, as the case may be) in favour of the resolution including the casting vote, if any of the Chairman) by members who, being entitled to vote in person or by proxy, do so vote, exceed the votes, if any, cast against the resolution by members entitled and voting;

"Office" means the registered office, for the time being, of the Company.

"Managing Director" means the Chief Executive of the Company, by whatever name called, appointed pursuant to the section 198 of the Ordinance;

"Member" means the Member of the Company as defined in Section 2(1)(21) of the Ordinance;

"Register" means the Register of members to be kept pursuant to section 147 of the Ordinance;

"Registrar" means a Registrar, an Additional Registrar, A Joint Registrar, a Deputy Registrar or an Assistant Registrar, performing under the Ordinance;

"Seal" means the Common seal of the Company;

"Shares" means the share in the share capital of the Company;

Expressions referring to in "writing" and "written" includes printing, lithography, type-writing, telex, facsimile, (fax), and other modes of representing or reproducing words in a visible or audible form by modern electronic devices, including tape and video compact disc recordings;

Words importing singular number include the plural number and vice versa;

Words importing the masculine gender include the feminine gender;

PRIVATE COMPANY

3 The Company is "Private Company" within the meaning of sub section 2(1) (28) of the Ordinance and accordingly:

(1) No invitation shall be issued to the public to subscribe for any share of the Company.

(2) The numbers of the members of the Company (exclusive of persons in the employment of the Company), shall be limited to fifty, provided that for the purpose of this provision, where two or more persons hold one or more shares in the company jointly, they shall be treated as single member; and

(3) The right to transfer shares of the Company is restricted in manner and to the extent herein appearing.

BUSINESS

4. The company is entitled to commence business from the date of its incorporation. The business of the company shall include all or any of the objects enumerated in the Memorandum of Association. The business of the company shall be carried out at such place or places anywhere in Pakistan or elsewhere as the directors may deem proper or advisable from time to time.

SHARES AND CAPITAL

5 The nominal share capital of the Company is Rs.100,000/- (Rupees One Hundred Thousands Only), divided into 10,000 (Ten Thousands) Ordinary Shares of Rs. 10/- (Rupees Ten Only) each with powers of the Company to increase or reduce the same and to divide the shares into several classes.

6 The shares shall be under the control of the Board of Directors who may allot or otherwise dispose off the same to such persons, on such terms and conditions and at such times, as the Board of Directors think fit. Shares may also be allotted in consideration other than cash.

7. Fully paid shares shall be allotted to all subscribers in the first instance and the Company shall not be bound to recognize any equitable, contingent, future or partial claim to or interest in a share on the part of any person other than the registered share holder, save as herein provided or saves as ordered by some Court of competent jurisdiction.

8. The certificate of title to shares shall be issued under the seal of the Company.

9. Every member shall be entitled to one certificate for the shares registered in his name, or at the discretion of the directors to several certificates, each for one or more of such shares.

TRANSFER AND TRANSMISSION OF SHARES

10. Every person, whose name is entered as a member in the Register of Members shall without payment, be entitled to a certificate under the common seal of the Company specifying the shares held by several persons. The Company shall not be bound to issue more than one certificate and delivery of a share certificate to any one of several joint holders shall be sufficient delivery to all.

11. The directors may decline to register any transfer of shares to transferee of whom they do not approve and shall be bound to show any reasons for exercising their discretion subject to the provisions of Section 77 and 78 of the Ordinance.

12. No share can be mortgaged, pledged, sold, hypothecated, transferred or disposed off by any member to a non-member without the previous sanction of the Board of Directors or any authority under the law regulating the business of the company, as the case may be.

13. The legal heirs, executors or administrators of a deceased holder shall be the only persons to be recognized by the directors as having title to the shares. In case of shares registered in the name of two or more holders, the survivors and the executors of the deceased shall be the only persons to be recognized by the company as having any title to the shares.

BORROWING POWERS

14. Subject to the provision of the Ordinance, the Directors may from time to time at their absolute discretion raise or borrow any sum, or sums of money for the purpose of the company from banks, firms or companies, particularly a person holding the office of the director, and may secure the payment of money in such manner and upon such terms, and conditions in all respects as they think fit particularly by the issue of debentures of the company or by making, drawing, accepting or endorsing on behalf of the company any promissory note or bills of exchange or giving or issuing any other security of the Company.

15. Debentures and other securities may be made assignable free from any equities between the Company and the persons to whom the same may be issued.

16. Any debentures or other security may be issued at a discount, premium or otherwise and with any special privilege as to redemption, surrender, drawing, allotment of shares, attending and voting at general meeting of the Company or subject to compliance of the provisions of the Ordinance.

RESERVES

17 The directors may from time to time before recommending any dividend set aside out of the profit of the company such sums as they think fit as a reserve for redemption of debentures or to meet contingencies for equalization of or for special dividends or for rebuilding, repairing, restoring replacing, improving, maintaining or altering any of the property of the Company or for such other purpose as the directors may in their absolute discretion think conducive to the interest of the Company.

GENERAL MEETINGS

18. A General meeting, to be called annual general meeting shall be held, in accordance with the provisions of section 158, within eighteen months from the date of incorporation of the Company and thereafter once at least in every year within a period of four months following the close of its financial year and not more than fifteen months after the

holding of its last preceding annual general meeting as may be determined by the directors.

19 The directors may, whenever, they think fit, call an extra ordinary general meeting, and extra ordinary general meetings shall also be called on such requisition, or in default, may be called by such requisitions, as is provided by section 159 of the Ordinance.

NOTICE AND PROCEEDINGS OF GENERAL MEETING

20. Twenty-One days' notice at the least (exclusive of the day on which the notice is served or deemed to be served, but inclusive of the day for which notice is given) specifying the place, the day and the hour of meeting and, in case of special business, the general nature of that business shall be given in manner provided by the Ordinance for the general meeting, to such persons as are, under the Ordinance or the regulation of the Company, entitled to receive such notice from the Company, but the accidental omission to give notice to, or the non-receipt or notice by, any member shall not invalidate the proceedings at any general meeting.

21. All business shall be deemed special that is transacted at an extraordinary general meeting, and also all that is transacted at annual general meeting with the exception of declaring dividend, the consideration of the accounts, balance sheet and the reports of the directors and auditors, the election of the directors, the appointment of, and the fixing of the remuneration of, the auditors.

QUORUM

22. No business shall be transacted at any general meeting unless a quorum of two members is present at that time when the meeting proceeds to business; save as herein otherwise provided, members having twenty-five percent of the voting power present in person or through proxy will be quorum of the Company's meeting.

23. If within half an hour from the time appointed for the meeting a quorum is not present, the meeting, if called upon the requisition of members, shall be dissolved: in any other case, it shall stand adjourned to the same day in the next week at the same time and place, and, if at the adjourned meeting quorum is not present within half an hour from the time appointed for the meeting, the members present being not less than two, shall be a quorum.

24. The Chairman of the Board of Directors, if any, shall preside as Chairman at every general meeting of the Company, but if there is no such Chairman, or if at any meeting he is not present within fifteen minutes after the time appointed for the meeting, or is unwilling to act as Chairman, any one of the Directors present may be elected to be Chairman, and if none of the directors is present, or willing to act as Chairman, the members present shall choose one of their number to be Chairman.

25. The Chairman may, with the consent of any meeting at which the quorum is present (and shall if so directed by the meeting), adjourn the meeting from time to time but no business shall be transacted at any adjourned meeting, other than the business left unfinished at the meeting from which the adjournment took place. When the meeting is adjourned for ten days or more, notice of the adjourned meeting shall be given as in the case of an original meeting. Save as aforesaid, it shall not be necessary to give any notice of an adjournment of the business to be transacted at an adjourned meeting.

26. At any general meeting a resolution put to the vote of the meeting shall be decided on a show of hands unless a poll is (before or on the declaration of the show of hands) demanded. Unless a poll is so demanded, a declaration by the Chairman that a resolution has, on a show of hands, being carried, or carried unanimously, or by particular majority, or lost an entry to that effect in the book of the proceedings of the company shall be conclusive evidence of the fact, without proof of the number or proportion of the votes recorded in favour of, or against that resolution.

27 A poll may be demanded only in accordance with the provisions of section 167 of the Ordinance.

28. If a poll is duly demanded, it shall be taken in accordance with the manner laid down in section 168 of the Ordinance and the result of the poll shall be deemed to be the resolution of the meeting at which the poll was demanded.

29. A poll demanded on the election of Chairman or on a question of adjournment shall be taken at once.

30. In the case of an equality of votes, whether on a show of hand or on a poll, the Chairman of the meeting at which the show of hands take place, or at which the poll is demanded, shall have and exercise a second or casting vote.

VOTES OF MEMBERS

31. Subject to any rights or restrictions for the time being attached to any class or classes of shares, on a show of hands every member present in person shall have one vote except for election of Directors in which case, the provisions of section 178 of the Ordinance shall apply. On a poll every member shall have voting rights as laid down in section 160 of the Ordinance.

32. A member of unsound mind, or in respect of whom an order has been made by any Court having jurisdiction in lunacy, may vote, whether on show of hands, or on a poll, by his committee or other legal guardian, and any such committee or guardian may, on a poll vote by proxy.

33. On a poll votes may be given either personally or by proxy.

34. (1) The instrument appointing a proxy shall be in writing under the hand of the appointer or of his attorney duly authorized in writing. A proxy must be a member.

(2) The instrument appointing a proxy and the power of attorney or other authority (if any) under which it is signed, or a notarially certified copy of that power or authority, shall be deposited at the registered office of the company not less than forty-eight hours before the time for holding the meeting at which the person named in the instrument proposes to vote and in default the instrument of proxy shall not be treated as valid.

35. An instrument appointing a proxy may be in the following form, or a form, as near thereto as may be:-

HARTFORD ALTERNATIVE ENERGY (PRIVATE) LIMITED

I.....of.....in the district of ..... being a member of the **HARTFORD ALTERNATIVE ENERGY (PRIVATE) LIMITED** hereby appoint ..... of ..... as my proxy to vote for me and on my behalf at the (annual, extraordinary, as the case may be) general meeting of the company, to be held on the ..... day of..... . .. and at any adjournment thereof.

DIRECTORS

36. The number of directors shall not be less than two. The following persons shall be the first directors of the Company and shall hold the office upto the date of the First Annual General Meeting.

1. **VAJIH ASLAM KHAN**
2. **DOST MUHAMMAD QURESHI**

3. HAMID HASSAN KHAN

4. MOIN US SAMAD KHAN

5. TANVIR MUHAMMAD QURESHI

37 The remuneration of the directors shall from time to time be determined by the Company in general meeting subject to the provisions of the Ordinance.

38. Save as provided in Section 187 of the Ordinance, no person shall be appointed as a director unless he is a member of the Company.

POWERS AND DUTIES OF DIRECTORS

39. The business of the company shall be managed by the directors, who may pay all expenses incurred in promoting and registering the company, and may exercise all such powers of the company as are not by the Ordinance or any statutory modification thereof for the time being in force, or by these regulations, required to be exercised by the company in general meeting, subject nevertheless to the provisions of the Ordinance or to any of these regulations, and such regulations being not inconsistent with the aforesaid provisions, as may be prescribed by the company in general meeting but no regulations made by the company in general meeting shall invalidate any prior act of the directors which would have been valid if that regulation had not been made.

40. The directors shall appoint a chief executive in accordance with the provisions of sections 198 and 199 of the Ordinance.

41. The amount, for the time being remaining undischarged, of moneys borrowed or raised by the directors for the purposes of the company (otherwise than by the issue of share capital) shall not at any time without the sanction of the company in general meeting, exceed the issued share capital of the company.

42. The directors shall cause minutes to be made in books provided for the purpose:-

(a) of all appointments of officers made by the directors;

(b) of the names of the directors present at each meeting of the directors and of any committee of the directors;

(c) of all resolutions and proceedings at all meetings of the company and of the directors and of committees of directors.

DISQUALIFICATION OF DIRECTORS

43. No person shall become the director of a company if he suffers from any of the disabilities or disqualifications mentioned in section 187 of the Ordinance and, if already a director, shall cease to hold such office from the date he so becomes disqualified or disabled:

Provided, however, that no director shall vacate, his office by reason only of his being a member of any company which had entered into contracts with, or done any work for, the company of which he is director, but such director shall not vote in respect of any such contract or work, and if he does so vote, his vote shall not be counted.

PROCEEDINGS OF DIRECTORS

44. The directors may meet together for the dispatch of business, adjourn and otherwise regulate their meetings, as they think fit. Questions arising at any meeting shall be decided by a majority of votes. In case of an equality of votes, the chairman shall have and exercise a second or casting vote. A director may, and the secretary on the requisition

of a director shall, at any time, summon a meeting of directors. It shall not be necessary to give notice of a meeting of directors to any director for the time being absent from Pakistan.

45 The directors may elect the chairman of their meetings and determine the period for which he is to hold office; but, if no such chairman is elected, or if at any meeting the chairman is not present within ten minutes after the time appointed for holding the same or is unwilling to act as chairman, the directors present may choose one of their number to be chairman of the meeting.

46 A resolution in writing signed by all the directors for the time being entitled to receive notice of a meeting of the directors shall be as valid and effectual as if it had been passed at a meeting of the directors duly convened and held.

FILLING OF VACANCIES

47. At the first annual general meeting of the company, all the directors shall stand retired from office, and directors shall be elected in their place in accordance with section 178 of the Ordinance for a term of three years.

48. A retiring director shall be eligible for re-election.

49. The directors shall comply with the provisions of sections 174 to 178 and sections 180 and 184 of the Ordinance relating to the election of directors and matters ancillary thereto.

50. Any casual vacancy occurring on the board of directors may be filled up by the directors, but the person so chosen shall be subject to retirement at the same time as if he had become a director on the day on which the director in whose place he is chosen was last elected as director.

51. The company may remove a director but only in accordance with the provisions of the Ordinance

CHIEF EXECUTIVE

52. The Chief Executive shall be the Chief Executive of the Company who shall be appointed by the Board of Directors of the Company. The Directors shall within 15 days of incorporation of the Company or from the date of election of directors or the office of the Chief Executive falling vacant, as the case may be, appoint, subject to the provisions of Section 198 of the Ordinance, a Chief Executive of the Company upto the date of first annual general meeting and subsequently he will hold office for a period of three years. The Board may revoke such appointment and appoint another person in place of the Chief Executive so removed or who may vacate office by reason of death, resignation or otherwise as the case may be. The Chief Executive of the Company, if required, may also be the Chairman of the Board of the Company.

53. The period for which the Chief Executive shall be appointed shall not exceed three years unless he ceases to hold office or a shorter time of appointment is fixed by the directors, or he earlier resigns or his services as Chief Executive has been terminated by the Board in accordance with the provisions of the Ordinance. On the expiry of his term of office, the Chief Executive shall be eligible for re-appointment in the manner provided in these Articles or in accordance with the provisions of the Ordinance. The terms and conditions of appointment of the Chief Executive, including his powers, duties, obligations and remuneration, shall be determined by the Board, subject to the provisions of the Ordinance and these Articles.

54. The Board shall have the powers to assess the performance of the Chief Executive every year and shall replace the Chief Executive, if his performance is found unsatisfactory in the opinion of the Board, subject to section 198 of the Companies Ordinance, 1984.

55. The Chief Executive shall hold office, enjoy and exercise such powers, duties, obligations and privileges as the Board may confer upon him from time to time and shall

accordingly in exercise of such powers delegated to him, conform to any limits and restrictions which may be imposed by the Board from time to time in this respect. The Chief Executive may exercise all such powers and do all acts and things on behalf of the Company as he may be authorized to do by the Board.

56. The Chief Executive shall be entitled to remuneration and benefits commensurate with his performance, of which determination shall be made by the Board.

57 The Chief Executive may be removed in accordance with the provisions of Section 202 of the Ordinance.

58. The Chief Executive shall also be the head of the Executive Committee and responsible for the day to day management of the Company and without prejudice to the generality of the foregoing, he shall be responsible:

i. for ensuring that the Company's Governing Principles are adhered to;

ii. for the proper administration of the affairs, funds and resources of the Company;

iii. to make draw, endorse, sign, accept, negotiate and give all cheques, bills of lading, drafts, orders, bills of exchange, promissory notes, and other negotiable instruments as may be required by and be in the interest of the Company;

iv. to secure the fulfillment of any contract, agreements or engagements entered into by the Company by mortgage or charge of all or any of the properties of the Company from time to time or in such manner as he may think fit in the interest of the Company;

v. to appoint and at his discretion to remove or suspend managers, secretaries, officers, clerks and employees, either permanent or temporary, as he may think fit and to determine their powers and duties and fix their salaries or emoluments and to require security in such instances and to such amount as he thinks fit;

vi. to prescribe the duties of all employees and staff of the Company;

vii. to institute, conduct, defend or abandon any legal proceedings by or against the Company or its officers or otherwise concerning the affairs of the Company and also to compound and allow time for payment or satisfaction of any debts due and of any claims or demands by or against the Company and for the purpose to appoint advocate(s);

viii to refer any claims or demands by or against the Company to Arbitration and observe and perform the awards;

ix. for exercising supervision and disciplinary control over the work and conduct of all employees of the Company;

x. for co-coordinating, and exercising general supervision over all the activities of the Company;

xi. for any other tasks as may be delegated by the Board.

xii. The Chief Executive may in writing delegate such of his powers, as he may consider necessary to any officer of the Company.

DIVIDENDS AND RESERVE

59. The company in general meeting may declare dividends but no dividend shall exceed the amount recommended by the directors. No dividends shall be paid otherwise than out of the profits of the Company.

THE SEAL

60. The directors shall provide for the safe custody of the seal and the seal shall not be affixed to any instrument except by the authority of a resolution of the board of directors or by a committee of directors authorized in that behalf by the directors and the presence of at least two directors; and those two directors shall sign every instrument to which the seal of the company is so affixed in their presence.

ACCOUNTS

61. The directors shall cause to be kept proper books of account as required under section 230 of the Ordinance.

62. The books of account shall be kept at the registered office of the company or at such other place as the directors shall think fit and shall be open to inspection by the directors during business hours.

63. The directors shall, under sections 233 and 236 of the Ordinance, cause to be prepared and to be laid before the company in general meeting such profit and loss accounts or income and expenditure accounts and balance sheets duly audited and reports as are referred to in those sections.

AUDIT

64. Once at least in every year the accounts of the Company shall be audited and the correctness of profit and loss accounts or income and expenditure accounts and balance sheet ascertained by an auditor or auditors and the provisions of the Ordinance in regard to audit and the appointment and qualification of auditors shall be observed.

65. Auditors shall be appointed and their duties regulated in accordance with sections 252 to 255 of the Ordinance.

WINDING UP

66. If the company is wound up, whether voluntarily or otherwise the liquidator may, with the sanction of a special resolution, divide amongst the contributories in specie or kind, the whole or any part of the assets and liabilities of the company, subject to the section 421 and other provisions of the Ordinance as may be applicable.

INDEMNITY

67. Every director and other officer or servant of the company shall be indemnified by the company against, and it shall be the duty of the directors to pay out of the funds of the company, all costs, losses and expenses which any such officer or servant may incur or become liable to be by reason of any contract entered into or thing done by such officer or servant as such in any way in the discharge of the duties of such officer or servant including traveling expenses.

68. No director or other officer of the company shall be liable for the acts, receipts, neglect or default of any other director or officer or for joining in any receipt or other act for conformity or for any loss or expenses happening to the company through the insufficiency or deficiency of title to any property acquired by order of the directors for or on behalf of the company or for the insufficiency or deficiency of any security or investment in or upon which any of the money of the company shall be invested or for any loss or damage arising from bankruptcy, insolvency or tortuous act of any person with whom any money, securities or effects shall be deposited or for any loss occasioned by any error of judgment or oversight on his part or for any other loss, damage or misfortune whatever which shall happen in the execution of his office or in relation thereto unless the same happens through his dishonesty.

NOTICES

69. (1) A notice may be given by the company to any member either personally or by sending it by post to him to his registered address or (If he has no registered address in Pakistan) to the address, if any, within Pakistan supplied by him to the company for giving of notices to him.

(2) Where a notice is sent by post service of the notice shall be deemed to be effected by properly addressing, prepaying and posting a letter containing the notice and, unless the contrary is proved, to have been effected at the time at which the letters would be delivered in the ordinary course of post.

70. A notice may be given by the company to the joint-holders of the share by giving the notice to the joint-holder named first in the register in respect of the share.

ARBITRATION

71. Whenever any difference arises between the company on the one hand and any of the members, their executors, administrators or assignees on the other hand touching the intent or construction or the incidence or consequences of these presents, or of the statute or touching anything then or thereafter done, executed, omitted, or suffered in pursuance of these presents or of the statute or touching breach or alleged breach or otherwise relating to the premises, or to any statute effecting the company, or to any of the affairs of the company, including the fixing of the fair value of the shares of the company, every such difference shall be referred to the decision of an arbitrator to be appointed by the parties in difference or if they cannot agree upon a single arbitrator to the decision of two arbitrators of whom one shall be appointed by each of the parties in difference or any umpire to be appointed by the two arbitrators.

SECRECY CLAUSE

72. Every director, manager, member of the committee, officer, servant, accountant or other person employed in the business of the Company shall if so require by the directors before entering upon his duties, sign a declaration pledging to observe a strict secrecy respecting all transactions of the company with the customers and the state of accounts with individuals, matters relating thereto and shall by such declaration pledge himself not to reveal any of the matters which come to his knowledge in the discharge of his duties except when required to do so by the directors or by a Court of Law and except so far as may be necessary in order to comply with any of the provisions in these presents contained.

We the several persons, whose names and addresses are subscribed below are desirous of being formed into a Company in pursuance of the Articles of Association and we respectively agree to take the number of shares in the capital of the Company set opposite our respective names:-

Name and surname (present & former) in full (in Block Letters)	CNIC No. (in case of foreigner, Passport No)	Father's/ Husband's Name in full	Nationality with any former Nationality	Occupation	Residential Address in full	Number of shares taken by each subscriber	Signatures
Vanh Aslam Khan	42301-0652499-9	Aslam R Khan	PAKISTANI	Business	122/1, Khayaban-e-Ghazi, Phase 6, DHA, South Karachi	6,000	
Dost Muhammad Qureshi	42101-1845205-3	Sultan Muhammad Qureshi	Pakistani	Business	House No D-159, Block-B, Haidri North Nazimabad, Karachi	1,000	
Hamid Hassan Khan	61101-4968730-9	Shafaat Ahmad Khan	PAKISTANI	Business	House No 10, Street No. 80, G-6/4, Islamabad	1,000	
Moin us Samad Khan	42201-2511144-7	Muhammad Abdul Haleem Khan	PAKISTANI	Business	Flat No A-4, Universal Heights, Gulistan-e-Johar, Block-16, Karachi	1,000	
Tanvir Muhammad Qureshi	42000-3019279-1	Dost Muhammad Qureshi	PAKISTANI	Business	House No D-159, Block-B, Haidri North Nazimabad, Karachi	1,000	
					Total number of shares taken	10,000	
					(Ten Thousands Only)		

Dated the 11th day of April 2014

CERTIFIED TO BE TRUE COPY

Witness to above signatures.

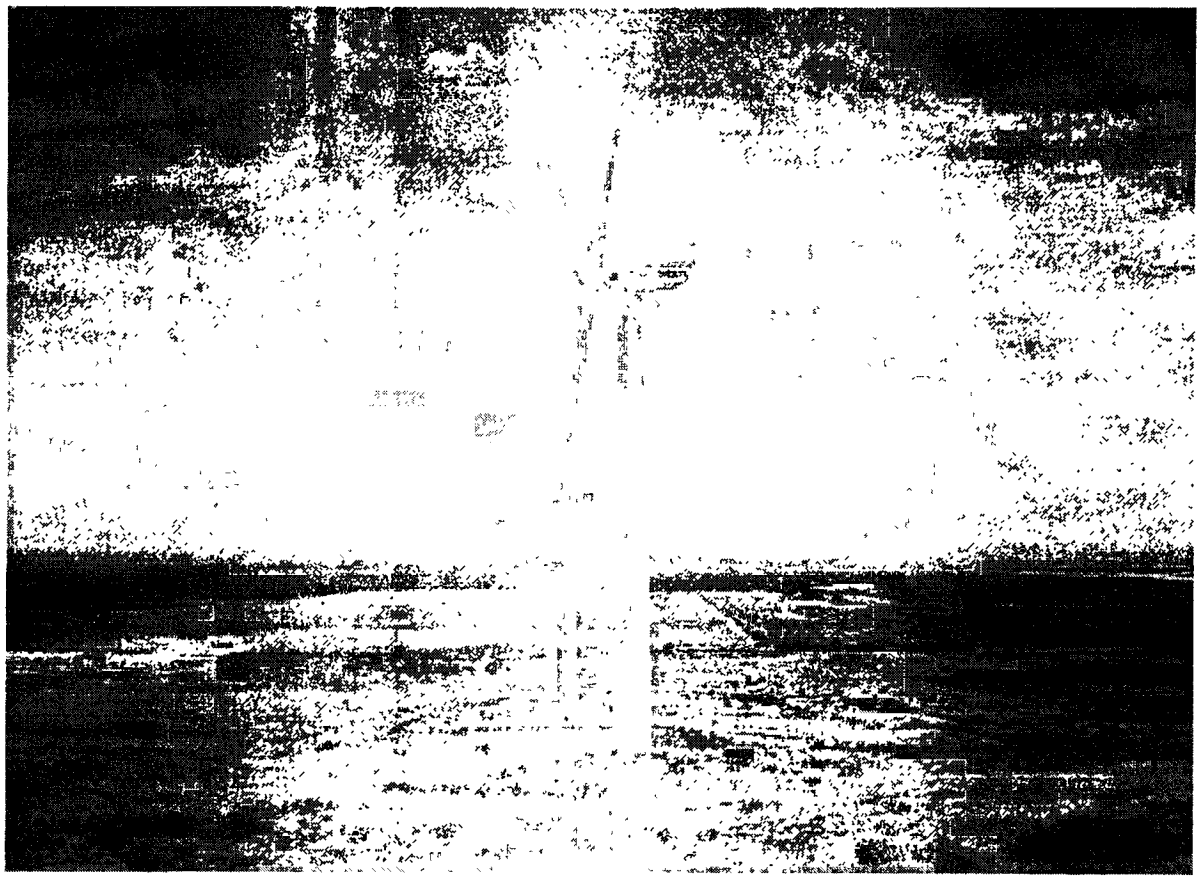
National Institutional Facilitation Technologies (Pvt) Ltd.
5th Floor, AWT Plaza I.I. Chundrigar Road.
Karachi, Pakistan.

Deputy Registrar
Company Registration Office Islamabad

Company Registration Office Islamabad

PROJECT FEASIBILITY REPORT

50 MW WIND POWER PROJECT AT JHAMPIR, THATTA



Project Company:

Hartford Alternative Energy Pvt Limited

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Acknowledgements

The management of Hartford Alternative Energy (Pvt.) Limited (HAEPL) is thankful to Alternative Energy Development Board for generous support at all stages of project development and looks forward to continue for future milestones.

The management of HAEPL also recognizes the cooperation of Government of Sindh and other Government departments (NEPRA, NTDC, HESCO, SEPA) which was extended at every stage of the project.

Copyright Notice

1 EXECUTIVE SUMMARY

In light of the threefold global crisis mankind is facing currently – the energy crisis, the finance crisis and the environment/climate crisis – it is becoming more and more obvious that wind energy offers solutions to all of these huge challenges, offering a domestic, reliable, affordable and clean energy supply.

At this point of time it is difficult to predict the short-term impacts of the credit crunch on investment in wind energy. However, In the mid to long term it is clear that wind energy investments will rather be strengthened due to their low-risk character and societal and additional economic benefits. Investment in a wind turbine today means that the electricity generation cost is fixed to the major extends over the lifetime of the wind turbine. Wind energy implies no expenses on fuel and operation and maintenance costs are usually well predictable and rather marginal, in relation to the overall investment.

Pakistan is also facing the severe problem of high energy demand to sustain the economic growth and development. This comes with the dire fact that the conventional sources of energy, the fossil fuels, are depleting. The environmental impacts of these conventional energy sources are also alarming. This has led towards the development of alternative energy resources especially wind energy so that fuel diversification is achieved and energy systems are not highly vulnerable to shortages or prices increases of a particular fuel. The Government of Pakistan has clearly articulated its support for the development of renewable energies through Renewable Energy Policy 2006 to the world.

Hartford Alternative Energy Pvt Ltd (HAEPL) is entering into Pakistan's wind energy market by developing a 50MW wind farm in sindh province, south of Pakistan. To determine the feasibility of the project HAEPL has conducted necessary technical and environmental studies to develop a detailed project feasibility study. One of the major outcomes of this study is an essential range of production numbers at the selected generator for the project. These are required for further economical and financial evaluations of the project.

A total of two wind measuring masts have been considered for the calculation of annual energy yield at the project site of HAE. These wind measuring masts are installed in the neighboring area of HAEPL wind farm.

- FFC Energy Limited Mast (FFCEL)
- Lucky Energy (Pvt) Limited Mast (LEPL)

The detailed wind data analysis has been made on the above mentioned wind measuring masts. However, the wind measuring mast of FFCEL has been used for the calculation of Annual Energy Yield for 50 MW wind power project of HAEPL. The mast of FFCEL has been selected mainly due to the following reasons:

- Installation arrangements of the mast are of IEC compliance
- Measnet Calibrated Anemometers
- Highest recording period/ Long term data
- Good data coverage for all the instruments during the measurement period
- Site conditions of project site are similar to that of FFCEL mast site.
- In close proximity of the project site than the other wind measuring masts

The analysis is made on two layouts of the project, one with considering all the proposed neighboring wind farms in the vicinity and second with consideration that HAEPL is the only wind farm in the vicinity. Details can be seen through the respective chapters of the document.

2. GLOBAL WIND ENERGY INDUSTRY

2.1 WIND ENERGY BACKGROUND

The kinetic energy in the wind is a promising source of renewable energy with significant potential in many parts of the world. The energy that can be captured by wind turbines is highly dependent on the local average wind speed. Regions that normally present the most attractive potential are located near coasts, inland areas with open terrain or on the edge of bodies of water. Some mountainous areas also have good potential. In spite of these geographical limitations for wind energy project siting, there is ample terrain in most areas of the world to provide a significant portion of the local electricity needs with wind energy projects.

2.2 HISTORY OF WIND POWER

Wind energy has been used for thousands of years for a wide variety of purposes; its early harnessing, via sails, as a means of ship propulsion played a significant role in the expansion of the early empires. When static windmills were first used on land is uncertain, but it has been suggested that the Babylonian Emperor Hammurabi used them for an irrigation scheme in 700 BC.

By the 18th century, what we commonly call the Dutch windmill was becoming a common sight across Europe, used not only for the milling of corn and similar products, but also for lifting water for irrigation purposes. The other prominent development was the wind pump which sprung up all over rural America, Australia, and elsewhere as a means of pumping water from deep boreholes for cattle grazing and farm irrigation. It is estimated that there were 5 million such machines in the USA around 1900. Many can still be seen functioning around the world, apart from their frequent scene-setting role in Hollywood movies.

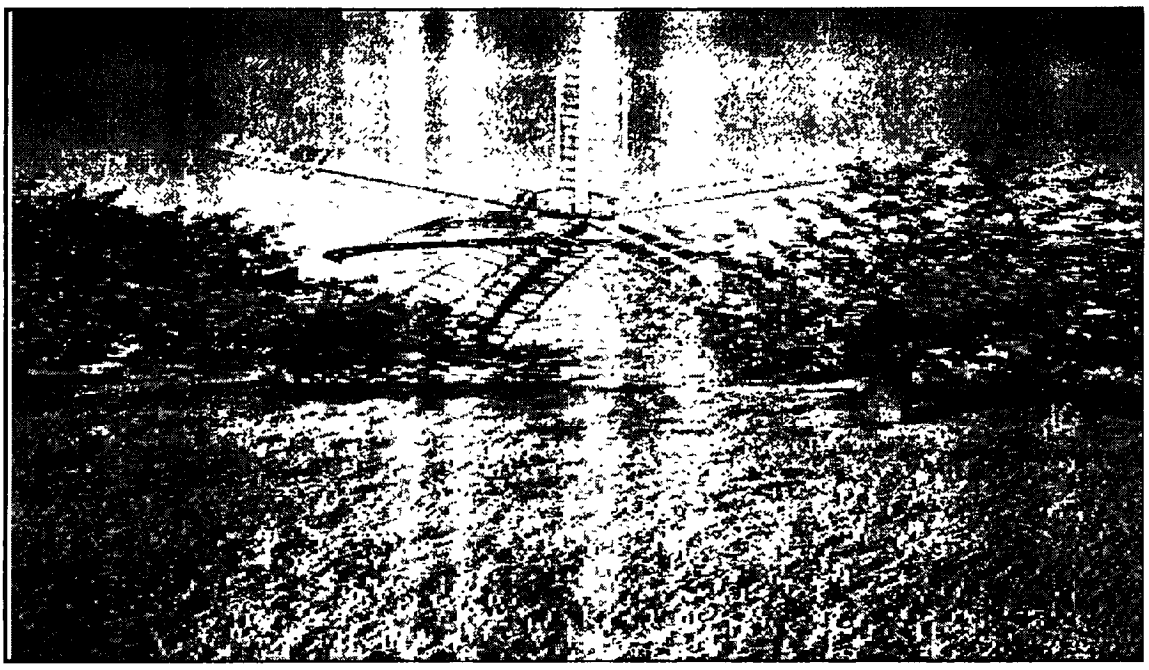


Figure 2-1: An old turbine

Between 1900 and the oil crisis of 1973 there was no sustained development of wind energy, although the odd electricity generating wind turbine did appear from time to time. However, the basis for the modern wind turbine for electricity generation was set during that period by European inventors such as Poul la Cour and Johannes Juul in Denmark and Ulrich Hütter in Germany.

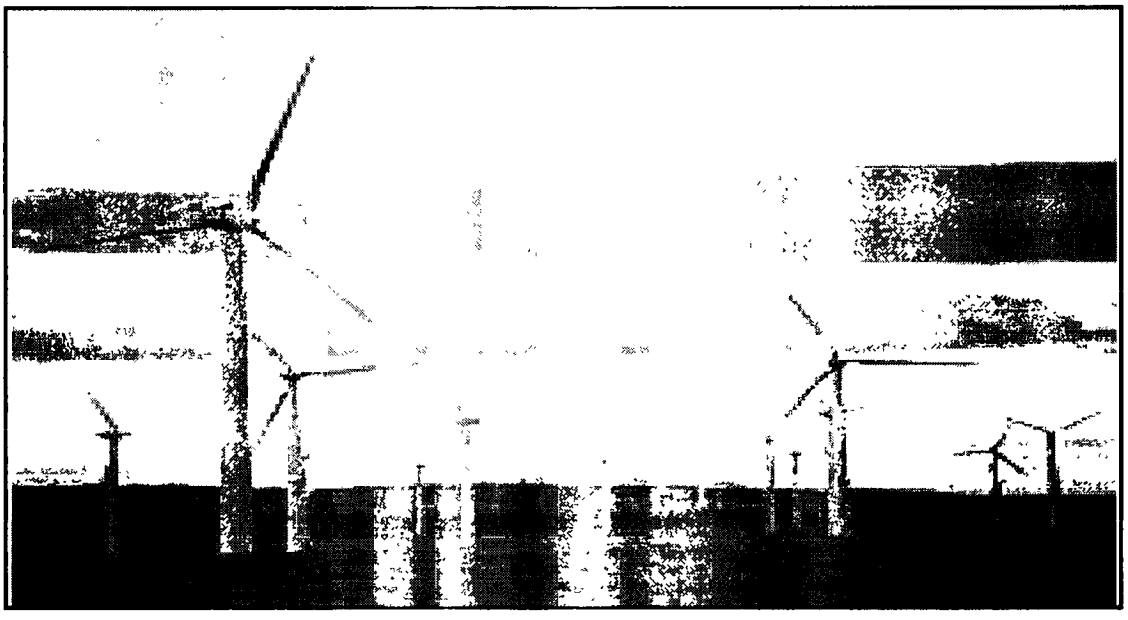


Figure 2-2: Modern Day Wind Turbine

The USA was the first nation to invest heavily in wind energy, and in the early 1980s Californian wind farms served as a beacon to researchers and enthusiasts around the world. Activities increased in many western European countries but the falling back of oil prices tended to reduce the political and economic pressure for rapid progress. Various European countries continued to invest individually in the harnessing of wind energy for electricity production and rapid progress was made during the last quarter of the 20th century. The cost of wind-produced electricity from favorable sites is already competitive with fossil-fuel sources.

Today, wind turbines are gigantic rotating machines with blades up to twice the length of the largest plane wings. Nacelles with gearboxes and generators weighing more than a jumbo jet are erected on top of 120-metre masts, and rotors sweep an area the size of a football field. Wind technology can no longer borrow research from other sectors: it needs to forge ahead on its own.

2.3 DESCRIPTION OF WIND TURBINES

Wind turbine technology has reached a mature status during the past 15 years as a result of international commercial competition, mass production and continuing technical success in research and development (R&D). The earlier concerns that wind turbines were expensive and unreliable have largely been allayed. Wind energy project costs have declined and wind turbine technical availability is now consistently above 97%. Wind energy project plant capacity factors have also improved from 15% to over 30% today, for sites with a good wind regime.

Modern wind energy systems operate automatically. The wind turbines depend on the same aerodynamic forces created by the wings of an aeroplane to cause rotation. An anemometer that continuously measures wind speed is part of most wind turbine control systems. When the wind speed is high enough to overcome friction in the wind turbine drive train, the controls allow the rotor to rotate, thus producing a very small amount of power. This cut-in wind speed is usually a gentle breeze of about 4m/s. Power output increases rapidly as the wind speed rises. When output reaches the maximum power the machinery was designed for, the wind turbine controls govern the output to the rated power. The wind speed at which rated power is reached is called the rated wind speed of the turbine, and is usually a strong wind of about 15 m/s. Eventually, if the wind speed increases further, the control system shuts the wind turbine down to prevent damage to the machinery. This cut-out wind speed is usually around 25 m/s.

The major components of modern wind energy systems typically consist of the following:

- Rotor, with 2 or 3 blades, which converts the energy in the wind into mechanical energy onto the rotor shaft;
- Gearbox to match the slowly turning rotor shaft to the electric generator;
- Tall tower which supports the rotor high above the ground to capture the higher wind speeds;
- Solid foundation to prevent the wind turbine from blowing over in high winds and/or icing conditions; and
- Control system to start and stop the wind turbine and to monitor proper operation of the machinery.

Following figure illustrates the configuration of a typical "Horizontal Axis Wind Turbine" or HAWT wind energy system. A "Vertical Axis Wind Turbine" or VAWT is an equally viable alternative design, although it is not as common as the HAWT design in recent projects implemented around the world.

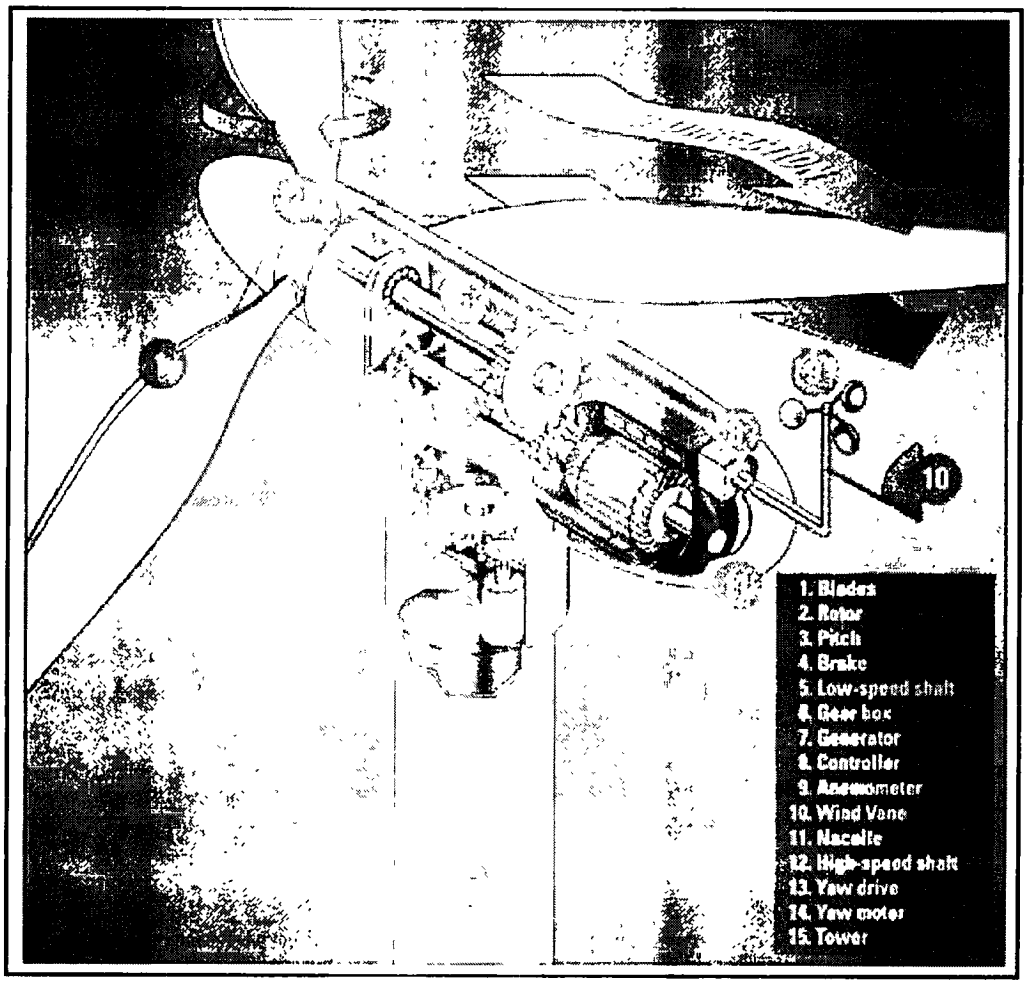


Figure 2-3. Horizontal Axis Wind Turbine

2.4 WIND ENERGY APPLICATION MARKETS

Wind energy markets can be classified based on the end-use application of the technology. Wind energy projects are common for off-grid applications. However, the largest market potential for wind energy projects is with on-grid (or grid-connected) applications.

2.4.1 OFF-GRID APPLICATIONS

Historically, wind energy was most competitive in remote sites, far from the electric grid and requiring relatively small amounts of power, typically less than 10 kW. In these off-grid applications, wind energy is typically used in the charging of batteries that store the energy captured by the wind turbines and provides the user with electrical energy on demand. Water pumping, where water, rather than energy, can be stored for future use, is also a key historical application of wind energy. The key competitive area for wind energy in remote off-grid power applications is against electric grid extension, primary (disposable) batteries, diesel, gas and thermoelectric generators. Wind energy is also competitive in water pumping applications.

2.4.2 ON-GRID APPLICATIONS

In on-grid applications the wind energy system feeds electrical energy directly into the electric utility grid. Two on-grid application types can be distinguished.

2.4.2.1 ISOLATED-GRID ELECTRICITY GENERATION

Wind turbine generation capacities typically ranging from approximately 10kW to 200kW Isolated-grids are common in remote areas. Electricity generation is often relatively expensive due to the high cost of transporting diesel fuel to these isolated sites. However, if the site has good local winds, a small wind energy project could be installed to help supply a portion of the electricity requirements. These wind energy projects are normally referred to as wind-diesel hybrid systems. The wind energy system's primary role is to help reduce the amount of diesel fuel consumption.

2.4.2.2 CENTRAL-GRID ELECTRICITY GENERATION

Wind turbine generation capacities typically ranging from approximately 200kW to 2MW Central-grid applications for wind energy projects are becoming more common. In relatively windy areas, larger scale wind turbines are clustered together to create a wind farm with capacities in the multi-megawatt range. The land within the wind farm is usually used for other purposes, such as agriculture or forestry. Another common approach for wind energy project development includes the installation of one or larger scale wind turbines by individuals, businesses or co-operatives.

2.5 WIND FARM DEVELOPMENT

A wind farm consists of a number of wind turbines (which are often installed in rows perpendicular to the wind direction), access roads, electrical interconnections and a substation, a monitoring and control system and a maintenance building for the larger farms. The development of a wind energy project includes the determination of the wind resource, the acquisition of all authorizations and permits, the design and specification of the civil, electrical and mechanical infrastructure, the layout of the wind turbines, the purchasing of the equipment, the construction and the commissioning of the installation. Construction involves preparing the site, grading roads, building turbine foundations, installing the electrical collection lines and transformers, erecting the turbines and construction of the substation and building.

The wind resource assessment and approvals for a wind farm are often the longest activities in the development of the wind energy project. These can take up to 4 years in the case of a large wind farm requiring a comprehensive environmental impact study. The construction itself can normally be completed within a few months. The precise determination of the wind resource at a given site is one of the most important aspects in the development of a wind energy project as the available wind resource at the project site can dramatically impact the cost of wind energy production. In the case where a pre-feasibility study indicates that a proposed wind energy project could be financially viable, it is typically recommended that a project developer take at least a full year of wind measurements at the exact location where the wind energy project is going to be installed.

For very small-scale projects (e.g. off-grid battery charging and water pumping), the cost of wind monitoring could actually be higher than the cost to purchase and install a small wind turbine. In this case a detailed wind resource assessment would normally not be completed.

2.6 GROWTH TRENDS OF WIND INDUSTRY

Wind Power has proven to be the fastest growing renewable energy technology in the world from a mere 6,100 MW in 1996 to visible more than 196 630 Megawatt by the end of year 2010. It is registered that the installed wind capacity is more than doubling every third year. The turnover of the wind sector worldwide reached 40 billion Euro (55 billion US$) in 2010 and about 670 000 persons were employed worldwide directly and indirectly in the various branches of the wind sector. Within five years, the

number of jobs almost tripled, from 235 000 in 2005. The success of the industry has attracted investors from the mainstream finance and traditional energy sectors.

Proportion of electricity generation from wind energy to the conventional sources is growing at a speed that seems to challenge the traditional electricity sources. The significance is visible from the moves made by major world industry players in the conventional markets such as British Petroleum and General Electric who have entered this emerging market with huge investments.

In the year 2010, the wind capacity reached worldwide 196 630 Megawatt, after 159 050 MW in 2009, 120 903 MW in 2008, and 93 930 MW in 2007.

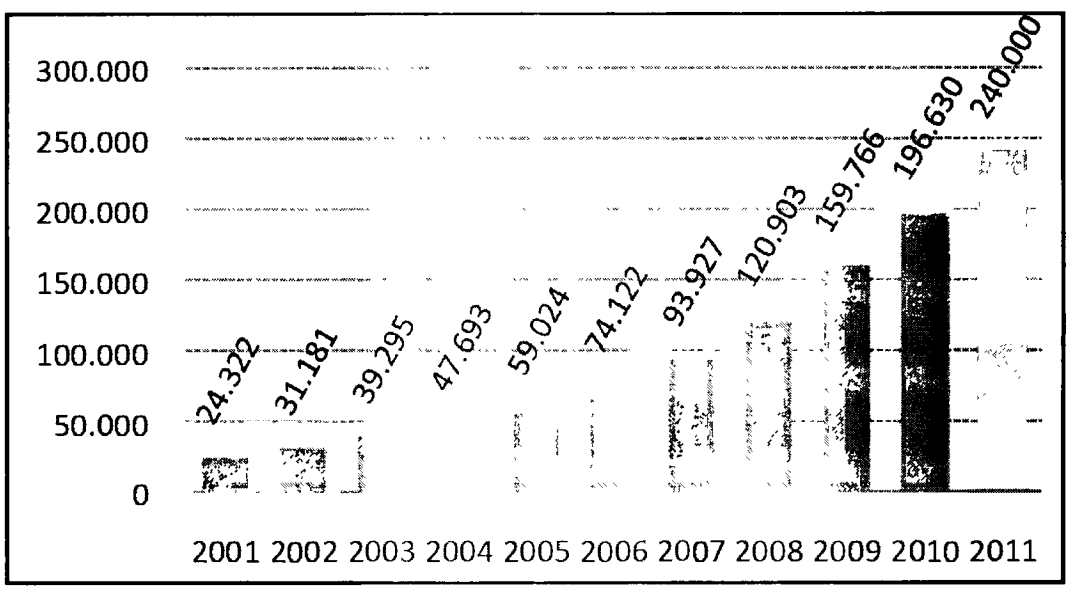


Figure 2-4. Global Installed Capacity by Year[1]

The top five countries (USA, China, Germany, Spain and India) represented 74,2 % of the worldwide wind capacity, significantly more than 72.9 % in the year. The USA and China together represented 43,2 % of the global wind capacity (up from 38,4 % in 2009).

[1] World Wind Energy Report by WWEA, 2010

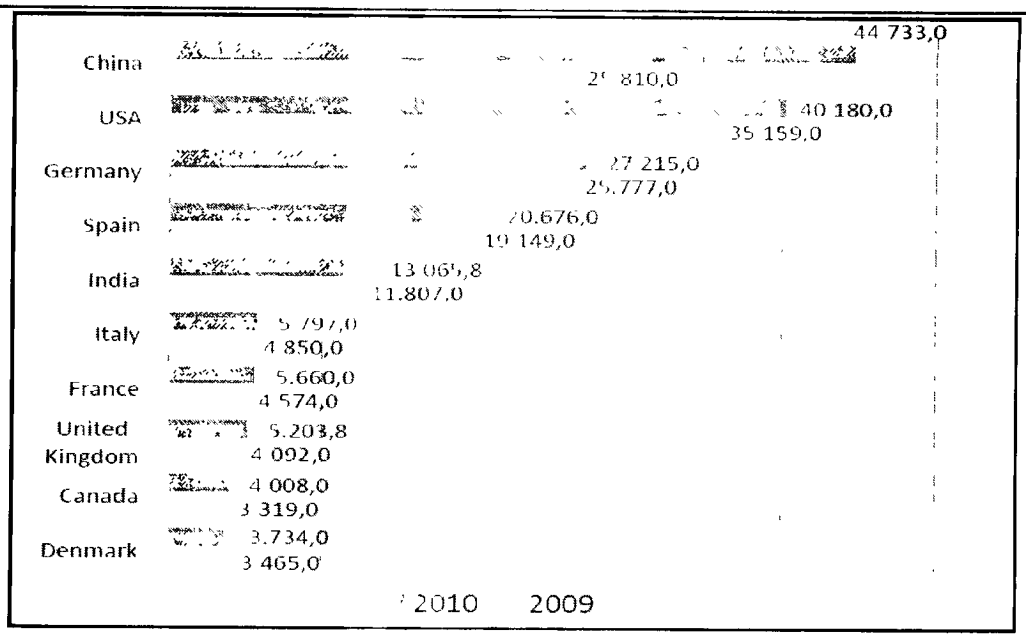


Figure 2-5: Top 10 Wind Power Producers in the World[2]

According to the recent newsletter published on February 7th, 2012 by WWEA, the latest shape of statistics for the year ending 2011 is given below:

[2] World Wind Energy Report by WWEA, 2010

Table 2-1: Top Wind Power Generating Countries (Comparison of 2009, 2010 & 2011)[3]

Country	Total Capacity end of 2011 [MW]	Added Capacity 2011 [MW]	Total Capacity end 2010 [MW]	Added Capacity 2010 [MW]	Total Capacity end 2009 [MW]
China *	62.733	18.000	44.733	18.928	25.810
USA	46.919	6.810	40.180	5.600	35.159
Germany	29.075	2.007	27.215	1.551	25.777
Spain	21.673	1.050	20.676	1.515	18.865
India *	15.800	2.700	13.065	1.258	11.807
Italy *	6.747	950	5.797	950	4.850
France	6.640	980	5.660	1.086	4.574
United Kingdom	6.018	730	5.203	962	4.245
Canada	5.265	1.267	4.008	690	3.319
Portugal *	4.290	588	3.702	345	3.357
Denmark	3.927	180	3.803	309	3.460
Sweden	2.816	746	2.052	603	1.450
Japan	2.501	167	2.334	251	2.083
Rest of the World*	24.200	6.000	18.201	3.191	15.010
Total*	238.604	42.175	196.629	37.642	159.766

* Preliminary Data

The world market for wind turbines set a new record in the year 2011 and reached a total size of 42Gigawatt, after 37,6 Gigawatt in 2010. According to the preliminary data gathered by WWEA and published on the occasion of the 3rd WE.20 by 2020 conference in Coimbatore/India, the total capacity worldwide has come close to 239 Gigawatt, enough to cover 3% of the world's electricity demand.

[3] WWEA Latest Newsletter about Installations during 2011

2.7 WIND ENERGY IN ASIA

The total installed wind capacity in Asia by the end of year 2010 reached 61,2 GW (31,1 % of the global capacity). The continent had the highest growth rate of all world regions and added 20,6 GW in 2009.

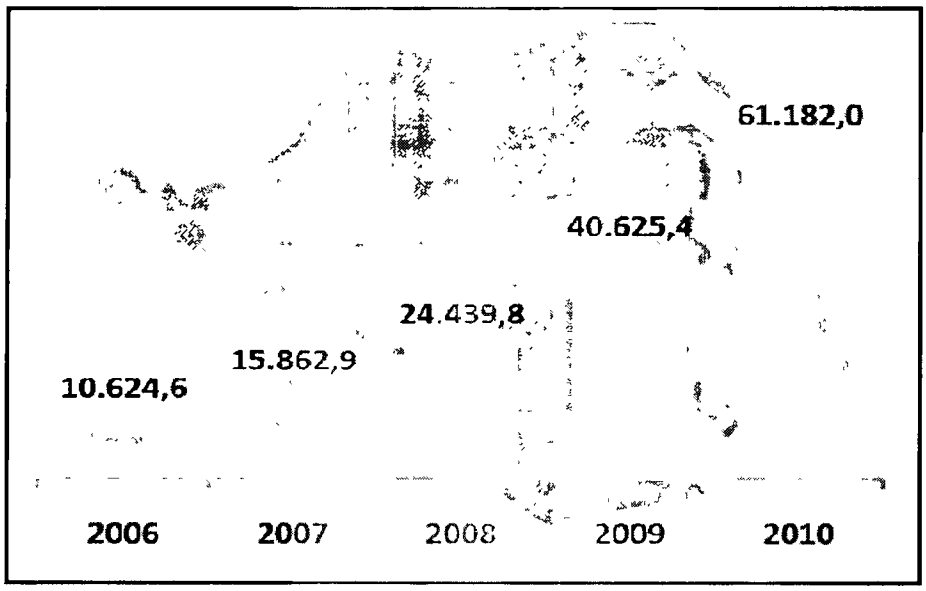


Figure 2-6. Total Installed Wind Energy in Asia[4]

2.8 WIND SHARE IN ELECTRICITY SUPPLY

All wind turbines installed globally by the end of the year 2010 contribute potentially 430 Terawatthours to the worldwide electricity supply which represents 2,5 % of the global electricity demand.

This energy amount is more than the electricity needs of the United Kingdom, an industrialised country with more than 60 million inhabitants, and the sixth largest economy in the world.

In some countries and regions wind has become one of the largest electricity sources. Again in terms of wind share, Denmark is the world leader. The countries with the highest wind shares are:

- Denmark: 21 %
- Portugal: 18 %

[4] World Wind Energy Report by WWEA, 2010

- Spain: 16 %
- Germany: 9 %

In China, wind contributed 1,2 % to the overall electricity supply, while in the USA the wind share has reached about 2 %.

3. PAKISTAN ELECTRICITY MARKET

3.1 ELECTRICITY SUPPLIERS

The electricity suppliers in Pakistan are given below:

- Water & Power Development Authority with 11,399 MW installed capacity is the largest utility company in Pakistan and provides services to the entire country except Karachi.

- Karachi Electric Supply Company (KESC, http://www.kesc.com.pk) with installed capacity of 1,995MW supplies Karachi with electricity.

- Pakistan Atomic Energy Commission (PAEC, http://www.paec.gov.pk) has installed capacity of 462MW from Chasma 1.

- Independent Power Producers (IPPs) have an installed capacity of 7,678MW (http://www.ppib.gov.pk).

WAPDA and PAEC are government entities, while KESC and IPPs operate in private sector.

The primary energy supply by suppliers is shown below:

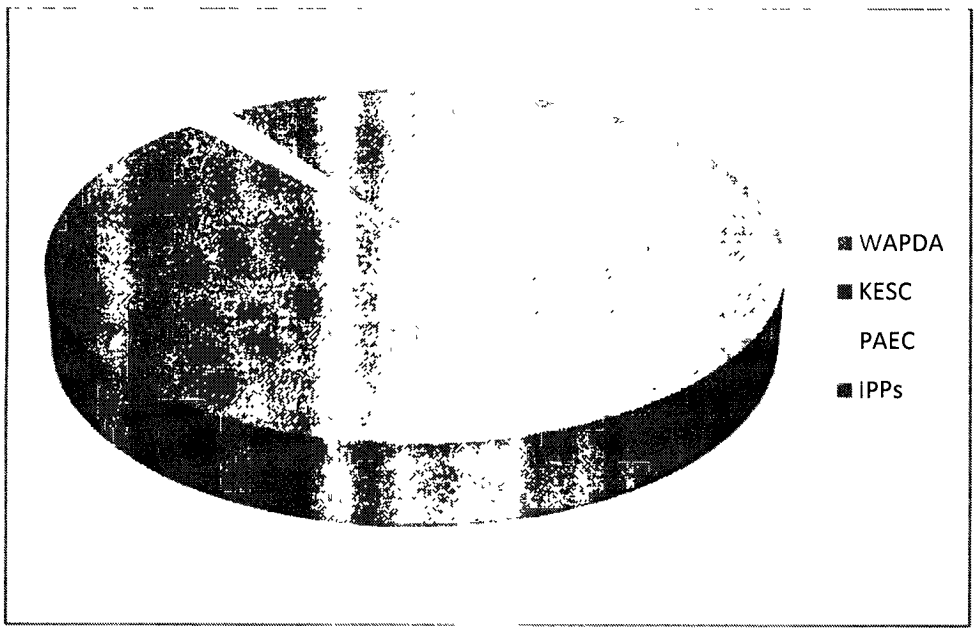


Figure 3-1: Percentage Share of Electricity Suppliers in Pakistan[5]

3.2 ELECTRICITY GENERATION SOURCES

The major sources of electricity generation are:

- Thermal (both Gas & Oil)
- Hydro Power
- Nuclear Power

Thermal generation capacity is distributed among WAPDA, IPPs and KESC. Hydro Power is owned by WAPDA and Nuclear by PAEC.

The total existing installed capacity during 2009-10 is 20,190MW in the form of thermal, hydro and nuclear power plants. KESC has 1955MW capacity in the form of thermal and nuclear power plants (source: Energy security Report published by Planning Commission of Pakistan)

[5] Economic Survey of Pakistan 2009-10 published by Ministry of Finance

There are a very small number of captive power stations for industrial groups which are mostly thermal. A few are generating electricity from bagasse (residual waste in sugar mills) during the sugar cane crushing seasons.

In term of renewable sources, there are a few personal/ off grid installation of wind and solar power. The on grid projects are all in the development phase except one project of 50MW, which has installed its first 6MW capacity. Another 50MW wind power project is in the construction phase and will achieve the COD in November 2012.

3.3 POWER CRISIS

An increase in industrialization is accompanied by an increase in electricity demand. The non-availability of natural resources for expansion of the power sector has widened the gap between demand and supply, which has resulted in excessive and frequent load shedding. The shortfall in supply could be the major cause for stunned growth in the industrial sector in Pakistan. At the moment industrial units are facing a dichotomous situation where market sources demand increased production, especially of consumer products, while the utility infrastructure fails to keep pace with this requirement. This dilemma is typical for organizations which see the potential for enhancing the market share of their products, while the utility infrastructure fails to keep pace with this requirement. This dilemma is typical for organizations which see the potential for enhancing the market share of their products but are facing constraints in the reliability and supply of electricity.

The demand for electricity has continued to increase by out pacing the growth rate of the economy. A power shortage was likely to appear in 2006 which did and forced the utilities to ge for load-shedding. The shortfall at times crosses 5,000MW and this is the time when urban areas have 8-12 hours of load shedding and small cities/ rural areas have 18 hours of load shedding.

The industry having its self-generation on gas has a suspended supply of gas for 2-3 days a week during winters.

The situation is so scary that Government even had to opt for early shut down of markets, two holidays per week, suspension of private functions etc; which reduced the productive working time and shortened the social life of the people. Electricity consumption by the sector is shown below:

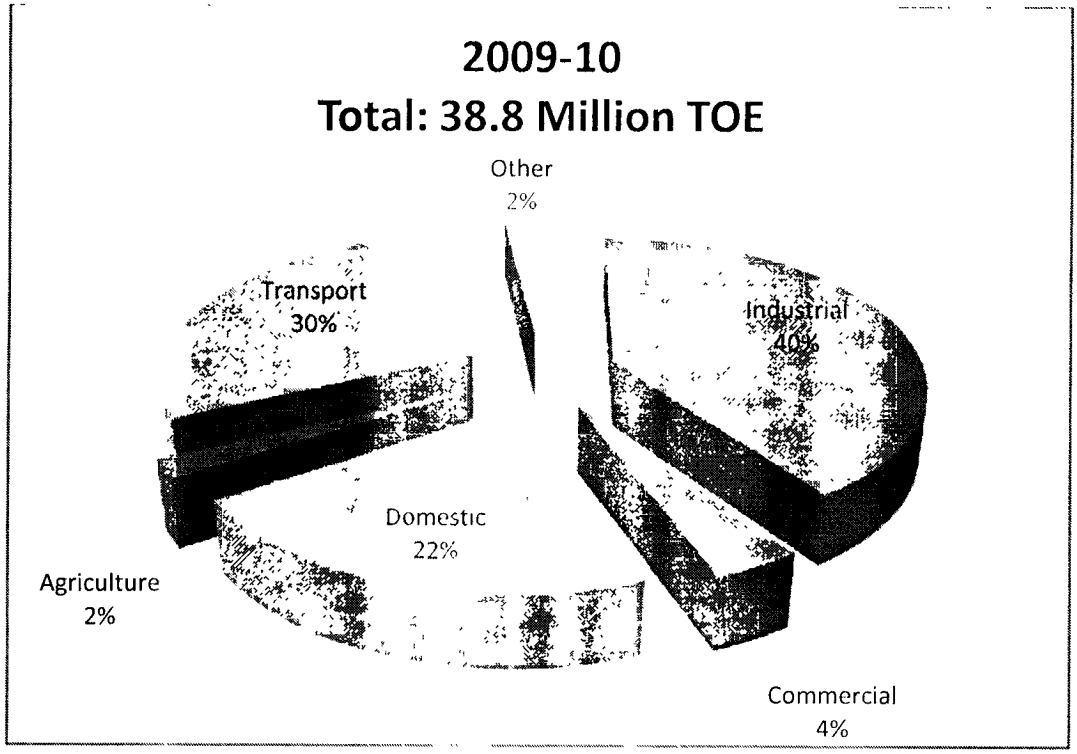


Figure 3-2: Energy Consumption by Sector[6]

Increase in electricity demand is directly linked to the growth of the country's economy. Keeping in view the sustained growth in all sectors of the economy in the coming years, it is expected that future demand for electricity will rise to more than 20,000MW in near future.

Supply of electricity as compared to demand has been stagnant for last decade or so with very little additions.

The typical capacity factor of thermal IPPs is 60% and that of hydro power is 80%. Once transmission and distribution losses of 22% and auxiliary consumption of 4% are added, the situation starts to look further bleak.

[6] Pakistan Energy Year Book, 2010

Table 3-1: Total Installed Generation Capacity[7]

S.No	Power Company	Installed Capacity 2008-09	Share (%)	Installed Capacity 2009-10	Share (%)	Change
1	WAPDA	11,454	57.9	11,399	56.5	-0.5
	Hydel	6,555	57.2*	6,555	57.5*	0.0
	Thermal	4,899	42.8*	4,844	42.5*	-1.1
2	IPPs	5,954	30.1	6,374	31.6	7.1
3	Nuclear	462	2.3	462	2 3	0.0
4	KESC	1,910 0	9 7	1 955.0	9 7	2.4
	Total	19,780	100.0	20,190	100.0	2.1
*: Share in WAPDA system						

Main drivers for the growth are industrial and domestic users. The demand for electricity from the industrial sector, given current growth trends, is going to rise substantially over the next five years. There has also been a rapid increase in the number of electricity consumers in recent years. This is due primarily to rapid urbanization and also the extension of the national grid to include an increased number of rural areas. In fact, village electrification has been a central part of the government's agenda.

The electricity demand and supply analysis is shown below:

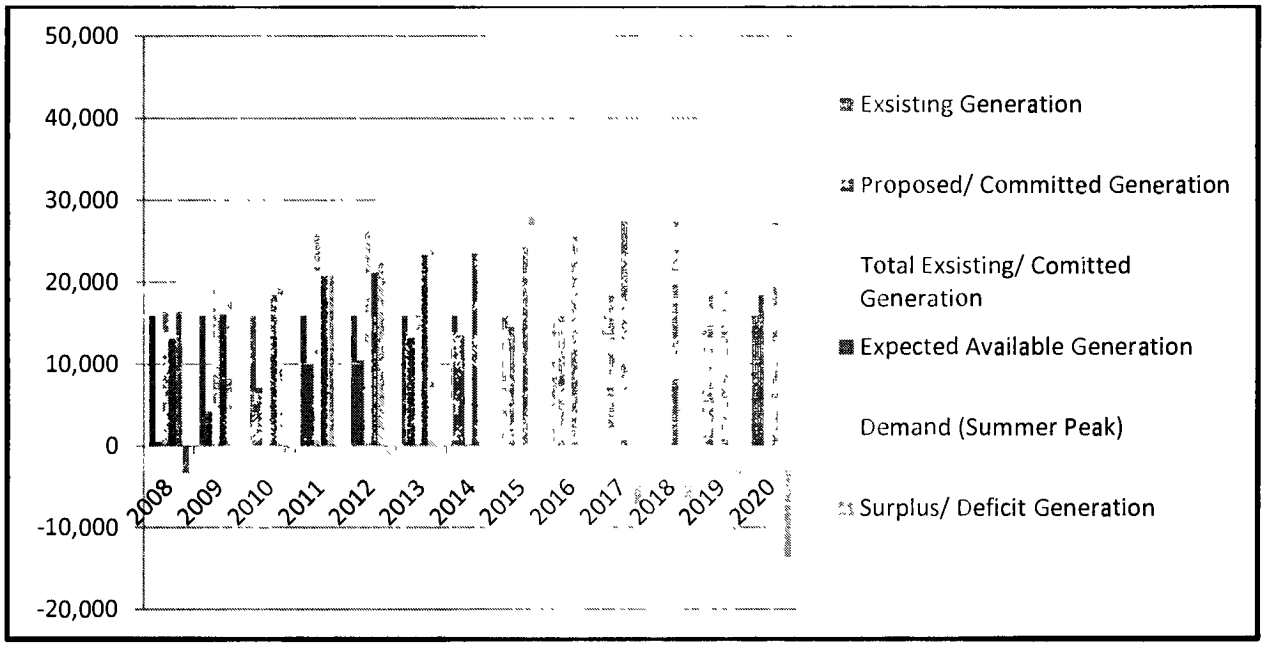


Figure 3-3: Electricity Demand Supply Analysis[8]

[7] Hydrocarbon Development Institute of Pakistan & PEPCO
[8] Private Power & Infrastructure Board (PPIB) – Government of Pakistan

3.4 NECESSITY OF WIND ENERGY IN POWER SECTOR OF PAKISTAN

The Government of Pakistan has achieved rapid economic growth during the past 10 years. The Government of Pakistan is making concerted efforts to speed up the development of energy resources to effectively contribute to the nation's economic growth. Pakistan, which suffers from a perennial insufficiency of energy supply, has enthusiastically taken up energy issues since the 1990's. However, the insufficiency of energy supply has obstructed the social and economic growth of Pakistan without definite resolution.

At present, Pakistan's major electricity sources are thermal and hydro generation, meeting approximately 70% and 28% (respectively) of the country's annual electricity demand. The primary thermal generation fuels employed are furnace oil and gas. While both are produced domestically, demand for oil already outstrips supply by a considerable amount, and gas demand is expected to outstrip domestic supply within a few years. Oil imports are already a significant burden on the national exchequer and the increasing import bill continues to exert further pressure on the foreign exchange reserves.

Importation of gas could be seen as a viable option to overcome the depleting domestic reserves, but gas import has significant issues, mainly the need for substantial capital investment in infrastructure, security difficulties and physical terrain concerns. Moreover, it would increase Pakistan's reliance on imported fuels with associated foreign exchange effects. This must be considered in the context of rising fuel costs for gas and oil-based fuels as a result of uncertainty over future supply.

Increase of energy utilization will be expected by securing preparation of the infrastructure of energy supply since further economic growth will be expected in the near future. On the other hand, expansion of the nation's energy consumption will cause the following negative issues:

a. Deterioration of the trade balance due to increase in imports of oil and oil products.
b. Negative impacts on the global environment due to consumption of hydrocarbon fuels.

Securing alternative fuels and the technical management should be strengthened to solve these problems. Alternatives to further fuel imports for electricity generation are the use of domestic coal, or generation from hydro-electric or other renewable sources, such as wind power. Potential of wind energy in Pakistan has not been properly explored in the past. There is large potential of power generation from wind energy available in the country. The development of wind generation projects could reduce dependence on fuels for thermal power generation, increase diversity in Pakistan's electricity generation mix, and reduce

greenhouse gas (GHG) emissions through the avoidance of thermal power generation. Also the per kWh tariff for wind power projects are comparatively less than that of furnace oil tariff.

4. CARBON CREDITS

4.1 THE KYOTO PROTOCOL

The Kyoto Protocol to the United Nations Framework Convention on Climate Change will strengthen the international response to climate change. Adopted by consensus at the third session of the Conference of the Parties (COP) in December 1997, it contains legally binding emissions targets for Annex I (industrialized) countries. By arresting and reversing the upward trend in greenhouse gas emissions that started in these countries 150 years ago, the Protocol promises to move the international community one step closer to achieving the Convention's ultimate objective of preventing dangerous anthropogenic [man-made] interference with the climate system.[9]

4.2 EMISSION REDUCTIONS

The developed countries are to reduce their collective emissions of six key greenhouse gases by at least 5%. This group target will be achieved through cuts of 8% by Switzerland, most Central and East European states, and the European Union (the EU will meet its group target by distributing different rates among its member states); 7% by the US; and 6% by Canada, Hungary, Japan, and Poland. Russia, New Zealand, and Ukraine are to stabilize their emissions, while Norway may increase emissions by up to 1%, Australia by up to 8%, and Iceland 10%. The six gases are to be combined in a "basket", with reductions in individual gases translated into "CO2 equivalents" that are then added up to produce a single figure.

Each country's emissions target must be achieved by the period 2008 - 2012. It will be calculated as an average over the five years. "Demonstrable progress" must be made by 2005. Cuts in the three most important gases carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O) will be measured against a base year of 1990 (with exceptions for some countries with economies in transition). Cuts in three long-lived industrial gases – hydro fluorocarbons (HFCs), per fluorocarbons (PFCs), and sulphur hexafluoride (SF6) - can be measured against either a 1990 or 1995 baseline. (A major group of industrial gases, chlorofluorocarbons, or CFCs, are dealt with under the 1987 Montreal Protocol on Substances that Deplete the Ozone Layer.)

[9] Source: European Commission

Actual emission reductions will be much larger than 5%. Compared to emissions levels projected for the year 2000, the richest industrialized countries (OECD members) will need to reduce their collective output by about 10%. This is because many of these countries will not succeed in meeting their earlier non-binding aim of returning emissions to 1990 levels by the year 2000, and their emissions have in fact risen since 1990. While the countries with economies in transition have experienced falling emissions since 1990, this trend is now reversing. Therefore, for the developed countries as a whole, the 5% Protocol target represents an actual cut of around 20% when compared to the emissions levels that are projected for 2010 if no emissions-control measures are adopted.

4.3 OTHER MEASURES

Countries will have some flexibility in how they make and measure their emissions reductions. In particular, an international "emissions trading regime" will be established allowing industrialized countries to buy and sell emissions credits amongst themselves. They will also be able to acquire "emission reduction units" by financing certain kinds of projects in other developed countries. In addition, a "clean development mechanism" for promoting sustainable development will enable industrialized countries to finance emissions-reduction projects in developing countries and to receive credit for doing so. The use of these three mechanisms is to be supplemental to domestic action.

Flexible mechanisms to allow countries to achieve their emission targets cost effectively:

- Emission trading
- Clean Development Mechanism
- Joint Implementation

They will pursue emissions cuts in a wide range of economic sectors. The Protocol encourages governments to cooperate with one another, improve energy efficiency, reform the energy and transportation sectors, promote renewable forms of energy, phase out inappropriate fiscal measures and market imperfections, limit methane emissions from waste management and energy systems, and manage carbon "sinks" such as forest, croplands and grazing lands. The methodologies for measuring changes in

net emissions (calculated as emissions minus removals of CO2) due to the use of sinks are particularly complex. The Kyoto Protocol entered into force on 16 February 2005.

4.4 EMISSION REDUCTION MECHANISM

The Kyoto Protocol provides that nations can redeem a part of their climate protection commitments by implementing projects aimed at reducing emissions in other countries. These projects are primarily to be carried out by the private sector.

These investment projects can financially benefit from generating additional emissions reductions as compared to a business as usual case.

There are three methods in Kyoto Protocol which permits the acquisition of emissions credits by means of project-based investment abroad.

4.5 EMISSIONS TRADING

Emissions trading, or Carbon Trading as it is alternatively known, involve trading carbon emission credits within nations. Allowances are created, thereby making emissions a commodity that can be traded between industries etc. The Kyoto Protocol says that it is ok to trade in emissions, but that it should not be the major means to achieve one's commitments. Some European countries and corporations have started implementing such programs to get a head start and to see how well it will work.

4.6 CLEAN DEVELOPMENT MECHANISM

The underlying principle is the same for JI and CDM; an investor implements a project in a host country which reduces emissions and receives emission credits in return[10]. The project might, for example, involve introducing state of the art technology to improve the efficiency of a coal-fired power plant or building a new plant based on renewable resource. The participation of private and public sector of the host country is allowed in project development.

[10] Source: The International Solar Energy Society

Emission credits are issued on condition that these emission reductions are achieved in addition to those achieved by other actions which would have taken place anyway without the projects. This ecological "additionality" is verified against the emission reductions in a reference scenario or base line. This base line will show what volume of emissions would have been achieved without the project.

An important difference between JI and CDM is in the nature of host country. A distinction is drawn between industrialized countries and economies in transition on the one hand and emerging economies and developing countries on the other. These countries are accorded different treatment under the Kyoto Protocol, resulting in a few differences in the modalities and requirements of the projects concerned.

The CDM is a very important element of the Kyoto Protocol for developing countries. The CDM has a dual purpose. On the one hand, it delivers certified emission reductions (CERs) which can be used by industrialized countries to meet their emission reduction commitments. The CDM allows developed country to implement a project in a territory of a developing country. The project can also be initiated by a developing country, in which case they need to find a buyer for CERs.

This is termed as unilateral CDM. On the other hand, it assists the host countries from the developing world in achieving sustainable development. The Kyoto Protocol also specifies that the public funding for CDM should not result in the diversion of funds from official development assistance. This may provide additionally of development resources to the developing countries from the developed countries.

The developing countries particularly Germany, are focusing their CDM policy towards renewable energies and energy efficiency; since these are the two key technologies where both the developing and the developed countries have to achieve substantial progress in order to live up to the challenge of climate change. The renewable technologies have assumed an important dimension in the context of global environment.

Pakistan has ratified the Kyoto Protocol in December 2004 and submitted the instrument of accession to UN Headquarters in January 2005. The Designated National Authority (DNA) as the institutional prerequisites for national approval of CDM projects has been set up within the Ministry of Environment.

The contribution of the CERs to the financing of renewable projects in developing countries depends on the following:-

One the development of the value of CERs which at this stage is difficult to predict since it is dependent on the climate policy of the industrialized countries. And, on the cost of used technology in relation to the

emission reduction. For cost-effective measures or technology (micro hydel or wind energy) it is likely that CDM shall render a major contribution to financing, depending on the value of CERs. For expensive technologies such as solar energy, CDM may render negligible contribution to financing.

In the developing countries there are generally unrealistic expectations in the CDM process. There is a common misconception that developing countries have a right to these "Certified Emission Reduction units" (CERs) and can sell these certificates to the industrialized nations. It is wrongly perceived by a large number of people that CERs could even be obtained and sold if the measure was financed and implemented within the country.

CDM is no doubt an interesting instrument to provide an incentive for new projects and new activities in energy efficiency and renewable energy. But, renewable projects should not be based on the uncertain price of CERs as these would not make them credit worthy.

4.7 JOINT IMPLEMENTATION

Joint Implementation (also known as Activities Implemented Jointly) is where developed countries invest in emission-reducing activities in other industrialized countries, and gaining reduction units as a result.

4.8 ROLE OF CDM IN HAE PROJECT

The project is a power generation project with renewable resource and zero emission. When put into operation, the project can provide power supply to the southern Pakistan power grid, which currently is relying on fossil fuel. Therefore, it can help to reduce the green house gas emission from coal or oil-fired power generation. It can deliver good environmental and social benefits. It is also consistent with the spirit of Kyoto Protocol and qualified for the application of CDM Projects. If the project is approved and registered as a CDM project, CERs can provide extra financial resource for the project. It will provide favorable conditions for the project financing, improve competitiveness of the project, and reduce investment risks during the project implementation process.

5. PROJECT SITE

5.1 GENERAL AREA

The Gharo – Keti-Bandar wind corridor, identified by Alternative Energy Development Board, lies between the coastal towns of Gharo and Ketibandar stretching more than 80 Km along the coast of Arabian Sea and runs more than 170 km deep inland towards Hyderabad. The area has been surveyed by AEDB and Pakistan Meteorological Department (PMD) which shows a high wind speed regime within the corridor. The study carried out for wind mapping of Pakistan by NREL in 2006 also confirms the presence of high wind speed regime in the coastal areas of Sindh.

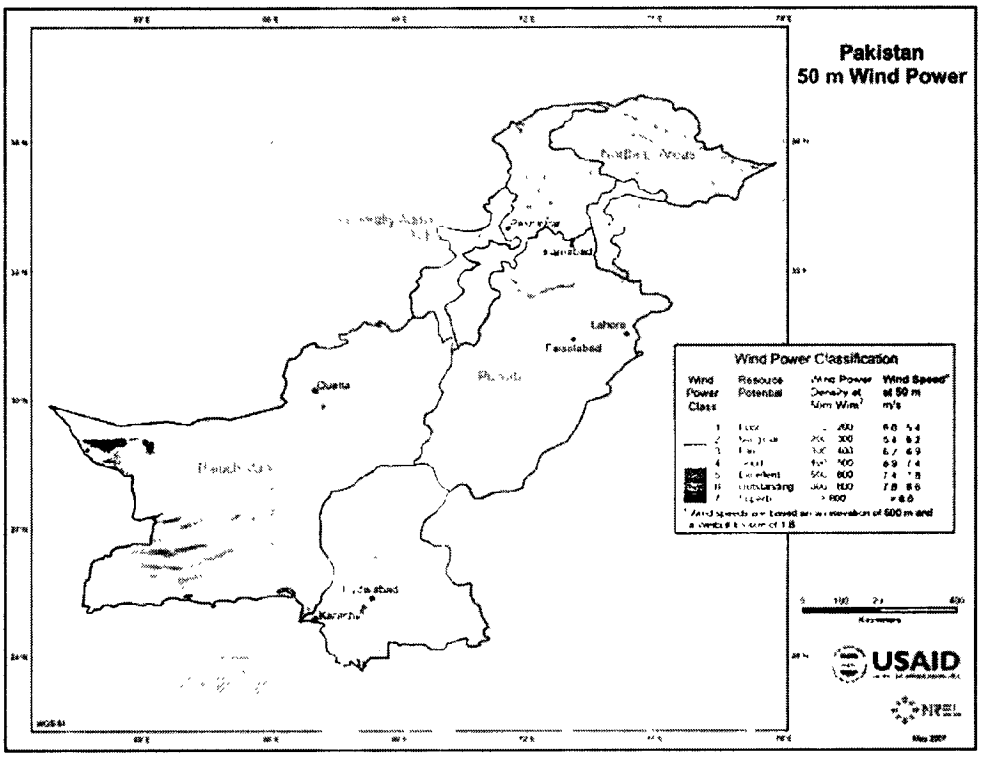


Figure 5-1: Pakistan wind map[11]

[11] www.aedb.org

5.2 SELECTION OF PROPOSED SITE

The project site of HAE is located near the village Jhampir, District Thatta. The Jhampir area has been selected for implementing the project on the basis of its exceptional wind regime, flat terrain and nearness to the National and local grid. The area has been extensively surveyed and is identified as having strong potential site for the proposed wind farm. The following other parameters has also been considered for the implementation of the project at the proposed site.

- Forecasted power output
- Access to the proposed site (materials and equipment transport feasibility study)
- Interconnection to the power grid, and the effect on the power grid
- Suitability for the surrounding environment

5.3 LOCATION OF THE PROJECT SITE

HAE has received the project land from Government of Sindh (GoS) on 30 years of lease for the development of 50MW wind power project. The project site is located about 84 km East of Karachi. The nearest settlement to the proposed site is Nooriabad (20 km North). The site is located in a strong and partly rocky area at 49m to 78m above sea level. The size of the whole wind farm is 320 acres. The coordinates of HAE project wind farm site are given under:

Table 5-1: Land Coordinates

	UTM Coordinates; zone 42R		Geodetic Coordinates	
	Easting [m]	**Northing [m]**	**Latitude**	**Longitude**
1	382854.5155	2764212.807	24.98883379	67.83926222
2	382736.1238	2764120.619	24.98799224	67.83809715
3	386914.331	2758456.411	24.93716576	67.87995335
4	387806.0191	2759437.569	24.94609095	67.8887042
5	387065.5745	2760441.351	24.95509961	67.88128921
6	386942.5175	2760354.051	24.95430218	67.88007754
7	387672.8388	2759365.371	24.9454292	67.88739108
8	386986.9481	2758610.683	24.93856389	67.88065988

The geographical location of the site on the map is given below.

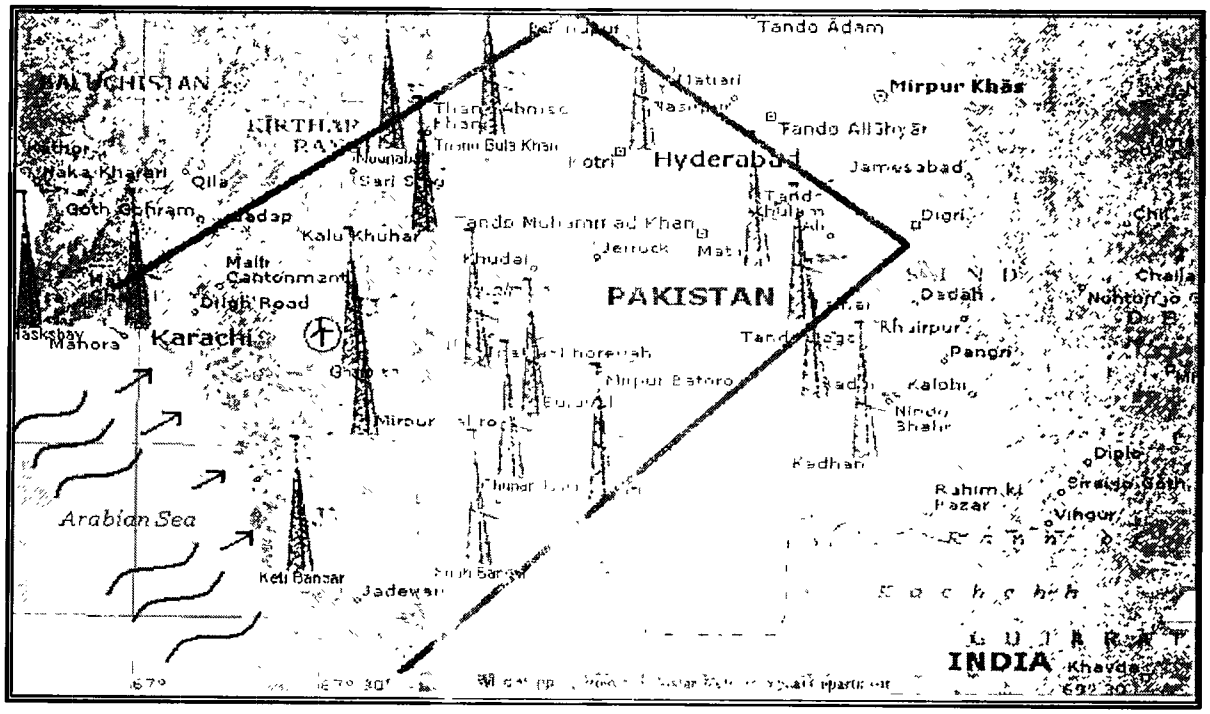


Figure 5-2: Site Location on Map

The terrain is flat at the project site with little plantation. There are some very small and scattered pieces of agriculture land in the surroundings of the project site. The area has a dry climate. The satellite map and the site pictures of the project land is given below:

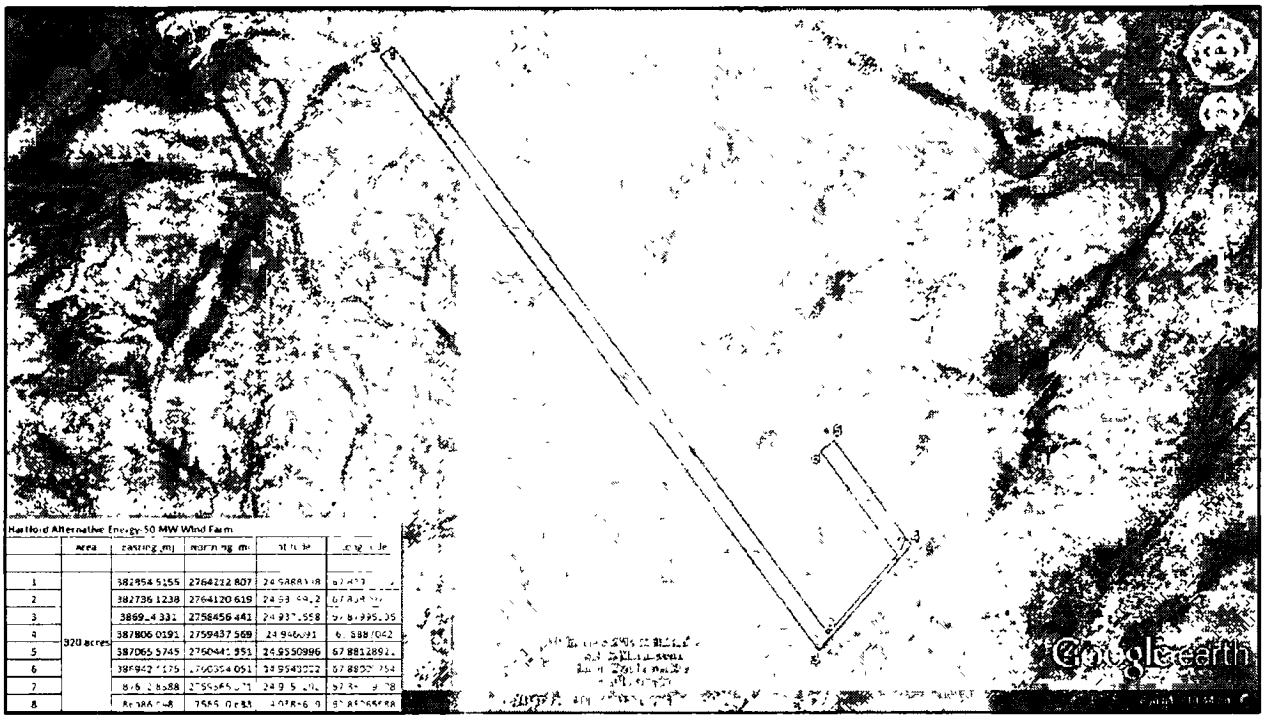


Figure 5-3: HAE Site Location on Map

Figure 5-4: Project Site of HAE Land

5.4 CLIMATIC CONDITIONS

The climate of southern parts of the Sindh province is characterized by fluctuating temperatures and sparse rainfall. The summers are hot and humid with average temperature ranging between 33 °C to 37 °C. The temperature in summers may reach up to 45 °C. The winters are pleasant with average temperature in the range of 12 °C to 15 °C. The months of July and August generally observe the annual monsoon rainfalls. The climatologically information of Karachi is shown in table 11.2. The recorded monthly temperature data at 80m height from the neighboring mast of FFCEL to the project site is given in table 11.3 below. The monthly mean temperature at the FFCEL site which is on the same plane of the project site and is 17km in the north-east, ranges between 13°C to 32 °C. Maximum temperature at the neighboring mast of FFCEL is recorded as 47 °C.

able 5-2: Karachi Climatological Information

Month	Average Temperature (°C)		Relative Humidity (%)		Total Rainfall (mm)
	Min	Max	am	pm	Mean
Jan	13	25	63	45	3.6
Feb	14	26	72	49	6.4
Mar	19	29	79	57	8.3
Apr	23	32	87	62	4.9
May	26	34	88	68	0
Jun	28	34	86	69	3.9
Jul	27	33	28	73	64.4
Aug	26	31	90	74	44.8
Sep	25	31	89	71	22.8
Oct	22	33	83	57	0.3
Nov	18	31	68	49	1.7
Dec	14	27	64	45	4.5

Table 5-3: Monthly Temperature conditions at Neighboring FFCEL Mast

Year	Month	Mean	Min	Max
		(-C)	(-C)	(-C)
2007	Jun	30.998	24.311	41.084
2007	Jul	30.364	24.848	37.617
2007	Aug	29 038	23.542	36.979
2007	Sep	29.111	21.711	40.621
2007	Oct	29.522	21.279	41.406
2007	Nov	27.545	20.465	35.693
2007	Dec	17.999	-	45.4
2008	Jan	17.463	11.077	26.721
2008	Feb	12.682	-	32.875
2008	Mar	25.675	-	40.37
2008	Apr	29.34	19.486	41.891
2008	May	29 712	25.02	41.376
2008	Jun	30.589	26.707	38.933
2008	Jul	29.245	26.233	35.744
2008	Aug	28.051	24.056	35.497
2008	Sep	29.639	24.315	38.951
2008	Oct	29.825	22.492	46.244
2008	Nov	26.174	17.837	39.344
2008	Dec	20.254	13.564	31.225
2009	Jan	19.012	11.374	27.065
2009	Feb	23.532	15.244	34.89
2009	Mar	26.87	16.034	35.53
2009	Apr	30.704	21.726	42.181

2009	May	31.717	25.941	43.247
2009	Jun	30.988	23.395	42.271
2009	Jul	30.841	18.655	41.774
2009	Aug	29.283	19.427	46.281
2009	Sep	28.079	23.946	34.351
2009	Oct	29.502	22.719	40.647
2009	Nov	25.496	17.282	34.836
2009	Dec	21.284	14.043	28.439
2010	Jan	20.059	9.81	28.379
2010	Feb	22.374	12.291	33.737
2010	Mar	28.723	19.745	40.487
2010	Apr	30.558	22.281	41.374
2010	May	31.887	25.95	44.177
2010	Jun	30.322	22.363	40.176
2010	Jul	30.145	24.595	41.162
2010	Aug	28.84	24.321	37.216
2010	Sep	29.191	17.864	40.625
2010	Oct	29.855	19.124	38.881
2010	Nov	25.774	17.708	33.383
2010	Dec	20.282	13.03	27.71
2011	Jan	18.935	6.569	27.663
2011	Feb	21.643	14.932	31.733
2011	Mar	27.034	15.509	39.849
2011	Apr	29.49	17.816	39.905
2011	May	30.543	24.645	45.257
2011	Jun	30.987	26.808	44.239
2011	Jul	30.517	22.985	43.109

2011	Aug	29.257	19.836	41.634
2011	Sep	29.58	19.023	47.369
2011	Oct	28.778	20.655	39.224
2011	Nov	26.689	20.172	35.043
2011	Dec	20.92	11.734	32.585
2012	Jan	18.733	10.488	26.505
2012	Feb	19.918	8.523	31.185
2012	Mar	25.837	18.078	40.377
2012	Apr	29.361	17.772	39.679
2012	May	31.777	25.337	41.535

6. WIND DATA ANALYSIS

6.1 WIND DATA SOURCES

A total of two wind measuring masts have been considered for this study namely:

- FFC Energy Limited Mast (FFCEL)
- Lucky Energy (Pvt) Limited Mast (LEPL)

Wind Data analysis has been made on both the two wind measuring masts. The data analysis on these masts is presented below.

6.2 WIND MEASURING MAST USED FOR THE ENERGY YIELD CALCULATION

The wind measuring mast of FFCEL has been used for the calculation of Annual Energy Yield for 50MW wind power project of HAE. The mast has been selected for the study due to the following reasons:

- Installation arrangements of the mast are of IEC compliance
- Measnet Calibrated Anemometers
- Highest recording period/ Long term data
- Good data coverage for all the instruments during the measurement period
- Site conditions of project site are similar to that of FFCEL mast site.
- In close proximity of the project site than the other wind measuring masts

The detailed wind data analysis of all the wind measuring masts is presented below.

6.3 WIND DATA ANALYSIS OF FFCEL MAST

6.3.1 GENERAL INFORMATION OF MAST

The 81.5m high FFCEL wind measuring mast was installed in June 2007 and has started collecting the wind data since then. FFCEL Mast is located at distance of 17 km in the north east of HAE (Project Site) wind farm area as shown below in figure 6-1. The mast is of lattice structure with triangular cross section having side width of approx. 2 ft. The view of FFECEL wind measuring mast can be seen from the figure 6-2 whereas the installation arrangement at the mast can be seen from the figure 6-3 given below.

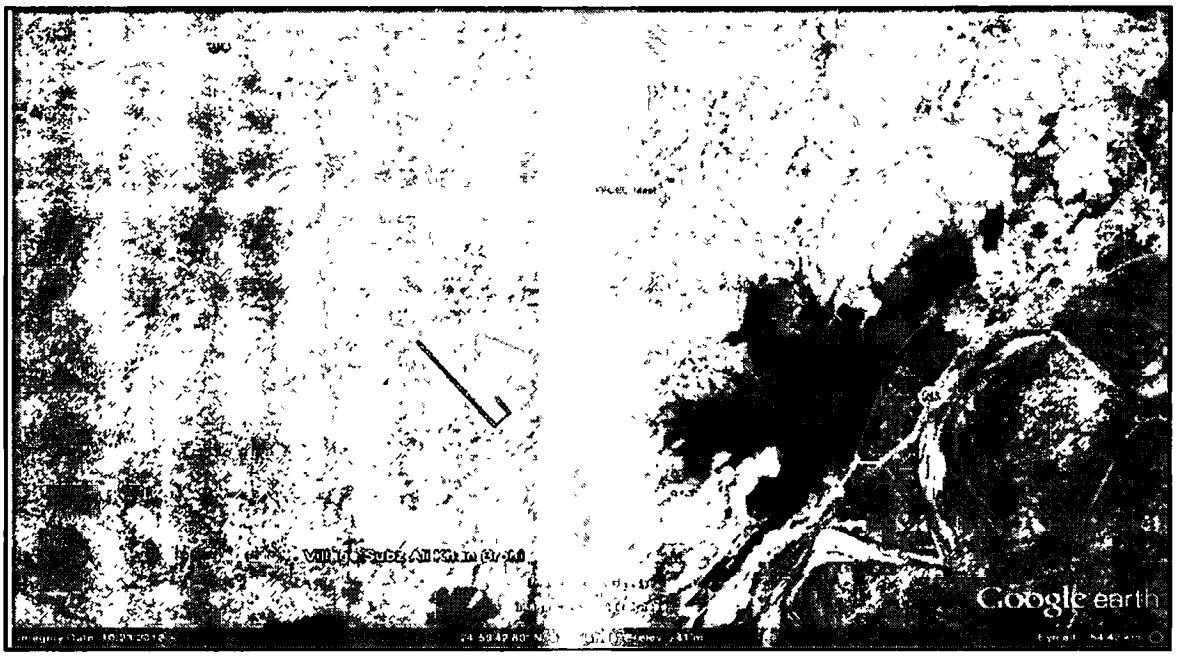


Figure 6-1: Neighboring Mast of FFCEL and Project Site

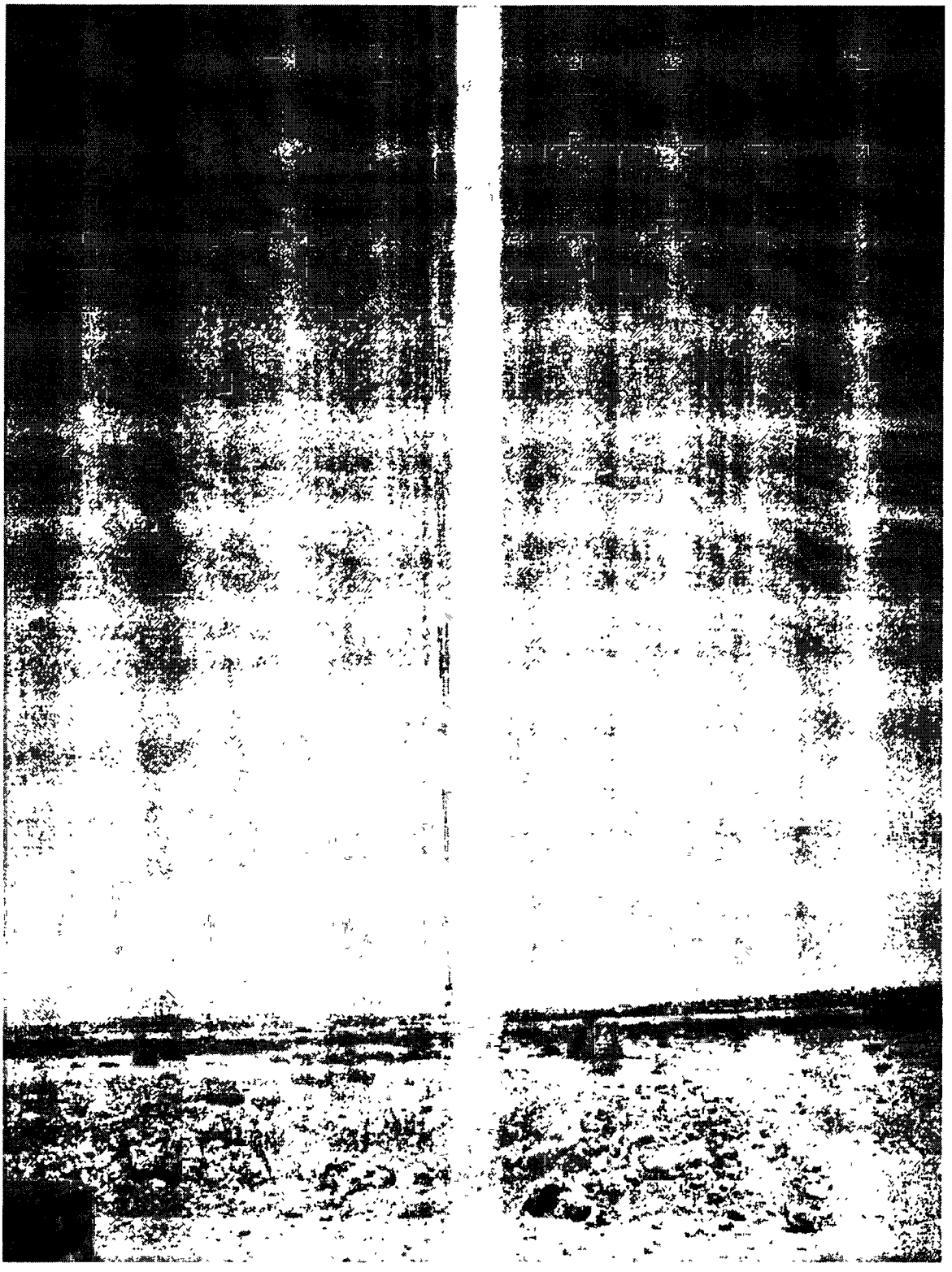


Figure 6-2. View of FFC LL Wind Measuring Mast

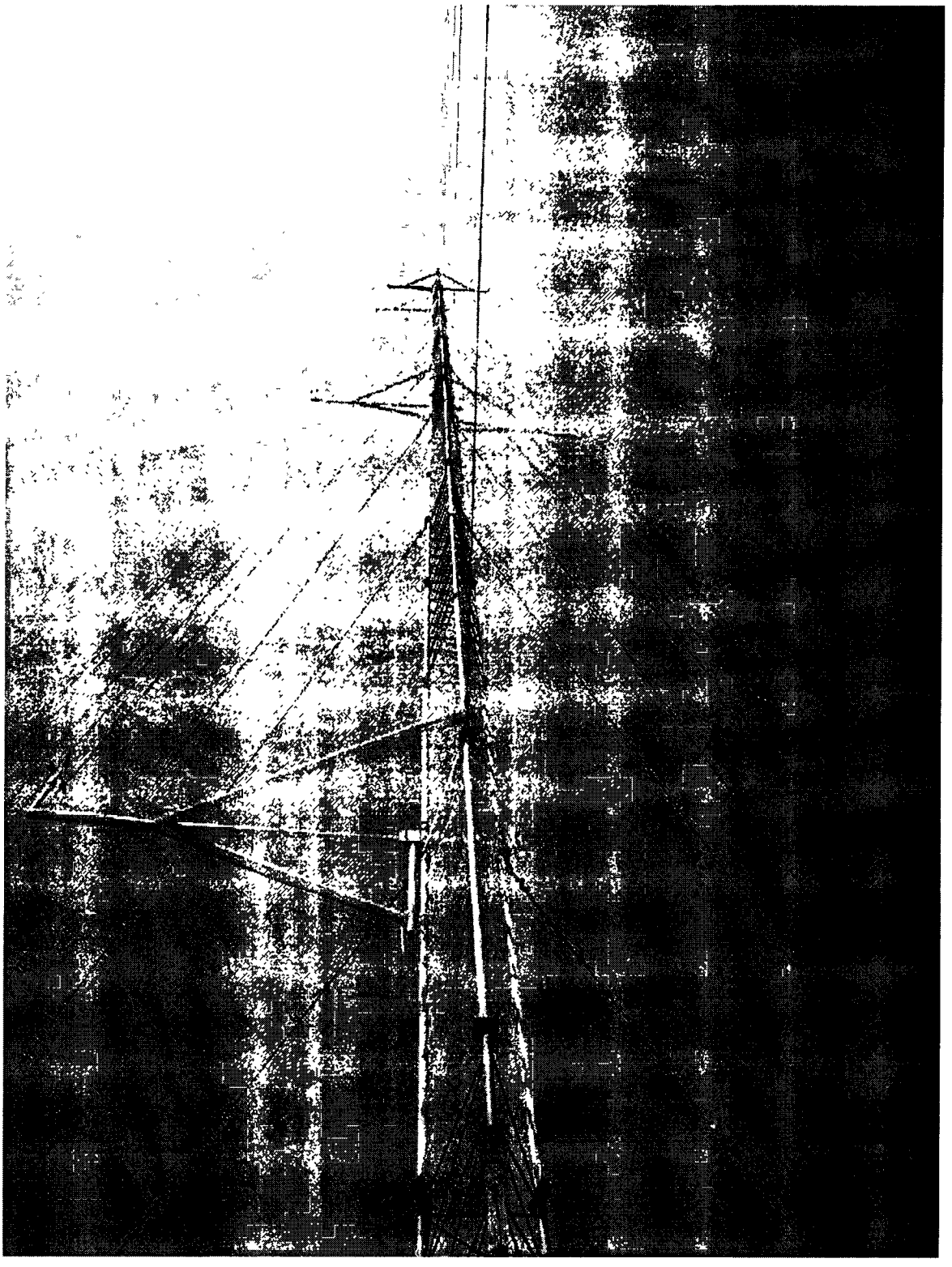


Figure 6-3: Installation Arrangements of Sensors installed at FFCEL Mast

6.3.2 INSTALLED SENSOR INFORMATION

Wind speed at FFCEL mast is recorded through five Theis first class anemometers installed at 81.5, 80, 60, 30 and 10m from ground level. The data from FFCEL mast were collected using Theis anemometers and NDL data logger. The anemometers were individually calibrated in the Measnet accredited wind tunnel at DKD.

The roughness of the FFCEL mast site is 0.0513m whereas the power law exponent calculated using the 4.9 year's data is 0.16. The specifications of FFCEL mast are shown in table 6-1 given below.

Table 6-1: Specification of FFCEL Mast

Latitude	25° 04' 33.20"N
Longitude	67° 58' 22.20"E
Observation	Wind speed, wind direction, temperature,
Observation height	wind speed: 81.5, 80, 60, 30 & 10m (Theis first class anemometers) wind direction: 78.5, 28.5m
Observation period	From June 2007 ongoing
Data used for the Study	June 2007 to May 2012 (4.9 years) 60m Wind Speed and 28.5m Direction

6.3.3 WIND DATA ANALYSIS

The data from the 81.5m high FFCEL wind measuring mast were collected over the period 1st June 2007 to 8th May 2012 (4.9 years). The data coverage was good for all the instruments during the measurement period. The data acquisition of FFCEL mast is presented in table below.

Table 6-2: Wind Data Acquisition ratio of FFCEL Mast

Installed Sensors	Data Acquisition Ratio
10m anemometer (V10)	89 81%
30m anemometer (V30)	89.65%
60m anemometer (V60)	89.38%
80m anemometer (V80b)	89.81%
81.5m anemometer (V80a)	89.81%
28.5m Wind Vane	89.81%
78.5m Wind Vane	89.81%

The wind data recoded at FFCEL Mast during the period i.e. June 2007 to May 2012 has been analyzed to determine the monthly mean wind speeds. The results are shown in table 6-3 and Figure 6-4 and 6-5 respectively.

Table 6-3: Monthly Mean Wind Speeds Calculated at FFCEL Mast

Year	Month	Mean WS 81.5m	Mean WS 80m	Mean WS 60m	Mean WS 30m	Mean WS 10m
		(m/s)	(m/s)	(m/s)	(m/s)	(m/s)
2007	Jul	8.711	8.608	8.514	7.942	6.9401
2007	Aug	8.973	8.75	8.737	8.122	7.1509
2007	Sep	8.348	8.191	8.078	7.414	6.3901
2007	Oct	6.064	6.066	5.716	4.837	3.6908
2007	Nov	5.243	5.25	4.925	4.062	2.9694
2007	Dec	7.145	7.184	6.715	5.499	4.1698
2008	Jan	7.115	7.144	6.727	5.61	4.3263
2008	Feb	5.243	5.238	5.047	4.338	3.3311
2008	Mar	6.631	6.613	6.333	5.594	4.5813
2008	Apr	7.5	7.357	7.222	6.536	5.5958
2008	May	11.852	11.526	11.597	10.893	9.7052
2008	Jun	9.035	8.876	8.87	8.369	7.4259
2008	Jul	10.243	9.872	10.07	9.539	8.5358
2008	Aug	9.464	9.127	9.257	8.706	7.7539
2008	Sep	8.173	7.944	7.912	7.249	6.3176
2008	Oct	6.88	6.833	6.553	5.705	4.577
2008	Nov	7.332	7.349	6.925	5.824	4.5347
2008	Dec	6.396	6.417	6.104	5.295	4.2777
2009	Jan	7.862	7.916	7.445	6.315	5.173
2009	Feb	6.121	6.09	5.82	5.036	4.0463
2009	Mar	6.472	6.412	6.209	5.508	4.577
2009	Apr	7.202	7.133	6.909	6.209	5.2341
2009	May	9.192	9.01	8.974	8.378	7.3794

2009	Jun	9.913	9.688	9.681	9.052	7.9439
2009	Jul	8.509	8.396	8.273	7.676	6.6652
2009	Aug	9.031	8.762	8.79	8.19	7.0768
2009	Sep	8.488	8.19	8.134	7.442	6.4088
2009	Oct	5.505	5.487	5.185	4.463	3.4949
2009	Nov	6.738	6.78	6.299	5.185	3.8398
2009	Dec	6.837	6.885	6.379	5.223	3.9339
2010	Jan	6.363	6.394	5.954	4.96	3.8057
2010	Feb	6.236	6.259	5.88	5.036	3.9362
2010	Mar	6.759	6.687	6.433	5.75	4.727
2010	Apr	8.234	8.058	7.877	7.252	6.2567
2010	May	10.134	9.901	9.786	9.184	8.1104
2010	Jun	10.065	9.695	9.748	9.212	8.1409
2010	Jul	8.125	7.969	7.864	7.393	6.5232
2010	Aug	7.111	6.935	6.799	6.246	5.391
2010	Sep	7.113	7.037	6.789	6.117	5.1597
2010	Oct	5.912	5.916	5.551	4.79	3.6567
2010	Nov	6.582	6.637	6.175	5.183	3.9453
2010	Dec	6.892	6.932	6.429	5.398	4.0969
2011	Jan	6.678	6.702	6.26	5.258	4.0449
2011	Feb	6.193	6.213	5.832	5.002	3.9636
2011	Mar	6.624	6.585	6.291	5.611	4.6392
2011	Apr	6.565	6.517	6.251	5.642	4.7625
2011	May	10.317	10.048	9.987	9.46	8.3834
2011	Jun	10.61	10.303	10.281	9.813	8.7191
2011	Jul	9.509	9.455	9.178	8.487	7.2776
2011	Aug	8.89	8.867	8.558	7.775	6.5086

2011	Sep	7.535	7.535	7.244	6.542	5.4291
2011	Oct	5.566	5.544	5.247	4.483	3.3614
2011	Nov	5.76	5.768	5.382	4.511	3.325
2011	Dec	6.918	6.958	6.432	5.252	3.7895
2012	Jan	6.335	6.351	5.978	5.004	3.7694
2012	Feb	6.591	6.615	6.168	5.179	4.0331
2012	Mar	6.736	6.682	6.372	5.65	4.5694
2012	Apr	6.972	6.898	6.636	5.994	5.0811
2012	May	6.888	6.83	6.589	5.943	4.9917

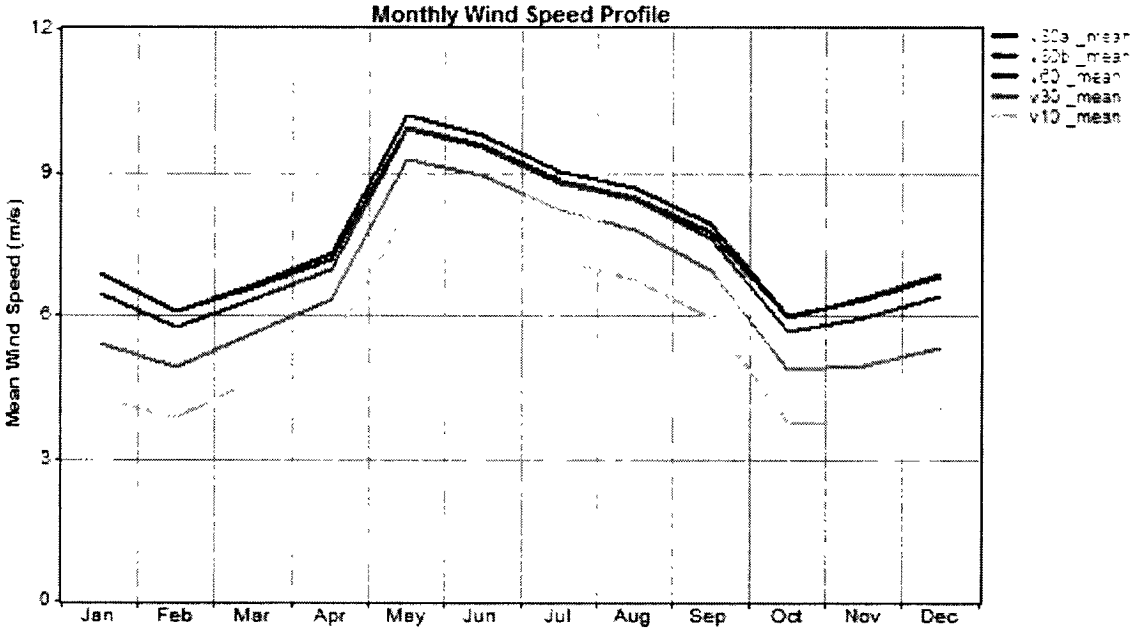


Figure 6-4: Mean of Monthly mean wind speeds at FFCEL Mast during 2007 – 2012

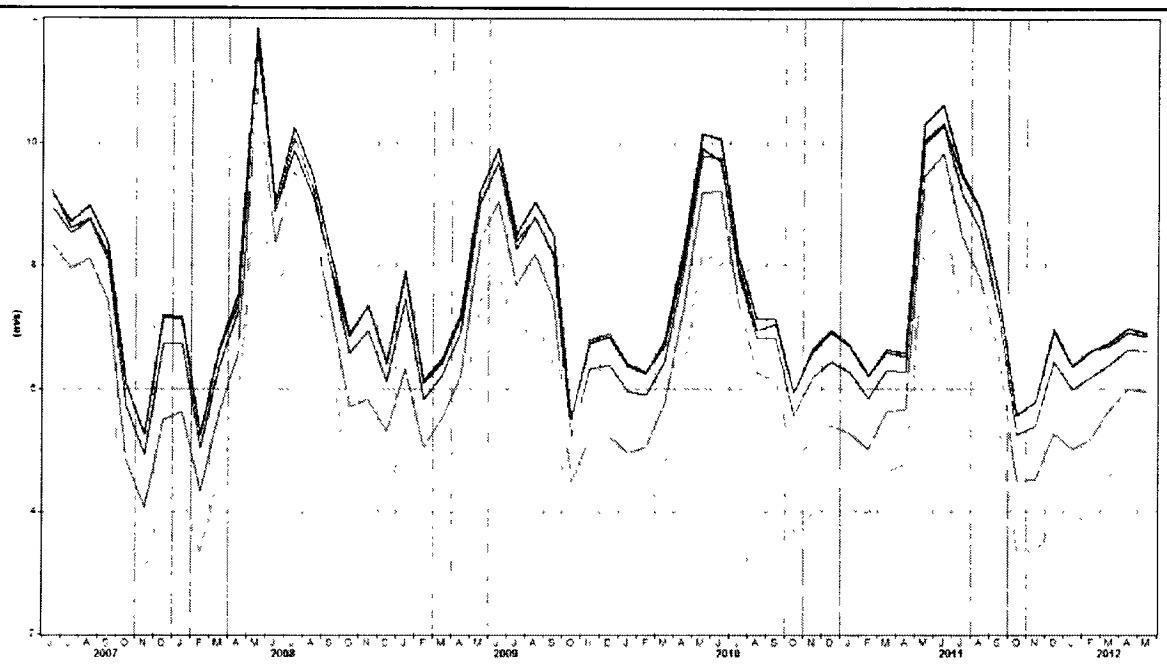
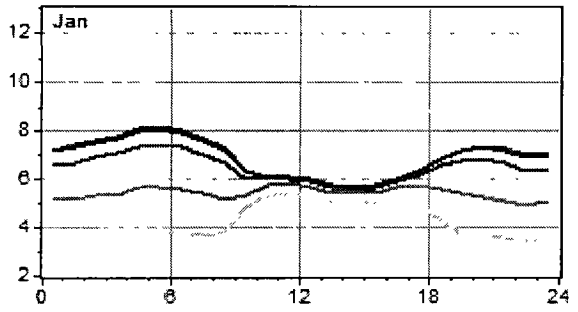


Figure 6-5: Monthly mean wind speeds at FFCEL Mast during 2007 – 2012

6.3.4 DIURNAL VARIATION

The monthly and annual diurnal variation of wind speed, for the wind data recorded during the period of Jun 2007 to May 2012 at 10, 30, 60, 80 and 81.5m are shown below in figure 6-6 and 6-7 respectively.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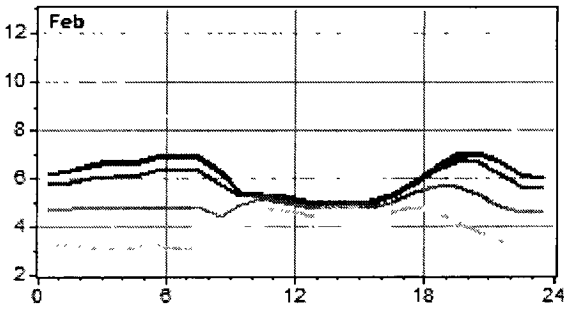
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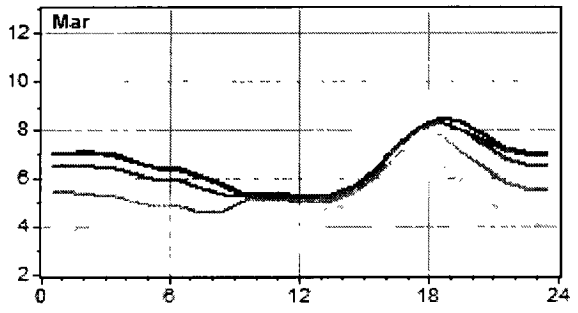
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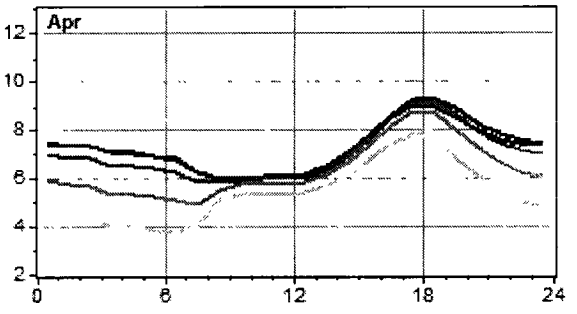
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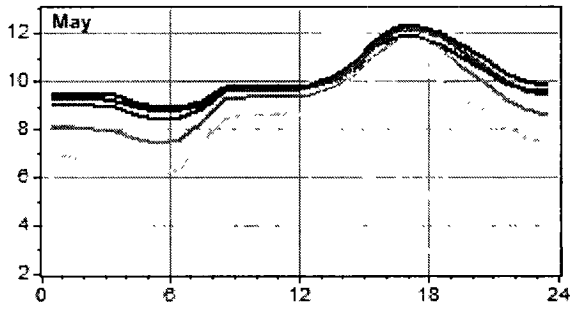
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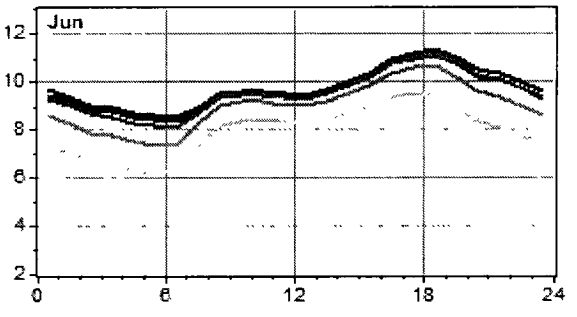
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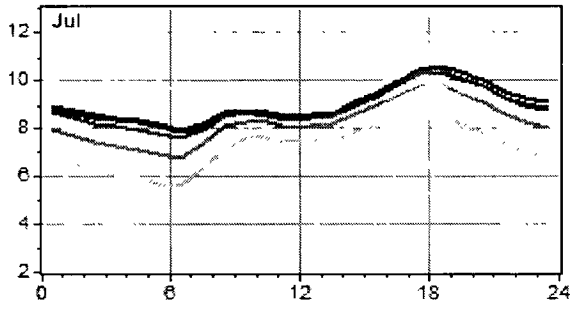
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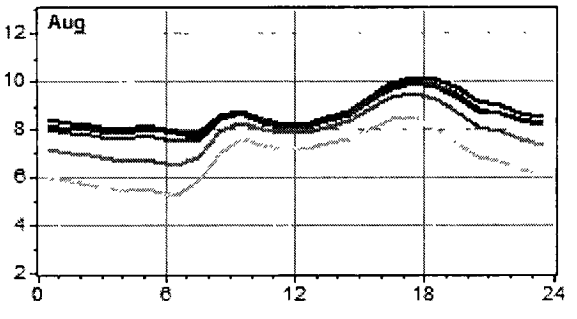
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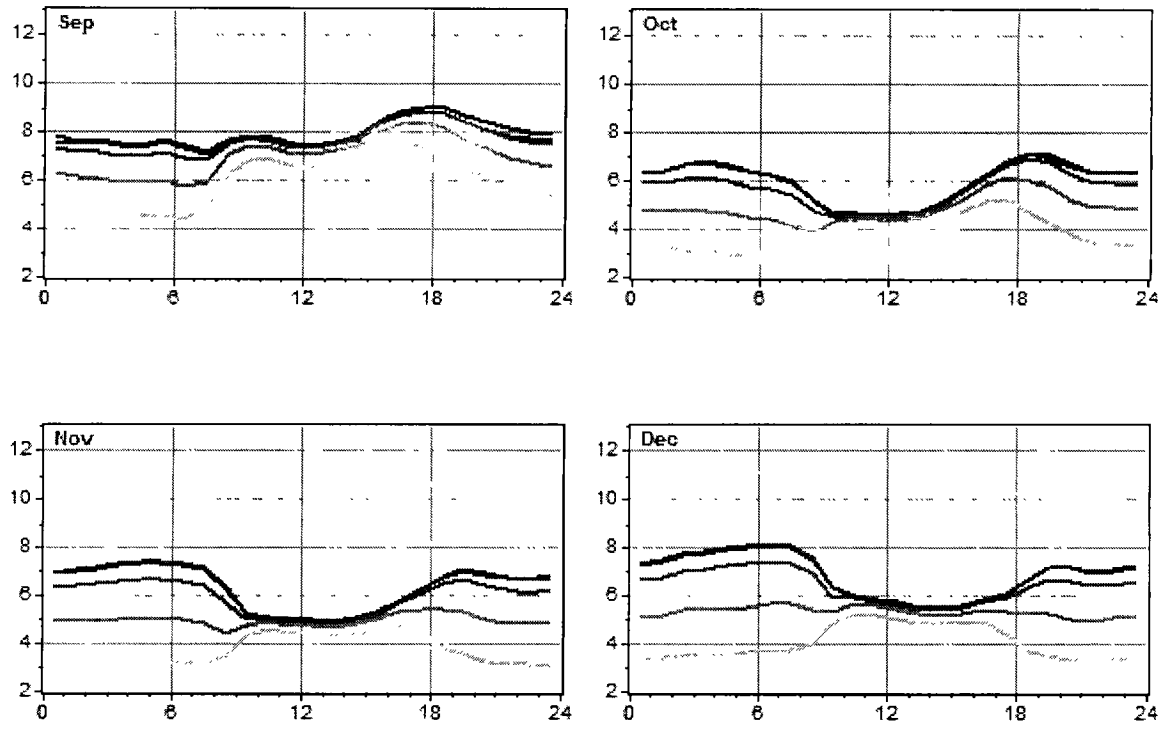


Figure 6-6: Monthly Diurnal Wind Speed Profile at FFCEL Site Wind Data

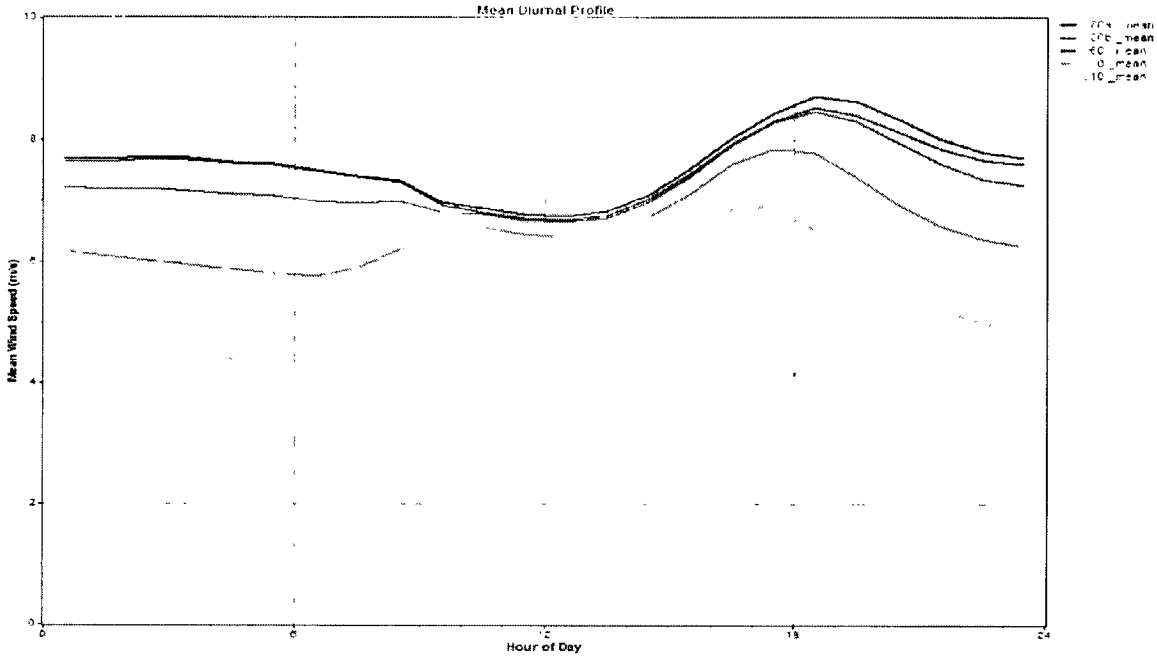


Figure 6-7: Annual Diurnal Wind Speed Profile at FFCEL Site Wind Data

6.3.5 WIND SHEAR PROFILE

The vertical and monthly wind shear profiles for the wind data recorded during the period of Jun 2007 to May 2012 have been computed. The results derived are given below.

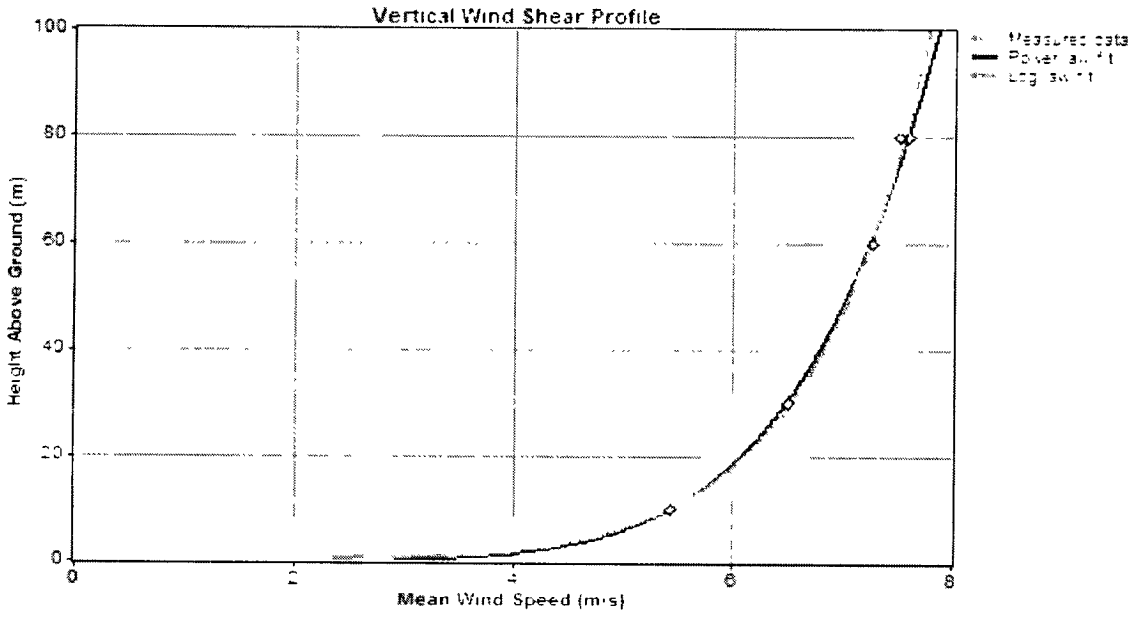


Figure 6-8: Vertical Wind Shear Profile at FFCEL Site

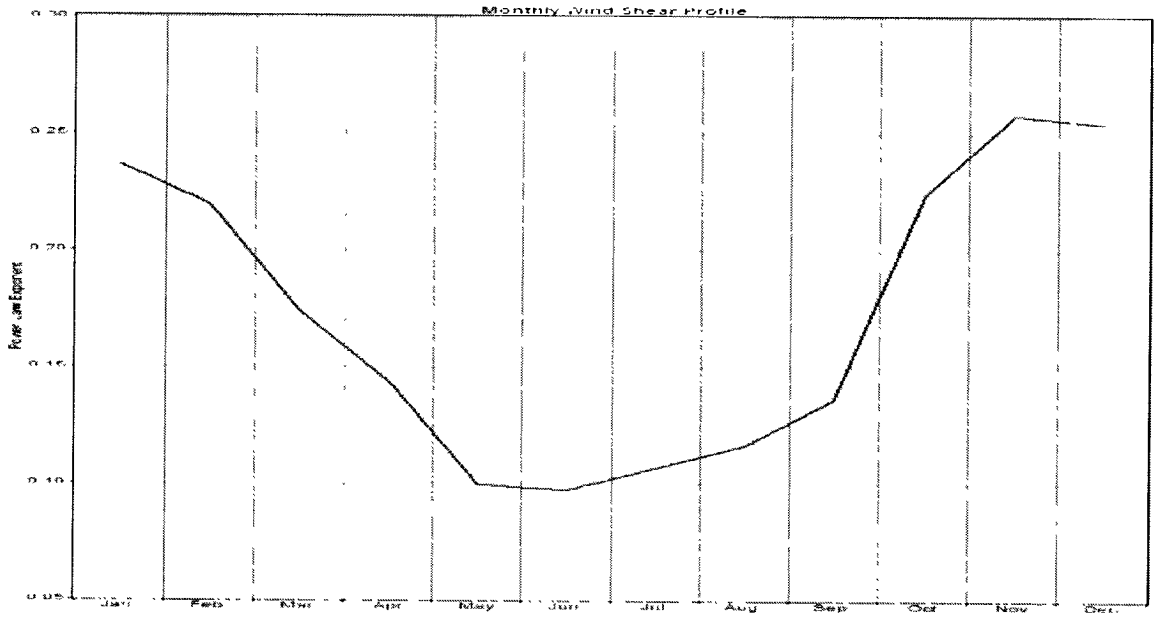


Figure 6-9: Monthly Wind Shear Profile at FFCEL Site

Table 6-4: Monthly Wind Shear Profile

Month	Power law Exponent
Jan	0 237
Feb	0.220
Mar	0.174
Apr	0.143
May	0.099
Jun	0.097
Jul	0.106
Aug	0.116
Sep	0.136
Oct	0.224
Nov	0.258
Dec	0.254

6.3.6 WIND DIRECTION AND FREQUENCY DISTRIBUTION

The annual and monthly wind rose developed using the FFCEL mast data (Jun 2007-May 2012) at 78.5m height are given below in Figure 6-10 and 6-11 respectively.

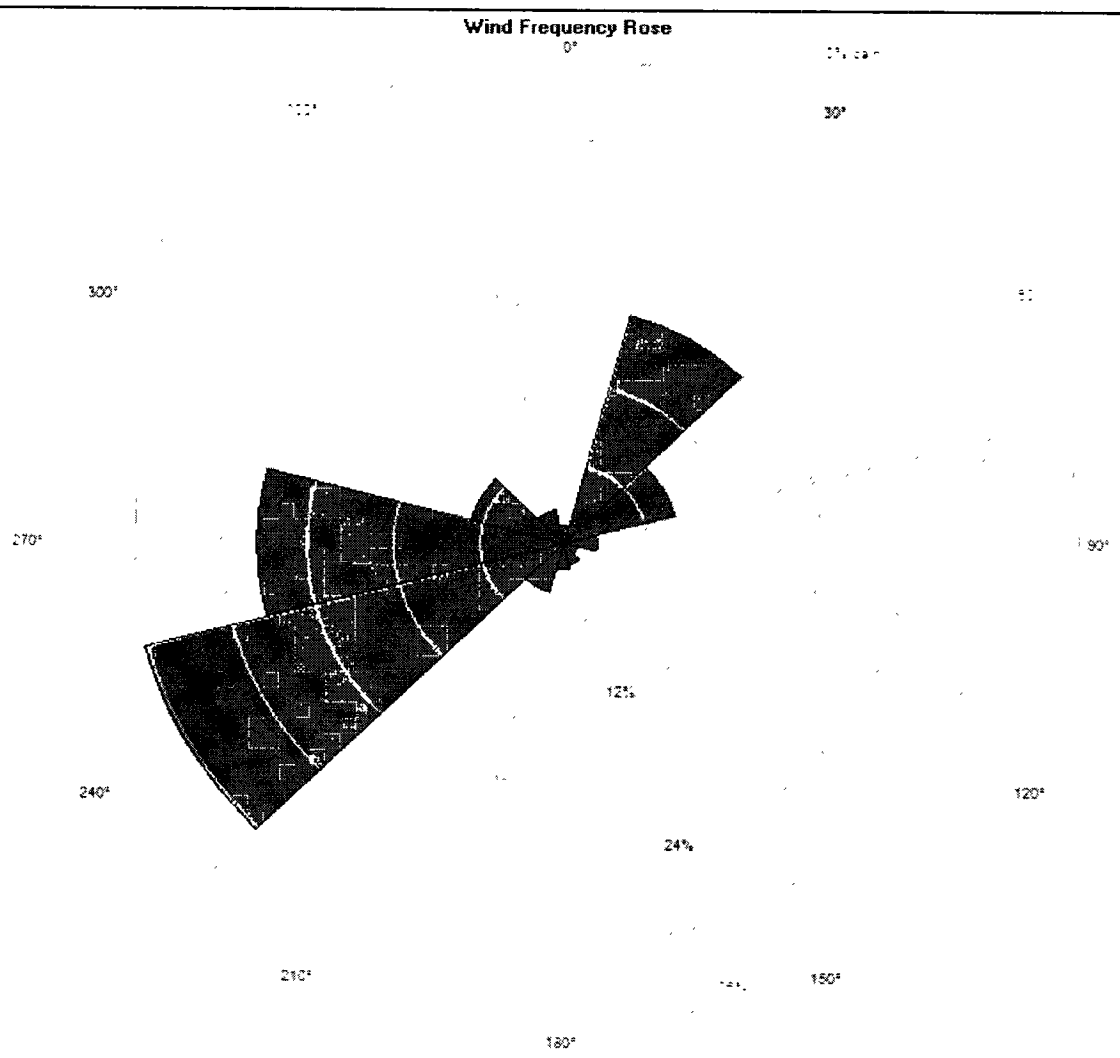
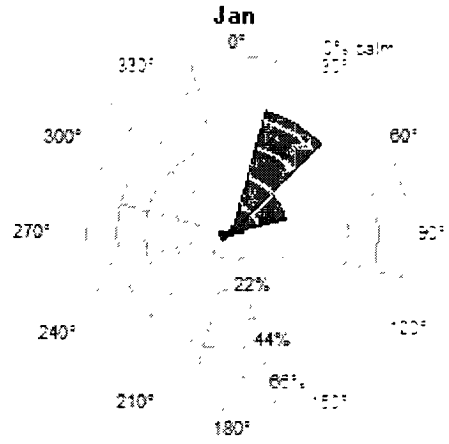
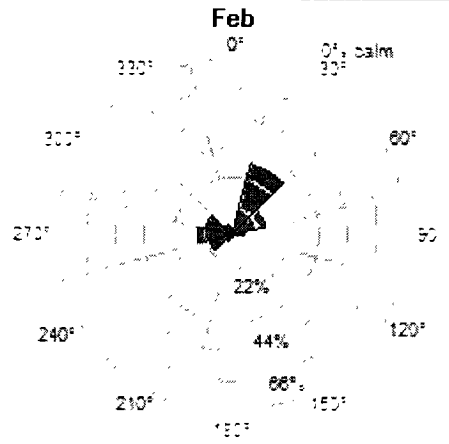
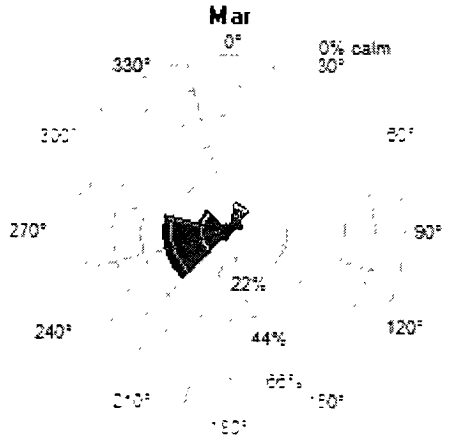
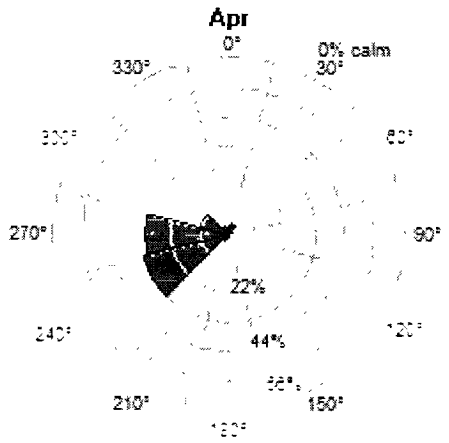


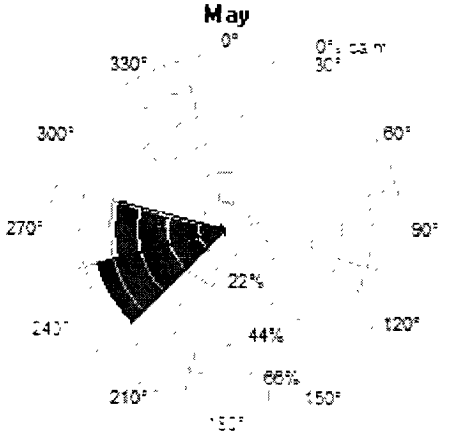
Figure 6-10: Wind Frequency Rose of FFCEL Mast at 78.5m

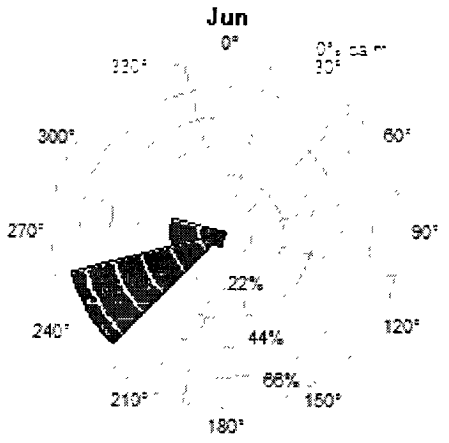

Jan
0°
0% calm
30°
330°
300°
60°
270°
90°
22%
240°
120°
44%
66%
210°
150°
180°


Feb
0°
0% calm
30°
330°
300°
60°
270°
90°
22%
240°
120°
44%
66%
210°
150°


Mar
0°
0% calm
30°
330°
270°
90°
22%
240°
120°
44%
66%
150°


Apr
0°
0% calm
30°
330°
270°
90°
22%
240°
120°
44%
66%
210°
150°


May
0°
330°
300°
60°
270°
90°
22%
240°
120°
44%
66%
210°
150°


Jun
0°
330°
300°
60°
270°
90°
22%
240°
120°
44%
66%
210°
150°
180°

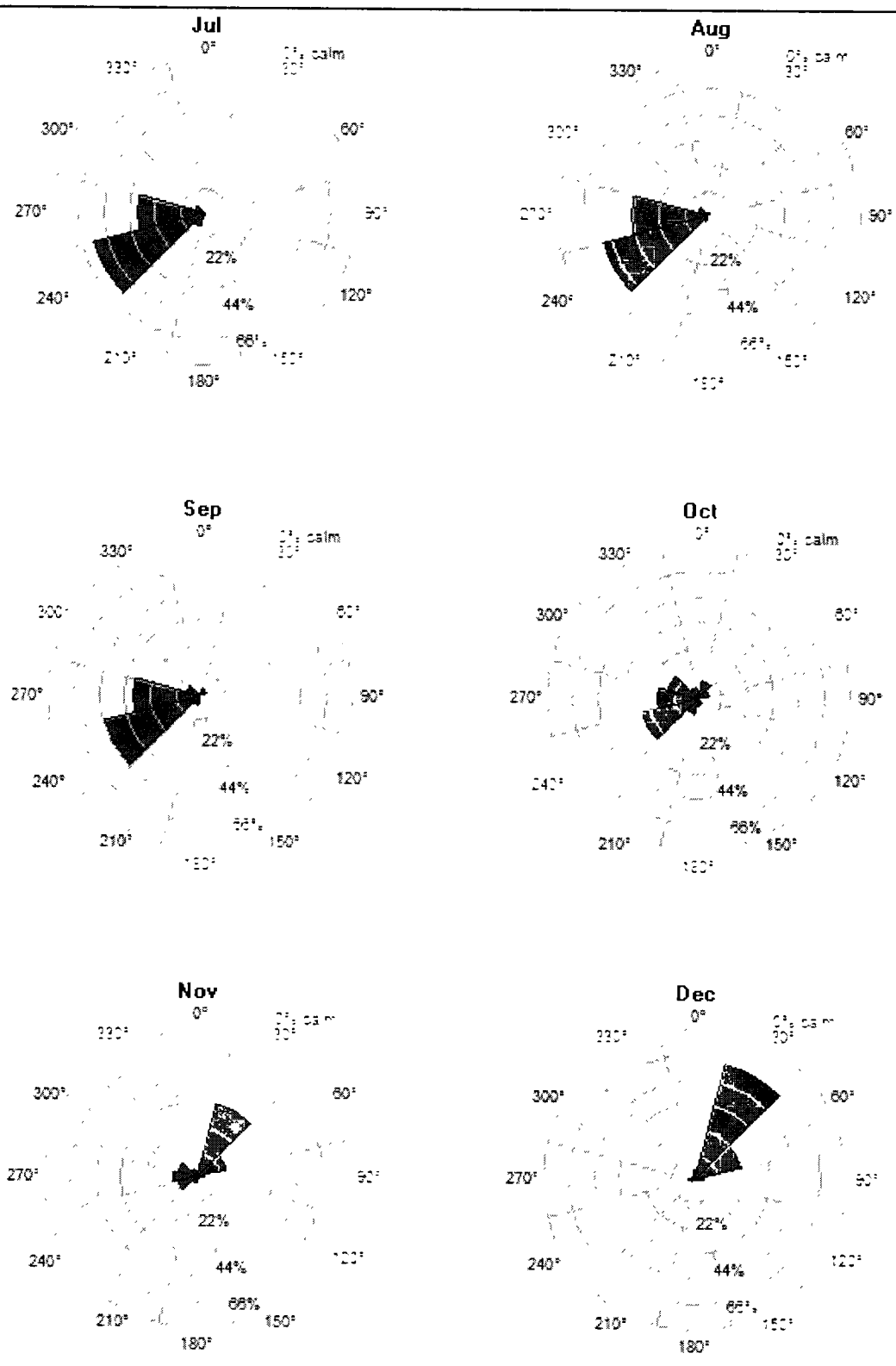


Figure 6-11: Monthly Wind Frequency Rose of FFCEL Mast at 78.5m

The annual and monthly wind rose developed using the FFCEL mast data (Jun 2007-May 2012) at 28.5m height are given below in Figure 6-12 and 6-13 respectively.

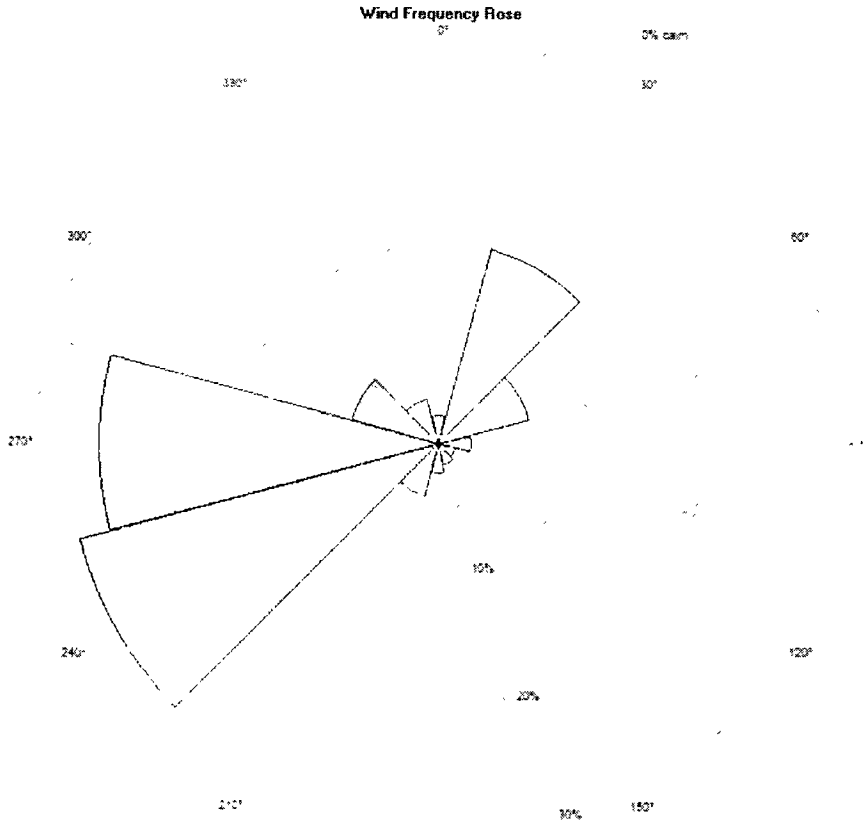
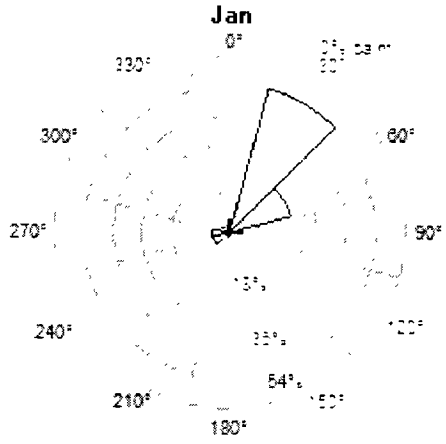
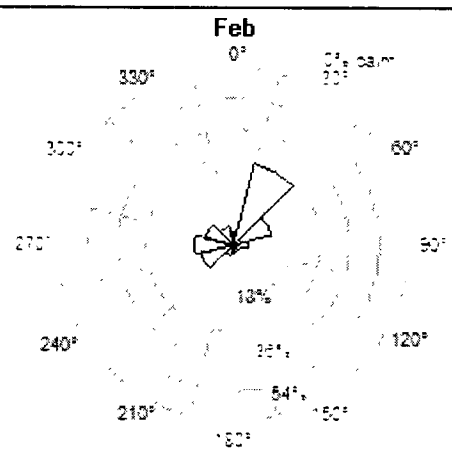
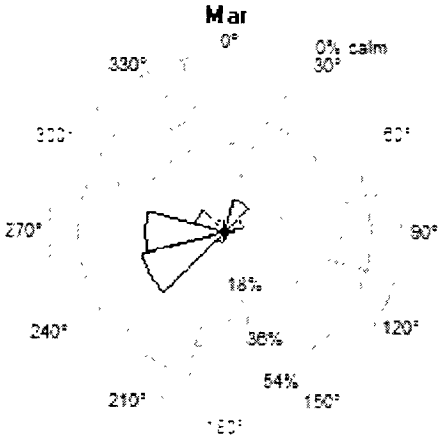
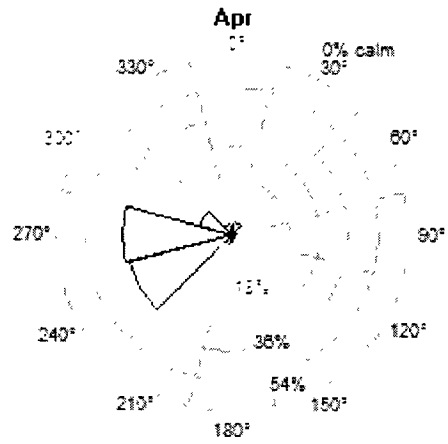


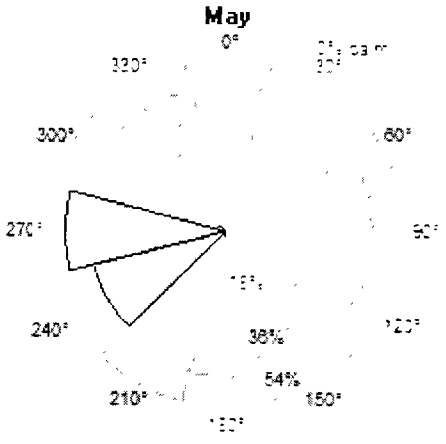
Figure 6-12: Wind Frequency Rose of FFCEL Mast at 28.5m

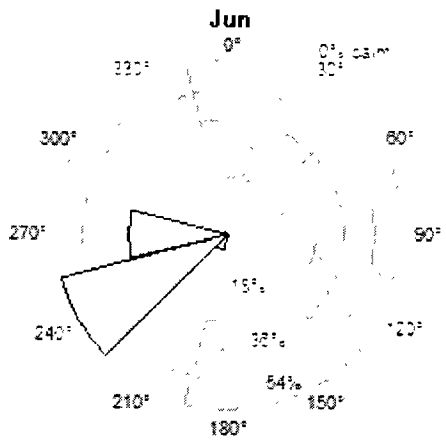

Jan
0°
330°
60°
300°
270°
90°
240°
120°
210°
150°
180°


Feb
0°
330°
60°
300°
270°
90°
240°
120°
210°
150°
180°


Mar
0°
0% calm
30°
330°
60°
300°
270°
90°
18%
240°
120°
36%
54%
210°
150°
180°


Apr
0% calm
30°
330°
60°
300°
270°
90°
240°
120°
36%
54%
210°
150°
180°


May
0°
330°
60°
300°
270°
90°
240°
120°
36%
54%
210°
150°
180°


Jun
0°
330°
60°
300°
270°
90°
240°
120°
36%
54%
210°
150°
180°

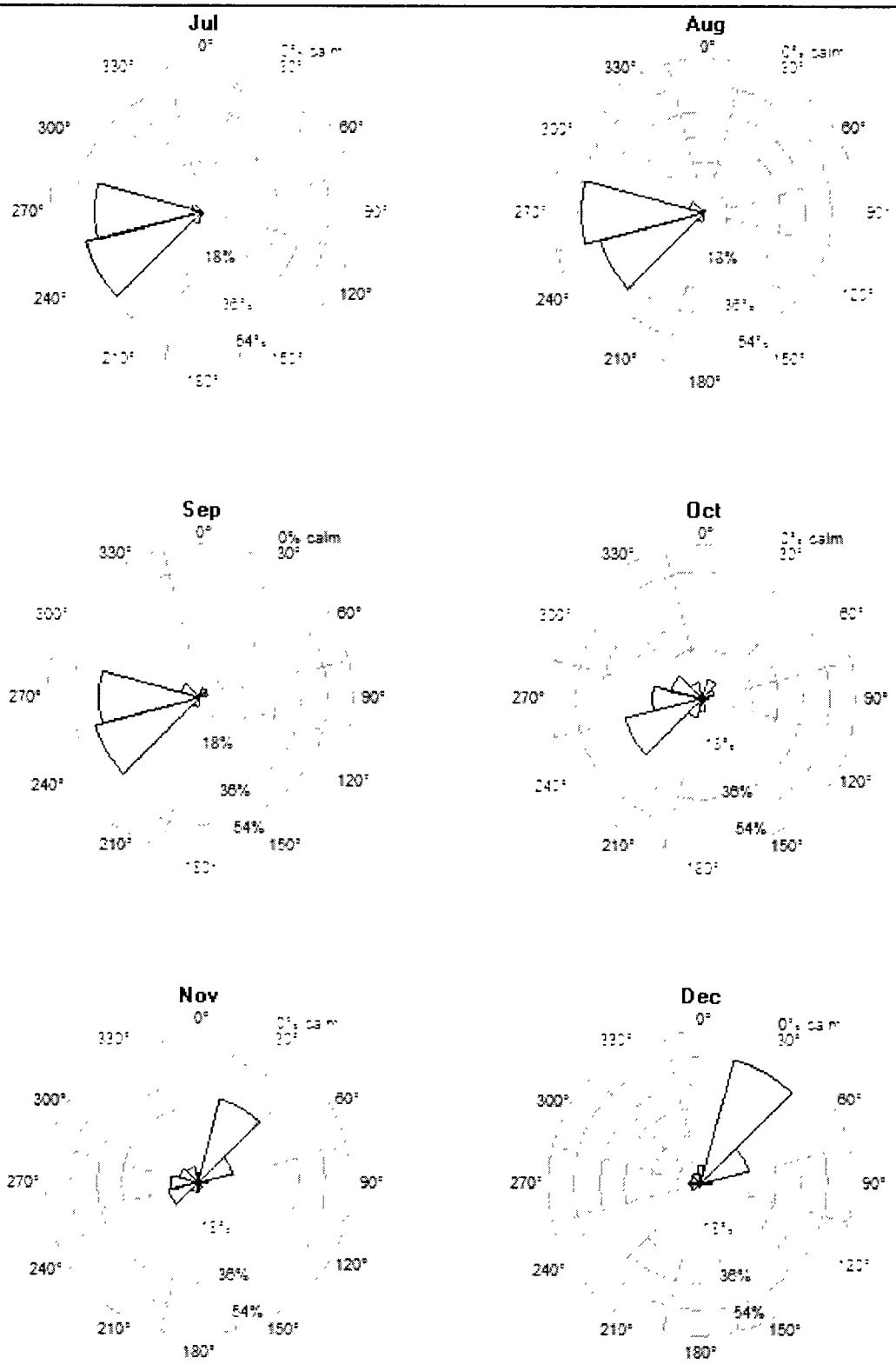


Figure 6-13: Monthly Wind Frequency Rose of FFCEL Mast at 28.5m

It can be seen from the wind rose given below that the predominant wind direction is southwest and west-southwest to a lesser extent west. The frequency distributions of the measurement are given in the following table.

Table 6-5: Wind Direction Data with Frequency Distribution

	Direction	Frequency (%)	
	Sector	Dir 28.5	Dir 78.5
1	345 - 15	2 15	1.7545
2	15 - 45	15.0876	16.3556
3	45 - 75	7.1473	7.7662
4	75 - 105	2.5529	2.5306
5	105 - 135	1.3986	1.2584
6	135 - 165	1.734	1.8223
7	165 - 195	2.3122	2.0915
8	195 - 225	4.089	4.3336
9	225 - 255	27.7575	30.0785
10	255 - 285	25.4495	21.914
11	285 - 315	6.8149	7.2393
12	315 - 345	3.5062	2.8541

6.4 NEIGHBORING WIND MEASURING MAST OF LUCKY ENERGY PROJECT

6.4.1 GENERAL INFORMATION OF MAST

The 85m high Lucky Energy Pvt. Limited (LEPL) wind measuring mast was installed in December 2008 and has started collecting the wind data since then. LEPL Mast is located at distance of approx. 24 km in the North East of HAE wind farm site as shown below in Figure 6-14. The mast is of lattice structure with triangular cross section having side width of approx. 2 ft. The view of the lucky energy mast can be seen

from the figure 6-15 whereas the installation arrangement at the mast can be seen from the figure 6-16 given below.

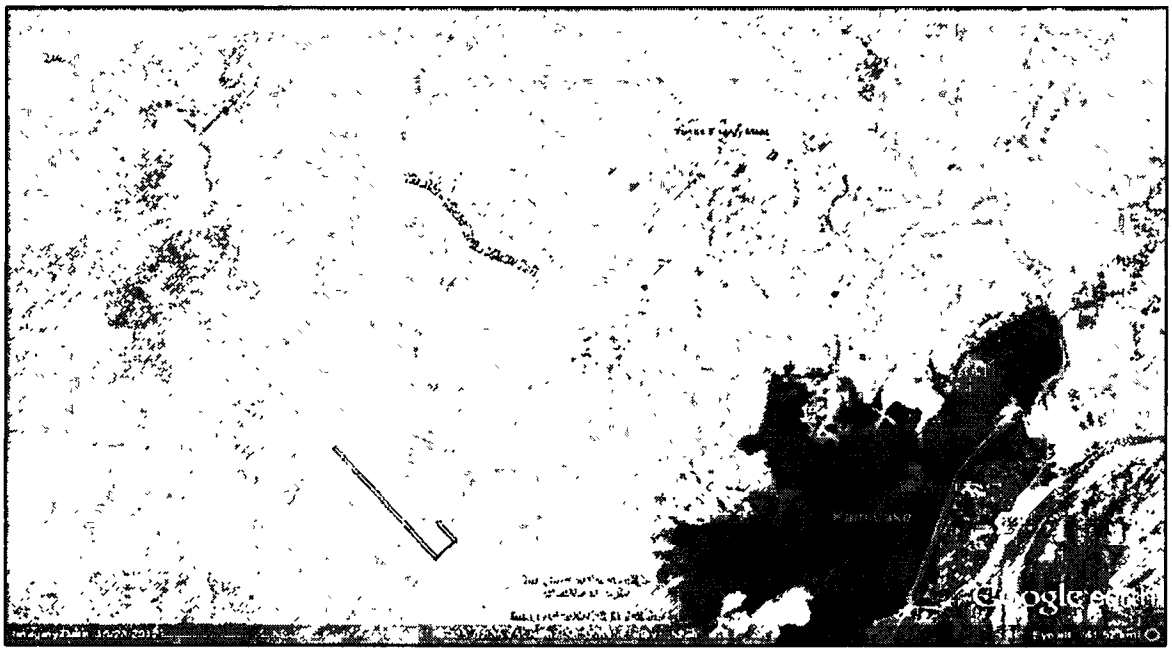


Figure 6-14: Neighboring Mast of LEPL and Project Site Area

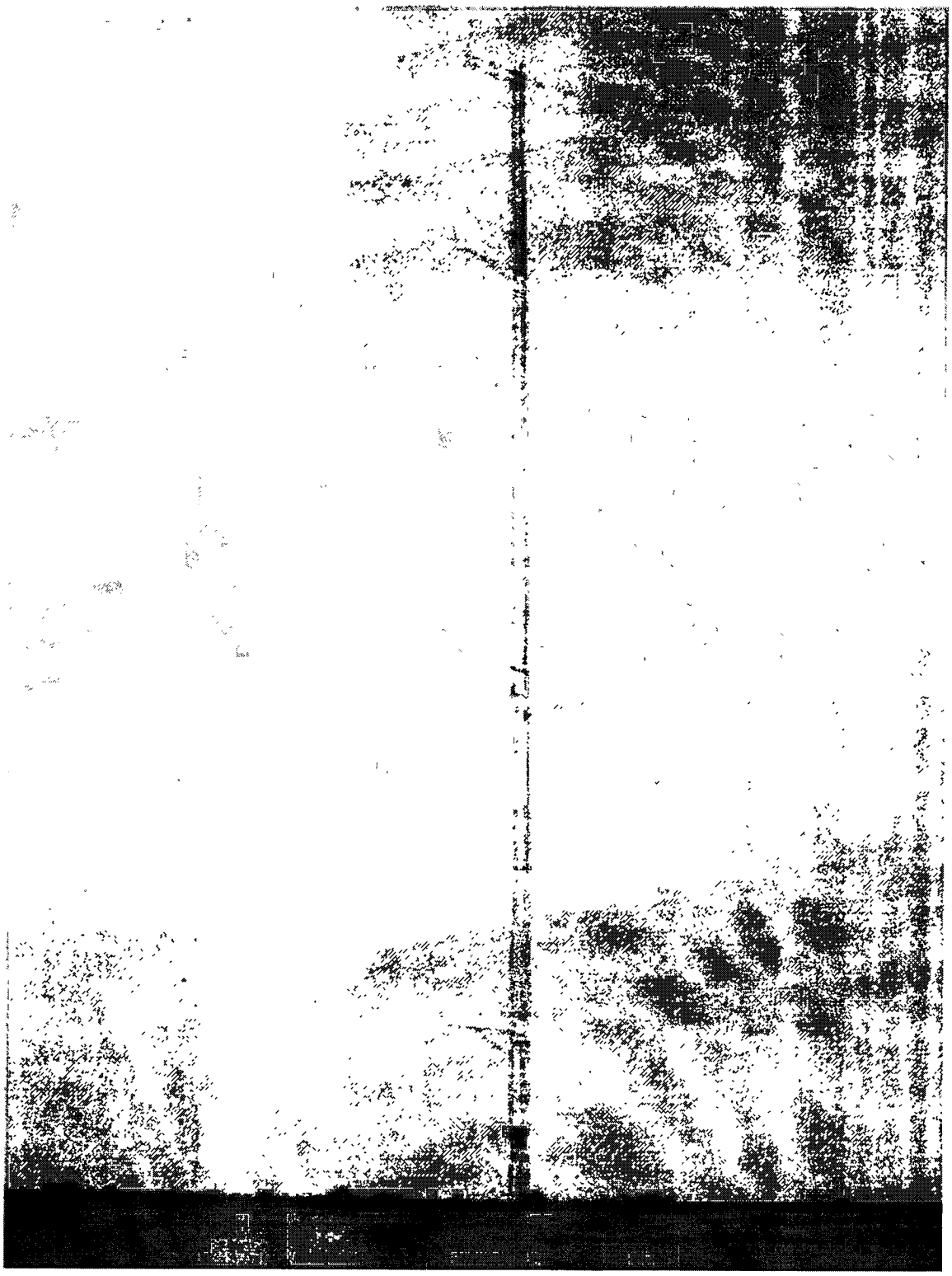


Figure 6-15: View of LEPL Wind Measuring Mast

Figure 6-16: Installation Arrangements of Sensors installed at LEPL Mast

6.4.2 INSTALLED SENSOR INFORMATION

Wind speed at LEPL mast is recorded through five Theis first class anemometers installed at 85-a, 85-b, 60, 30 and 10m from ground level. The data from LEPL mast were collected using Theis anemometers and NDL data logger. The anemometers were individually calibrated in the Measnet accredited wind tunnel at DKD. The installation arrangement of sensors can be seen through figures below.

The roughness of the LEPL mast site is 0.06m whereas the power law exponent calculated using the 3.3 year's wind data is 0.165. The specifications of LEPL mast are shown in table 6-6 given below.

Table 6-6: Specification of LEPL Mast

Latitude	25° 08' 0.80"N
Longitude	67° 59' 46.9"E
Observation	Wind speed, wind direction, temperature,
Observation height	wind speed: 85-a, 85-b, 60, 30 & 10m (Theis first class anemometers) wind direction: 83.5, 28.5m
Observation period	From December 2008 ongoing
Data used for the Analysis	December 2008 to March 2012 (3.3 years)

6.4.3 WIND DATA ANALYSIS

The data from the 85m high LEPL wind measuring mast were collected over the period 1st December 2008 to 21st March 2012 (3.3 years). The data coverage was good for all the instruments during the measurement period. The data acquisition of LEPL mast is presented in table below.

Table 6-7: Wind Data Acquisition ratio of LEPL Mast

Installed Sensors	Data Acquisition Ratio
10m anemometer (V10)	97.02%
30m anemometer (V30)	97.02%
60m anemometer (V60)	97.02%
85-a m anemometer (V85a)	97.00%
85-b m anemometer (V85b)	88.07%
28.5m Wind Vane	97.02%
83.5m Wind Vane	97.02%

The wind data recoded at LEPL Mast during the period of three years and four months, i.e. December 2008 to March 2012, has been analyzed to determine the monthly mean wind speeds. The results are shown in table 6-8 and Figure 6-17 and 6-18 respectively.

Table 6-8: Monthly Mean Wind Speeds Calculated at LEPL Mast

Year	Month	Mean WS 85m (a) (m/s)	Mean WS 85m (b) (m/s)	Mean WS 60 m (m/s)	Mean WS 30m (m/s)	Mean WS 10m (m/s)
2008	Dec	7.375	7.357	6.86	5.8579	4.7332
2009	Jan	8.019	8.005	7.444	6.3336	5.1507
2009	Feb	6.07	6.079	5.711	4.937	3.9816
2009	Mar	6.131	6.149	5.824	5.1615	4.3107
2009	Apr	7.027	7.051	6.656	5.9047	4.9913
2009	May	8.936	8.977	8.668	8.034	7.1246
2009	Jun	8.786	8.824	8.586	8.0257	7.1841
2009	Jul	9.297	9.336	9.036	8.3809	7.4504
2009	Aug	9.343	9.378	9.123	8.496	7.543
2009	Sep	8 446	8.487	8.105	7.3427	6.3419
2009	Oct	5.685	5.691	5.331	4.5853	3.6604
2009	Nov	6.853	6.84	6.353	5.2333	3.9693
2009	Dec	7.11	7.084	6.552	5.2973	4.041
2010	Jan	6.477	6.458	6.082	5.07	3.9407
2010	Feb	6.17	6.169	5.774	4.966	3.98
2010	Mar	6.585	6.605	6.249	5.5016	4.5774
2010	Apr	8.029	8.067	7.667	6.9353	6.0067
2010	May	9.901	9.955	9.562	8.7921	7.745
2010	Jun	9.605	9.651	9.335	8.6367	7.6486
2010	Jul	8.131	8.162	7.882	7.2854	6.4313
2010	Aug	7.047	7.075	6.736	6.0751	5.1983
2010	Sep	6.602	6.619	6.264	5.5753	4.7248
2010	Oct	5.94	5.95	5.53	4.7375	3.7843

2010	Nov	6.735	6.722	6.288	5.2784	4.125
2010	Dec	7.328	7.314	6.731	5.5089	4.2773
2011	Jan	6.677	6.662	6.22	5.1985	4.0636
2011	Feb	6.29	6.275	5.901	5.0257	3.9945
2011	Mar	6.693	6.709	6.296	5.529	4.6121
2011	Apr	6.526	6.546	6.203	5.5476	4.7139
2011	May	10.039	10.087	9.775	9.0791	8.0029
2011	Jun	10.662	10.718	10.414	9.6716	8.5744
2011	Jul	9.441	9.486	9.236	8.6033	7.6518
2011	Aug	8.295	9.439	8.008	7.3594	6.4762
2011	Sep	7.716	-	7.234	6.3368	5.3046
2011	Oct	5.954	-	5.595	4.7867	3.7399
2011	Nov	5.903	8.689	5.542	4.5959	3.5144
2011	Dec	7.09	7.046	6.57	5.3418	4.0755
2012	Jan	6.477	6.451	6.058	5.1118	4.0117
2012	Feb	6.748	6.719	6.291	5.3123	4.2564
2012	Mar	6.787	6.76	6.425	5.6745	4.7363

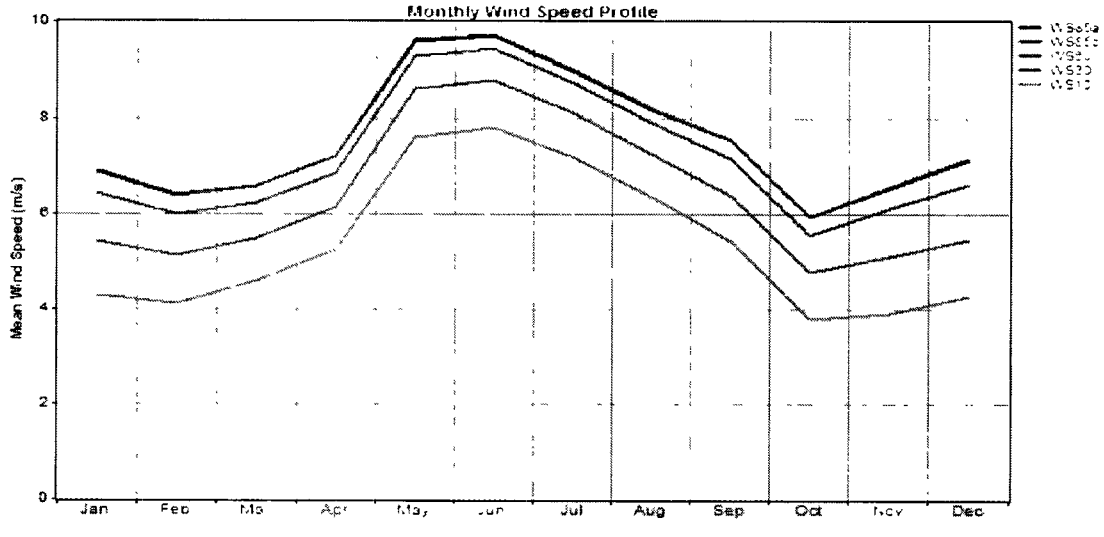


Figure 6-17: Mean of Monthly mean wind speeds at LEPL Mast during 2008 – 2012

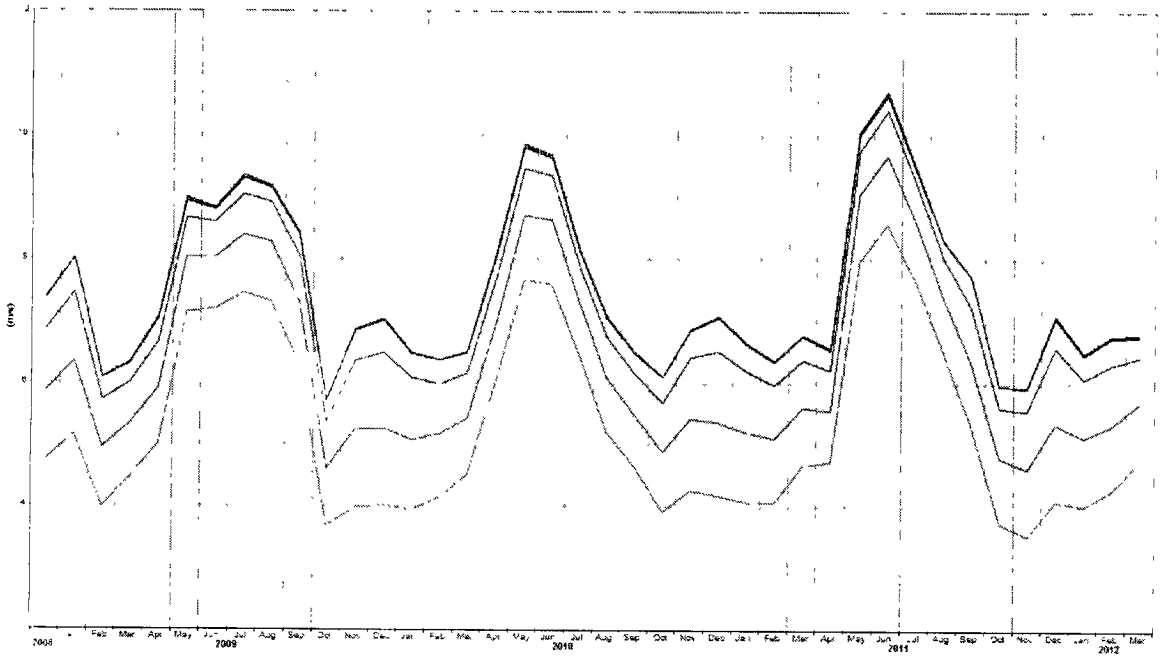
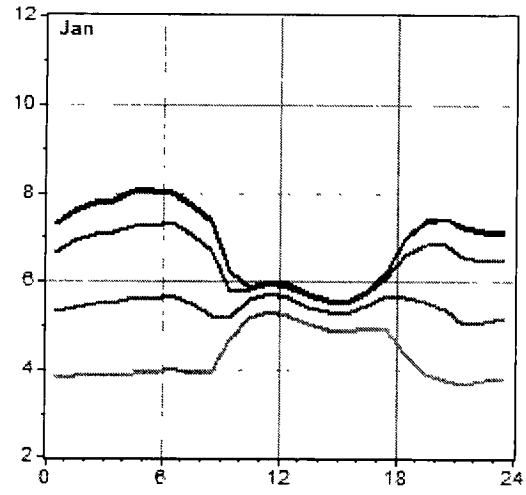
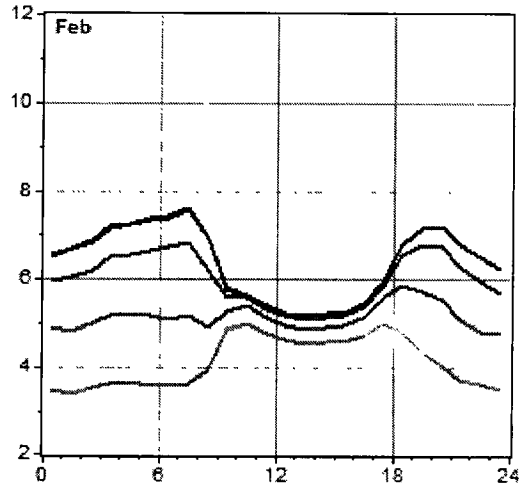


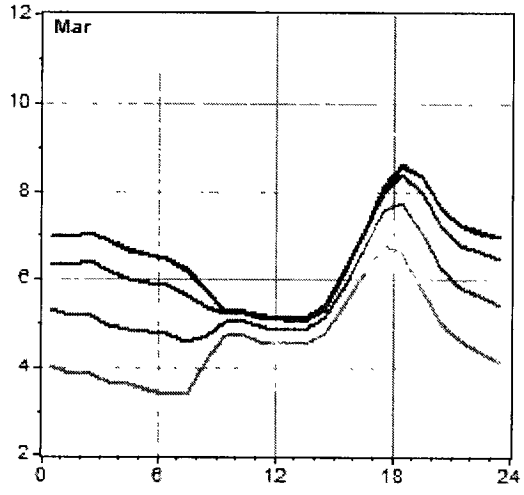
Figure 6-18: Monthly mean wind speeds at LEPL Mast during 2008 – 2012

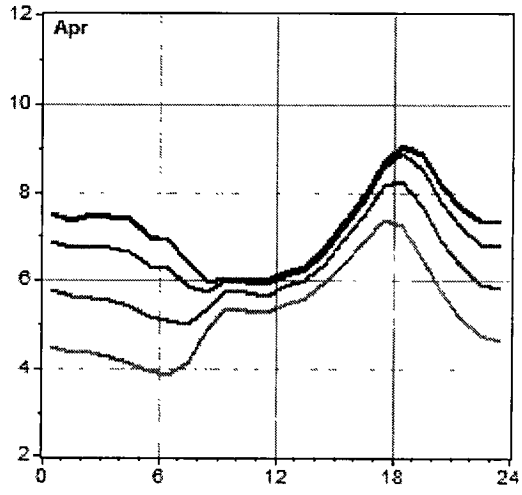
6.4.4 DIURNAL VARIATION

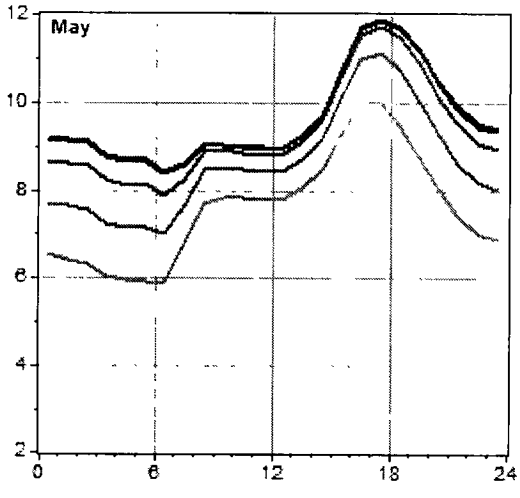
The monthly and annual diurnal variation of wind speed, for the wind data recoded during the period of Dec 2008 to March 2012 at 10, 30, 60, 85(a) and 85(b) m are shown below in figure 6-19 and 6-20 respectively.

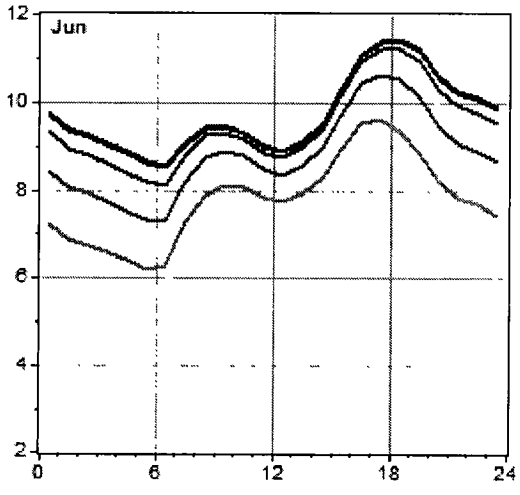

Jan
12
10
8
6
4
2
0
6
12
18
24


Feb
12
10
8
6
4
2
0
6
12
18
24


Mar
12
10
8
6
4
2
0
6
12
18
24


Apr
12
10
8
6
4
2
0
6
12
18
24


May
12
10
8
6
4
2
0
6
12
18
24


Jun
12
10
8
6
4
2
0
6
12
18
24

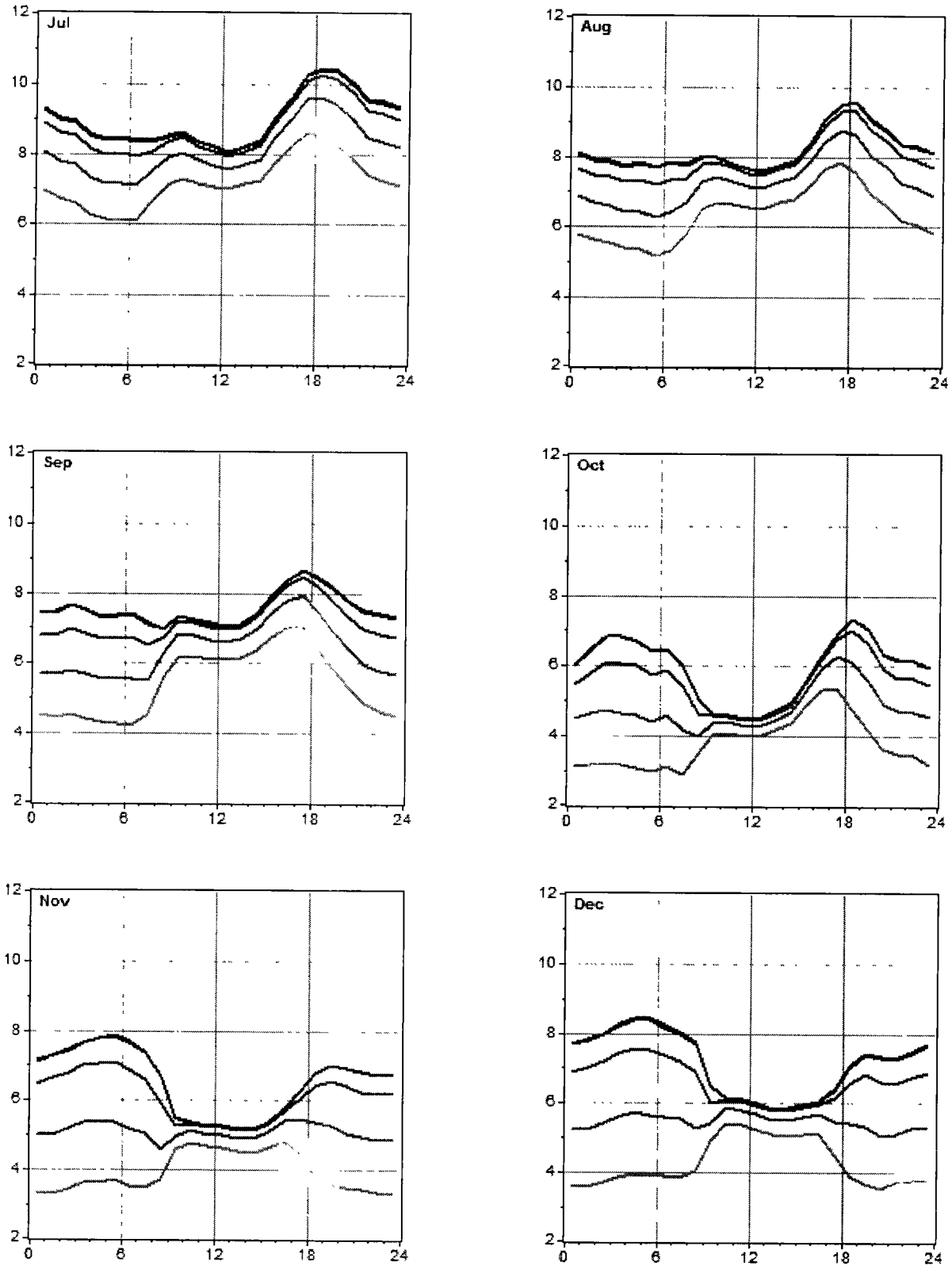


Figure 6-19: Monthly Diurnal Wind Speed Profile at LEPL Site Wind Data

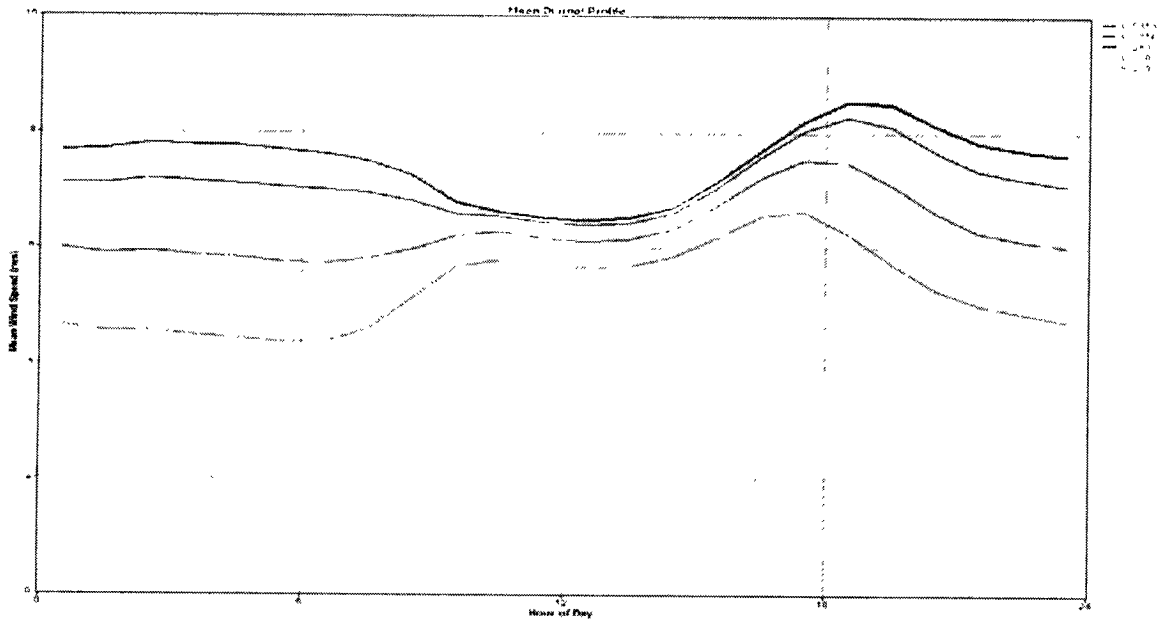


Figure 6-20: Annual Diurnal Wind Speed Profile at LEPL Site Wind Data

6.4.5 WIND SHEAR PROFILE

The vertical and monthly wind shear profiles for the wind data recorded during the period of Dec 2008 to Mar 2012 have been computed. The results derived are given below.

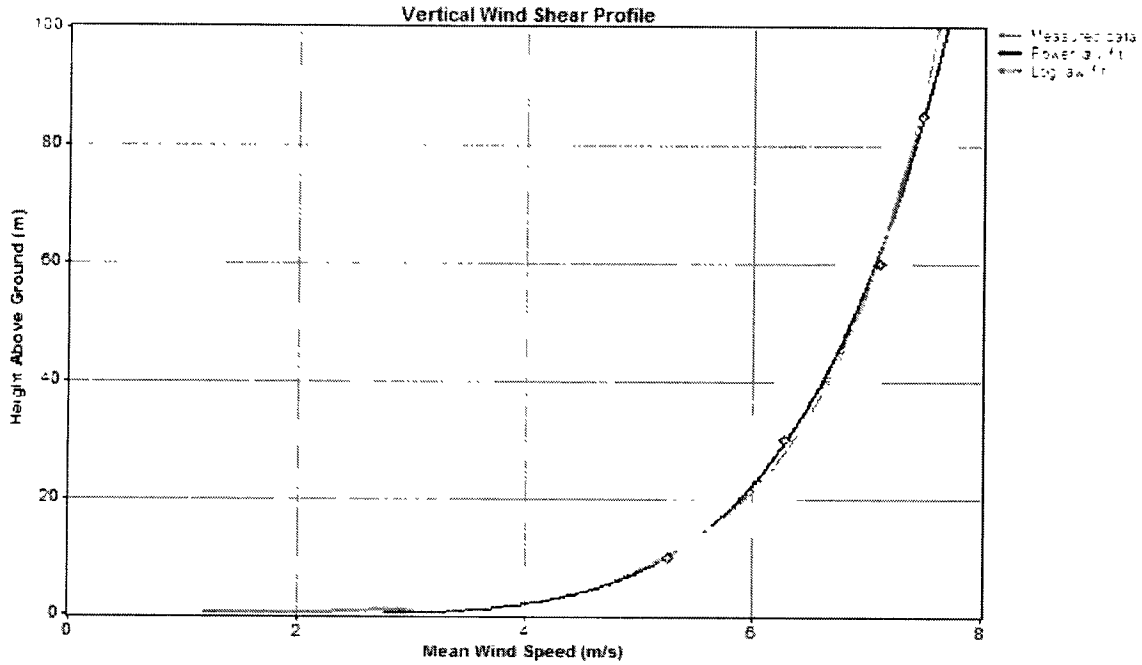


Figure 6-21: Vertical Wind Shear Profile at LEPL Site

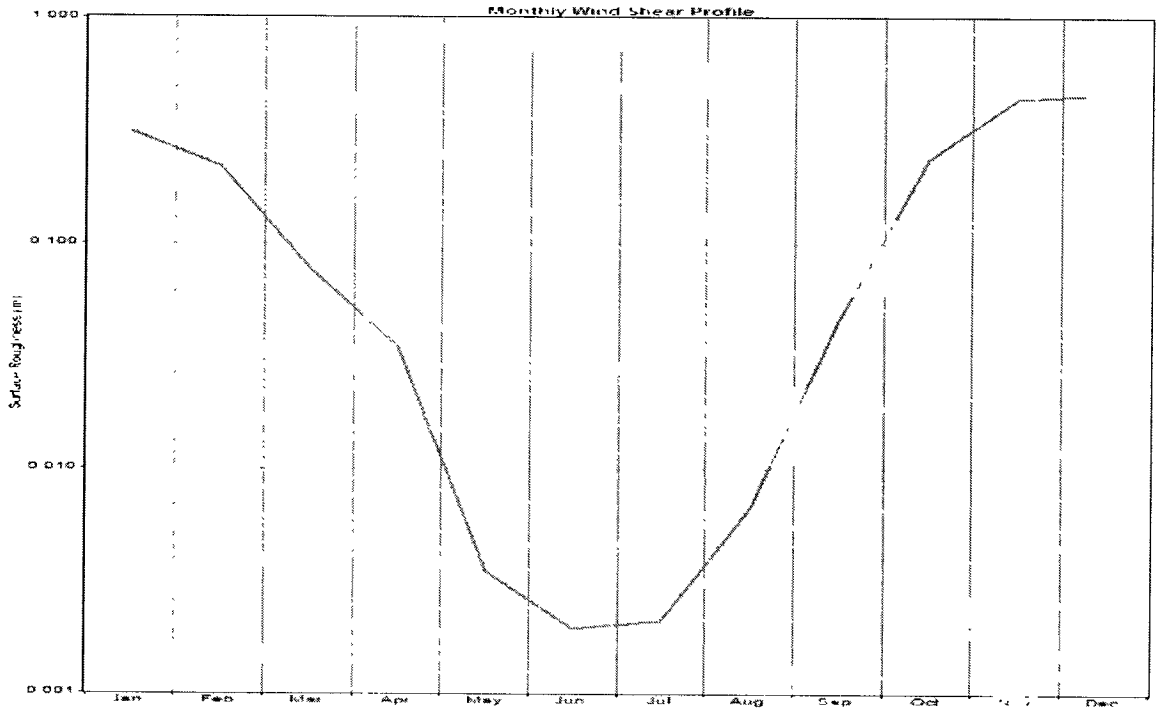


Figure 6-22: Monthly Wind Shear Profile at LEPL Site

Table 6-9: Monthly Wind Shear Profile

Month	Power law Exponent
Jan	0.224
Feb	0.207
Mar	0.170
Apr	0.149
May	0.111
Jun	0.105
Jul	0.106
Aug	0.120
Sep	0.156
Oct	0.211
Nov	0.243
Dec	0.244

6.4.6 WIND DIRECTION AND FREQUENCY DISTRIBUTION

The data from the 85m high LEPL mast were collected over the period Dec 2008 to Mar 2012. The data coverage was good for all of the instruments during the measurement period.

Based on our experience of this region, the prevailing wind direction was slightly more westerly than expected. The Lucky Energy wind direction data were compared with the wind direction data from other neighboring wind measuring masts. The comparison indicated that the direction vanes from the LEPL mast were recording directional data approx. 10° higher than the neighboring mast data. Therefore, an offset of 10° was applied to the LEPL directional data.

The annual and monthly wind rose developed using the LEPL mast data (Dec 2008 - Mar 2012) at 83.5m height are given below in Figure 6-23 and 6-24 respectively.

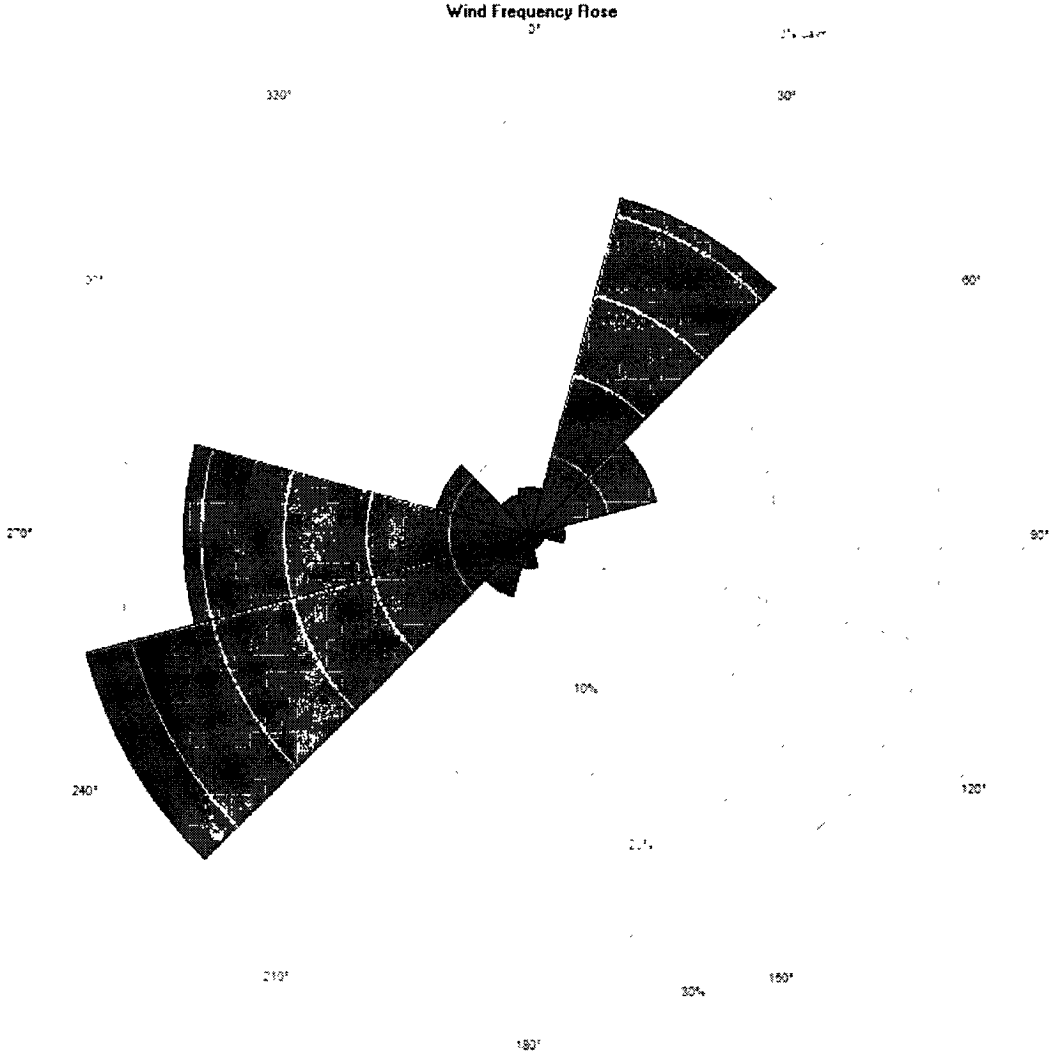
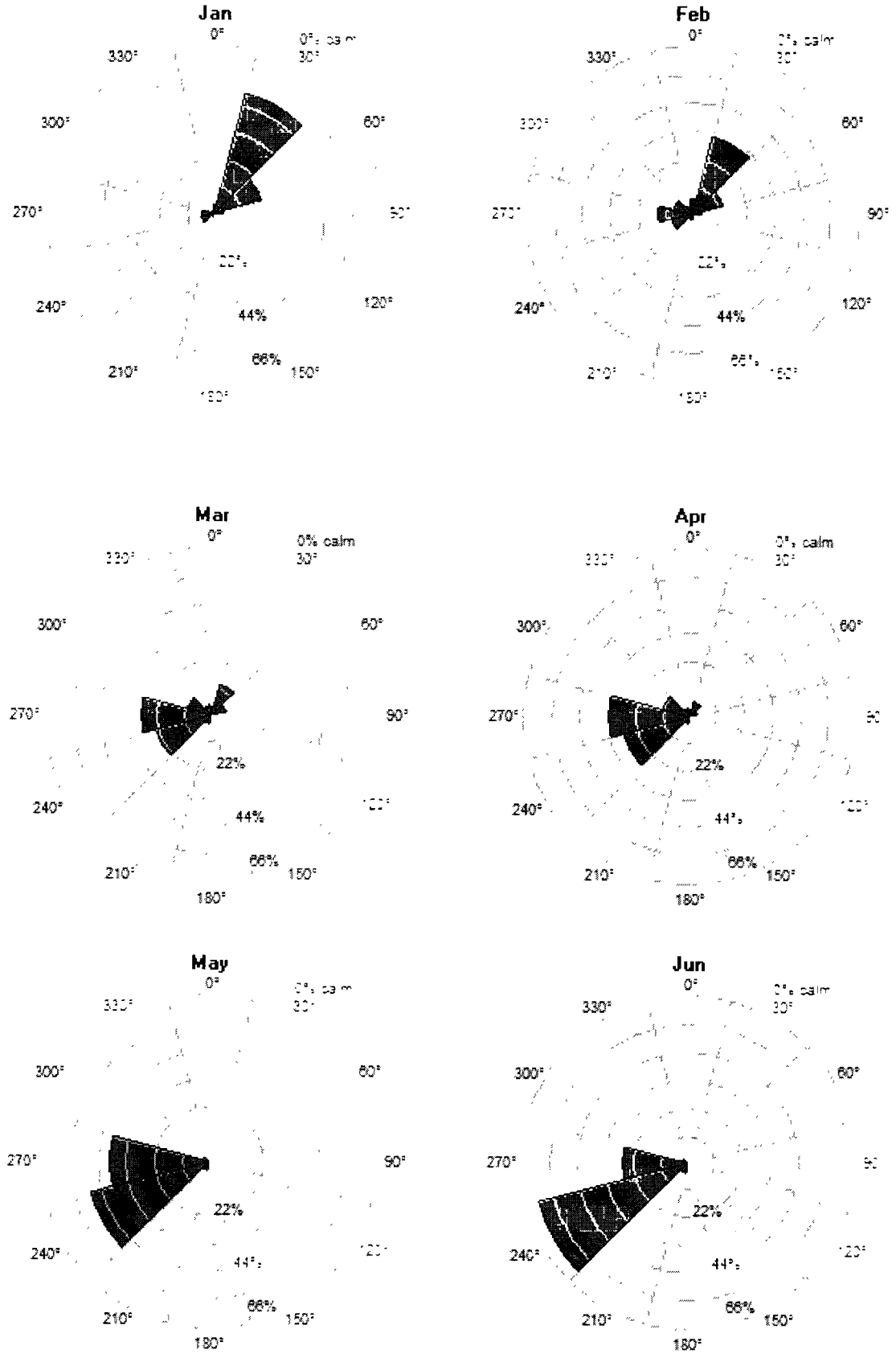


Figure 6-23: Wind Frequency Rose of LEPL Mast at 83.5m


Jan
0°
0% calm
30°
330°
300°
60°
270°
90°
22%
240°
120°
44%
66%
210°
150°
180°
Feb
0°
30°
330°
300°
60°
270°
90°
22%
240°
120°
44%
66%
210°
150°
180°
Mar
0°
0% calm
30°
330°
300°
60°
270°
90°
22%
240°
120°
44%
66%
210°
150°
180°
Apr
0°
0% calm
30°
330°
300°
60°
270°
90°
22%
240°
120°
44%
66%
210°
150°
180°
May
0°
30°
330°
300°
60°
270°
90°
22%
240°
120°
44%
66%
210°
150°
180°
Jun
0°
30°
330°
300°
60°
270°
90°
22%
240°
120°
44%
66%
210°
150°
180°

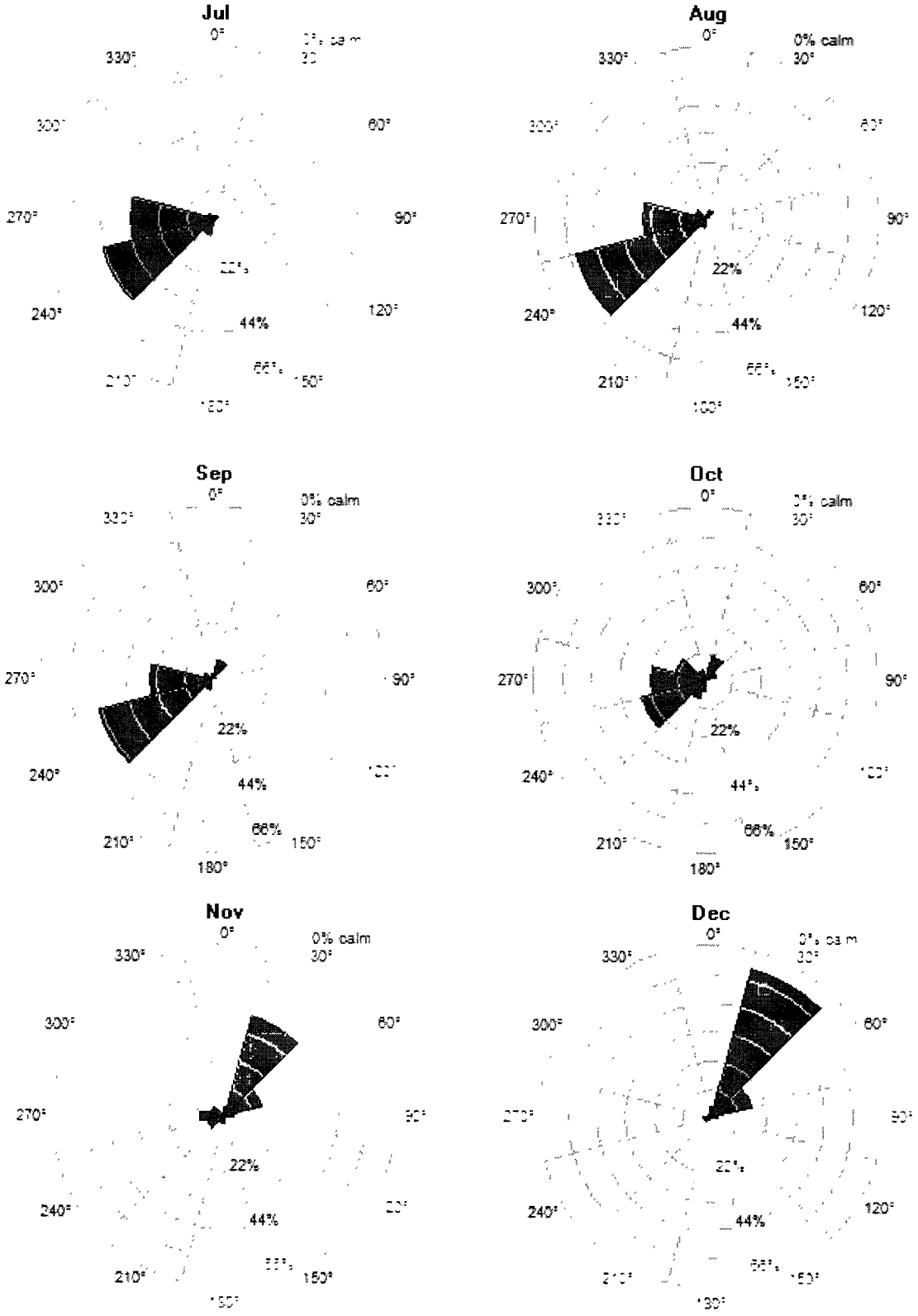


Figure 6-24: Monthly Wind Frequency Rose of LEPL Mast at 83.5m

The annual and monthly wind rose developed using the LEPL mast data (Dec 2008 - Mar 2012) at 28.5m height are given below in Figure 6-25 and 6-26 respectively.

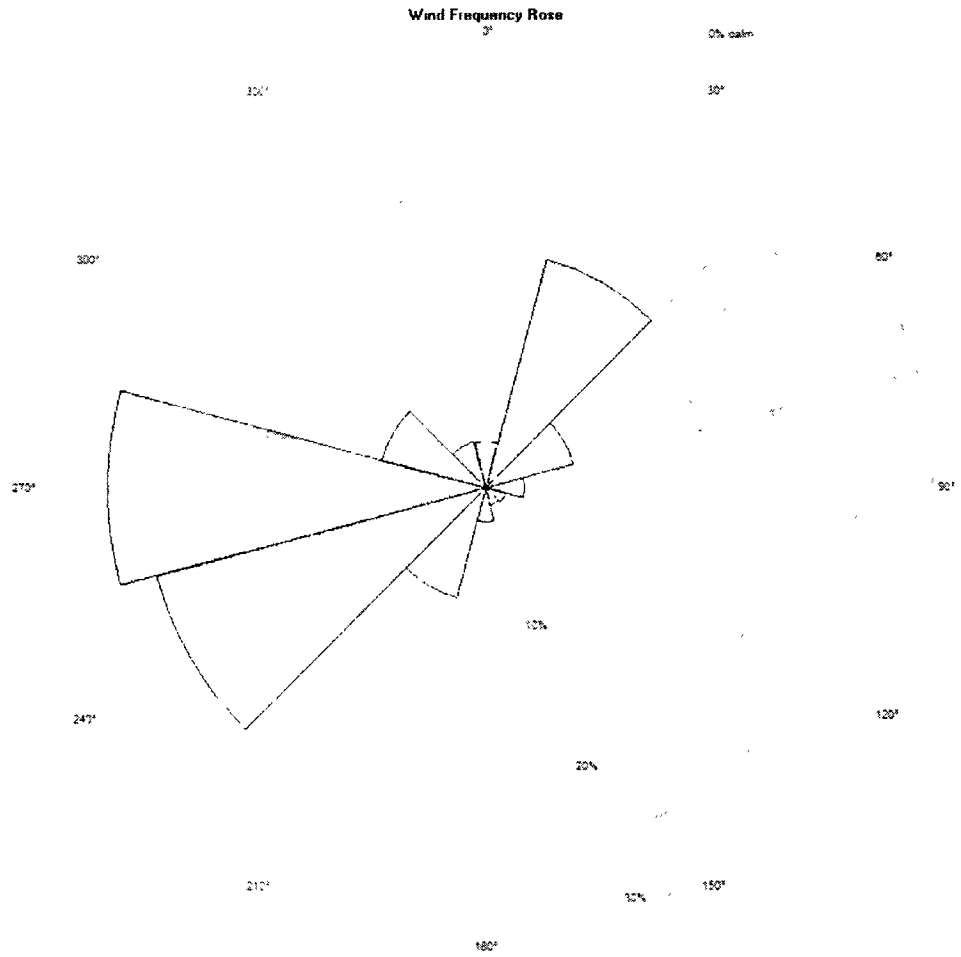
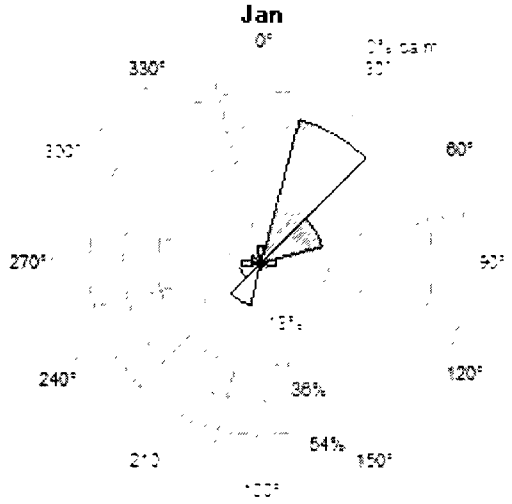
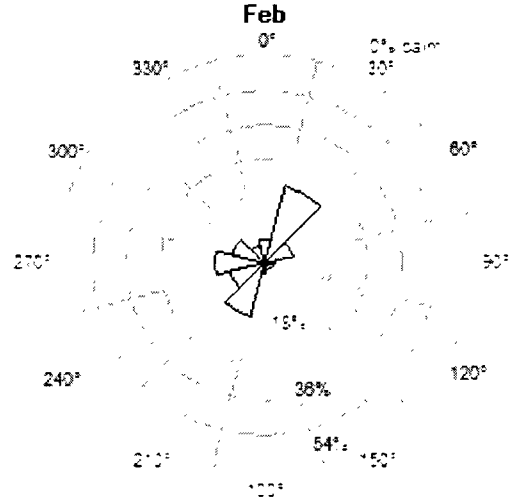
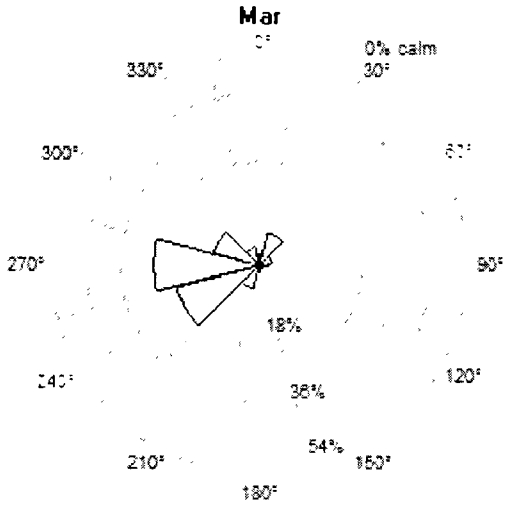
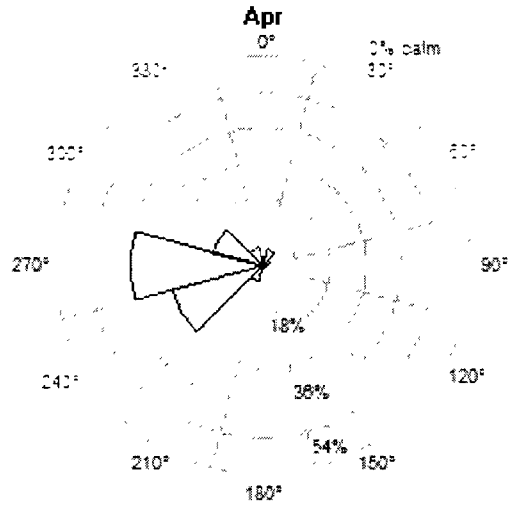


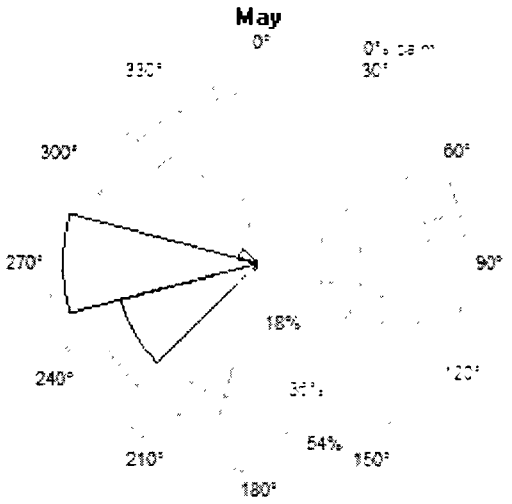
Figure 6-25: Wind Frequency Rose of LEPL Mast at 28.5m

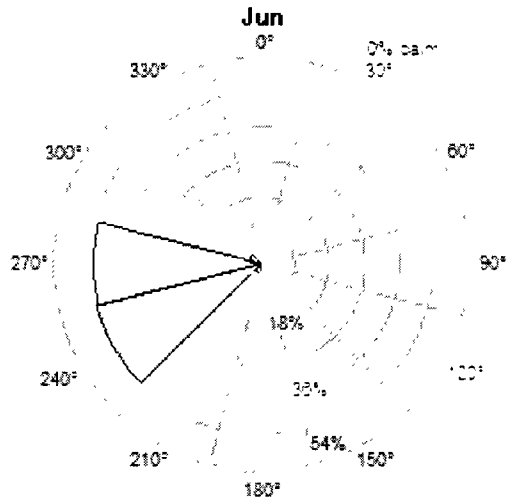

Jan
0°
0% calm
30°
60°
90°
120°
150°
180°
210°
240°
270°
300°
330°
18%
36%
54%


Feb
0°
0% calm
30°
60°
90°
120°
150°
180°
210°
240°
270°
300°
330°
18%
36%
54%


Mar
0°
0% calm
30°
60°
90°
120°
150°
180°
210°
240°
270°
300°
330°
18%
36%
54%


Apr
0°
0% calm
30°
60°
90°
120°
150°
180°
210°
240°
270°
300°
330°
18%
36%
54%


May
0°
0% calm
30°
60°
90°
120°
150°
180°
210°
240°
270°
300°
330°
18%
36%
54%


Jun
0°
0% calm
30°
60°
90°
120°
150°
180°
210°
240°
270°
300°
330°
18%
36%
54%

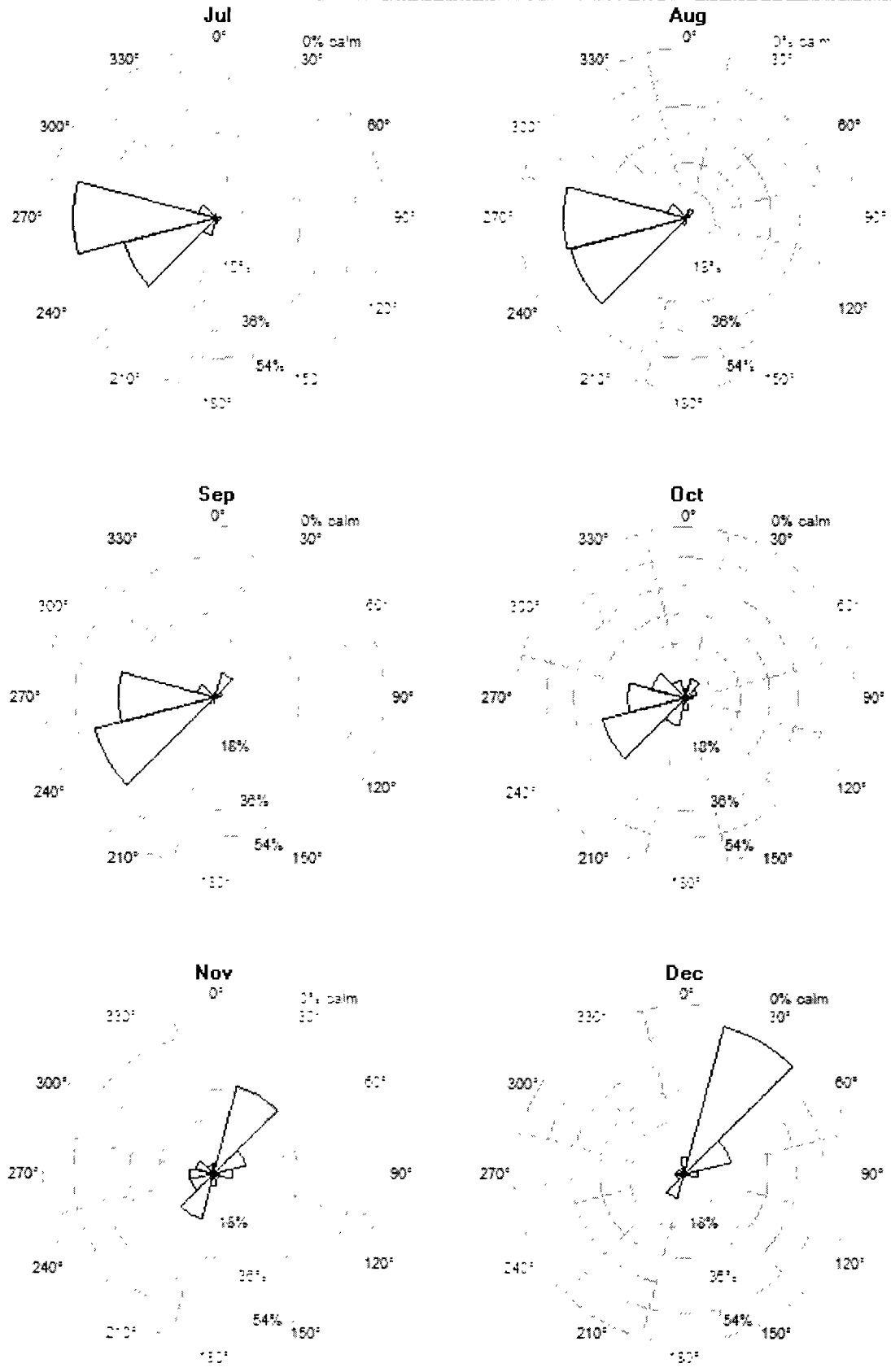


Figure 6-26: Monthly Wind Frequency Rose of LEPL Mast at 28.5m

It can be seen from the wind roses given above that the predominant wind direction is southwest and west-southwest to a lesser extent west. The frequency distribution of the measurement is given in the following table.

Table 6-10: Wind Direction Data with Frequency Distribution

	Direction	Frequency (%)	
	Sector	Dir 28.5m	Dir 83.5m
1	345 - 15	3 1782	3.1247
2	15 - 45	15.9112	20.9064
3	45 - 75	6.2138	7.9916
4	75 - 105	2.7041	2.2266
5	105 - 135	1.4999	0.9700
6	135 - 165	1.2704	1.0500
7	165 - 195	2.3411	2.1719
8	195 - 225	7.7252	4.0976
9	225 - 255	22.9909	27.6713
10	255 - 285	25.4321	21.0456
11	285 - 315	7.3673	6.0435
12	315 - 345	3.2760	2.6236

7. LAYOUT DESIGN FOR 50MW PROJECT

7.1 LAYOUT OF WIND FARM

The maximum wind farm rated capacity is 50MW. The Micrositing of the wind farm has been done in a way so as to have the minimum wake losses and maximum power production numbers. The layouts were developed by the company based on the following criteria:

- Maximum installed capacity 50MW
- Given boundaries of the wind farm area
- Prevailing wind direction
- Suitable spacing between WTGs
- Consideration of orographical structure

Further following assumptions were made:

- **Option1:** Assuming the HAE wind farm will be only the one farm in Jhampir area. The detailed results are shown in the following section of this feasibility study. The layout made using option1 is shown in figure given below.

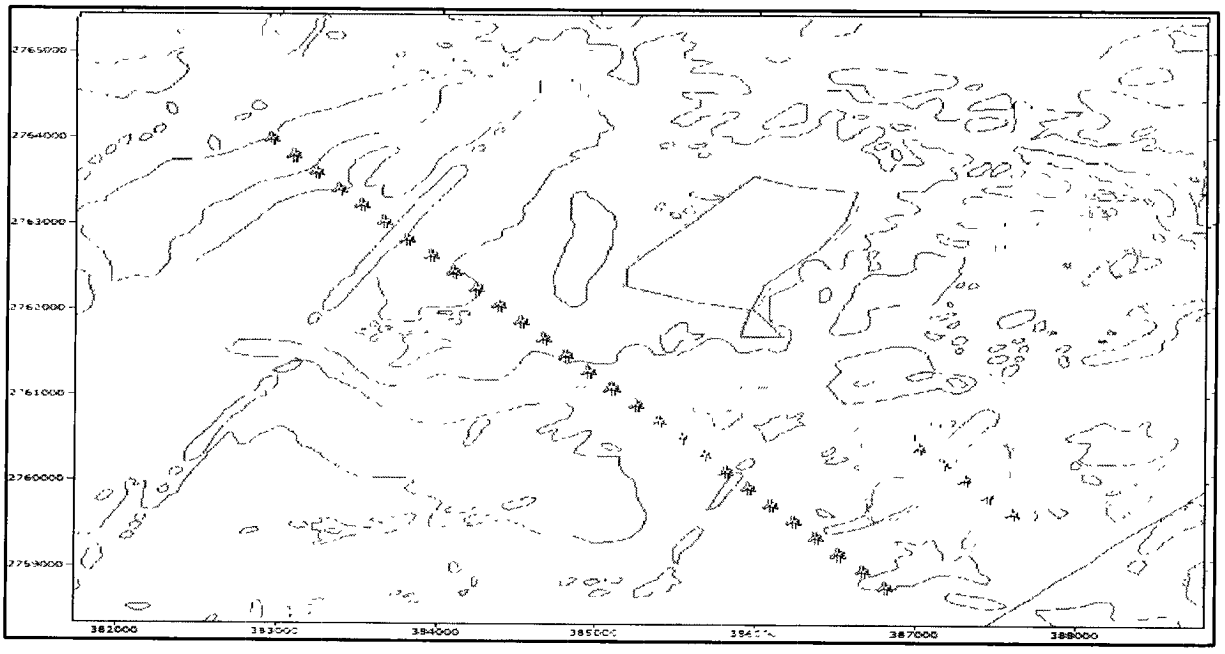


Figure 7-1: HAE Wind farm layout without considering neighbouring wind farms

- **Option2:** Assuming the HAE wind farm will be placed together with the neighboring wind farms and several other potential wind farms planned in the same vicinity. The detailed results are shown in the following section of this feasibility study. Since this option has the most influence to the wake losses, it was used for all further calculations. The layout made using option2 is shown in figure given below:

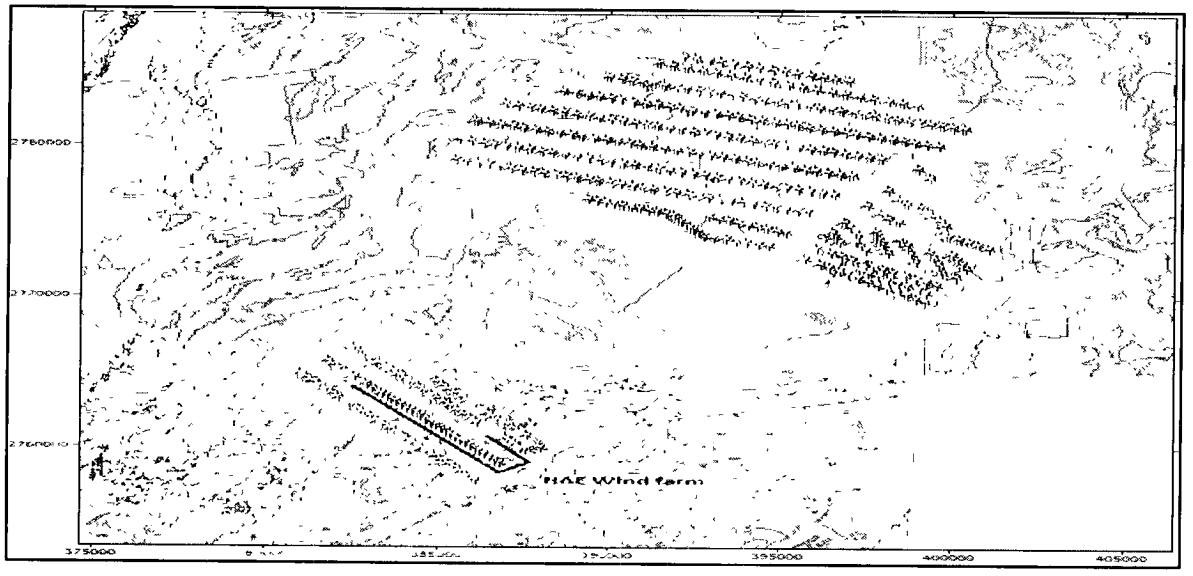


Figure 7-2: HAE wind farm layout with several other planned wind farms

7.2 WIND RESOURCE ASSESSMENT

The wind resource maps have been calculated using the wind data available at FFCEL Mast. The wind resource map of the site using the wind measuring data of FFCEL mast is given below.

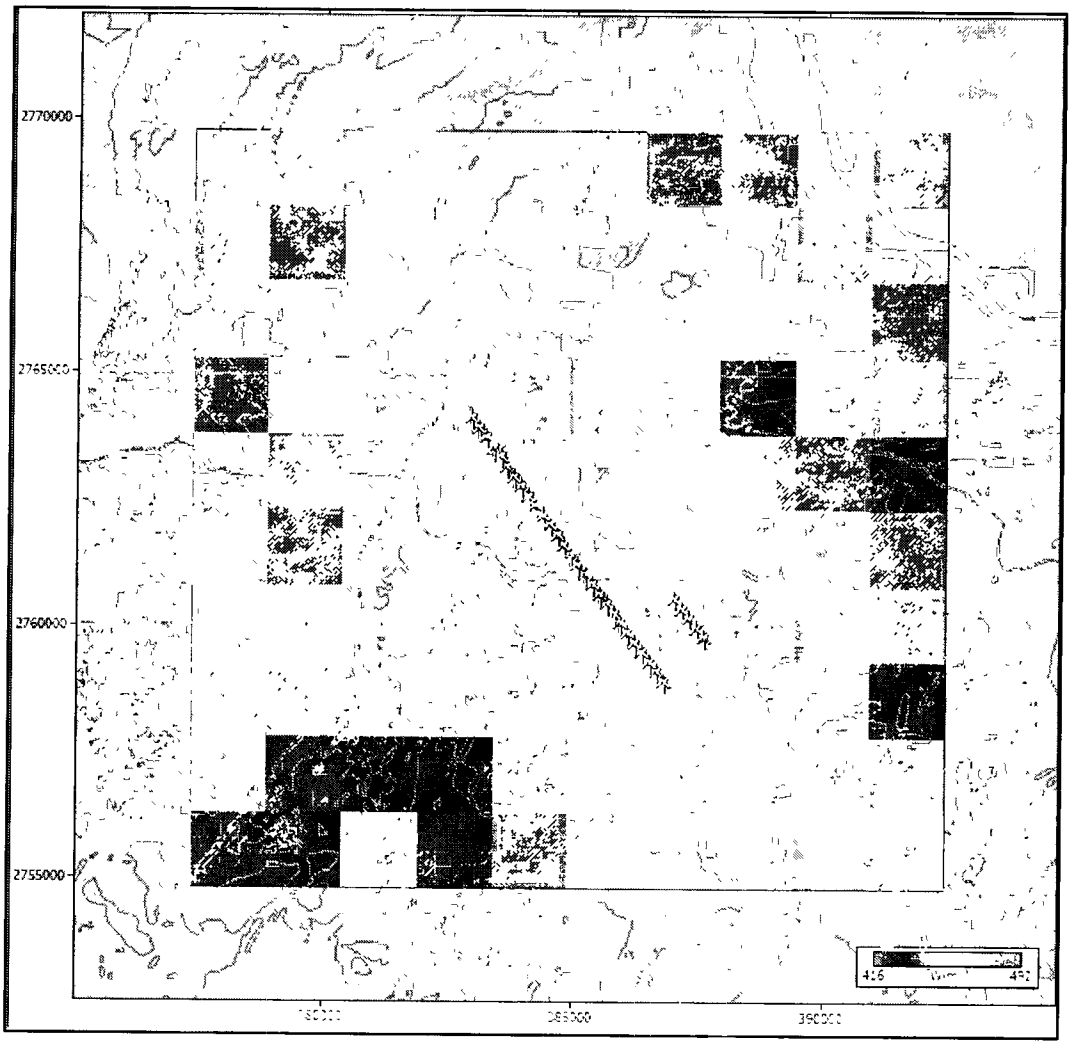


Figure 7-3: HAE Wind Resource Map at 80m hub height (FFCEL Mast)

7.3 WIND TURBINE LOCATIONS

The turbine coordinates for layout developed for HAE 50MW wind farm in Jhampir is shown in table given below.

Table 7-1: Turbine Coordinates of HAE 50MW Wind Farm

	Layout - 33 WTGs – 1500kW	
	UTM WGS84 (Zone 42)	
WTG ID	X	Y
WTG 1	387033.1	2760340
WTG 2	387177.5	2760149
WTG 3	387321.9	2759957
WTG 4	387466.4	2759765
WTG 5	387610.8	2759574
WTG 6	386823.7	2758707
WTG 7	386680.9	2758900
WTG 8	386538.2	2759093
WTG 9	386395.4	2759286
WTG 10	386252.7	2759479
WTG 11	386109.9	2759672
WTG 12	385967.2	2759864
WTG 13	385824.4	2760057
WTG 14	385681.6	2760250
WTG 15	385538.9	2760443
WTG 16	385396.1	2760636
WTG 17	385253.4	2760829

WTG 18	385110.6	2761022
WTG 19	384967.9	2761215
WTG 20	384825.1	2761408
WTG 21	384682.3	2761601
WTG 22	384539.6	2761794
WTG 23	384396.8	2761987
WTG 24	384254.1	2762180
WTG 25	384111.3	2762372
WTG 26	383968.6	2762565
WTG 27	383825.8	2762758
WTG 28	383683	2762951
WTG 29	383540.3	2763144
WTG 30	383254.8	2763530
WTG 31	383396.8	2763335
WTG 32	383112	2763723
WTG 33	382969.3	2763916

8. ANNUAL ENERGY YIELD CALCULATIONS

8.1 INTRODUCTION

HAE has undertaken an energy yield prediction for its 50MW wind Farm which is located in southern Pakistan in Sindh province.

The Annual yield is calculated by the company using the time series derived from wind measuring mast of FFCEL. The annual energy yield has been calculated using the following two approaches:

- HAE wind farm will be only the one farm in Jhampir area.
- HAE wind farm with the neighbouring wind farms and several other potential wind farms planned in the same vicinity.

However, for the purpose of tariff calculations, the company will use the annual energy yield estimated using the option/ approach in which all future planned wind farms are considered.

8.2 WIND FARM LAYOUT

A WTG layout was designed by the company based on the land boundary, prevailing wind direction and suitable spacing between WTGs.

It should be noted that numerous wind farm developments are planned in the vicinity of the HAE wind farm. These planned wind farms have the most influence to the wake losses. The company takes into account the wake effects of both neighboring wind farms and all other wind farms planned in the vicinity while performing the energy yield calculations at HAE wind farm site.

8.3 ANNUAL ENERGY PREDICTION

8.3.1 WASP WIND FLOW MODEL

The wind rose was introduced into the WAsP model, together with the topographic and roughness map for the area. Free stream wind speeds were then predicted for each WTG location. The WAsP wind flow model was then used to calculate the topographic, roughness and obstacles effects across the HAE wind farm.

8.3.2 ENERGY YIELD PREDICTION

The results derived were then modified by the application of a series of calculated and nominal effects and losses, in order to produce a final energy yield for the site.

8.4 ANNUAL ENERGY YIELD WITHOUT CONSIDERING THE NEIGHBORING WIND FARMS

The annual energy production for 50MW wind farm, using long term time series developed at FFCEL Mast, on the proposed wind turbine generator has been estimated using WAsP. The summary of annual energy yield calculated without taking into account the other/ neighboring wind farms is shown below in Table 8-1. The details of estimated annual energy production of the whole wind farm and individual wind turbines without considering the other / neighboring wind farms in the region are given in section 8.4.1.

Table 8-1: Summary of Estimated AEP without considering the Other/ Neighboring Wind Farms

HAE Wind Farm	GE 1.5xle
Turbine Capacity (kW)	1500
Number of WTG	33
Installed Wind Farm Capacity (MW)	49.5
Hub Height (meters)	80
Rotor Diameter (m)	82.5
Gross Electrical Output of Wind Farm (GWh)	212.575
Wake Losses (GWh)	5.854
Net Electrical Output of Wind Farm (GWh)	206.721
Availability (95%) - (GWh)	10.336
Power Curve density correction Losses (3%) - (GWh)	6.202
Electrical Losses (3%) - (GWh)	6.202
Scheduled maintenance/ Miscellaneous (1.0 %) - (GWh)	2 067
High Temperature Losses (1 5%) – GWh	3.101
Blade Degradation (0.5%) - (GWh)	1 034
P50 Wind Farm Yield (GWh/annum)	177.780
P50 Capacity Factor (%age)	40.99

8.4.1 INDIVIDUAL WTG WASP OUTPUTS

The details of estimated annual energy production (AEP) of the whole wind farm and individual wind turbines, without considering the other / neighboring wind farms in the region using the time series of FFCEL mast are shown in Table 8-2 and 8-3 respectively.

Table 8-2: Summary of Estimated AEP without considering other/ neighboring Wind Farms

Parameters	Total	Average	Minimum	Maximum
Net AEP [GWh]	206.721	6.264	5.998	6 433
Gross AEP [GWh]	212 575	6 442	6.346	6.564
Wake Loss [%]	2.757	-	-	-

Table 8-3: Site Results of HAE wind farm without considering other/ neighboring Wind Farms

Site ID	Site x [m]	Site y [m]	Turbine	Elevation [m]	Height [m]	Net AEP [GWh]	Wake Loss [%]
WTG 1	387033.1	2760340	GE 1.5 xle	55	80	6.097	5.2
WTG 2	387177.5	2760149	GE 1.5 xle	55	80	6.031	6.06
WTG 3	387321.9	2759957	GE 1.5 xle	55	80	5.998	6.27
WTG 4	387466.4	2759765	GE 1.5 xle	55	80	6.012	6.2
WTG 5	387610.8	2759574	GE 1.5 xle	57	80	6.055	5.92
WTG 6	386823.7	2758707	GE 1.5 xle	54	80	6.253	3.02
WTG 7	386680.9	2758900	GE 1.5 xle	55	80	6.195	3.49
WTG 8	386538.2	2759093	GE 1.5 xle	55	80	6.189	3.66
WTG 9	386395.4	2759286	GE 1.5 xle	56	80	6.214	3.34
WTG 10	386252.7	2759479	GE 1.5 xle	57	80	6.248	2.96
WTG 11	386109.9	2759672	GE 1.5 xle	58	80	6.284	2.55
WTG 12	385967.2	2759864	GE 1.5 xle	59	80	6.312	2.37
WTG 13	385824.4	2760057	GE 1.5 xle	60	80	6.373	2.13
WTG 14	385681.6	2760250	GE 1.5 xle	58	80	6.323	2.04
WTG 15	385538.9	2760443	GE 1.5 xle	59	80	6.313	2.04
WTG 16	385396.1	2760636	GE 1.5 xle	60	80	6.31	2.01
WTG 17	385253.4	2760829	GE 1.5 xle	59	80	6.275	2.01
WTG 18	385110.6	2761022	GE 1.5 xle	60	80	6.253	2.01
WTG 19	384967.9	2761215	GE 1.5 xle	60	80	6.219	2
WTG 20	384825.1	2761408	GE 1.5 xle	60	80	6.245	1.98
WTG 21	384682.3	2761601	GE 1.5 xle	62	80	6.246	2.02

WTG 22	384539.6	2761794	GE 1.5 xle	66	80	6.257	2.08
WTG 23	384396.8	2761987	GE 1.5 xle	69	80	6.274	2.07
WTG 24	384254.1	2762180	GE 1.5 xle	70	80	6.323	2.01
WTG 25	384111.3	2762372	GE 1.5 xle	70	80	6.348	1.96
WTG 26	383968.6	2762565	GE 1.5 xle	73	80	6.381	1.95
WTG 27	383825.8	2762758	GE 1.5 xle	78	80	6.433	2
WTG 28	383683	2762951	GE 1.5 xle	79	80	6.429	2.01
WTG 29	383540.3	2763144	GE 1.5 xle	75	80	6.383	1.94
WTG 30	383254.8	2763530	GE 1.5 xle	70	80	6.342	1.76
WTG 31	383396.8	2763335	GE 1.5 xle	71	80	6.356	1.81
WTG 32	383112	2763723	GE 1.5 xle	70	80	6.348	1.52
WTG 33	382969.3	2763916	GE 1.5 xle	70	80	6.402	0.58

8.5 ANNUAL ENERGY YIELD CONSIDERING THE NEIGHBORING WIND FARMS

The annual energy production for 50MW wind farm, using long term time series developed at FFCEL Mast, on the proposed wind turbine generator has been estimated using WAsP. The summary of annual energy yield calculated taking into account the other/ neighboring wind farms is shown below in Table 8-4. The details of estimated annual energy production of the whole wind farm and individual wind turbines after considering the other / neighboring wind farms in the region are given in section 8.5.1.

Table 8-4: Summary of Estimated AEP after considering the Other/ Neighboring Wind Farms

HAE Wind Farm	GE 1.5xle
Turbine Capacity (kW)	1500
Number of WTG	33
Installed Wind Farm Capacity (MW)	49.5
Hub Height (meters)	80
Rotor Diameter (m)	82.5
Gross Electrical Output of Wind Farm (GWh)	212.575
Wake Losses (GWh)	16.421
Net Electrical Output of Wind Farm (GWh)	196.154
Availability (95%) - (GWh)	9 808
Power Curve density correction Losses (3%) - (GWh)	5 885
Electrical Losses (3%) - (GWh)	5 885
Scheduled maintenance/ Miscellaneous (1.0 %) - (GWh)	1.962
High Temperature Losses (1.5%) – GWh	2 942
Blade Degradation (0.5%) - (GWh)	0 981
P50 Wind Farm Yield (GWh/annum)	168.692
P50 Capacity Factor (%age)	38.903

8.5.1 INDIVIDUAL WTG WASP OUTPUTS

The details of estimated annual energy production (AEP) of the whole wind farm and individual wind turbines, considering the other / neighboring wind farms in the region using the time series of FFCEL mast are shown in Table 8-5 and 8-6 respectively.

Table 8-5: Summary of Estimated AEP considering other/ neighboring Wind Farms

Parameters	Total	Average	Minimum	Maximum
Net AEP [GWh]	196.154	5.944	5.802	6.090
Gross AEP [GWh]	212.575	6.442	6.346	6.564
Wake Loss [%]	7.728	-	-	-

Table 8-6: Site Results of HAE 50MW wind farm considering other/ neighboring Wind Farms

Site ID	Site x [m]	Site y [m]	Turbine	Elevation [m]	Height [m]	Net AEP [GWh]	Wake Loss [%]
WTG 1	387033.1	2760340	GE 1.5 xle	55	80	5.841	9.17
WTG 2	387177.5	2760149	GE 1.5 xle	55	80	5.802	9.64
WTG 3	387321.9	2759957	GE 1.5 xle	55	80	5.802	9.33
WTG 4	387466.4	2759765	GE 1.5 xle	55	80	5.874	8.36
WTG 5	387610.8	2759574	GE 1.5 xle	57	80	5.889	8.51
WTG 6	386823.7	2758707	GE 1.5 xle	54	80	6.006	6.86
WTG 7	386680.9	2758900	GE 1.5 xle	55	80	5.927	7.67
WTG 8	386538.2	2759093	GE 1.5 xle	55	80	5.913	7.95
WTG 9	386395.4	2759286	GE 1.5 xle	56	80	5.941	7.58
WTG 10	386252.7	2759479	GE 1.5 xle	57	80	5.954	7.53
WTG 11	386109.9	2759672	GE 1.5 xle	58	80	5.977	7.32
WTG 12	385967.2	2759864	GE 1.5 xle	59	80	5.996	7.26
WTG 13	385824.4	2760057	GE 1.5 xle	60	80	6.056	7
WTG 14	385681.6	2760250	GE 1.5 xle	58	80	5.977	7.41
WTG 15	385538.9	2760443	GE 1.5 xle	59	80	5.942	7.79
WTG 16	385396.1	2760636	GE 1.5 xle	60	80	5.926	7.96
WTG 17	385253.4	2760829	GE 1.5 xle	59	80	5.895	7.95
WTG 18	385110.6	2761022	GE 1.5 xle	60	80	5.856	8.23
WTG 19	384967.9	2761215	GE 1.5 xle	60	80	5.825	8.22
WTG 20	384825.1	2761408	GE 1.5 xle	60	80	5.846	8.23
WTG 21	384682.3	2761601	GE 1.5 xle	62	80	5.86	8.07
WTG 22	384539.6	2761794	GE 1.5 xle	66	80	5.859	8.31

WTG 23	384396.8	2761987	GE 1.5 xle	69	80	5.884	8.16
WTG 24	384254.1	2762180	GE 1.5 xle	70	80	5.929	8.1
WTG 25	384111.3	2762372	GE 1.5 xle	70	80	5.984	7.58
WTG 26	383968.6	2762565	GE 1.5 xle	73	80	6.013	7.6
WTG 27	383825.8	2762758	GE 1.5 xle	78	80	6.08	7.38
WTG 28	383683	2762951	GE 1.5 xle	79	80	6.09	7.17
WTG 29	383540.3	2763144	GE 1.5 xle	75	80	6.082	6.57
WTG 30	383254.8	2763530	GE 1.5 xle	70	80	6.046	6.35
WTG 31	383396.8	2763335	GE 1.5 xle	71	80	6.048	6.55
WTG 32	383112	2763723	GE 1.5 xle	70	80	5.985	7.16
WTG 33	382969.3	2763916	GE 1.5 xle	70	80	6.049	6.06

9. UNCERTAINTY ANALYSIS

The production estimates made on p50 exceedance level are the best estimates of the long term mean value to be expected from the project. There is therefore a 50% chance that, even when taken over very long periods, the mean energy production will be less than the values given. The uncertainties associated with the wind speed measurement accuracy, long term wind speed predictions, wind flow model, array loss modeling, instruments, topography, simulation software have been estimated. Annual Energy production of the wind farm is calculated at different probability level. Four sources of uncertainties are included in this analysis out of seven sources of uncertainty considered for the analysis:

- The wind data are assumed to represent long term statistics. The uncertainty of that assumption – the inter annual variability on the wind speed – is estimated to be 7%.
- The wind flow model may have random uncertainty which is for the wind speed set to 10%. It is to be noted that the flatness of the area constitute near ideal condition for the software.
- Uncertainty owing to the difference between the RIX numbers of the site of prediction and the reference mast. The difference is negligible and not considered.
- Landscape and forest complexity not taken into account, this term is considered negligible.
- Set-up of the instruments is according to standards. The effect on the FFCEL mast is considered to be negligible.

These uncertainty estimates are combined into a single uncertainty and results in an overall uncertainty of 12 % for FFCEL mast. Probability exceedance levels for the production estimates are found by Gaussian distribution. The results obtained for different confidence levels are summarized below in Table 9.1 and 9.2.

Table 9.1: Energy Production Estimates for 50MW Wind Farm after considering Other Neighbouring wind farms

WTG Type	GE 1.5xle
P50 Wind Farm Yield (GWh/annum)	168.692
P60 Wind Farm Yield (GWh/annum)	163.63
P70 Wind Farm Yield (GWh/annum)	158.17
P75 Wind Farm Yield (GWh/annum)	155.13
P90 Wind Farm Yield (GWh/annum)	142.78

Annexure-X
INITIAL ENVIRONMENTAL EXAMINATION (IEE) REPORT FOR HAEPL

Reference No:EPA/2014/02/18/IEE/11
ENVIRONMENTAL PROTECTION AGENCY
GOVERNMENT OF SINDH
Plot # ST – 2/1, Sector 23, Korangi
Industrial Area, Karachi – 74900
Ph: 021 – 35065950, 35065621, 35065946
epasindh@cyber.net.pk
Fax No: 021 - 35065940

Date: 28th May, 2015

DECISION ON INITIAL ENVIRONMENTAL EXAMINATION (IEE).

1. **Name & Address of Proponent:** Chief Executive Officer, Hartford Alternate Energy Islamabad.
2. **Description of Project:** 50 MW Wind Power Project
3. **Location of Project:** Jhimpir, Sindh
4. **Date of Filing of IEE:** 24-11-2013

5. After careful review and analysis of the Initial Environmental Examination (IEE) report, Sindh Environmental Protection Agency (SEPA), has accord its approval subject to the following conditions:

i. During the project execution, safe distances of the under mentioned environmental sensitivities will be maintained:
   - 500m from communities, industries and main transport network
   - 300m from community water well
   - 100m from archaeological / cultural site / monument
   - Distance will be measured from the tip blade of turbines or/and transmission power lines associated.

ii. Project activity will not be carried out within buffer zone of any projected area designated under Sindh wildlife protection act.

iii. Effect on wildlife will be monitored during the migratory season of birds and reports of findings will be submitted to EPA Sindh.

iv. Campsites will be located at least one kilometer away from any settlement to avoid disturbance to the local people.

v. No industrial or residential activity will be permitted on the land allocated for wind energy projects.

vi. The project area will be restored to its original nature to the possible extent. For the purpose, documentation (Photographs) will be kept in record.

vii. The project shall be constructed in the prescribed time strictly as per schedule, which shall be submitted to this office at the start of construction activity.

viii. Employment will be provided to local people and assured for all unskilled jobs. Skilled jobs will be given to the locals after providing them proper field training, where a minimum training will be required.

Reference No:EPA/2014/02/18/IEE/11
ENVIRONMENTAL PROTECTION AGENCY
GOVERNMENT OF SINDH
Plot # ST – 2/1, Sector 23, Korangi
Industrial Area, Karachi – 74900
Ph: 021 – 35065950, 35065621, 35065946
epasindh@cyber.net.pk
Fax No: 021 - 35065940

ix. Benefits to local people will be offered under Corporate Social Responsibility (CSR) policy. community development schemes will be decided in consultation with local communities and may be facilitated by involving district/local Government office.

x. The proponent shall ensure facilitation to the EPA officer(s)/official(s) for the regular inspections to verify the compliance of the PEP Act, Rules and Regulations framed there under and the conditions contained in this approval.

xi. Compensation will be provided to the inhabitants in case of loss of agriculture land, crop property, etc., in accordance with the rates, that are agreed upon. All conflicting issues regarding compensation etc. should be settled in advance prior to the start of activity.

6. This approval shall be treated cancelled if any of the conditions, mentioned in para-5 above is violated. In follow up of the cancellation of this approval prosecution under the provision of Sindh Environmental Protection Act, 2014 will be initiated against the proponent.

7. The proponent will be liable for compliance of EIA/IEE Regulation, 2014, which permits the authority i.e. Environmental Protection Agency to enter, inspect and monitor the development of the project so that the conditions are effectively monitored.

8. This approval does not absolve the proponent of the duty to obtain any other approval or consent that may be required under any other law in force.

9. Implementation Report of all the mitigation measures and EMP laid down in the IEE Report be submitted to this office on quarterly basis for review. No violation of any Regulations, Rules, Instruction and Provisions of PEP Act, 1997, shall be made

10. The relevant organization/proponent will submit separate EIA to EPA, Sindh for construction of new grid station to cater electricity generation from proposed wind energy project.

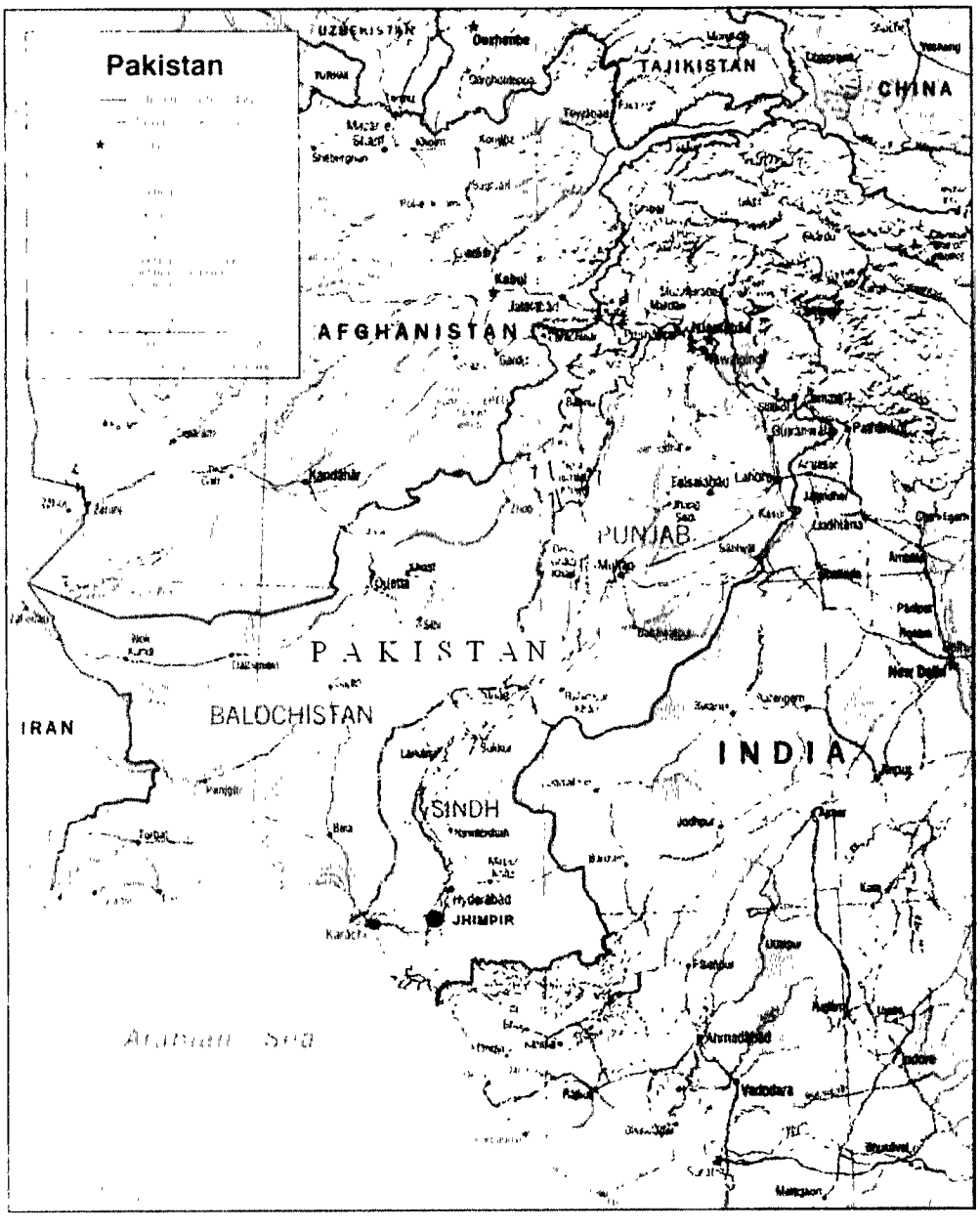
Naeem Ahmed Mughal
Director General

SCHEDULE-I

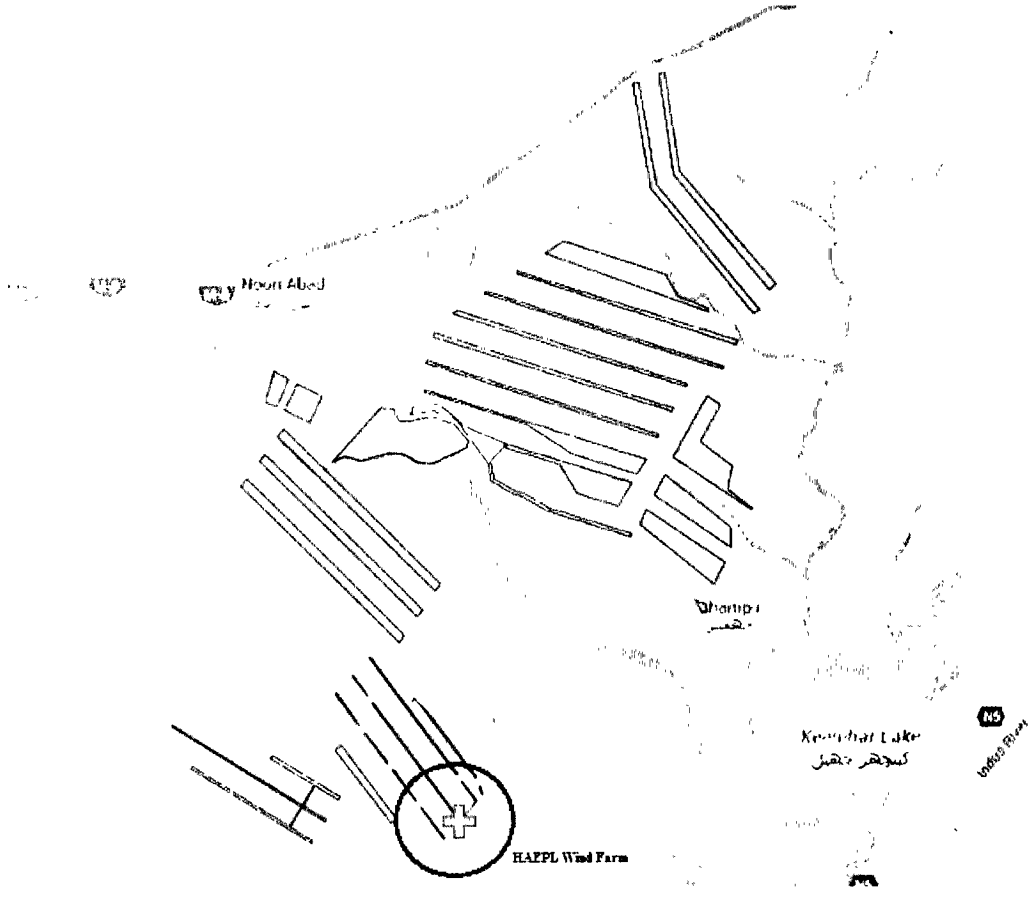
The Location, Size (i.e. Capacity in MW), Type of Technology, Interconnection Arrangements, Technical Limits, Technical/Functional Specifications and other details specific to the Generation Facilities of the Licensee are described in this Schedule.

Location of the Generation Facility/Wind Farm

HAEPL is a Project Company for 49.3 MW Wind power project located in Jhimpir, Sindh, East of Karachi. The National Highway and Superhighway are major connecting roads having a distance of approximately 145 km from Port Qasim. Project Company has acquired 320 acres of land from Government of Sindh. The monsoon from the Arabia Sea, which is stable in its direction and high in its quality, brings rich wind energy resource to the Site. The geographical location of the project is shown in figure below.



The terrains are flat at the Project Site with little vegetation, consisting mostly of savanna. There are some very small and scattered pieces of agricultural lands. The area has a dry climate. The map of Project Site is shown in figure below:



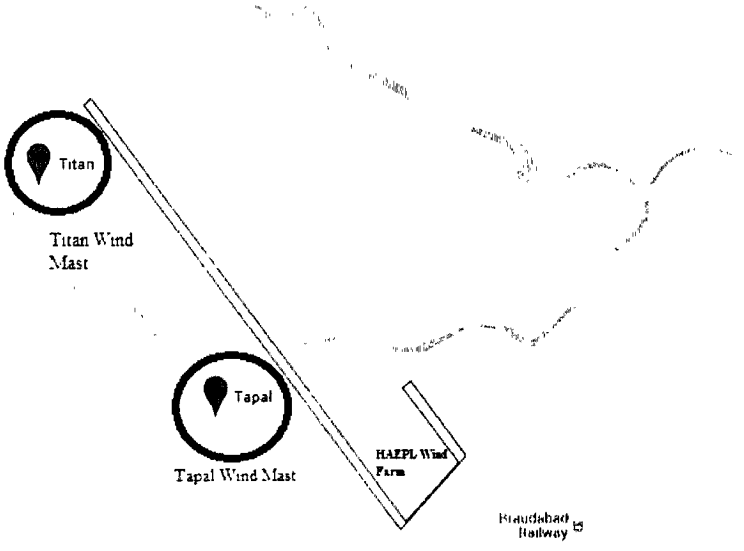
Project Size

The Project shall have an installed capacity of 49.3 MW rated power. The number of WTG are 29 with capacity 1.7 MW each.

Layout of the Generation Facility/Wind Farm with Coordinates

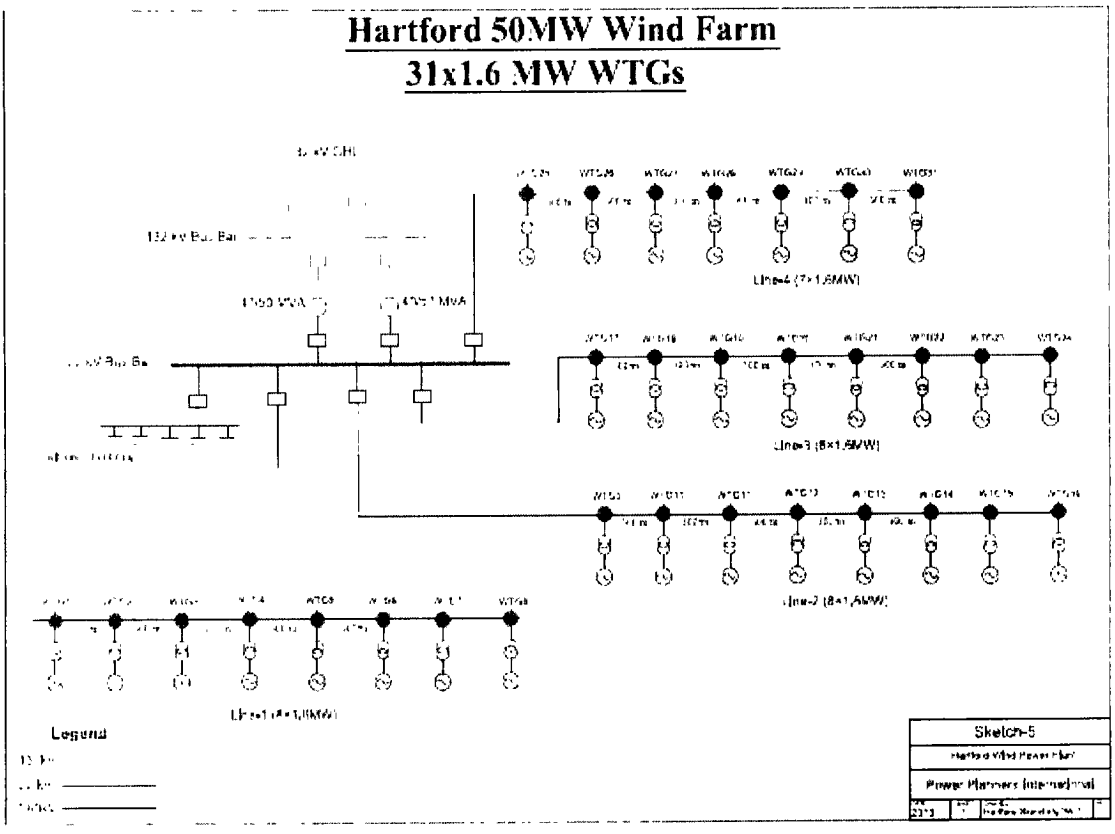
The coordinates of the Wind Turbines are given in Table:

Turbine No.	Easting (m)	Northing (m)
1	382,834	2,764,113
2	382,985	2,763,914
3	383,134	2,763,713
4	383,279	2,763,509
5	383,433	2,763,312
6	383,579	2,763,109
7	383,876	2,762,707
8	384,024	2,762,505
9	384,172	2,762,304
10	384,321	2,762,103
11	384,471	2,761,903
12	384,616	2,761,700
13	384,767	2,761,500
14	385,064	2,761,098
15	385,212	2,760,897
16	385,361	2,760,695
17	385,509	2,760,494
18	385,656	2,760,292
19	385,803	2,760,090
20	385,951	2,759,888
21	386,098	2,759,686
22	386,248	2,759,486
23	386,694	2,758,883
24	386,843	2,758,682
25	387,045	2,760,344
26	387,193	2,760,142
27	387,341	2,759,940
28	387,489	2,759,739
29	387,637	2,759,537


Titan
Titan Wind Mast
Tapal
Tapal Wind Mast
HAEPL Wind Farm
Hyderabad Hallway

Single Line Diagram (Electrical) of the Generation Facility/Wind Farm

Below SLD shows 31 WTGs (GE1.5), which are from the previous configuration planned for the Project. In reality, the project will install 29 WTGs (GE1.7). The interconnection will remain the same as shown in below figure except that the WTG loops will be changed from 8 + 8 + 8 + 7 to 8 + 7 + 7 + 7. This is an adjustment in internal connectivity within the wind farm and does not have an impact.



Interconnection Arrangement/Transmission Facilities for Dispersal of Power from the Generation Facility/Wind Power Plant/Wind Farm of Hartford Alternative Energy (Pvt.) Limited (HAEPL)

Interconnection Arrangement:

The interconnection scheme is shown in the schematic diagram on page 11 of 17, and elaborated as follows:

1. Hartford Alternative Energy Wind Power Plant would be connected by a double circuit of 132kV looping in-out with a sub cluster also connecting Fina, Tapal, Titan and Sunec WPPs to Jhimpir-New 132 kV collector substation.

2. The scheme of interconnection of Hartford WPP presupposes the following reinforcement already in place in Jhimpir and Gharo clusters by end of 2016:
   - 220/132 kV Jhimpir-New substation at suitable location in Jhimpir cluster
   - 80 km long double circuit from Jhimpir-New 220 kV Substation to the existing T.M. Khan Road 220 kV Substation
   - A 132kV double circuit of 82 km using Greeley conductor would be constructed to connect Jhimpir-New 220/132 kV Substation with T.M. Khan in HESCO network.
   - 220/132 kV Gharo-New substation at suitable location in Gharo cluster
   - 65 km long 220 kV double circuit from Gharo-New 220 kV Substation to
   - Jhimpir-New 220 kV Substation
   - Five sub-collectors groups will be connected to Jhimpir 220/132 kV collector substation through 132 kV double circuits
   - FFC and Zorlu looped in-out with Jhimpir-Nooriabad 132 kV circuit.
   - Four WPPs in the collector system of Gharo 220/132 kV substation
   - FWEL-I and FWEL-II through a 64 km long 132 kV D/C on Greeley conductor connected to Thatta
   - Rehabilitation of the exiting 132 kV lines in the vicinity of WPP clusters, i.e. Jhimpir-Kotri, Jhimpir-Thatta, Thatta-Sujawal and Nooriabad-Jamshoro Old.

3. The existing grid system of HESCO and NTDC in the vicinity of Hartford WPP has been studied in detail by performing load flow, short circuit and dynamic analysis for the conditions prior to commissioning of Hartford WPP and no bottlenecks or constraints have been found in the grid system.

4. For the interconnection scheme proposed above, the Hartford Wind Farm has been modeled considering GE 1.7-103 with capacity of 1.7 MW each. It is a Doubly Fed Induction Generator which is designated as Type-3 WTG. Its terminal voltage is 0.69 kV. The medium voltage level of wind farm has been selected as 22 kV for unit step-up transformers, for collector circuits and step-up from MV to HV (132 kV) at Farm

substation to connect to the HESCO/NTDC Grid. The modeled plant is detailed in the 'Technical Specifications – BOP' below.

5. Any change in the above mentioned Interconnection Arrangement/Transmission Facilities duly agreed by HEPL, NTDC and HESCO, shall be communicated to the Authority in due course of time.

Technical Specifications - BOP:

Please refer to the Single Line Diagram (SLD) on page 7/17. Key equipment specifications are as under:

Medium Voltage (MV) 22 kV switchgear:

a. Two single bus-sections of 22 kV with a bus sectionalizer
b. Four breaker bays to connect four collector circuits from four collector groups of WTGs
c. Two breaker bays to connect two 132/22 kV transformers
d. Two breaker bays to connect two switched shunt capacitor banks of 2 x (4x2.5) MVAR, one in each bus section
e. Two breaker bays to connect two station auxiliary transformers 22/0.4 kV, 315 kVA

High Voltage (HV) 132 kV switchgear:

a. Single busbar with sectionalizer GIS equipped substation
b. Double bus bars with a Bus Coupler AIS equipped substation
c. Two breaker bays to connect two 132/22 kV transformers
d. The protection scheme would be designed in compliance of NTDC requirements sent by Chief Engineer Protection, vide letter No.3416-19/CE/SP/MN/50MW CWE WPP Jhimpir dated 23/07/2010
e. The telecommunication scheme would be designed in compliance of NTDC requirements sent by Chief Engineer Telecommunication, vide letter No CE (Tel)/NTDC/232/4372 dated 27/08/2010.

Other Equipment:

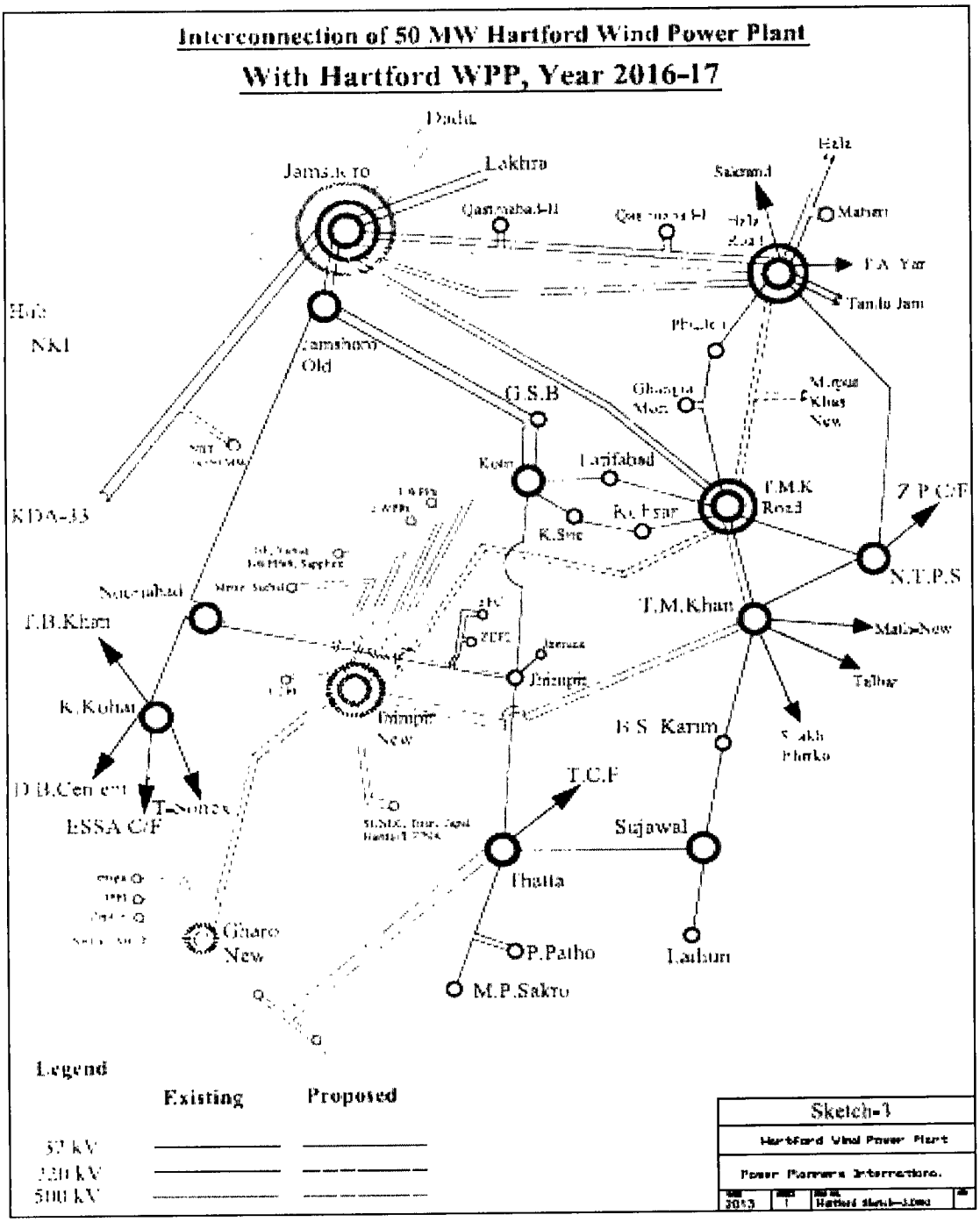
a. Two 132/22 kV, 31.5/40/50 MVA ONAN/ONAF1/ONAF2 OLTC transformers, 132±11×1%/22 kV, to fulfill N-1 criteria of Grid Code
b. Two station auxiliary transformers of 22/0.4 kV, 315 kVA
c. Two switched shunt capacitor banks each of the size of 10 MVAR (4 x 2.5 MVAR) to provide 20 MVAR at 22 kV with contactors and PLC (Programmable Logic Controller).
d. Energy meters would be installed on HV side (132 kV) of the 132/22 kV transformers

Protection and Control:

a. Line distance/differential protection
b. HV busbar differential protection
c. Transformer differential protection
d. Backup overcurrent/earth fault protection

e. Overcurrent, over/under voltage/frequency protections built in the Wind turbine generators
f. All instrumentation to be sized as per relevant NTDC specifications and prudent practices.

Schematic Diagram for Interconnection Arrangement/Transmission Facilities for Dispersal of Power from HAEPL



Detail of Generation Facility/Wind Power Plant/Wind Farm

(A). General Information

(i).	Name of the Company/Licensee	HARTFORD Alternative Energy (Pvt.) Limited
(ii).	Registered/Business Office	Plot 4 & 8, Sector 25, Korangi Industrial Area, Karachi
(iii).	Plant Location	Jhampir, Nooriabad, District Thatta, Sindh
(iv).	Type of Generation Facility	Wind Power

(B). Wind Farm Capacity & Configuration

(i).	Wind Turbine Type, Make & Model	General Electric (G.E.) 1.7-103
(ii).	Installed Capacity of Wind Farm (MW)	49.3 MW
(iii).	Number of Wind Turbine Units/Size of each Unit (KW)	29 x 1.70 MW

(C). Wind Turbine Details

(a).	**Rotor**	
(i).	Number of blades	3
(ii).	Rotor diameter	103 m
(iii).	Swept area	8,332 m^2
(iv).	Power regulation	Combination of blade pitch angle adjustment, and generator / converter torque control.
(v).	Cut-in wind speed	3 m/s
(vi).	Cut-out wind speed	20 m/s
(vii)	Survival wind speed	20 m/s (10-minute average), resp. 23/25 m/s (30/3 second average)

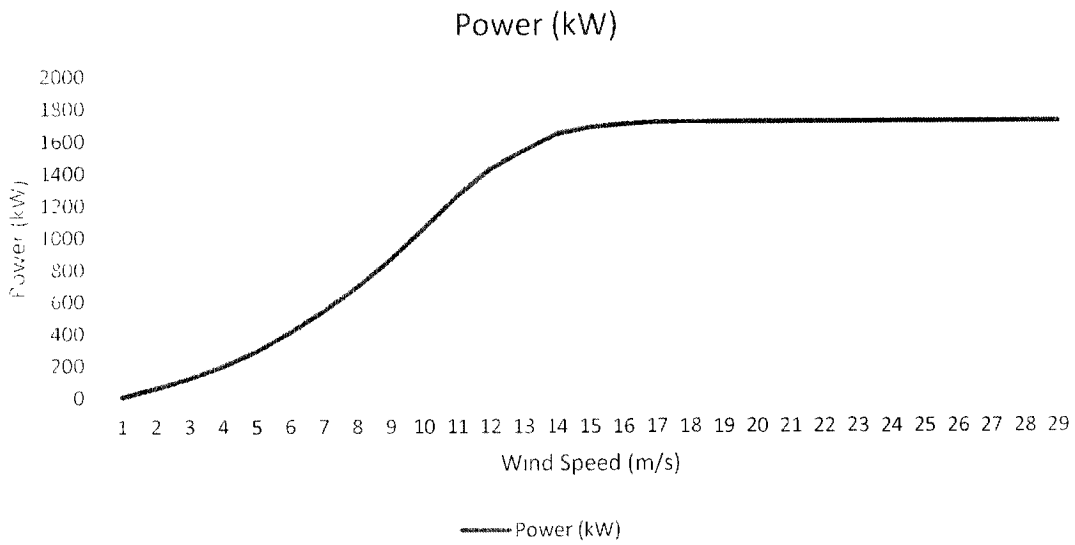
(viii)	Pitch regulation	Electric motor drives a ring gear mounted to the inner race of the blade pitch bearing.
(b).	**Blades**	
(i).	Blade length	50.2 m
(c).	**Gearbox**	
(i).	Type	Multi-stage planetary/helical gear design
(ii).	Gear ratio	1 : 107 (50 Hz)
(d).	**Generator**	
(i).	Power	1,700 kW
(ii).	Voltage	690 V
(iii).	Type	Three–phase double-fed asynchronous generator connected to the grid with partial converter
(iv).	Enclosure class	IP 54
(v).	Coupling	Flexible coupling
(vi).	Power factor	+0.95 to -0.95
(e).	**Control System**	
(i).	Type	Automatic or manually controlled.
(ii).	Scope of monitoring	Remote monitoring of different parameters, e.g. temperature sensors, pitch parameters, speed, generator torque, wind speed and direction, etc.
(iii).	Recording	Production data, event list, long and short-term trends
(f).	**Brake**	
(i).	Design	Three independent systems, fail safe (individual pitch)
(ii).	Operational brake	Aerodynamic brake achieved by feathering blades.
(iii).	Secondary brake	Mechanical brake on (high speed) shaft of gearbox.
(g).	**Tower**	

(i).	Type	Tubular steel tower
(ii).	Hub heights	79.7 m

(D). Other Details

(i).	Project Commissioning date (Anticipated)	June 31, 2017
(ii).	Expected Life of the Project from Commercial Operation date (COD)	20 Years

Graphical Power Curve of Wind Turbine Generator (GE 1.7-103)



Tabular Power Curve of Wind Turbine Generator (GE 1.7-103)

Wind Speed at Hub height (m/s)	Power (kW)	C_t
3	3	0.96
3.5	57	0.9
4	119	0.89
4.5	194	0.9
5	288	0.87
5.5	406	0.83
6	539	0.81
6.5	692	0.80
7	861	0.80
7.5	1056	0.80
8	1258	0.80
8.5	1427	0.76
9	1536	0.69
9.5	1640	0.59
10	1682	0.49
10.5	1700	0.41
11	1714	0.35
11.5	1715	0.30
12	1715	0.26
12.5	1715	0.23
13	1715	0.20
13.5	1715	0.18
14	1715	0.16
14.5	1715	0.14
15	1715	0.13
15.5	1715	0.12
16	1715	0.11
16.5	1715	0.10
17	1715	0.09

SCHEDULE-II

The Total Installed/Gross ISO Capacity (MW), Total Annual Full Load Hours, Average Wind Turbine Generator (WTG) Availability, Total Gross Generation of the Generation Facility/Wind Farm (in GWh), Array & Miscellaneous Losses (GWh), Availability Losses (GWh), Balance of Plant Losses (GWh) and Annual Energy Generation (GWh) of the Generation Facility /Wind Farm of Licensee is given in this Schedule

SCHEDULE-II

(1).	Total Installed Gross ISO Capacity of the Generation Facility /Wind Farm (MW/GWh)	49.3 MW
(2).	Total Annual Full Load Hours	3066 Hrs
(3).	Average Wind Turbine Generator (WTG) Availability	98 %
(4).	Total Gross Generation of the Generation Facility/Wind Farm (in GWh)	179.8 GWh
(5).	Array & Miscellaneous Losses GWh	20.81 GWh
(6).	Availability Losses GWh	3.47 GWh
(7).	Balance of Plant Losses GWh	4.33 GWh
(8).	Annual Energy Generation (AEP 50) GWh	151.15 GWh
(9).	Net Capacity Factor	35.0%

Note

All the above figures are indicative as provided by the Licensee. The Net energy available to Power Purchaser for dispatch will be determined through procedures contained in the Energy Purchase Agreement.