SCHEDULE I
(Regulation 3(1))

The Registrar
National Electric Power
Regulatory Authority.

Subject: Application for a Generation License NBT Wind Power Pakistan III (PVT) Limited 250MW

I, Lt General (Rtd) Hamid Rab Nawaz, Chief Executive officer (CEO), being the duly authorized representative of **NBT Wind Power Pakistan III (Pvt) Limited** by virtue of BOARD RESOLUTION dated 18th September 2013, hereby apply to the National Electric Power Regulatory Authority for the grant of a GENERATION LICENSE to NBT Wind Power Pakistan III (Pvt) Limited pursuant to section 3(1) of the Regulation of Generation, Transmission and Distribution of Electric Power Act, 1997.

I certify that the documents-in-support attached with this application are prepared and submitted in conformity with the provisions of National Electric Power Regulatory Authority Licensing (Application and Modification Procedure) Regulations, 1999, and undertake to abide by the terms and provisions of above- said regulations. 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.

A Bank Draft #03100841 **Dated** 23-04-14 **in the sum of Rupees 662,400/- (Six hundred sixty two thousand four hundred only),** being the non-refundable license application fee calculated in accordance with Schedule-II to National Electric Power Regulatory Authority Licensing (Application and Modification Procedure) Regulations,1999, is also attached herewith.

Date: 22nd April, 2014

CEO

Extracts of the Minutes of the Meeting of the Board of Directors of M/S NBT Wind Power Pakistan III (Pvt.) Ltd held at 18 September 2013 in Oslo, Norway.

BOARD RESOLUTION:

The following resolutions were discussed in detail by the Board and approved unanimously.

"RESOLVED THAT NBT Wind Power Pakistan III (Pvt.) Limited, a company incorporated under the laws of Pakistan with its registered office located at D-94 B Street, 5th Avenue, Block 5, Kehkashan, Clifton, Karachi, Pakistan (**The Company**) be and is hereby authorized to file application for the grant of Generation License for submission at National Electric Power Regulatory Authority (NEPRA) in respect of its 250 MW wind power generation project located in District Thatta, Province of Sindh, Pakistan (**The Project**) and in relation thereto, enter into and execute all required documents, make all fillings and pay all applicable fees, in each case, of any nature whatsoever as required."

"FURTHER 'RESOLVED THAT in respect of application for the grant of Generation License (including any modification to the application for the Grant of Generation License) for submission to National Electric Power Regulatory Authority, **Lt. Gen. Hamid Rab Nawaz (Rtd)** as the **Chief Executive Officer** of **the Company** be and hereby empowered and authorized for and on behalf of the Company to:

(i) review, execute, submit and deliver the Generation License Application (including any modification to the application for the Grant of Generation License) and related documentation required by National Electric Power Regulatory Authority, including any contracts, 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) sign and execute 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 Generation License Application (modification to the application for the Grant of Generation License);

(iii) 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".

"AND FURTHER RESOLVED THAT. **Lt. Gen. Hamid Rab Nawaz (Rtd)** as the **Chief Executive Officer (CEO)** of the Company be and is hereby authorized to delegate all or any of the above powers in respect of the foregoing to any other officials of the Company as deemed appropriate."

Arne Jonny Myre	Joar Gudmund Viken	Arnstein Ødegaard
Chairman	**Director**	**Director**

Dated:

To,

The Registrar

National Electric Power Regulatory Authority,

Islamabad, Pakistan.

EXTRACTS FROM THE MINUITES OF THE BOARD MEETING OF NBT WIND POWER PAKISTAN III (PVT) LTD.

Held on 18th September, 2013 in Oslo/Norway.

PRESENTS:

I.	**Arne Jonny Myre**	**Chairman.**
II.	**Joar Gudmund Viken**	**Director.**
III.	**Arnstein Ødegaard**	**Director.**

The Board Members of NBT Wind Power Pakistan III (Pvt.) Ltd in their meeting do hereby resolve that *Mr.Sayyed Ali Mustafa Gillani, Legal Counsel* of the Company is hereby authorized to file Applications, submit documents and sign any and all documents, Affidavits regarding such applications and receive any documents in all manners/matters relating to the Generation License Application and Upfront Tariff Acceptance Application. Any and all acts carried out by *Mr.Sayyed Ali Mustafa Gillani* on our behalf and on behalf of the Company within the above mentioned scope shall have the same legal effect as acts of our own".

NBT Wind Power Pakistan III (Pvt.) Limited.

Arne Jonny Myre	**Joar Gudmund Viken**	**Arnstein Ødegaard**
Chairman.	**Director.**	**Director.**

SECURITIES AND EXCHANGE COMMISSION OF PAKISTAN

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

Corporate Universal Identification No. **0080094**

I hereby certify that **NBT WIND POWER PAKISTAN III (PVT.) 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 **Karachi** this **Sixth** day of **June,** Two **Thousand** and **Twelve**.

Incorporation fee Rs. **7,000/=** only

(Sidney Custodio Pereira)
Joint Registrar,
Karachi

Certified to be true Copy

Deputy Registrar of Companies

Memorandum of Association

THE COMPANIES ORDINANCE, 1984
(COMPANY LIMITED BY SHARES)

MEMORANDUM OF ASSOCIATION
OF
NBT WIND POWER PAKISTAN III (PRIVATE) LIMITED

I. The name of the Company is "NBT WIND POWER PAKISTAN III (PRIVATE) LIMITED".

II. The Registered Office of the Company will be situated in Sindh.

III. The objective for which the Company is established will be all or any of the followings;

1. To carry on all or any of the businesses of hydel, thermal and wind power generation including selling, generating, transmitting, purchasing, importing, transforming, converting, distributing, supplying exporting and dealing in electricity and all other forms of energy and products or services associated therewith including construction, installation, operation, and maintenance of power generation plants and allied engineering services and electrical, mechanical installations and of promoting the conservation and efficient use of electricity and all other forms of energy and to exercise all other powers necessary or incidental to the business of electricity generation, transmission, distribution and supply.

2. To locate, establish, construct, equip, operate, use, manage and maintain wind energy, thermal and hydel power plants, power grid stations, transforming, switching, conversion and transmission facilities, grid stations, cables, overhead lines, sub-stations, switching stations, tunnels, cable bridges, link boxes, telecommunication systems, masts, aerials and dishes, fiber optics circuits, satellites and satellite micro wave connection, heat pumps, plant and equipment for combined heat and power scheme, offices, computer centers, shops, dispensing machines for pre-payment cards and other devices, show rooms, depots, factories workshops, plants, warehouses and other storages.

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, LPG, RFO, natural gas, users, inspectors, reconditions, improvers, alterers, protectors, removers, hirers, replaces, 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 carry on or expand the facilities and to take over or assume any or all of the belongings, funds, assets, rights, privileges, liabilities, obligations and contracts related to or in respect of such facilities.

5. To do any thing which a public electricity supplier is empowered or required to do by virtue of or under a license or other authorization granted according to law and its implementing rules and regulations or any statutory instrument made here under or any statutory notification or re-enactment thereof, and to plan, survey, design and supply equipment, and to carry out the electrification of cities, cantonments, towns, villages, housing colonies, industrial states, complexes gas and oil refineries, workshops, building, highways, bridges, ports, air terminals, and other pry within its area of supply.

6. To act as agents or representatives of foreign and local manufacturers, consultants of plants, machinery, materials or other articles for sale to any Government, local authorities, firms, companies, association of persons or individuals and also to import and export such items (except managing agency).

7. To carry on the business of general order supplies including Government, Semi-Government Agencies, Armed Forces, Army Military or Defense and commission agents, indenters, traders and as general merchants, wholesalers, retailers, dealers, distributors, stockiest agents, sub-agents in any goods or products within the scope of the object of the Company, subject to any permission required under the law.

8. To acquire or obtain for use, whether by purchase, lease, concession, grant, hire or otherwise, from a private owner, a government department and from any Company, body corporate or other entity engaged in the generation, transmission or distribution of electric power, part of the business, properties, assets and undertakings.

9. To prepare feasibilities and to conduct studies for engineering, electrical, mechanical and allied projects.

10. To ascertain the tariff for supply of power 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 a reasonable return on investment, obtain any approval thereof as may be required by law or license for the time being in force, to quote the tariff to purchasers of electrical power.

11. To pay all costs, charges and preliminary expenses, if any, incidental to the promotion, formation, registration and establishment of the company.

12. To borrow or raise money by means of loans or by obtaining lease facility from directors, banks, government or other financial institutions, leasing companies, investment companies and other lending institutions for the purpose of business of the company in such manner as the company may think fit and in particular by issue of debentures, perpetual or otherwise convertible into shares or non-convertible or perpetual annuities and as security for any such money so borrowed; and to mortgage, pledge, or charge whole or any part of the property, assets or revenue of the company, by special assignment or otherwise to transfer or convey the same absolutely or in trust as may seem expedient and to purchase, redeem or pay of any such securities.

13. To invest the surplus funds of the Company upon such securities and in such manner as shall from time to time be thought necessary or for the benefit of the Company and to create any Reserve Fund, Sinking Fund, insurance Fund, Depreciation Fund or provident Fund thereat.

14. To remunerate any person or Company and pay commission or brokerage in cash or otherwise howsoever for services rendered or to be rendered in placing or assisting to place or guaranteeing the placing if any shares in the Company's capital or any debentures or other securities or the Company and to adopt become bound by and carry into effect any agreement or arrangement which may have been entered into for that purpose with any person or Company on behalf of the Company.

15. To advance, lease or deposit money to any person with or without taking any security therefore and upon such other terms as may be thought fit by the Company but only in furtherance of objects of the Company.

16, To apply for tender, offer, accept, purchase or otherwise acquire any contracts and concession for or in relation to the projection, execution, carrying out, improvements, management, administrations or control of works and conveniences and undertake, execute, carryout, dispose of or otherwise turn to account the same.

17. To enter into arrangements with the government or authority (supreme, municipal, local or otherwise) or any corporation, company or persons that may seem conducive to the Company's objects or any of them and to obtain from any such government, authority, corporation, company or person any charters, contracts, rights, privileges and commission which the Company may think desirable and to carry on exercise and comply with any such charters, contracts, decrees, rights, privileges and concessions.

18. To set up a countywide network for power generation systems, procure equipment, Purchase material and allied items and arrange its management, operations and maintenance to serve the needs of the subscribers.

19. To sell, lease and in any other manner, deal with or dispose off the undertaking or Property of the company or any part thereof for such consideration as the company may think fit.

20. To open bank account of the company and to draw, accept, make, endorse, discount, Execute and issue cheques, promissory notes, bills of exchange, bills of lading or other negotiable or transferable instruments related to the business of the company.

21. To amalgamate with any other company having objects altogether or in part similar to those of this company, and to enter into partnership or any arrangement for sharing profits, union of interest, co-operation, joint venture, reciprocal, concession, or otherwise with any person or company carrying on or engaged in, or about to carry on or engaged in business or transaction which this company is authorized to carry on or engage in or any business or transaction capable of being conducted so as directly or indirectly to benefit this company.

22. The company shall not engage in banking business or business of an investment Company or any unlawful business and that nothing in object clauses shall be

Construed to entitle it to engage in such business or undertake business of banking company, investment, leasing, payment sales receipt scheme and insurance business directly or indirectly. The company shall not launch multilevel marketing, pyramid and ponzi schemes.

23. Notwithstanding anything stated in any object, the company shall obtain such other approvals or licenses from concerned competent authorities as may be required under any law for the time being enforce to undertake a particular business.

IV. The liability of the members is limited.

V. The authorized capital of the company is Rs.1,000,000 (Rupees One Million Only) divided into 100,000 ordinary shares of Rs. 10/- each and the Company shall have the power from time to time to attach thereto, any qualified or other special rights, privileges, restrictions and conditions, as may, from time to time be permitted by law.

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

Names & Surname In Full	Father's Name in Full	Nationality	Occupation	Residential Address in Full	No. of shares Taken by each Subscriber	Signature
NBT Pakistan Holding (Pte) Ltd. Incorporated: Singapore Reg. # 201135006H Nominee: Mr. Joar Gudmund Viken (Passport # 25691179)	Mr. Johannes Viken	Norwegian	Power Generation Company	159 Telok Ayer Street, Singapore, 068614	99,997/- (Ninety nine thousand nine hundred ninety seven only)	
Mr. Joar Gudmund Viken (Passport # 25691179)	Mr. Johannes Viken	Norwegian	Power Consultant	Frits Kiaers Vei 11B, 0383 Oslo	01/- (One only)	
Mr. Arne Jonny Myre (Passport # 28071237)	Mr. Henry Myre	Norwegian	Power Consultant	Hoevik Skolevei 11, 1363, Norway	01/- (One only)	
Mr. Thorstein Jenssen (Passport # 28126301)	Mr. Thorleif Jenssen	Norwegian	Power Consultant	Filipstad Brygge 1, 0252 Oslo, Norway	01/- (One only)	
				Total number of shares	**100,000/- (One hundred thousand only)**	

Witness:

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

Certified to be true Copy

Place: Karachi
Dated: 3 February 2012

Articles of Association

THE COMPANIES ORDINANCE 1984
COMPANY LIMITED BY SHARES

ARTICLES OF ASSOCIATION
OF
NBT WIND POWER PAKISTAN III (PRIVATE) LIMITED

1. PRELIMINARY

1. **Table 'A' not to apply**

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 these are adopted or contained in these Articles.

2. **Rule of Interpretation**

The chapter headings shall not affect the construction hereof. "In Writing" and "Written" include printing, lithography and other modes of representing or reproducing words in a visible form. Words importing the singular number include the plural number and vice versa. Words importing persons include bodies corporate. Words importing the masculine gender include the feminine gender.

3. **Definitions**

Words or expressions contained in these Articles shall, unless otherwise defined herein or unless inconsistent with the subject or context, have the same meanings as in the Companies Ordinance, 1984. In these Articles, unless there is something in the subject or context inconsistent therewith:

(a) "Articles" means these Articles of Association, as originally framed or as altered from time to time by Special Resolution.
(b) "Board" shall mean the Board of Directors from time to time of the Company.
(c) "Company" means the NBT WIND POWER PAKISTAN III (PRIVATE) LIMITED
(d) "Chief Executive" means the Chief Executive of the Company appointed from time to time pursuant to these Articles.
(e) "Ordinance" means the Companies Ordinance, 1984 as amended and now in force in Pakistan and any amendment or re-enactment thereof for the time being in force.
(f) "Debenture" shall include Term Finance Certificates.
(g) "Directors" means the Directors of the Company appointed from time to time pursuant to these Articles and shall include alternate Directors.
(h) "Dividend" means the distribution of profits of the Company to its Members.
(i) "Member" means a member of the Company within the meaning of Clause (21) of sub-section (1) of Section 2 of the Ordinance.

(j) "Memorandum" means the Memorandum of Association of the company as originally framed or as altered from time to time in accordance with the provisions of the Ordinance.
(k) "Month" means a calendar month according to the Gregorian calendar.
(l) "Register" means the Register of Members to be kept pursuant to Section 147 of the Ordinance.
(m) "Registered Office" means the Registered Office of the Company.
(n) "Registrar" shall have the meaning assigned thereto in clause (31) of sub-section (1) of Section 2 of the Ordinance.
(o) "Share" means share in the share capital of the Company.
(p) "Seal" means to common Seal of the Company.
(q) "Special Resolution" shall have the meaning assigned thereto in clause (36) of sub-section 1 of Section 2 of the Companies Ordinance.

II. FORMATION OF COMPANY

Private Limited Company

4. The Company is a Private Company and accordingly the following provisions shall have effect:

(a) The number of the members of the Company (exclusive of persons who are for the time being in the employment of the Company) shall not any time exceed fifty: Provided that where two or more persons hold one or more shares in the Company jointly, they shall, for the purpose of this Article, be treated as a single member.
(b) The company shall not at any time offer any of its shares, debentures or debenture stock to the public for subscription.
(c) The right to transfer shares in the Company is restricted as provided in these Articles.

5. **Registered Office**

The Registered Office of the Company will be situated in the in the Province of Sindh.

6. **Authorised Capital**

The authorized share capital of the Company is Rs.1,000,000/- (Rupees One Million only) divided into 100,000 ordinary shares having a par value of Ten Rupees (Rs. 10/-) each.

III. SHARES

7. **Issuance of Shares Controlled by Board**

Subject to the provisions of the Ordinance and of these Articles, the shares shall be under the control of the Board. The Board shall, as regards any allotment of shares, duly comply with such provisions of Sections 67 to 73 of the Ordinance as may be applicable.

8. **Further Issuance of Shares**

The Board may allot or otherwise dispose of any shares of the Company to such persons, on such terms and conditions and at such times as the Board thinks fit, and at a premium or at par or (subject to the provisions of the Ordinance) at a discount and for such consideration as the Board thinks fit: Provided that, where at any time the Board decides to increase the issued capital of the Company by issuing any further shares, such shares shall be offered to the members in proportion to the existing shares held by each Member, and such an offer shall be made by a notice specifying the number of shares to which the Member is entitled, and limiting a time within which the offer, if not accepted, will be deemed to be declined; and on the expiration of such time, or on receipt of information from the Member to whom such notice is given that he declines to accept the shares offered, the Board may, subject to the provision of Section 86(7) of the Ordinance, dispose of the same in such manner as it may consider most beneficial to the Company.

9. **Shares for Consideration Other Than Cash**

Subject to the provisions of the Ordinance and these Articles, the Board may allot and issue shares in the capital of the Company as payment for any property, (tangible) sold or transferred, goods or machinery supplied, or for services rendered to the Company or expenses incurred on behalf of the Company or in the conduct of its business or affairs; any shares which may be so allotted shall be issued as fully paid up shares.

IV. CERTIFICATES

10. **Certificates**

The certificates of title to shares shall be issued under the Seal of the Company and signed by at lease two (2) Directors.

11. **Members' Right to Certificates**

Every Member shall be entitled, within the time period prescribed under Section 74 of the Ordinance, without payment, to one (1) certificate for all of the shares registered in his name, or upon paying such fee as the Board may from time to time determine, to several certificates, each for one or more shares. Every certificate of shares shall specify and denote the number of shares in respect of which it is issued, and the amount paid thereon. In respect of a share or shares held jointly by several persons, the Company shall not be bound to issue more than one certificate and delivery of the share certificate to anyone of the joint holders shall be sufficient delivery to all.

12. **Issue of Duplicate Certificate**

If any certificate is worn-out, defaced or rendered useless, then upon production thereof to the Board, the Board may order the same to be canceled and may issue a new certificate in lieu thereof, and if any certificate is lost or destroyed, then, on proof thereof to the satisfaction of the Board and on such indemnity as the Board deems adequate being given, a new certificate in lieu thereof may be issued on such terms

and fee as may be prescribed by the Board including payment of expenses incurred by the Company in investigating title.

V. TRANSFER AND TRANSMISSION OF SHARES

13. Instrument of Transfer

The instrument of transfer of any share shall be in writing in the form specified in regulation 9 of Table A of the First Schedule to the Ordinance or in any other form which the Directors shall approve and must be left at the Registered Office accompanied by the Certificate or, if no Certificate is in existence, such evidence as the Directors may require to prove the title of the transferor or his right to transfer the shares. The transferor shall be deemed to remain holder of the shares until the name of the transferee is entered in the Register.

14. Transfer of Shares

A shareholder may gift, transfer or sell shares to members of his family and family members in this context shall mean only the spouse, sons and daughters of said shareholder and the Board will not refuse such transfer.

15. Refusal to Transfer shares

a) The Directors may refuse to transfer any shares to a non-member of the Company after assigning sufficient reason. If any shareholder of the Company shall desire to sell his shares, he shall convey such desire to the Company by a written notice. The directors shall offer these shares to the existing Members. If any one or more of the existing Shareholder(s) is / are willing to purchase those shares, then the Transferor shall be bound to transfer such shares to the existing shareholder on receipt of sale price determined by the Auditor of the Company. If the existing members refuse to purchase these shares, the "transferor" shall be at liberty to sell these shares to non-member(s) and Directors will not refuse such transfer of shares.

b) The Directors may also refuse to transfer any shares if the transfer deed is for any reason defective or invalid: Provided that the Company shall, within thirty (30) days from the date on with the instrument of transfer was lodged with it, notify the transferor and transferee to the defect or invalidity, either of whom shall, after removal of such defect or invalidity, be entitled to re-lodge the transfer deed with the Company.

c) If the Company refuses to register the transfer of any shares, the Company shall, within thirty (30) days after the instrument of transfer was lodged with it, send to the transferor and the transferee notice of the refusal indicating the reasons for such refusal.

16. Transmission of Shares of Deceased Member

The executors, administrators, heirs or nominees, as the case may be, of a deceased sole holder of a share shall be the only persons recognised by the Company as having

any title to the share. In the case of a share registered in the names of two or more holders, the survivors or survivor, as the case may be, shall be the only person(s) recognised by the Company as having any title to the share.

17. **Right of Successor to Become Member or Transfer Shares**

Any person becoming entitled to a share in consequence of the death or insolvency of a Member shall, upon such evidence being produced as may from time to time be required by the Directors, have the right, either to be registered as a Member in respect of the share or, instead of being registered himself, to make such transfer of the share as the deceased or insolvent person could have made; but the Directors shall, in either case, have the same right to decline or suspend registration as they would have had in the case of transfer of the share by the deceased or insolvent person before the death or insolvency.

18. **Right of Successor to Receive Dividends and Other Advantages**

Any person becoming entitled to a share by reason of the death or insolvency of the holder shall be entitled to the same dividends and other advantages to which he would be entitled as if he were the registered holder of the share, except that he shall not, before being registered as a Member in respect of the share, be entitled in respect of it to exercise any rights in relation to meetings of the Company.

19. **Company not to be Liable**

The Company shall incur no liability or responsibility whatever in consequence of its registering or giving effect to a transfer of shares made or purporting to be made by any apparent legal owner thereof (as shown or appearing in the Register) to the persons having or claiming any equitable right, title or interest in the same shares notwithstanding that the Company may have had notice of such equitable right, title or interest or notice prohibiting registration of such transfer, and the Company shall not be bound or required to regard to or attend or give effect to any notice which may be given to it of any equitable right, title or interest, or be under any liability whatsoever for refusing or neglecting so to do.

VI. ALTERATION OF CAPITAL

20. **Power to Increase Authorised Capital**

The Company may, from time to time by Special Resolution, increase its authorized share capital by such sum, to be divided into such number of shares, as the resolution shall prescribe.

21. **Power to Reduce Share Capital**

The Company may by Special Resolution reduce its share capital in any manner and with and subject to any incident authorized and consent required by law.

22. **Power to Sub-Divide or Consolidate Shares**

Subject to the provision appearing after clause (d) of sub-section 1 of Section 92 of the Companies Ordinance, the Company may in General Meeting by Special Resolution of the Members alter the conditions of its Memorandum as follows:

(a) Consolidate and divide the whole or any part of its shares into shares of larger amount than its existing shares;

(b) Sub-divide its shares or any of them into shares of smaller amount than is fixed by the Memorandum; or

(c) Cancel any shares which, at the date of passing of the Special Resolution in that behalf, have not been taken or agreed to be taken by any person, and diminish the amount of its share capital by the amount of shares so canceled.

VII. GENERAL MEETINGS

23. **Holding of Annual General Meetings**

An Annual General Meeting of the Company shall be held in accordance with the provisions of Section 158 of the Companies Ordinance within eighteen (18) Months form the date of incorporation of the Company and thereafter once at least in every calendar year within a period of four (4) months following the close of its financial year at such time and place as may be determined by the Board: Provided that no greater interval than fifteen (15) months shall be allowed to elapse between two such General Meetings. Such General Meetings shall be called "Annual General Meetings" and all other General Meetings shall be called "Extraordinary General Meetings".

24. **Extraordinary General Meetings**

Subject to the provisions of Section 159 of the Ordinance, the Directors may at anytime call an Extraordinary General Meeting of the Company to consider any matter which requires the approval of the Company in a General Meeting and shall also, on the requisition of Members representing not less than one-tenth of the voting power on the date of the deposit of the requisition, forthwith proceed to call an Extraordinary General Meeting.

25. **Notice of Meetings**

Twenty-one (21) days notice at the least (exclusive of the day on which 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 the manner provided by Section 160 of the Companies Ordinance for the General Meeting, to such persons as are under the Companies Ordinance or these Articles, entitled to receive such notices from the Company.

26. **Special Business**

All business shall be deemed special that is transacted at an Extraordinary General Meeting, and also all business that is transacted at an Annual General Meeting with the exception of (i) declaring a dividend, (ii) the consideration of the accounts, balance sheet and reports of the Directors and Auditors, (iii) the election and appointment of Directors and (iv) the appointment, and the fixing of the remuneration of, the Auditors.

27. **Shorter Notice**

In the event of an emergency affecting the business of the Company, the Board may, in accordance with the provisions of section 159(7) of the Companies Ordinance, make application to the Registrar for a shorter notice period, and, if the Registrar authorises a shorter notice period, then an Extraordinary General Meeting may be convened upon such shorter notice as authorized by the Registrar.

28. **Omission to Give Notice**

The accidental omission to give notice to any Member of the Company or the accidental non-receipt of notice by any Member shall not invalidate the proceedings at any such General Meeting.

29. **Quorum at General Meetings**

At least two (2) Members present in person or by proxy entitled to vote and representing not less than Twenty-Five percent (25%) of the total voting power either in their own account or as proxies shall be quorum for a General Meeting, and no business shall be transacted at any general Meeting unless the quorum requisite is present at the commencement of the business.

30. **Who to Preside General Meetings**

The Chief Executive of the Company shall also be the Chairman of the General Meetings and Board of Directors Meetings, and if at any meeting the Chairman is not present or willing to take the Chair, the Members present may choose one of the Directors to be the Chairman of General Meeting.

31. **Adjournment of Meeting for Lack of Quorum**

If within thirty (30) minutes after the time appointed for the holding of General Meeting a quorum is not present, the meeting, if convened on the requisition of the Members, shall be dissolved, and in every other case it shall stand adjourned to the same day in the next following week at the same time and place as was appointed for holding the General Meeting, and if at such adjourned meeting a quorum is not present, those Members who are present and entitled to vote not being less than two (2) shall be a quorum and they may transact the business for which the meeting was called.

32. **Adjournment by Chairman**

The Chairman of General Meeting may, with the consent of the General Meeting, adjourn any General Meeting from time to time and from place to place, but no business shall be transacted at any adjourned General Meeting other than business left unfinished at the General Meeting from which the adjournment took place.

33. **Voting on Resolution by Show of Hands and When Poll Demanded**

At any General Meeting a resolution put to the vote of the General Meeting shall be decided by a show of hands, unless a poll is demanded (before or on the declaration of the results of the show of hands) by at least two (2) members present in person or by proxy, or by the Chairman of the Meeting, or by any Member or Members present in person or by proxy and holding not less than one-tenth of the total voting power and, unless a poll is so demanded, declaration by the Chairman that a resolution has been carried or lost and an entry to that effect in the books of the proceedings of the Company, shall be conclusive evidence of the fact without further proof of the number or proportion of the votes recorded in favour of or against such resolution. The demand for a poll may be withdrawn at any time by the person or persons who made the demand.

34. **Poll**

If a poll is demanded as aforesaid it shall be taken (subject to Section 168 of the Companies Ordinance) in such manner and at such time and place as the Chairman of the Meeting directs, and either at once or after an interval or adjournment of not more than fourteen (14) days from the day on which the poll is demanded, and the results of the poll shall be deemed to be the resolution of the Meeting at which the poll was held.

35. **Poll on Election of Chairman and Adjournment**

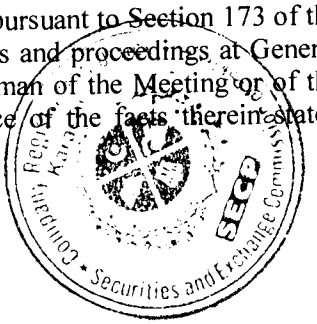
Any poll demanded on the election of a Chairman of a Meeting or on any question of adjournment shall be taken at the Meeting and without adjournment.

36. **Effect of Demand for Poll**

The demand for a poll shall not prevent the continuation of a General Meeting for the transaction of any business, other than the question on which the poll was demanded.

37. **Minutes**

Minutes shall be made in books provided by the Board pursuant to Section 173 of the Companies Ordinance for the purposes of all resolutions and proceedings at General meetings, and any such Minutes if signed by the Chairman of the Meeting or of the next following Meeting shall be receivable as evidence of the facts therein stated without further proof.



VIII. VOTING

38. **Votes of Members**

Except as to voting for the election of Directors as provided in Section 178 of the Companies Ordinance, every Member entitled to vote may vote, either in person or by proxy, and upon a poll every member entitled to vote and present in person or by proxy shall heave one (1) vote for every share conferring voting rights as aforesaid held by him.

39. **Voting by Joint Holders**

In the case of joint holders, the vote of the senior who tenders a vote, whether in person or by proxy, shall be accepted to the exclusion of the votes of other joint holders; and for this purpose seniority shall be determined by the order in which their names stand in the Register.

40. **Representative of Corporate Members**

A corporation, foundation or a company being a Member may by a resolution of its Directors authorize any of its officers or any other person to act as its representative at any General Meeting and the person so authorized shall be entitled to exercise the same powers on be half of the Company which he represents as if he were an individual Member.

41. **Instrument of Proxy**

An instrument of proxy shall be in the form specified in Regulation 39 of Table A in the First Schedule to the Companies Ordinance, or in any other form which the Board may approve.

42. **Validity of Proxy**

A vote given in accordance with the terms of an instrument of proxy shall be valid notwithstanding the previous death of the principal or revocation (where permissible) of the proxy or of any power of attorney or other authority under which such proxy was singed: Provided that no intimation in writing of the death or revocation shall have been received at the Registered Office before the Meeting or the adjourned Meeting at which the proxy is used.

43. **Validity of Vote**

No objection shall be made to the validity of any vote except at the Meeting or at the poll at which such vote shall be tendered, and every vote whether given personally or by proxy not disallowed at such Meeting or poll shall be deemed valid for all purposes of such Meeting or poll.

44. **Chairman to Decide**

If any question is raised, the Chairman of the Meeting shall decide the validity of every vote tendered at such Meeting in accordance with the Ordinance and these Articles.

IX. DIRECTORS

45. **First Directors**

The following shall be the first Directors of the Company who shall hold office until the election of Directors at the first Annual General Meeting:

1. Arne Jonny Myre
2. Joar Gudmaund Viken
3. Thorstein Jenssen

46. **Appointment of Chairman**

The Directors shall appoint Chief Executive of the Company who shall also be the Chairman of Board of Directors and of General Meetings whose tenure shall be co-terminus with the tenure of the Board.

47. **Number of Directors**

The number of Directors shall not be less than two (2). The Board shall fix the number of Directors of the Company to be elected not later than thirty-five (35) days before the convening of the General Meeting at which Directors are to be elected, and the number so fixed shall not be changed except with the prior approval of the Company in General Meeting.

48. **Election of Directors**

(a) After the expiry of first term of Directors, the number of Directors to be elected shall be fixed by the Board (and such number shall not be less than two) and Directors shall be elected by the Members in the General Meeting, unless the number of candidates is not more than the number of Directors to be elected, in the following manner, namely:

(i) A Member shall have such number of votes as is equal to the product of the voting shares held by him and the number of Directors to be elected;

(ii) A member may give all his votes to a single candidate, or divide them between more than one of the candidates in such manner as he may choose; and

(iii) The candidate who gets the highest number of votes shall be declared elected as Director and then the candidate who gets the next highest

number of votes shall be so declared, and so on until the total number of Directors to be elected has been so selected.

(b) No person, whether a retiring director or otherwise, shall be eligible for election as a Director unless notice of his candidature for election has been lodged in writing at the Registered Office not less than fourteen (14) days before the date of the Meeting at which the election of Directors is to take place.

(c) Where the number of candidates is equal to or less than the number of Directors to be elected, it will not be necessary to hold an election as laid down in paragraph (a) above of this Article and all candidates shall be deemed to have been elected under this Article.

49. **Term of Office**

An elected Director shall hold office for a period of three (3) years, unless he resigns, becomes disqualified from being a Director or otherwise ceases to hold office earlier under these Articles. An election of Directors in the manner prescribed by the preceding Article shall be held once in every three (3) years. A retiring Director shall be eligible for re-election.

50. **Removal of Director**

The Company may by resolution in a General Meeting remove an elected Director: Provided that a resolution for removing a director shall not be deemed to have been passed unless the number of votes cast in favour of such a resolution is not less than 50% of total votes held by all the shareholders.

51. **Continuing Directors to Act**

The continuing Directors may act notwithstanding any vacancy in the Board, but if the number falls below the minimum fixed, the directors shall not, except for the purpose of filling a vacancy in their number or of convening a General Meeting, act so long as the number remains below the minimum.

52. **Filling Casual Vacancy**

The Directors may at any time appoint any member of the Company to be a Director to fill a casual vacancy in the Board. Any Director so appointed shall hold office for the remainder of the term of the Director in whose place he is appointed.

53. **Remuneration of Directors**

Every Director, the Chief Executive or a full time working Director shall be entitled to be paid such remuneration for his services as may be determined by the Board. Every Director (including each alternate Director) shall be entitled to be reimbursed his reasonable expenses incurred in consequence of his attendance at meetings of the Directors, or of Committees of Directors.

54. **Remuneration for Extra Services**

Any Director who serves on any Committee of Directors or who devotes special attention to the business of the Company or who otherwise performs services which, in the opinion of the Board, are outside the scope of the statutory duties of a Director, may be paid such extra remuneration by way of salary, allowances, facilities, perquisites, etc., as the Board may determine.

X. POWERS OF DIRECTORS

55. **General Powers**

The control of the Company shall be vested in the Board and the business of the Company shall be managed by the Board which may pay all expenses incurred in forming and registering the company, and may exercise all such powers of the Company as are not by Ordinance or any statutory modification thereof, for the time being in force, or by these Articles, required to be exercised by the company in General Meeting, subject nevertheless to the regulations of these Articles, to the provisions of the Ordinance and such regulations, (not being inconsistent with the aforesaid regulations or provisions) as may be prescribed by the Company in General Meeting; but no regulation made by the Company in General Meeting shall invalidate any prior act of the Board which would have been valid if the regulation had not been made.

56. **Power to Obtain Finances and Giving of Securities**

(a) For the purposes of the Company only, the Board may obtain finance or borrow moneys and secure payment of such sum or sums of money in such manner and upon such terms and conditions as it may think fit, and in particular by the issue of bonds, perpetual or redeemable Debentures, or by mortgage or charge or other security on the whole or any part of the property, assets and rights of the Company (both present and future), and the undertaking of the Company: Provided, however, that the above power of the Board shall not entitle the Company to carry on the business of banking / finance / investment company.

(b) Any bonds, Debentures or other securities issued or to be issued by the Company shall be under the control of the Board which may issue them upon such terms and conditions and in such manner and for such consideration as shall be considered by the Board to be for the benefit of the Company.

57. **Minute Books**

(a) The Board shall cause minutes to be made in books provided for the purposes:

(i) Of the names of Directors present in person, at each meeting of the Board or any Committee of the Directors;

(ii) Of all resolutions and proceedings at all meetings of the Company, and the Board, and of the Committees of Directors; and

(iii) Of appointments of officers made by the Directors.

(b) Any such minutes of any meeting of the Board or of a committee of Directors or of the Company, if signed by the Chairman of such meeting or of the next succeeding meeting, shall be receivable as evidence of the matters stated in such Minutes.

(c) Every Director present in person at any meeting of Directors shall sign his name in a Book to be kept for that purpose and a list of the Directors present in person shall be listed as such in the Book by the Chairman of the meeting.

XI. PROCEEDINGS OF DIRECTORS

58. Meetings of Directors

The Directors may meet together at least twice a year for the dispatch of business, adjourn and otherwise regulate meetings of the Board as they think fit. The Chairman may at any time, and shall on the written requisition of any two (2) Directors, summon a meeting of the Board. At least seven (7) days' notice will be given to all Directors for a meeting of the Board, and such notice shall set forth the purpose or purposes for which such meeting is summoned, and such notice shall be sent by registered air mail or telexed or e-mailed to any Director residing outside Pakistan. With the consent in writing of the majority of Directors entitled to receive notice of a meeting, or to attend or vote at any such meeting, a meeting of the Board may be convened by shorter notice than specified in this Article. Any Director may waive notice in writing for the time, place and purpose of any meeting either before, at or after such meeting.

59. Quorum of Directors' Meeting

A meeting of the Board, at which a quorum is present, shall be competent to exercise all or any of the authorities, powers and discretion by or under the Articles or by or under any law vested in or exercisable by the Board generally. Except as hereinafter provided, Two (2) Directors shall constitute a quorum. If there is no quorum at a meeting properly called, the meeting of the Board will be adjourned for seven (7) days. Questions arising at any meeting shall be decided by a majority of votes.

60. When acts of Meetings of the Board or a Committee Valid Notwithstanding Defective Appointment

All acts done by any meeting of the Board or of a Committee of Directors, or by any person acting as Director or Alternate Director shall, notwithstanding that it be afterwards discovered that there was some defect in the appointment of any such Directors or persons acting as aforesaid, or that they or any of them were disqualified, be as valid as if every such Director or person had been duly appointed and was qualified to act: Provided that as soon as any such defect has come to notice, the Director or other person concerned shall not exercise the right of his office till the defect has been rectified.

61. **Resolution By Circulation**

A resolution which is circulated together with the necessary papers, if any, to all Directors and signed by majority of the Directors entitled to vote thereon shall be as valid and effectual as if it had been passed at a meeting of Directors duly called and constituted. Transmission of documents and signature of resolutions by facsimile or other electronic transmission shall be effective for purposes of circulating and executing documents and resolutions.

XII. ALTERNATE DIRECTORS

62. **Power to Appoint Alternate Directors.**

Any Director intending to be absent from Pakistan for a period of not less than three (3) Months may appoint any Member of the Company acceptable to the Board to be an Alternate Director of the Company to act for him. Every such appointment shall be in writing under the hand of the Director making the appointment. An Alternate Director so appointed shall not be entitled to appoint another Director, but shall otherwise be subject to the provisions of the Articles with regard to Directors. An Alternate Director shall be entitled to receive notice of all meetings of the Board, and to attend and vote as a Director at any such meeting at which the Director appointing him is not personally present, and generally to perform all the functions of his appointer as a Director in the absence of such appointer. An Alternate Director shall ipso facto cease to be an Alternate Director if his appointer for any reason ceases to be a Director or if and when his appointer returns to Pakistan, or if the appointee is removed from office by notice in writing under the hand of the appointer.

63. Subject to the provisions of Section 196 (2) (g), 214, 216 and 219 of the Companies Ordinance, the Directors shall not be disqualified from contracting with the Company as vendor, purchaser or otherwise, but in respect of any such contract or arrangement entered into by or on behalf of the Company with any company or partnership or in which any director shall be a director or member or interested, the nature of his interest must be disclosed by him at the meeting of the Directors at which the contract or arrangement is determined, if the interest then exists, or in any other case at the meeting of the Directors after the acquisition of the interest. No Director shall vote as a Director in respect of any contract or arrangement in which he is so interested as aforesaid, and if he does so vote, his vote shall not be counted but he shall be entitled to be present at the meeting during the transaction of the business in relation to which he is precluded from voting, although he shall not be reckoned for the purpose of ascertaining whether there is a quorum of Directors present. These provisions shall not apply to any contract by or on behalf of the Company to give to Directors or any of them any security for advances or by way of indemnity against any loss which they or any of them may suffer by reason of becoming or being sureties for the Company. A general notice that any Director is a member of any specified company or is a member of any specified firm and is to be regarded as interested in any subsequent transaction with such firm or company shall be given for purposes of disclosure under this Article, and any such general notice shall expire at the end of the financial year in which it was given but it may be renewed for a further period of one financial year by giving fresh notice in the last month of the financial year in which it would otherwise

expire. A register shall be kept by the Directors in which shall be entered particulars of all contracts or arrangements to which this Article applies.

XIII. CHIEF EXECUTIVE

64. **Appointment of the Chief Executive**

(a) The Board shall, within fifteen (15) days of the incorporation of the Company, appoint any person including a Director as the Chief Executive of the Company. The first Chief Executive shall hold office until the first Annual General Meeting of the Company (unless he earlier resigns or otherwise ceases to hold office). If the Chief Executive ceases to hold office before the first Annual General Meeting, the Board shall fill the vacancy within fourteen (14) days, but the person so appointed to fill the vacancy shall hold office only until the first Annual General Meeting.

(b) Within fourteen (14) days from the date of an election of Directors or the date the office of Chief Executive becomes vacant, as the case may be, the Board shall elect the Chief Executive of the Company, but such appointment shall not be for a period exceeding three (3) years from the date of such appointment.

(c) Upon the expiry of the terms of appointment under (a) or (b) above, the Chief Executive shall be eligible for reappointment.

(d) The Chief Executive shall be appointed on such terms including remuneration (whether by way of salary, commission, participation in profits, allowances, perquisites, etc.; or partly in one way and partly in another) as the Board shall fix.

65. **Powers of Chief Executive**

The Board may delegate to the Chief Executive such of its powers, authorities and discretion as are necessary for and consistent with the effective management of the Company, and as are not required to be exercised by the Directors at their meetings, upon such terms and conditions and with such restrictions as they may think fit, and either collaterally with or to the exclusion of their own powers.

66. Without prejudice to the general powers conferred above and to any other powers or authorities conferred by these Articles on the Chief Executive, and subject to the provisions of Section 196 of the Companies Ordinance, it is hereby expressly declared that the Chief Executive shall have the following powers, that is to say, power:

(a) To pay the costs, charges and expenses, preliminary and incidental to the promotion, formation, establishment and registration of the Company and also to pay to the promoters all costs and charges they may have incurred in acquiring land, properties, machinery or other rights which the Company my take over from them and to pay to the promoters pre-incorporation expenses;

(b) To purchase or otherwise acquire for the Company any land, property, rights or privileges which the Company is authorised to acquire at such price and generally on such terms and conditions as he thinks fit and subject to the provisions of Section 196(3) of the Companies Ordinance to sell, let, exchange or otherwise dispose of, absolutely or conditionally, property of the Company and for such consideration as he may think fit;

(c) To pay for any land, property, rights and privileges acquired by or services rendered to or expenses incurred on behalf of the Company either wholly or partially in cash or in shares (subject to Section 86 of the Companies Ordinance), bonds, debentures, or other securities of the Company, and any such shares shall be issued as fully paid-up, and any such bonds, debentures or other securities maybe either specifically charged upon all or any part of the property of the Company or not so charged;

(d) To secure the fulfillment of any contracts, agreements or engagements entered into by the Company by mortgage or charge on all or any of the property of the Company for the time being or in such other manner as they think fit;

(e) To appoint and, at his discretion, remove or suspend such agents, secretaries, officers, legal advisers, clerks and servants for permanent, temporary or special services as he may from time to time 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, and to send any such persons to foreign countries for technical education or otherwise for the purpose of the Company's business and pay all expenses thereon on such terms as he may think fit;

(f) To appoint in furtherance of the business of the Company any person or persons (whether incorporated or not) to accept and hold in trust for the Company any property belonging to the Company or in which it is interested or for any other purposes and to execute and do all such trusts and also all such deeds, documents and things as maybe requisite in relation to any such trust and to provide for the remuneration of such trustee or trustees;

(g) Subject to the provisions of Section 196(3) (b) of the Ordinance, to institute, conduct, defend, compound 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;

(h) To refer any claims or demands by or against the Company to arbitration and observe and perform or resist the awards;

(i) To appoint agents and attorneys and grant powers of attorney to any other Officer of the Company;

(j) To establish the organizational setup of the Company and powers, authorities and functions of its departments;

(k) From time to time provide for the management of the affairs of the Company either in different parts of Pakistan or elsewhere in such manner as he thinks fit, and in particular to establish branch offices and to appoint any person to be the attorneys or agents of the Company with such powers (including power to sub-delegate) and upon such terms as he may think fit;

(l) Subject to the provisions of the Ordinance, to invest and deal with any of the moneys of the Company upon such securities (not being shares in the Company) and in such manner as he thinks fit and, form time to time, vary or realize such investments;

(m) To execute in the name and on behalf of the Company in favour of any Director or other person who may incur or be about to incur personal liability to the benefit of the Company such mortgage of the Company's property (present or future) as he may think fit, and any such mortgage may contain a power of sale and such other power, covenant and provisions as shall be agreed upon;

(n) To give to any persons employed by the Company, as remuneration for their services, a commission on the profits of any particular business or transaction or a share in the general profits of the Company, and such commission or share of profit shall be treated as part of the working expenses of the Company;

(o) To enter into all such negotiations and contracts and rescind and vary all such contracts and execute and do all such acts, deeds and things in the name and on behalf of the Company as the Directors consider expedient for or in relation to any of the matters aforesaid or otherwise for the purposes of the Company;

(p) To establish, maintain, support and subscribe to any charitable or public objects, and any institution, society, or club which may be for the benefit of the Company or its employees or may be connected with any town or place where the Company carries on business; to give pensions, gratuities, bonuses or charitable aid to any parson or persons who have served the company or to their wives, children or dependents of such person or persons, that may appear to him just or proper, whether any person, his widow, children or dependent have or have not a legal claim upon the Company.

(r) To make and alter rules and regulations concerning the time and manner of payment of the contributions of the employees and the Company respectively to any such Fund and the accrual, employment, suspension and the application and disposal thereof, and otherwise in relation to the working and management of the said Funds as he shall from time to time think fit.

XIV. OFFICIAL SEAL

67. Official Seal

The Board shall provide a Common Seal for the purposes of the Company and shall provide for the safe custody of the Common Seal. The Common Seal shall never be used except by the authority of the Board or a Committee of Directors previously given, and two Directors at least shall sign every instrument to which the Common

Seal is affixed: Provided, nevertheless, that any instrument bearing the Common Seal of the Company and issued for valuable consideration shall be binding on the Company notwithstanding any irregularity.

XV. DIVIDENDS AND RESERVES

68. Declaration of Dividends and Restrictions on Amount thereof

The Company in General meeting may declare dividends, but no dividends shall exceed the amount recommended by the Board.

69. Interim Dividends

The Board may from time to time pay to the Members such interim dividends as appear to be justified by the profits of the Company.

70. Distribution of Dividends

The profits distributed as dividends shall be declared and paid according to amounts paid on the shares and the number of shares themselves.

71. Power of Board to Create Reserve

The Board, before recommending any dividend, may set aside out of the profits of the Company such sum as they think proper as a reserve or reserves, which shall, at the discretion of the Board, be applicable for meeting debt obligations, or contingencies, or for equalizing dividends, or for any other purpose to which the profits of the Company may properly be applied, and pending such application may, in the like discretion, either be employed in the business of the Company or be invested in such investments (other than shares of the Company), as the Board may from time to time think fit.

72. Receipts for Dividends by Joint Holders

If several persons are registered as joint holders of any share, any one of them may give effectual receipts for any dividends payable on the shares.

73. No Interest on Dividends

No dividend shall bear interest or mark-up against the Company. The dividend shall be paid within the period laid down in the Ordinance.

74. Carrying Forward of Profits

The Directors may carry forward any profits, which they may think prudent not to distribute, without setting them aside as a reserve.

75. **Unclaimed Dividends**

Unclaimed dividends may be invested or otherwise used by the Board for the benefit of the Company until claimed.

XVI. CAPITALISATION

76. **Capitalisation of Reserves**

Any General Meeting may, upon recommendation of the Board, by ordinary resolution, resolve that any undistributed profits of the Company, (including profits carried and standing to the credit of any reserves or other special accounts or representing premiums received on the issue of shares and standing to the credit of the share premium account and capital reserves arising from realized or unrealized appreciation of the assets or goodwill of the Company or from any acquisition/sale of interests in other undertakings) be capitalized. Such capitalized undistributed profits and reserves shall be distributed amongst such of the Members as would be entitled to receive the same if distributed by way of dividend, and in the same proportions, on the footing that they become entitled thereto as capital. All or any part of such capitalized fund may be applied on behalf of such Members for payment in full or in part either at par or at such premium as the resolution may provide, for any unissued shares or debentures of the Company which shall be distributed accordingly, and such distributions or payment shall be accepted by such Members in full satisfaction of their interest in the said capitalised sum.

XVII. ACCOUNTS

77. **Books of Account to be Kept**

The Board shall cause to be kept proper books of account.

78. **Where to be Kept**

The books of account shall be kept at the Registered Office or at such other place as the Board think fit and shall be open to inspection by the Directors during business hours.

79. **Profit and Loss Account and Balance Sheet**

Within eighteen (18) Months of the incorporation of the Company, and subsequently once at least in every year, the Directors shall cause to be prepared and laid before the Company in Annual General Meeting a Balance Sheet and Profit and Loss Account, both made up in accordance with the Ordinance and to a date not more than four (4) months before the date of the Meeting. Every such balance sheet shall be accompanied by an Auditor's Certificate and the Directors' report, in accordance with the provisions of the Ordinance in that behalf.

80. **Copies of Directors' Report and Balance Sheet to be Sent to the Members**

A copy of the report of the Directors and of the Balance Sheet (including a report of the Auditors and every document required by law to be annexed thereto), and of the Profit and Loss Account shall be sent to all Members alongwith the notice convening the General Meeting before which the same are required to be laid at least twenty-one (21) days preceding the Meeting.

XVIII. AUDIT

81. **Appointment of Auditors and Their Duties**

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

XIX. NOTICE

82. **How Notices to be Served**

A notice may be given by the Company to any Member or Director either personally or by sending it to him by mail, postage prepaid, or by facsimile, at his registered address, or if he has no registered address in Pakistan, to the address supplied to the Company for the giving of notices to him. Notwithstanding the foregoing, notices to Members and Directors that are located outside Pakistan may be sent by facsimile.

83. **Personal Delivery of Notice**

Where a notice is delivered personally, the recipient shall sign a receipt in such form as the Board shall determine.

84. **Service by Post**

Where a notice is sent by post, service of the notice shall be deemed to be made 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 letter would be delivered in the ordinary course of post.

85. **Notice to Joint Holders**

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

86. **Notice of General Meetings**

Notice of every General Meeting shall be given in the same manner herein authorized to (a) every Member, and also to (b) every person entitled to a share in consequence of the death or insolvency of Member, who but for his death or insolvency would be entitled to receive notice of the meeting, and (c) to the Auditors of the Company for the time being.

XX. SECRECY

87. **Secrecy**

Every Director, Chairman, Chief Executive, General Manager, Auditor, Trustee, Member of a Committee, Officer, Servant, Agent, Accountant or other person employed in the business of the Company shall, if so required by the Board before entering upon his duties, sign a declaration in the form approved by the Board pledging himself to observe strict secrecy representing all transactions of the Company with the customers and the state of accounts with individuals and in matters relating thereto, and shall by declaration pledge himself not to reveal an of the matters which may come to his knowledge in the discharge of his duties except when required so to do by the Board, or by any General Meeting, or by a court of law, and except so far as may be necessary in order to comply with any provisions in these presents contained.

88. **Restrictions on Inspection of Books of Account of Company or on Entering Into Property of Company**

No Member or other person (not being a Director) shall be entitled to enter the property of the Company, or inspect any account or books of account or document of the Company or properties of the company, without permission of the Chief Executive or the Board and to require disclosure of any information respecting any detail of the Company's trading, or any matter which is or may be in the nature of a trade secret, mystery of trade, or secret to the conduct of the business of the Company and which in the opinion of the Board will be in expedient in the interest of the Company to communicate.

XXI. WINDING UP

89. **Distribution of Assets on Winding Up**

(a) If the Company shall be wound up (whether voluntarily or otherwise) the Liquidator may, with the sanction of a Special Resolution and any other sanction required by the Ordinance, divide amongst the Members, in specie or kind, the whole or any part of the assets of the Company, whether they consist of property of the same kind or not.

(b) For the purpose aforesaid, the Liquidator may set such value as he deems fair upon any property to be divided as aforesaid and may determine how such division shall be carried out as between the Member or different classes of Members.

(c) The Liquidator may, with the like sanction, vest the whole or any part of such assets in trustees upon such trust for the benefit of the contributors as the Liquidator, with the like sanction, think fit, but so that no Member shall be compelled to accept any shares or securities whereupon there is any liability.

XXII. INDEMNITY

90. **Indemnity**

Every Director, Chairman, Chief Executive, Manager or Officer of the Company or any person employed by the Company as Auditors or Adviser, shall be indemnified out of the funds of the Company against any liability incurred by him as such Director, Chairman, Chief Executive, Manager, Officer, Auditor or Advisor, in defending any proceedings, whether civil or criminal, in which judgments given in his favour or in which he is acquitted, or in connection with any application under Section 488 of the Companies Ordinance in which relief is granted to him by Court.

91. **Individual Responsibility of Directors, etc.**

No Director, Chairman, Chief Executive, Secretary, Legal Advisor, Attorney or other officer or employee of the Company will be liable for the acts, receipts, neglects or defaults of any other Director or Officer 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 Board, or other Officer for or on behalf of the Company, or for the insufficiency or deficiency of any security in or upon which any of the moneys of the Company shall be invested, or for any loss or damage arising from the bankruptcy, insolvency, or tortuous acts 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 whether which may happen in the execution of the duties of his office or in relation thereto, unless the same happens through his own willful act or dishonesty or negligence, breach of duty or breach of trust in relation to the Company.

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

Names & Surname In Full	Father's Name in Full	Nationality	Occupation	Residential Address in Full	No. of shares Taken by each Subscriber	Signature
NBT Pakistan Holding (Pte) Ltd. Incorporated: Singapore Reg. # 201135006H Nominee: Mr. Joar Gudmund Viken (Passport # 25691179)	Mr. Johannes Viken	Norwegian	Power Generation Company	159 Telok Ayer Street, Singapore, 068614	99,997/- (Ninety nine thousand nine hundred ninety seven only)	
Mr. Joar Gudmund Viken (Passport # 25691179)	Mr. Johannes Viken	Norwegian	Power Consultant	Frits Kiaers Vei 11B, 0383 Oslo	01/- (One only)	
Mr. Arne Jonny Myre (Passport # 28071237)	Mr. Henry Myre	Norwegian	Power Consultant	Hoevik Skolevei 11, 1363, Norway.	01/- (One only)	
Mr. Thorstein Jenssen (Passport # 28126301)	Mr. Thorleif Jenssen	Norwegian	Power Consultant	Filipstad Brygge 1, 0252 Oslo, Norway	01/- (One only)	
				Total number of shares	**100,000 (One hundred thousand only)**	

Witness:

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

Certified to be true Copy
Deputy Registrar of Companies

Company Registration Office • Securities and Exchange Commission

Place: Karachi
Dated: 3 February 2012

NON-BINDINGTERM SHEET

CHINA DEVELOPMENT BANK CORPORATION
INDUSTRIAL AND COMMERCIAL BANK OF CHINA
BANK OF CHINA

AS LENDERS

UP TO US$399,500,000 FACILITY FOR

THE 250MW NBT/MALAKOFF WIND PROJECT IN PAKISTAN

July [•], 2013

Please note that the terms set out in this term sheet are indicative and for discussion purposes only and do not constitute an offer to arrange or finance the Facility. The provision of the Facility is subject to due diligence, credit committee approval, government, corporate and third party approvals, satisfactory documentation and legal opinions.

PART 1
PARTIES, PROJECT

Project:	250MW NBT/Malakoff Wind Project in Pakistan
Buyer/Borrower:	NBT WIND POWER PAKISTAN II (PRIVATE) LIMITED, a special purpose company whose only business and undertaking will be executing the Project, incorporated in Pakistan.
Sponsors:	Malakoff International Limited, a company incorporated in Cayman Islands (a wholly owned subsidiary of Malakoff Corporation Berhad, Malaysia) that shall be the ultimate parent company owning 60% of the issued share capital of the Borrower. NBT AS, a Norway company organised under the laws of Norway that shall be the ultimate parent company owning 40% of the issued share capital of the Borrower.
Commercial Contracts	Contracts to be signed by the Supplier and the Buyer for the construction and installation and supply of turbines, warranty, service, and maintenance of 250MW Wind Project in the Islamic Republic of Pakistan.
Contract Amount	USD$ 468,750,000
EPC Contractor:	Harbin Electric International Company Limited ("**HEI**")
Guarantor:	To be discussed.
ECA Support:	China Export & Credit Insurance Corporation ("**Sinosure**") shall provide Political Risk Insurance and Breach of Contract Risk Insurance covering payment risk of the off-taker for the benefit of the Lenders

Mandated Lead Arranger:	China Development Bank Corporation ("**CDB**"). Industrial and Commercial Bank Of China ("**ICBC**") Bank Of China ("**BOC**")
Lender:	China Development Bank Corporation ("**CDB**"). Industrial and Commercial Bank Of China ("**ICBC**") Bank Of China ("**BOC**")
Facility Agent:	[Note: agency roles/fees to be identified and distributed among MLA at a later stage]
Security Agent and Trustee:	One of the lenders or any other bank designated by the Mandated Lead Arranger.
Account Bank:	Industrial and Commercial Bank of China Limited, Karachi Branch.
Finance Parties:	The Mandated Lead Arranger, the Lenders, the Facility Agent, the Security Agent and Trustee and the Account Bank.
Major Project Participants:	The Borrower, the EPC Contractor (until the end of the warranty period under the EPC Contract), the O&M Contractor (until the end of the warranty period under the O&M Contract), the Sponsors, the offtaker and any other party which the Facility Agent and the Borrower agree should be a Major Project Participant.
Signing Date:	The date on which the Facility Agreement is duly executed by all parties thereto.
EPC	Fixed price turnkey contract standard for a project of this nature together with full parent guarantee from [Harbin Electric Group], performance bonds and retention amounts to support amongst other things, turbine warranties (for availability and power curve), construction delays and advance payments.

PART 2
FACILITY

Currency and Amount:	Term loan facility of up to USD399,500,000.00
Purpose:	The Facility will be used to finance the construction of 250MW NBT/Malakoff Wind Project in Pakistan.
Gearing:	The debt to equity ratio shall be 3:1
Tenor:	15 years[or 13 years]
Availability Period:	24 months from the Signing Date. Any amount not drawn during the Availability Period shall automatically be cancelled.
First Repayment Date:	The business day falling 30 months after the Signing Date.

Final Maturity Date:	The final maturity date of this facility will be the earlier of: (a) 15[or 13]years after Signing Date; and (b) the date on which all amounts outstanding under this facility have been repaid or cancelled.
Repayment of Principal:	The total amount of principal of the Facility shall be repaid in 26 or 22 instalments according to preset repayment schedule, which should be designed [to ensure repayments are sculpted to match Project cashflow],with the first instalment due on the First Repayment Date and each subsequent instalment due on each Interest Payment Date thereafter. All amounts due or to become due under the Facility Agreement shall be paid or repaid in full by the Final Maturity Date.
Debt Service Coverage Ratio (DSCR)	To be determined.
Liquidity Support	Upon a request from the Lenders, the Sponsors and the intermediary Singapore Hold Co shall provide liquidity support in respect of certain project risks to be agreed. Liquidity support shall take the form of shareholders loans equity contribution agreements or a bank guarantee up to a maximum amount to be agreed. Lenders may call upon the liquiditysupportduring the construction and operation period by notifying the Sponsors in the event of certain breaches including but not limited to where there is a funding shortfall or if the DSCR is lower than a threshold to be agreed.
Costs and Expenses	The Borrower shall pay all reasonable costs and expenses (including but not limited to legal fees) incurred by the Lenders for the preparation, negotiation, arrangement and execution of the Facility Agreement and Security Documents. The Borrower shall pay for all reasonable costs and expenses (including but not limited to agreed legal fees) incurred by the Lenders relating to: (a) any amendments or waivers under the Facility Agreement and Security Documents; (b) investigating any default under the Facility Agreement and Security Documents; and (c) any enforcement under the Facility Agreement and Security Documents.

PART 3
PRICING

Management Fee:	2% of the amount of the total commitments under the Facility Agreement. This should be payable by the initial drawdown.

Commitment Fee:	The Borrower shall pay to the Facility Agent (for the account of each Lender) a commitment fee of 1.5% per annum on the unused and uncancelled amount of the Facility for the Availability Period, semi-annually in arrears.
Facility Agent Fee:	To be agreed between the Borrower and the Facility Agent in a fee letter, payable annually in advance.
Account Bank Fee:	To be agreed between the Borrower and each Account Bank in a fee letter, payable annually in advance.
Margin:	4.90% per annum. [or 4.75% per annum when Tenor is set on 13 years.]
Interest Periods:	Each Loan shall have successive interest periods of 6 months commencing on an Interest Payment Date (except for the initial Interest Period which shall commence on the utilisation date) and ending on the next Interest Payment Date or any other period agreed between the Borrower and the Lenders. An Interest Period for a Loan shall not extend beyond the Final Maturity Date.
Interest Rate:	Loans shall bear Interest at a rate per annum equal to the aggregate of: (a) the Margin; and (b) 6-month LIBOR set by reference to [Reuters][Telerate] or, if not available, on the basis of rates provided by agreed reference banks.
Interest Payment Dates:	Each date falling at 6 months intervals after the Financial Close or, if not a business day, the preceding business day.
Interest Payments:	Interest will be payable on each Interest Payment Date in arrears on the disbursed and outstanding principal amount commencing on the first Interest Payment Date following the first Utilisation.

PART 4
COMMON TERMS

Finance Documents:	The Finance Documents will comprise: (a) the Facility Agreement; (b) the Security Documents; (c) the Fee Letters; and (d) any other agreements in relation to the financing of the Project and noted by the Facility Agent as a Finance Document.
Security Documents:	The Lenders' overall security package shall include:

(a) Liquidity support agreements signed by the Sponsors and the Singapore Hold Co[1].

(b) Assignment of EPA and IA.

(c) Sinosure insurance policy cover, including Political Risk Insurance and Breach of Contract Risk Insurance covering payment risk of the off-taker.

(d) Guarantee of payment under EPA by Pakistan Government as set out in the IA.

(e) Assignment of Operation & Maintenance Contract or Full Service Agreement.

(f) Assignment of EPC contractand assignment of the parent guarantee provided by Harbin Electric Group.

(g) Assignment of the commercial insurance of the Project.

(h) Pledge of all accounts of the Project.

(i) Pledge of the Borrower's shares.

(j) Debt service reserve account funded with six months interest and principal (to be funded before the first repayment date).

(k) A first ranking charge by an equitable mortgage on all immovable assets of the Project.

(l) Hypothecation of all present and future movable assets of the Borrower with respect to the Project.

(m) Other typical security in Project Finance or requested by Mandated Lead Arranger.

PART 5
CONDITION PRECEDENT

Conditions Precedent to Initial Utilisation

The Facility Agreement shall contain standard conditions precedent in form and substance satisfactory to the Lenders. Subject to due diligence, the conditions precedent to initial utilisation include but are not limited to:

(a) Receipt of all permits, licences and governmental approvals required for construction and operation as need to be in place at the time of financial close.

(b) Execution of the Project Documents.

[1]To be discussed.

(c) Delivery of legal opinions issued by qualified solicitors in the relevant jurisdictions and a government issued opinion in relation to the Pakistan government guarantee in the IA.

(d) Completion of legal, financial and technical due diligence on the Project and the Borrower.

(e) Execution of the Facility Agreement and the security documents (and completion of perfection registration as required).

(f) A copy of a resolution of the board of directors or shareholders (as applicable) of the Borrower and security providers approving the Facility Agreement and the security documents (and completion of other corporate requirements).

(g) A certificate of an authorised signatory of the Borrower certifying that the total commitments would not cause any borrowing, guaranteeing or similar limit binding on it to be exceeded and that each document relating to it specified is correct, complete and in full force and effect as at a date no earlier than the date of the Facility Agreement.

(h) All reasonable fees, costs and expenses then due and payable by the Borrower (such as agreed legal fees, commitment fee, agency fee and arrangement fee) have been paid.

(i) The original Financial Statements of the Borrower, the intermediate Singapore Hold Co, [and the Sponsors].

(j) A certificate from accountants appointed by the Lender confirming that shareholder contributions to the equity have been paid in full.

(k) Evidence that each of the bank accounts have been opened in accordance with the terms of the Facility Agreement.

(l) Creation and perfection of all security.

Conditions Precedent to each following Utilisation

The Facility Agreement shall contain standard conditions precedent to each Utilisation following initial utilisation in form and substance satisfactory to the Lenders, including without limitation:

(a) No default is continuing or would result from theproposedutilisation;

(b) The repeating representations given by the Borrower are true in all material aspects;

(c) There is no Funding Shortfall;

(d) Confirmation from a technical adviser that construction costs are due and payable;

(e) Where the proposed utilisation date falls on or after a dated specified for the completion of the condition subsequent, such

condition subsequent has been satisfied or extended or waived;

(f) The Borrower has delivered to the Facility Agent a detailed utilisation request and an independent engineer's issuance of a cost certificate confirming the subsequent funding amount is due and payable.

PART 6
REPRESENTATIONS, UNDERTAKINGS AND DEFAULTS

Representations and Warranties: The Borrower and, where appropriate, the security providers, shall make representations and warranties usual for transactions of this nature as of the Signing Date and the date of Financial Close (subject to such qualifications as may be agreed), including without limitation:

(a) status;

(b) legal, valid, binding and enforceable obligations;

(c) non conflict with other obligations;

(d) power and authority;

(e) validity and admissibility in evidence;

(f) governing law and enforcement;

(g) no insolvency;

(h) no filings or stamp taxes;

(i) no deduction of taxes;

(j) no default;

(k) no misleading information;

(l) accuracy of original financial statements and no material adverse change since date of original financial statements;

(m) no proceedings pending or threatened;

(n) no breach of laws or conflict with any agreement binding on the Borrower or the security providers (as relevant);

(o) environmental claims and compliance;

(p) tax returns filed and taxes paid;

(q) no existing guarantees, financial indebtedness or security, except as specified;

(r) *paripassu* ranking;

(s) good title to assets;

(t) no other business;

(u) ownership of the Borrower;

(v) labour matters;

(w) no material contracts, except as specified;

(x) no adverse consequences; and

(y) no immunity (sovereign or otherwise).

Repetition of Representations

Certain representations and warranties shall be repeated on the date of each utilisation request, on the date of each utilisation and on the first day of each interest period.

Information Undertaking

The Borrower shall supply to the Facility Agent, including without limitation, each of the following:

(a) Technical advisers reports if any

(b) construction reports

(c) Quarterly operating reports

(d) Construction and Operating budget

(e) Financial statements

(f) Miscellaneous information

Customary undertakings relating to the provision by the obligors of information for any "know your customer" checks required to be carried out by the Facility Agent, and the Lenders shall also be included in the Facility Agreement.

General Undertakings

The Facility Agreement shall contain standard general undertakings for a project of this nature, including withoutlimitation:

(a) Corporate existence and conduct of business;

(b) Com

(c) pliance with laws;

(d) Paripassu ranking;

(e) No financial indebtedness;

(f) No hedging;

(g) No variation to constitutional documents without consent of the Facility Agent;

(h) Negative pledge;

(i) No disposals without consent;

(j) No merger or reorganisation without consent;

(k) Change of control;

(l) Arm's length terms;

(m) Maintain title to assets; and

(n) Maintain registration requirements for all security interests.

Project Undertakings

The Facility Agreement shall contain standard project undertakings for a project of this nature, including withoutlimitation:

(a) Maintain in force and duly perform project documents;

(b) Maintain authorisations and approvals;

(c) Ensure operation and maintenance;

(d) No variation to the project works without consent;

(e) Ensure access to project site for the Lenders and their agents;

(f) Maintain the insurances as required.

Events of Default

Events of Default usual for transactions of this nature (subject to such qualifications and remedy periods as may be agreed) in respect of the Borrower and, where appropriate, the security providers, including without limitation the following:

(a) non-payment;

(b) breach of other provisions of Finance Documents unless breach is capable of remedy and is remedied with [30] days of the Facility Agent giving notice as the obligor becoming aware.

(c) misrepresentation;

(d) cross default, subject to agreed minimum amounts;

(e) insolvency, bankruptcy or similar proceedings;

(f) creditors' process;

(g) judgments;

(h) unlawfulness or invalidity of Finance Documents or Project

Documents or ineffectiveness of security;

(i) change of control of the Borrower;

(j) repudiation or recession of Finance Documents or Project Documents;

(k) material adverse change;

(l) nationalisation, expropriation or compulsory acquisition;

(m) currency control regulations;

(n) loss of licenses and other authorisations;

(o) cessation of business or abandonment of Project;

(p) loss and destruction of the Project;

(q) breach under, or termination, default, revocation or suspension of, Project Documents;

(r) material litigation;

(s) money laundering, anti-corruption and financing of terrorism.

The remedies available to the Lenders upon the occurrence of an Event of Default will include, inter alia, cancellation of commitments and acceleration of all outstanding loans under the Facility and enforcement of the Security Documents.

PART 7
ADDITIONAL PROVISIONS

Governing Law: This Term Sheet and the Finance Documents shall be governed by English law, except that certain Security Documents will be governed by Pakistan law or PRC law if required by the Mandated Lead Arranger.

Waiver of Immunity: To the extent that the Borrower may be entitled in any jurisdiction to claim for itself or its assets immunity from any suit, execution, attachment or other legal process under the Finance Documents or Project Documents, the Borrower shall waive generally all immunity it or its assets or revenues may otherwise have in any jurisdiction, including immunity in respect of:

(a) the giving of any relief by way of injunction or order for specific performance or for the recovery of assets or revenues; and

(b) the issue of any process against its assets or revenues for the enforcement of a judgement or, in an action *in rem*, for the

arrest, detention or sale of any of its assets and revenues.

Clear Market: The Borrower, the Sponsors and the Singapore Hold Coagree that until the earlier of (i) the Signing Date and (ii) 31 December 2013, neither the Borrower, the Sponsors and the Singapore Hold Co shall raise or attempt to raise finance in respect of the Project or the international or domestic loan or capital markets other than the Facility without the prior written consent of the Lenders, excluding any arrangement between the shareholders inter se.

Confidentiality: This Term Sheet and its content are intended for the exclusive use of the Borrower and they shall not disclose this Term Sheet or its content to any person other than their legal and financial advisors for the purposes of the proposed transaction unless the prior written consent of the Arranger is obtained.

Expiry: This Term Sheet will remain valid for six 6months from the date of signing. Save as for this PART 7, the terms of it are not intended to be and should not be construed as an offer to provide financing or a document with legally binding effect. It may not be relied upon or enforced by the Borrower and any person in any court or tribunal.

_____

For and on behalf of

China Development Bank Corporation

_____

For and on behalf of

Industrial and Commercial Bank Of China

_____

For and on behalf of

Bank Of China

_____

For and on behalf of

Profile of Sub-contractors

To,

The Registrar,

National Electric Power Regulatory Authority,

NEPRA Tower Attaturk Avenue (East),

Sector G-5/1, Islamabad.

Subject: Profile of sub-Contractors.

Sir,

It is to inform your good office that we are in the process of finalizing our negotiations with the sub-contractors for our 250MW Wind power project and we are most likely to finalize our deal with Harbin Electric International Co., LTD (HEI) as it is the same contractor whose services have been hired for our other project NBT Wind Power Pakistan II (Pvt.) Limited, 250MW.

As soon as we finalize our agreement with the sub-contractor we will immediate provide you with the profile of the same sub-contractor.

Regards,

Sayyed Ali Mustafa Gillani

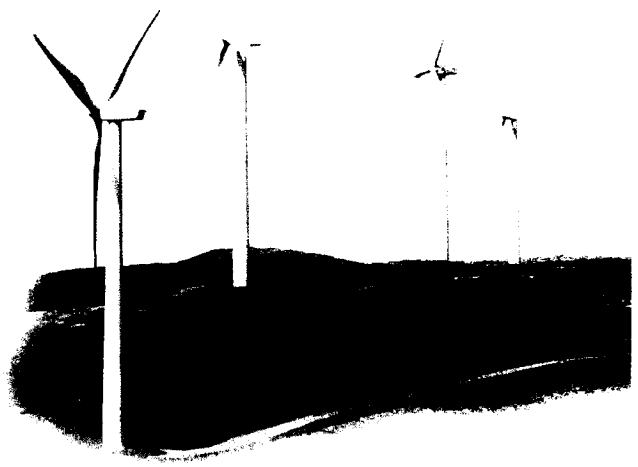
Legal Counsel

NBT Wind Power Pakistan III (Pvt.) Limited

Type of Technology

GE Energy

Technical Documentation
Wind Turbine Generator Systems
1.6-82.5 - 50 Hz / 60 Hz



Technical Description and Data

imagination at work

Table of Contents

1 Introduction

This document summarizes the technical specifications of the GE 82.5 wind turbine-generator system.

2 Technical Description of the Wind Turbine and Major Components

The wind turbine is a three-bladed, upwind, horizontal-axis wind turbine with a rotor diameter of 82.5 m. The turbine rotor and nacelle are mounted on top of a tubular tower. The machine employs active yaw control (designed to steer the machine with respect to the wind direction), active blade pitch control (designed to regulate turbine rotor speed), and a generator/power electronic converter system.

The wind turbine features a decoupled drive train design wherein the major drive train components including main shaft bearings, gearbox, generator, yaw drives, and control panel are attached to a bedplate (see Figure 1).

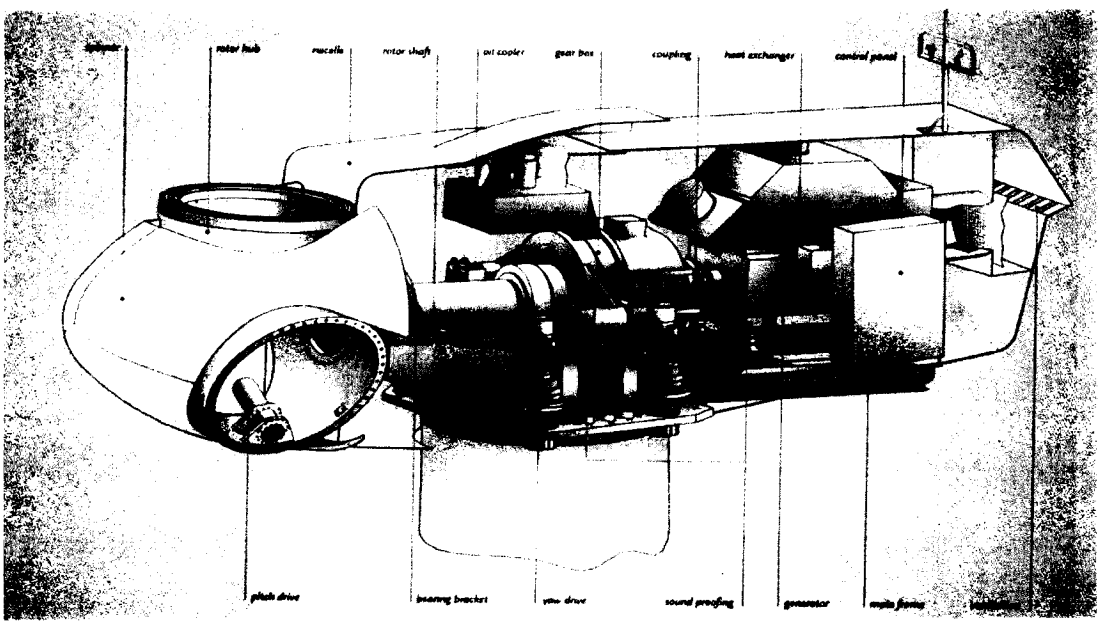


Figure 1 GE 82.5 wind turbine nacelle layout

2.1 Rotor

The rotor diameter is 82.5 m, resulting in a swept area of 5,346 m², and is designed to operate between 9.8 and 18.7 revolutions per minute (rpm). Rotor speed is regulated by a combination of blade pitch angle adjustment and generator/converter torque control. The rotor spins in a clock-wise direction under normal operating conditions when viewed from an upwind location.

Full blade pitch angle range is approximately 90°, with the 0°-position being with the airfoil chord line flat to the prevailing wind. The blades being pitched to a full feather pitch angle of approximately 90° accomplishes aerodynamic braking of the rotor, whereby the blades "spill" the wind thus limiting rotor speed.

2.7 Brake System

The blades are fully or partially pitched by the blade pitch system to control the rotational speed of the wind turbine. Braking under normal operating conditions is accomplished by feathering the blades out of the wind. Any single feathered rotor blade is designed to slow the rotor and each rotor blade has its own back-up to provide power to the electric drive in the event of a grid line loss.

The turbine is also equipped with a mechanical brake located at the output (high speed) shaft of the gearbox. This brake is only applied as an auxiliary brake to the main aerodynamic brake and to prevent rotation of the machinery as required by certain service activities.

2.8 Generator

The generator is a doubly-fed induction type. The generator meets protection class requirements of the International Standard IP 54 (totally enclosed). The generator is mounted to the bedplate and the mounting is designed so as to reduce vibration and noise transfer to the bedplate.

2.9 Flexible Coupling

Designed to protect the drive train from excessive torque loads, a flexible coupling is provided between the gearbox and generator output shafts. This coupling is equipped with a torque limiting device sized to keep the maximum allowable torque below the design limit of the drive train.

2.10 Yaw System

A roller bearing attached between the nacelle and tower facilitates yaw motion. Planetary yaw drives (with brakes that engage when the drive is disabled) mesh with the outside gear of the yaw bearing and steer the machine to track the wind in yaw. The outputs of the yaw brakes engage in order to prevent the yaw drives from seeing peak loads from any turbulent wind.

The controller activates the yaw drives to align the nacelle to the average wind direction based on the wind vane sensor mounted on top of the nacelle.

A cable twist sensor provides a record of nacelle yaw position and cable twisting. After the sensor detects excessive rotation in one direction, the controller automatically brings the rotor to a complete stop, untwists the cable by counter yawing of the nacelle, and restarts the wind turbine.

2.11 Tower

The wind turbine is mounted on top of a tubular tower. The tubular tower is manufactured in sections from steel plate. Access to the turbine is through a lockable steel door at the base of the tower. Service platforms are provided. Access to the nacelle is provided by a ladder and a fall arresting safety system is included. Interior lights are installed at critical points from the base of the tower to the tower top.

3 Technical Data for the 1.6-82.5

3.1 Rotor

Diameter	82.5 m
Number of blades	3
Swept area	5'346 m2
Rotor speed range	9 to 18 rpm
Rotational direction	Clockwise looking downwind
Maximum tip speed	77.2 m/s
Orientation	Upwind
Speed regulation	Pitch control
Aerodynamic brakes	Full feathering

3.2 Pitch System

Principle	Independent blade pitch control
Actuation	Individual electric drive

3.3 Yaw System

Yaw rate	0.5 degree/s

3 Technical Data for the 1.6-82.5

3.1 Rotor

Diameter	82.5 m
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Principle	Independent blade pitch control
Actuation	Individual electric drive

3.3 Yaw System

Yaw rate	0.5 degree/s

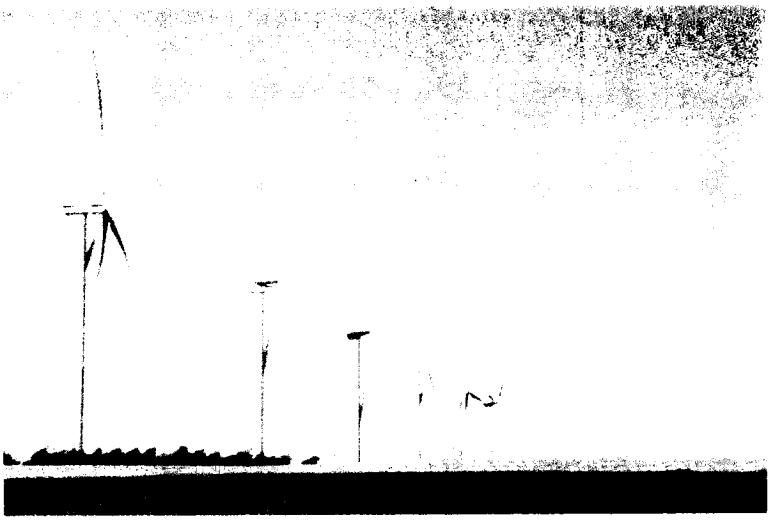
a. Manufacturer : General Electrics
b. Make &Model : GE1.6 – 82.5 WTG
c. Plant Capacity (MW) : 249.6MW
d. Technology : Double - Feed
e. Unit Size (MW) : 1.6
f. Number of Units : 156

Report No. PPI-46.5-Final-Draft/13

ELECTRICAL GRID STUDIES

For

2x250 MW NBT Wind Power Plant



Final Draft Report
(18-2-2013)

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Executive Summary

1. NBT 2x250 Wind Power Plant will be completed in two phases. The COD of the 250 MW first phase is 31st December 2014 whereas the COD of the second 250 MW phase will be 30th June 2015.
2. The interconnection scheme for NBT WPP has been developed to evacuate the complete 2x250 MW power of NBT WPP. The proposed interconnection scheme for NBT 2x250 MW WPP would require as follows:
   - Development of collector substation of 220/33 kV for NBT WPP for interface with NTDC Grid after internally collecting the output of NBT-WPP
   - Connect collector substation of 220/33 kV for NBT WPP by looping in-out of the existing 220 kV circuit from Jamshoro to KDA-33 at NBT-WPP. The looping distance is about 10 km
3. Wind Farm of NBT has been modeled by using Type-3 Doubly Fed Induction Generator.
4. A conceptual design scheme of 220/33 kV substation of NBT Wind Farm has been laid down that comprises of as follows
   i. For 220 kV;
      a. Two single bus-sections of 220 kV with a bus sectionalizer
      b. Five breaker bays to connect five 100 MVA 220/33 kV transformers
      c. Two breaker bays to connect outgoing lines of 220 kV to Jamshoro and KDA-33
   ii. For 33 kV;
      a. Two single bus-sections of 33 kV with a bus sectionalizer
      b. Twenty breaker bays to connect twenty collector circuits from twenty collector groups of WTGs
      c. Five breaker bays to connect five 132/33 kV transformers
      d. Two breaker bays to connect two switched shunt capacitor banks, one in each bus section
      e. Breaker bays to connect station auxiliary transformers 33/0.4 kV

5. Load flow analysis has been carried out for September 2015 considering the COD targeted by NBT, for the dispersal of load from NBT WPP into NTDC Grid at 220 kV level for using the latest load forecast, generation and transmission expansion plans of NTDC and HESCO. The above mentioned interconnection scheme (item-1) has been evolved by performing the load flow studies testing the steady state performance for normal as well as N-1 contingency conditions fulfilling the Grid Code criteria of Wind Power Plants. The reactive power requirement at point of common coupling to meet PF of ± 0.95, voltage and line loading criteria are fulfilled by these studies. The grid facilities of HESCO, after incorporating the reinforcements of the proposed scheme, are also found adequate to absorb output power of NBT WPP.
6. Maximum and minimum short circuit levels for three-phase faults and single-phase faults have been evaluated for the year 2015, and it has been found that the proposed scheme provides maximum SC strength for the evacuation of NBT WPP power to the grid.

   The switchgear ratings for NBT WPP substation are as follows:

   220 kV:

   Short circuit rating = 50 kA (3 sec.)

   Continuous rating = 3150 A

   33 kV:

   Short circuit rating = 50 kA (3 sec.)

   Continuous rating = 9000 A
7. Transient Stability analysis has been carried out for NBT Wind Farm with connectivity of the proposed scheme. Different disturbances have been simulated to apply stresses from the system faults on the wind farm and vice versa and it was found that NBT WTG unit's dynamic characteristics and the grid connectivity is strong enough to maintain stability under all disturbances. In turn, any disturbance from NBT WPP side did not cause any stress on the main grid or the power plants in HESCO area viz. HUBCO, Guddu, Kotri, Lakhra or Jamshoro such that the whole system remained stable under all events.
8. The LVRT requirements have been tested to fulfill 100 ms (5 cycles) under normal clearing time and 180 ms (9 cycles) for contingency condition of

delayed fault clearing due to stuck- breaker (breaker failure) reason. The simulations have proved that the proposed machine fulfills the LVRT criteria as required in the Grid Code for Wind IPPs.

9. The issues of power quality like flicker and harmonic resonance have been studied in detail. The results have indicated that the levels of flicker are within the permissible limits of IEC and other International Standards.

10. There are no technical constraints whatsoever in the way of bringing in the 2 x 250 MW of NBT Wind Power Plant at the proposed site and scheduled time of commissioning, in any respect of steady state (load flow) or short circuit or dynamic performance (stability) or power quality issues related to this plant.

Report Contents

1. Introduction

1.1 Background

There exists a huge wind corridor in coastal Sindh, starting from Gharo-Ketti Bandar up to Jhimpir and upward, that has been identified by AEDB with an actual potential of about 50,000MW. There are many entrepreneurs coming forward to tap this huge natural resource of power who have been allocated lands by AEDB to develop wind farms. NBT is one such pioneering entrepreneur who has come forward with a Wind Power Plant within this cluster near Jhimpir.

The proposed wind farm shall have the installed capacity of about 2x250 MW of electricity. The project is being developed in the private sector and the electricity generated from this project would be supplied to power grid of NTDC. The services of Power Planners International have been engaged to perform the impact studies of penetration of this wind power in the national grid to evolve the most feasible interconnection scheme for this plant.

1.2 Objectives

The overall objectives of this study are:

1. Impact of NBT Wind Power Plant on the System
2. Impact of the System on NBT Wind Power Plant

These impacts are to be studied for different operating conditions of Plant as well as the System. The operating condition of the plant may vary from its 100 % output to 0 % i.e. no output at all. The system conditions would be peak load, off-peak load under two generation dispatch scenarios with high hydro power availability and low hydro (or high thermal) power generation.

The impacts are required to be studied for steady state as well as the dynamic and disturbed conditions of the system. The specific objectives are:

1. To develop a feasible scheme of interconnections of NBT Wind Power Plant (WPP) with NTDC network at 220 kV for which right of way (ROW) and space at the terminal substations would be required to be made available.

2. To check the load-ability of lines and transformers to be within their rated limits satisfying the clauses OC 4.8, OC 4.9, and OC 4.10 of NEPRA Grid Code regarding the criteria of operation of frequency, voltage and stability under normal and contingency conditions for peak and off-peak load conditions of grid as well as the plant.
3. To check the voltage profile of the bus bars of the neighboring interconnected network under different operating conditions
4. To check the reactive power limitations of the wind turbines and the neighboring generators of the system; and evaluate the size of switched shunt capacitor banks at Medium Voltage level of substation of collector system of NBT Wind Farm to regulate the voltage under steady state and contingency conditions to fulfill the Grid Code criteria of ± 0.95 Power Factor at the point of common coupling (interface point) interconnecting Wind Farm and the Grid i.e. 220 kV or 132 kV gantries of outgoing circuits.
5. To check if the contribution of fault current from this new plant increases the fault levels at the adjoining substations at 500 kV, 220kV and 132 kV voltage levels to be within the rating of equipment of these substations.
6. To check the minimum short circuit strength of the system to handle large variation of generation of wind turbine
7. To check if the interconnection with the grid withstands transient stability criteria of post fault recovery with good damping satisfying the NEPRA Grid Code.
8. Transient stability to see the dynamic performance of NBT Wind PP in response to Grid disturbances and vice versa the dynamic impact of disturbances in NBT WPP on the Grid.
9. To check the ability of the wind turbine generators of NBT WPP to remain connected following major disturbances and grid disruptions i.e. the Low Voltage Ride Through (LVRT) capability to satisfy the Grid Code requirement of LVRT for 180 ms

10. Analysis of power quality issues such as flicker, voltage-unbalance, harmonics and resonance of the system.

1.3 Planning Criteria

The planning criteria required to be fulfilled by the proposed interconnection as enunciated in NEPRA Grid Code including Addendum No.1 for WPPs are as follows:

Voltage	± 5 %, Normal Operating Condition
	± 10 %, Contingency Conditions
Frequency	50 Hz, Continuous, ± 1% variation steady state
	49.8 - 50.5 Hz, Short Time

Short Circuit:

132 kV Substation Equipment Rating 40kA

Dynamic/Transient and Low Voltage Ride Through (LVRT):

The WTGs should remain connected during voltage dip upto 30 % level, under fault conditions by ride through capability for the following sequence of disturbance

1. Total normal fault clearing time from the instant of initiation of fault current to the complete interruption of current, including the relay time and breaker interruption time to isolate the faulted element, is equal to 100 ms (5 cycles) for the systems of 132 kV and above.

2. In case of failure of primary protection (stuck breaker case), the total fault clearing time from the instant of initiation of fault current to the complete interruption of current to isolate the faulted element, including the primary protection plus the backup protection to operate and isolate the fault, is equal to 180 ms (9 cycles) for 132 kV and higher voltage levels.

Reactive Power and Power factor:

Reactive Power Control to maintain the power factor within the range of 0.95 lagging to 0.95 leading, over full range of plant operation, according to Dispatch Instructions/manual voltage adjustment requirements.

Power Quality Requirements:

As per IEC61400-21standards

1.4 Operating Criteria

The operating requirements to be fulfilled by the proposed NBT WPP as enunciated in NEPRA Grid Code for WPPs (Addendum No.1) are as follows:

Black Start and Islanded Operation:

Exempted

Active Power and Frequency Control:

Exempted from precise frequency control responsibility

Synchronization / De-Synchronization:

(i) The Wind Power Plant will manage for

  (a) Smooth Synchronization

  (b) Smooth De-Synchronization

(ii) The above operations, achieved through appropriate equipment, will be without jerk(s), felt on the grid system

Power Generation Capability Forecasting Requirement:

(i) Power Generation Capability Forecasting, of average power on hourly basis, will be managed by the Wind Power Plant as required from conventional power plants, except provisions of clause (ii) &(iii) below.

(ii) The forecasting, as required in (i), will be estimated by Wind Power Plant through

  (a) Expected availability of plant during the period of forecast.

  (b) Predicted value of wind speed at site based upon analysis of historic wind data available.

(iii) The forecasting, as required in (i), will be on the basis of total Wind Power Plant and break-up for each WTG will not be required.

(iv) The forecasted values will not be a binding upon the wind power plant as actual wind speeds may differ significantly from predicted values over short durations.

1.5 Input Data

The system data of NTDC has been used as per permission granted by NTDC vide their letter No. GMPP/CEMP/TRP-380/6988-92. The latest Generation Expansion Plan and Load Forecast has been used as developed by NTDC in 2012 and is shown in Appendix 2. AEDB'savailable schedule of WPPs has been attached in Appendix-2 however AEDB is yet to issue an updated schedule of CODs of WPPs in the pipeline.

2. Description of Problem & Study Approach

2.1 Description of the Problem

In Pakistan, there is big wind power generation potential in the Southern parts of Sindh province, which is untapped as yet. However now with the establishment of Alternative Energy Development Board, this sector of power generation has taken an unprecedented stride and many entrepreneurs have come forward to build small and big Wind farms in this area.

The peculiar nature of wind power turbine is such that its output fluctuates in terms of MW and MVAR, being dependent on the wind speed and its direction. So long as the capacity of wind farm is less significant compared to the size of the power grid it is connected, these fluctuations are absorbable without compromising the power quality. But as the penetration of wind power in the power grid increases, the capability of the power grid may not be as strong as may be requiredto absorb constant variations of MW, MVAR and hence rapid deviation in voltage and frequency from the system's normal operating set point.

The existing power plants nearest to the vast wind farm areas of Jhimpir in the existing power grid are Kotri and Jamshoro having installed capacity of 120 MW and 636 MW respectively. Next to them are Hub with 1200 MW, Lakhra with 70 MW, and KESC combined generation of about 1600 MW. Apparently this amount of generation in Southern grid seems strong enough to absorb the penetration of wind power of 500 MW. But there are other variables that necessitate detailed studies like strengths of nodes of connectivity, loading capacity of the transmission lines to evacuate power from Wind Farm area and dynamic response of wind turbine generators and neighboring conventional synchronous generators.

The dynamic response of power plants in the neighborhood may not be uniform; as some of them are gas turbines and some are steam turbines i.e. Kotri has gas turbines whereas Jamshoro, Lakhra and Hub have steam turbines. Normally gas turbines are faster than the steam turbines to respond to changes in the system. The dynamic studies will determine how they respond to dynamic behavior of NBT WPP.

The above-mentioned thermal power plants do not run at their full capacity all along the whole year. During high water months when cheaper hydel power is abundantly

available in the Northern grid of NTDC, many generating units of these plants are shut down for the sake of economic dispatch. Therefore in high hydel season, which is low thermal season by default, the southern power grid would get weaker in terms of system strength, especially during off-peak hours. The dynamics of this season is different than that of high thermal season.

There are different models of different sizes and make available in the market viz. GE, Vestas, Nordex, Gamesa, Siemens, Goldwind and VenSys etc. The dynamics of each model may be different with respect to grid's dynamics. NBT has selected Type-3 Doubly-Fed Induction Generator (DFIG) as the WTG.

There are other wind farms going to get developed soon in the neighborhood of NBT farm. With the increase of penetration of more wind power in the same power grid, the impact studies would become even more involving from the point of view of dynamic stability.

2.2 Approach to the problem

We will apply the following approaches to the problem:

- NBT 2x250 Wind Power Plant will be completed in two phases. The COD of the 250 MW first phase is 31st December 2014 whereas the COD of the second 250 MW phase will be 30th June 2015. Thereforewehave decided to perform our analysis for the scenario of September 2015 to accommodate the COD provided by NBT and to judge the maximum impact of the plant as September is in the high wind season.
- A base case for the year 2015, comprising all 500kV, 220kV and 132 kV, and 66kV system would be prepared envisaging the load forecast, the generation additions and transmission expansions for each year particularly in the Southern parts of the country. The case would include the Wind Power Plants which are developing on fast track basis and are expected to be commissioned by 2015.
- Interconnection schemes without any physical constraints, like right of way or availability of space in the terminal substations, would be identified.

- Perform technical system studies for peak and light load conditions of high and low water seasons' power dispatches, to confirm technical feasibility of the interconnections schemes.
- The proposed interconnection scheme for September 2015 will be subjected to steady state analysis (load flow), short circuit and transient stability to test the robustness of the schemes under normal and contingency conditions by checking steady state and transient/dynamic behavior under all events.
- Determine the relevant equipment for the proposed technically feasible scheme of interconnection
- Perform sensitivity studies considering adjacent wind farms to check their impact on NTDC Grid. This sensitivity check can be performed for the ultimate planned number of Wind Power Plants in the neighborhood of NBT Wind PP.

3. Analysis of Network Prior to NBT WPP Interconnection

3.1 Description of the Network

Due to the size of NBT WPP, the electrical grid, which is relevant for interconnection of NBT WPP, is 220 kV or a mix of 220 kV and 132 kV network that stretches through South of Hyderabad and Jamshoro up to coastal areas of Southern Sind. This network, as it stands today is shown in Sketch-1 in Appendix-4. It comprises the following NTDC grid stations;

- Existing 500/220/132 kV grid station at Jamshoro connected through double circuits of 500 kV with Dadu in the North and Hub/New-Karachi in the South.
- Existing 220/132 kV Hala Road connected to Jamshoro 500/220/132 kV grid through a double circuit of 220 kV
- Existing T. M. Khan Road 220/132 kV gird station connected to Jamshoro 500/220/132 kV grid station by a double circuit of 220 kV

The 132 kV network under HESCO has been shown only for the circuits that emanate from Hyderabad, Jamshoro and Kotri to connect to the substations of 132 kV lying South of Hyderabad. There are four existing branches of network of 132 kV that stretch southward and pass close to NBT WPP near Jhimpir, as follows:

- Jamshoro-Old - Nooriabad – KaluKuhar 132 kV single circuit
- Kotri-Jhimpir-Thatta-P.Patho-M.P.Sakro-Gharo 132 kV single circuit (As part of operational measures, the Jhimpir-Kotri section of this line is considered open)
- Hyderabad-T.M.Khan-B.S.Karim-Sujawal-Thatta 132 kV single circuit
- The Jhimpir-Nooriabad 132 kV single circuit on double-circuit-towers (SDT) provides parallel reliability with the other two branches up to Thatta and Nooriabad.
- Furthermore, Hyderabad-TMK.RD and Jamshoro 132 kV substation are being operated on a split bus arrangement
- T.M Khan to HYD-NTPS line is considered open as an operational measure. HYD-NTPS gets its power requirements met by the incoming WPP based power on the 220/132 kV T.M. Khan Road substation which is then further transmitted to HYD-NTPS.

Two of the branches connecting Thatta provide parallel reliability to each other up to Thatta. The need for the 220/132 kV collector substations at Gharo and Jhimpir would arise when some considerable number of wind power plants are constructed in Gharo cluster to provide reliable connection for evacuation of power from these WPPs.

The network as it is planned with wind power plants scheduled prior to commissioning of both phases of the 2 x 250 NBT in 2015 is shown in Sketch-2 in Apendix-4. These WPPs indicated in this sketch are expected to be commercially in operation by September 2015.

3.1.2 Load Forecast

According to the latest load forecast of NTDC, the peak load of September 2015 diversified at system level is 22882 MW and in addition 650 MW export to KESC has been assumed.

3.1.3 Transmission Expansion

Because of sizable additions of generation scheduled in South, the transmission expansion has been planned to reinforce 500 kV and 220 kV network in South. The details of this expansion have been included in Appendix-2.

In addition due to the sizable addition of wind power to the gird till September 2015, the upgradation of existing Nooriabad 132 kV has been proposed to the 220 kV level by looping in out one circuit of the KDA-33 to Jamshoro 220 kV double circuit. The conceptual design of Nooriabad 220/132 kV substation is given as follows:

a. Addition of 220 kV switchyard in the existing Nooriabad 132 kV substation with 220 kV bus bars and other necessary equipment
b. 2 x 160 MVA 220/132 kV transformers and their respective 220 kV and 132 kV breaker bays for their connections on both sides
c. Two breaker bays of 220 kV to provide loop in-out connection to one existing circuit of 220 kV between Jamshoro and KDA-33

3.2 Load Flow Analysis

Load flow analysis has been carried out for the NTDC / HESCO network including the connections provided to new wind power plants. In the Jhimpir Cluster FFC,

Master, ZORLU, Yunus, Gul Ahmed, Metro, Sachal, Sapphire, TGF, Wind Eagle-1, Wind Eagle-2 are connected to Jhimpir-New 220/132 kV collector Substation via three 132 kV double circuits in ring formation with 3-4 WPPs in each ring. UEP and Wikov are connected to the Jhimpir-New 220/132 kV collector substation via a direct 132 kV double circuit. Similarly Dewan and Hawa WPP are also connected to the Jhimpir-New 220/132 kV collector substation via a direct 132 kV double circuit. SUNEC is connected to Nooriabad 132 kV substation via a 132 kV double circuit. FINA, Tapal and Titan WPPs are connected by looping in-out the existing Jhimpir-Thatta 132 kV circuit. In the Gharo cluster and FWEL-I, FWEL-II, Tenaga, Dawood, Zeni and Zephyr are connected via two 132 kV double circuits with 3 WPPs per double circuit to Gharo-New 220/132 kV collector substation. NBT-ZAB connected to the Gharo-New 220/132 kV collector substation via a direct 132 kV double circuit. New Park is connected by looping on-out the Gharo-Thatta 132 kV circuit. The case has been modeled without including NBT WPP to see if the network was adequate for dispersal of wind power without it. The results are shown plotted in Exhibit 3.0 in Appendix-3. The case has been studied for the system conditions of September 2015. The month of September has been selected as benchmark month because it falls within the high wind season and we can best judge the impact of maximum wind power output in September.We kept the dispatch of Jamshoro, HUB and Kotri at maximum so that we can see the maximum generation on the 500kV, 220kV and 132 kV network around NBT WPP prior to commissioning of NBT WPP.

The N-1 contingency check has been applied for the three Southward branches each, and the results are attached in Appendix-3 as below:

Exhibit 3.1	Nooriabad to KDA-33 220 kV Single Circuit Out
Exhibit 3.2	Jamshoro to KDA-33 220 kV Single Circuit Out
Exhibit 3.3	Nooriabad to Jamshoro 220 kV Single Circuit Out
Exhibit 3.4	Jhimpir-New to Nooriabad 220 kV Single Circuit Out
Exhibit 3.5	Gharo-New to Jhimpir-New 220 kV Single Circuit Out
Exhibit 3.6	Jhimpir-New to T.M.Khan Road 220 kV Single Circuit Out
Exhibit 3.7	T.M.Khan Road to Jamshoro 220 kV Single Circuit Out
Exhibit 3.8	T.M.Khan Road to Hala Road 220 kV Single Circuit Out

Exhibit 3.9	Jamshoro to Hala Road 220 kV Single Circuit Out
Exhibit 3.10	Jamshoro to Dadu 500 kV Single Circuit Out
Exhibit 3.11	Dadu to Shikarpur 500 kV Single Circuit Out
Exhibit 3.12	Shikarpur to Guddu 500 kV Single Circuit Out
Exhibit 3.13	Jhimpir-New to T.M.Khan 132 kV Single Circuit Out
Exhibit 3.14	Jhimpir to Jhimpir-New 132 kV Single Circuit Out
Exhibit 3.15.1	Jhimpir-New to Nooriabad 132 kV Single Circuit Out
Exhibit 3.15.2	Jhimpir-New to Nooriabad 132 kV Double Circuit Out
Exhibit 3.16	Nooriabad to Jamshoro-Old 132 kV Single Circuit Out

The load flow results of the network in the close vicinity of NBT-WPP shown plotted in Exhibits 3.1 to 3.16 indicate that all the power flows on the lines are within the rated limits of this network except in the case of Exhibit 3.15.1. In this case the outage of the Jhimpir-New to Nooriabad 132 kV circuit causes the entire load of this circuit to shift to the intact parallel circuit. Due to this the intact Jhimpir-New to Nooriabad circuit becomes overloaded and this causes it to trip due to the action of over current relays. This outage case is covered in Exhibit 3.15.2 and shows that the power flows on the remaining lines are within the rated limits of this network.

The load flow results show that the network existing before NBT is enough to absorb the power of the Jhimpir and Gharo WPPs, and has no limitations in terms of power transfer capacity under normal as well as N-1 contingency, prior to connection of NBT WPP. We will check the adequacy of the NTDC/HESCO network after adding NBT WPP in Chapter 6.

3.3 Short Circuit Analysis

In order to assess the short circuit strength of the network of 220 kV and 132 kV without NBT WPP for the grid of NTDC and Southern HESCO especially in the vicinity of the site of this Wind Farm, fault currents have been calculated for balanced three-phase and unbalanced single-phase short circuit conditions. The fault levels also include the contributions from other Wind Farms such as FFC, ZORLU, Lucky, Sapphire etc in the Jhimpir Cluster and FWEL-I, FWEL-II, New Park and Tenaga etc.

in the Gharo cluster, as mentioned earlier in section 3.2, which are expected to be in operation before NBT WPP as per AEDB'slatest generation schedule.

The results of this analysis will not only give us the idea of the fault levels without NBT WPP but also it will, by comparison, let us know as to how much the contribution of fault current from NBT WPP may add to the existing fault levels.From this analysis we also get a feel of the probable nodes to connect the Wind Farm depending on their relative short circuit strength. The calculations have been made for maximum and minimum short circuit levels considering maximum and minimum generation dispatch conditions of the system in high water and low water seasons.

3.3.1 Maximum Fault Levels

A case for the year 2015 has been developed in which all the hydel and thermal generating plants have been dispatched to cover the highest possible fault current contributions.

PSS/E software provides an option of calculating the fault currents using the IEC 909 criteria, and we have used this option for all the fault calculations for this study. For maximum fault currents we have applied the following assumptions under IEC 909:

- Set tap ratios to unity
- Set line charging to zero
- Set shunts to zero in positive sequence
- Desired voltage magnitude at bus bars set equal to 1.1 P.U. i.e. 10 % higher than nominal, which is the maximum permissible voltage under contingency condition.

The short circuit levels have been plotted in Exhibit 3.17 on the bus bars of500 kV, 220 kV and 132 kV of substations lying in the electrical vicinity of our area of interest.

Both 3-phase and 1-phase fault currents are indicated in the Exhibitwhich are given in polar coordinates i.e. the magnitude and the angle of the current. The total fault currents are shown below the bus bar.

The tabular output of the short circuit calculations is also attached in Appendix-3 for the bus bars of our interest. The tabular output is the detailed output showing the contribution to the fault current from the adjoining sources i.e. the lines and

transformers connected to that bus. The phase currents, the sequence currents and the sequence impedances are shown in detail for each faulted bus bar.

The total maximum fault currents for 3-phase and 1-phase short circuit at these substations are summarized in Table 3.1.We see that the maximum fault currents do not exceed the short circuit ratings of the equipment at these 132 kV substations which normally are 25 kA or 31.5 kA for older substations and 40 kA for new substations.

Table-3.1
Maximum Short Circuit Levels Without NBT WPP

Substation	3-Phase fault current, kA	1-Phase fault current, kA
Nooriabad 132 kV	22.65	22.32
Jhimpir-New 132kV	27.72	29.84
Kotri GTPS 132 kV	11.93	10.43
Jamshoro-Old 132 kV	12.81	12.03
Lakhra 132kV	7.99	6.23
Jamshoro-New 132kV	12.56	12.30
Jamshoro-New-2 132 kV	15.46	14.32
T.M.Khan 132 kV	9.61	6.79
Jhimpir 132 kV	18.78	16.54
Gharo-New 132 kV	13.24	15.76
Gharo-New 220kV	10.77	10.86
Jhimpir-New 220kV	22.08	21.65
T.M.Khan Road 220 kV	28.61	18.83
KDA-33 220kV	31.00	31.16
Nooriabad 220 kV	20.99	17.63
Jamshoro 220kV	37.35	31.41
NKI 500 kV	15.22	14.73
Jamshoro 500kV	17.92	13.78
Dadu 500kV	14.27	9.50
Shikarpur 500kV	18.02	12.73

3.3.2 Minimum Fault Levels

For minimum fault levels minimum generation dispatches are assumed which in practice may correspond to minimum load conditions. We normally have minimum thermal power dispatch during High Water season and it gets further minimum during off-peak hours. Especially in Southern Sind, the thermal generation would be at its minimum during minimum load conditions of high water season. Therefore we have calculated the minimum short circuit levels under High Wateroff-peak conditions. Also the dispatch of WTGs from other wind farms of FFC, ZORLU, Lucky, Sapphire etc in the Jhimpir Cluster and FWEL-I, FWEL-II, New Park and Tenaga etc in the Gharo cluster, as mentioned earlier in section 3.2, is also assumed as minimum to have the minimum fault contributions from these Farms. The results are shown in Appendix-3.

For minimum fault currents we have applied the following assumptions under IEC 909:

- Set tap ratios to unity
- Set line charging to zero
- Set shunts to zero in positive sequence
- Desired voltage magnitude at bus bars set equal to 0.9 P.U. i.e. 10 % lower than nominal, which is the minimum permissible voltage under contingency condition.

The plottedresults of the minimum fault currents are attached in Exhibit 3.18 the same way as before focusing on the substations in the electrical vicinity of NBT WPP. The tabular output of minimum fault currents shown in Appendix-3 is the detailed output showing the contribution to the fault current from the adjoining sources i.e. the lines and transformers connected to that bus. The phase currents, the sequence currents and the sequence impedances are shown in detail for each faulted bus bar.

The minimum fault currents for 3-phase and 1-phase short circuit at these substations are summarized in Table 3.2.

Table-3.2

Minimum Short Circuit Levels without NBT-WPP

Substation	3-Phase fault current, kA	1-Phase fault current, kA
Nooriabad 132 kV	13.83	13.32
Jhimpir-New 132kV	16.74	17.80
Matri GTPS 132 kV	9.42	8.38
Jamshoro-Old 132 kV	10.09	9.56
Lakhra 132kV	6.73	5.35
Jamshoro-New 132kV	9.96	9.76
Jamshoro-New-2 132 kV	12.30	11.35
T.M.Khan 132 kV	7.78	5.76
Jhimpir 132 kV	12.79	11.67
Gharo-New 132 kV	9.04	10.20
Gharo-New 220kV	7.64	7.49
Jhimpir-New 220kV	13.45	12.97
T.M.Khan Road 220 kV	16.73	12.56
KDA-33 220kV	16.91	17.31
Nooriabad 220 kV	13.24	11.48
Jamshoro 220kV	19.60	16.95
NKI 500 kV	8.18	7.95
Jamshoro 500kV	10.02	8.48
Dadu 500kV	9.41	7.02
Shikarpur 500kV	11.29	8.76

3.3.3 Comparison of fault levels

Comparing the short circuit strengths, both in terms of maximum and minimum, of the substations of 220 kV in the vicinity of NBT WPP *viz.* KDA-33 Nooriabad, Jamshoro and substations of 132 kV in the vicinity of NBT WPP *viz.* Nooriabad we find that the 220 kV substations of KDA-33 and Jamshoro are strong point with relatively higher short circuit levels because of the presence of a strong source at Jamshoro. In fact, the 132 kV substation of Nooriabad draws strength from its direct

connection with Jamshoro-old which has a direct connection with the very strong source of Jamshoro. Jamshoro 500/220/132 kV substation and the KDA-33 to Jamshoro 220 kV double circuit are in the vicinity of the planned site of NBT-WPP. This comparison provides an indicator that scheme of interconnection of NBT WPP should can be made with the strong nodes of 220 kV Jamshoro.

4. Development of Interconnection Scheme

4.1 Proposed Interconnection Scheme

We have evolved the connection scheme for interconnection of 2 x 250 MW NBT WPP for the scenario of 2015 follows:

- Development of collector substation of 220/33kV for NBT WPP for interface with NTDC Grid after internally collecting the output of NBT-WPP
- Connect collector substation of 220/33 kV NBT WPP by looping in-out of the existing KDA-33 to Jamshoro 220 kV circuits at NBT-WPP. The looping distance is about 10 km.

The scheme is indicated in Sketch-3 Appendix-2

5. Modeling of NBT Wind Farm

5.1 Electrical Layout of Wind Farm

5.1.1 Initial Selections

NBT has to provide details of the WTG selection made by them. Assuming that they select a 1.5 MW WTG, this would require about three hundred and thirty three WTGs in order to output 500 MW to the Grid.

5.2 Wind Farm Substation 220/33 kV

A 220/33 kV substation would be built in the Farm to collect all the power from the WTG collector groups at 33 kV level, spread out in the Farm, and then to step-up this power to 220 kV so that the Farm's output may be evacuated to the main grid of NTDC. The single line diagram of the substation, as a conceptual design, is briefly shown in SLD-1 in Appendix-3.

The scheme shown in SLD-1 is described as follows.

5.2.1 Conceptual Design of 220 kV

The single line diagram SLD–1 in Appendix-3 shows the conceptual design of 220kV switchgear of the Farm substation. It comprises of:

- Two single bus-sections of 220 kV with a bus sectionalizer
- Five breaker bays to connect five 100 MVA 220/33 kV transformers
- Two breaker bays to connect outgoing lines of 220 kV to Jamshoro and KDA- 33

Rating of all the breakers and bus bar equipment would be

Short circuit rating	= 50 kA (3 sec.)
Continuous rating	= 3150 A

5.2.2 Conceptual Design of 33 kV

The single line diagram SLD–1 in Appendix-3 further shows the conceptual design of 33 kV switchgear of the Farm substation. It comprises of:

The single line diagram SLD–1 in Appendix-5 shows the conceptual design of 33kV (MV) bus bar of the Farm substation. It comprises of

- Two single bus-sections of 33 kV with a bus sectionalizer
- Twenty breaker bays to connect twenty collector circuits from WTGs
- Five breaker bays to connect five transformers of 132/33 kV
- Breaker bays for connecting two auxiliary transformers of 33/0.4 kV
- Two breaker bays to connect switched shunt capacitor banks

Rating of all the breakers and bus bar equipment would be

Short circuit rating = 50 kA (3 sec.)

Continuous rating = 9000 A

5.2.3 Protection and Telecommunication Scheme

The protection scheme would be designed in compliance of NTDC requirements intimated by Chief Engineer Protection, vide letter No.3416-19/CE/SP/MN/50MW NBT WPP Jhimpir dated 23/07/2010 (attached in Appendix-5)

The telecommunication scheme would be designed in compliance of NTDC requirements intimated by Chief Engineer Telecommunication, vide letter No. CE(Tel)/NTDC/232/4372 dated 27/08/2010 (attached in Appendix-5).

6. Load Flow Analysis – Base Year 2015

Load flow analysis has been carried out for the proposed scheme of interconnection of NBT WPP with NTDC / HESCO grid for the base case of September 2015 as per Sketch-2 in Appendix-4.

6.1 Modeling of Wind Farm in the load flow

Representation of all the individual machines in a large Wind Farm is inappropriate in most grid impact studies [1]. There is a provision in the model structure of PSS/E to allow single equivalent WTG machine model to represent multiple WTGs. However there are limitations. Disturbances within the local collector grid cannot be analyzed, and there is some potentially significant variation in the equivalent impedance for the connection to each machine. A single machine equivalent requires the approximation that the power output of all the machines will be the same at a given instant of time. For grid system impact studies, simulations are typically performed with the initial wind of sufficient speed to produce the rated output on all the machines. Under this condition, the assumption that all the machines are initially at the same (rated) output is not an approximation [2]. Otherwise this assumption presumes that the geographic dispersion is small enough that the wind over the farm is uniform. Since the detail of the collector subsystem inside NBT Wind Farm has not yet been finalized, we have modeled NBT Wind Farm using four equivalent WTGs, two for the 250 MW first Phase of the Project and two for the 250 MW second phase of NBT WPP. From the perspective of the Grid Interconnection Study this has no impact on steady state simulations. For Dynamic simulation we will test the model with three phase fault directly on the bus bar on which the equivalent WTGS for 2x250 MW NBT WPP have been modeled to test the severest conditions. Any disturbance in the collector subsystem will have a much lower impact on the gird than the severity of the faults aforementioned. Thus we can test the worst case scenario with our proposed modeling. Hence, the modeling of NBT Wind Farm using four equivalent WTGs is justified.

6.2 Reactive Power Requirements

The power factor of the Type-3 WTG is around 0.95 lagging (capacitive/generating) and 0.95 leading (inductive/absorbing). Part of this reactive power will be consumed by the generator step-up (GSU) transformer and the rest may be consumed in the MV lines of the wind farm. However some reactive power might reach the MV bus bars of Farm substation. That means each WTG is self sufficient to meet VAR absorption requirement of its step-up transformer with some contribution of VARs to the Farm MV network.

The Grid Code Addendum No.1 requires to meet the criteria of ± 0.95 power factor at the point of interconnection with the NTDC grid at 220 kV or 132 kV (point of common coupling). Therefore a Farm of 500 MW generating capacity is required to pump 164.34 MVAR to the grid at full output of 500 MW. The VAR generating capability of WTG at 0.95 PF will not be able to fully meet this VAR demand of the system because of VAR loss in step-up transformers, collector cables and the HV/MV transformers at the Farm substation. In order to meet the Grid Code criteria, we need to install switched shunt capacitor bank at 33 kV bus of the Farm substation of sufficient size capable of delivering 164.34 MVAR at 220 kV or 132 kV bus after VAR loss across the step up transformers. However system may use this VAR source depending on actual VAR demand of system under different operating conditions of the system.

6.3 Load Flow Analysis for Peak Load Case of September

Load flow analysis has been carried out for the interconnection scheme proposed for the NTDC / HESCO network to see the steady state impact of adding the generation of NBT WPP on the network including the connections provided to other wind power plants already scheduled having been connected. In the Jhimpir Cluster FFC, Master, ZORLU, Yunus, Gul Ahmed, Metro, Sachal, Sapphire, TGF, Wind Eagle-1, Wind Eagle-2 are connected to Jhimpir-New 220/132 kV collector Substation via three 132 kV double circuits in ring formation with 3-4 WPPs in each ring. UEP and Wikov are connected to the Jhimpir-New 220/132 kV collector substation via a direct 132 kV double circuit. Similarly Dewan and Hawa WPP are also connected to the Jhimpir-New 220/132 kV collector substation via a direct 132 kV double circuit. SUNEC is

connected to Nooriabad 132 kV substation via a 132 kV double circuit. FINA, Tapal and Titan WPPs are connected by looping in-out the existing Jhimpir-Thatta 132 kV circuit. In the Gharo cluster and FWEL-I, FWEL-II, Tenaga, Dawood, Zeni and Zephyr are connected via two 132 kV double circuits with 3 WPPs per double circuit to Gharo-New 220/132 kV collector substation. NBT-ZAB connected to the Gharo-New 220/132 kV collector substation via a direct 132 kV double circuit. New Park is connected by looping on-out the Gharo-Thatta 132 kV circuit.

As the expected COD provided by NBT the COD of the 250 MW first phase is 31st December 2014 whereas the COD of the second 250 MW phase will be 30th June 2015, the upcoming high wind and period can be studied in September 2015 therefore the integrated case has been studied for the system conditions of this month. We kept the dispatch of Kotri, Jamshoro and HUBCO at their maximum, therefore we can see the maximum impact of the generation of 2x250 MW NBT WPP on the 500 kV, 220 kV and 132 kV network relevant to NBT-WPP.

The network configuration is same as discussed in Chapter-3 i.e. a collector substation of 220/132kV in Gharo and Jhimpir clusters connected to T.M. K. Road through 220kV D/C starting from Gharo-New 220 kV and looped in-out at Jhimpir-New.

The proposed Interconnection Scheme has been modeled as follows:

- Development of collector substation of 220/33kV for NBT WPP for interface with NTDC Grid after internally collecting the output of NBT-WPP
- Connect collector substation of 220/33 kV NBT WPP by looping in-out of the existing KDA-33 to Jamshoro 220 kV circuits at NBT-WPP. The looping distance is about 10 km.

Load flow simulations have been run for normal and contingency conditions. The results are shown plotted in Appendix-6.

6.3.1 Normal Case

Exhibit 6.0 shows the normal case with Alternative-I under the system conditions of September 2015. All the wind farms in Jhimpir and Gharo clusters with installed capacity of 50 MW or 49.5 MW has been assumed dispatching nearly 45 MW at point of delivery (132kV) to the grid after deducting Farm losses and given some diversity in the maximum output of all the Wind Power Plants at one time. For NBT we only

deduct the Farm loss and assume to deliver 468.5 MW at the point of delivery to grid at 220 kV.

We find that of the 468.5 MW power of NBT WPP 148.9 MW flow towards KDA-33 and most of this power is used to meet the load demand at KDA-33. About 319.7 MW flow from NBT WPP to Jamshoro. Some of this power is transmitted to Hala Road, but the rest combined with the output of Jamshoro as well as some power from the Gharo and Jhimpir WPP clusters received at Jamshoro via the T.M. Khan Road to Jamshoro 220 kV circuit, is transmitted to the 500 kV network via the 500/220 kV transformers at Jamshoro Substation. On the 500 kV network, this power, along with the output of HUB Power plant is transmitted on the Jamshoro-Dadu-Shikarpur-Guddu 500 kV double circuit. All these loadings are within the rated limits of these circuits. The bus voltages on all the substations in Southern HESCO grid are within the normal limits of operation.

The switched shunt capacitor banks are supplying 60.5 MVAR. Although the switched shunt capacitor bank is capable of meeting the 0.95 power factor criteria at the point of interconnection, the actual reactive power supplied will be as per the demand of the network. As voltage profile on all the bus bars of 132 kV of HESCO grid are well within the normal operating criteria of ± 5 % off the nominal, we can see that additional reactive power is not required by the network in these conditions.

6.3.2 Contingency cases and evolving of reliable scheme

The N-1 contingency cases have been run and the results have been shown plotted as under:

Exhibit 6.1	NBT 220/33 kV Single Transformer Out
Exhibit 6.2	NBT to KDA-33 220 kV Single Circuit Out
Exhibit 6.3	NBT-220 to Jamshoro 220 kV Single Circuit Out
Exhibit 6.4	KDA-33 to Nooriabad 220 kV Single Circuit Out
Exhibit 6.5	Nooriabad to Jamshoro 220 kV Single Circuit Out
Exhibit 6.6	Jhimpir-New to Nooriabad 220 kV Single Circuit Out
Exhibit 6.7	Gharo-New to Jhimpir-New 220 kV Single Circuit Out
Exhibit 6.8	Jhimpir-New to T.M.Khan Road 220 kV Single Circuit Out
Exhibit 6.9	Jamshoro to T.M.Khan Road 220 kV Single Circuit Out
Exhibit 6.10	T.M.Khan Road to Hala Road 220 kV Single Circuit Out

Exhibit 6.11	Jamshoro to Hala Road 220 kV Single Circuit Out
Exhibit 6.12	Jamshoro to Dadu 500 kV Single Circuit Out
Exhibit 6.13	Dadu to Shikarpur 500 kV Single Circuit Out
Exhibit 6.14	Shikarpur to Guddu 500 kV Single Circuit Out
Exhibit 6.15	Jhimpir-New to T.M.Khan 132 kV Single Circuit Out
Exhibit 6.16	Jhimpir to Jhimpir-New 132 kV Single Circuit Out
Exhibit 6.17.1	Jhimpir-New to Nooriabad 132 kV Single Circuit Out
Exhibit 6.17.2	Jhimpir-New to Nooriabad 132 kV Double Circuit Out
Exhibit 6.18	Nooriabad to Jamshoro-Old 132 kV Single Circuit Out

The results show that power flows on intact 500 kV, 220 kV and 132 kV circuits remain within their rated limits except in Exhibit 6.17.1. In this case the outage of the Jhimpir-New to Nooriabad 132 kV circuit causes the entire load of this circuit to shift to the intact parallel circuit. Due to this the intact Jhimpir-New to Nooriabad circuit becomes overloaded and this causes it to trip due to the action of over current relays. This outage case is covered in Exhibit 6.17.2 and shows that the power flows on the remaining lines are within the rated limits of this network

The results show that under all events of outages, the voltages on the bus bars remain within normal operating limits. The switched shunt capacitor banks regulate the voltage under all events. The reactive power being supplied by the switched shunt capacitor banks maintains the supply of VARS to the grid under all contingencies adjusting its output according to the system requirement.

6.4 Conclusion of Load Flow results

The load flow results of both the proposed interconnection scheme of NBT WPP shows no bottlenecks or capacity constraints in the adjoining 220 kV or 132 kV network in terms of absorbing all the output of NBT under normal as well as the contingency conditions.

However considering that in the near future additional Wind Farms may be developed in the vicinity, the extension or augmentation of the 500/220 kV substation of Jamshoro may be considered. Whether extension is possible will ultimately depend on the availability of space in the substation.

References:

1- WECC Wind Generator Modeling Group; *Generic Type-3 Wind Turbine-Generator Model for Grid Studies;Version 1.1*, September 14, 2006, p. 2.2

2- *Ibid.* p.3.1

7. Short Circuit Analysis- Base Year 2015

7.1 Methodology and Assumptions

The methodology of IEC 909 has been applied in all short circuit analyses in this report for which provision is available in the PSS/E software used for these studies. For calculations of maximum fault levels the bus voltage has been assumed as 1.10 PU i.e. 10 % above the nominal as per IEC909. For calculations of minimum fault levels the bus voltage has been assumed as 0.9 PU i.e. 10 % below the nominal. That covers the entire ± 10 % range of the ratings of the equipments.

7.1.1 Assumptions for maximum and minimum short circuit levels

7.1.1.1 Assumptions-Maximum short circuit levels

For evaluation of maximum short circuit levels we have assumed contribution in the fault currents from all the installed generation capacity of hydel, thermal and nuclear plants in the system in the year 2015.

The maximum fault currents have been calculated with the following assumptions under IEC909:

- Set tap ratios to unity
- Set line charging to zero
- Set shunts to zero in positive sequence

Desired voltage magnitude at bus bars set equal to 1.10 P.U. i.e. 10 % higher than nominal, which is the maximum permissible voltage under contingency condition

However tabular results of some significant bus bars in the electrical vicinity of NBT WPP have also been produced and placed in Appendix-7.

7.1.1.2 Assumptions-Minimum short circuit levels

The minimum fault currents are important for the evaluation of power quality issues such as flicker, unbalance, sudden voltage dip and harmonics.

For minimum short circuit levels we have considered the off – peak hydro conditions of the year 2015. For these conditions the generation dispatch on Southern Grid would be at the minimum. During summer months of August and September, the water reservoirs reach to their maximum level and the dispatch from hydel power plants is maximum. During high water season, the thermal units in Southern grid are made to

run on merit order of economic dispatch, which are usually at their minimum dispatch, especially during off-peak load conditions of this season. Therefore we have considered high-water off- peak conditions of 2015 to simulate the minimum short circuit strength of southern grid. For NBT WPP we have assumed dispatch of 25 % of its capacity for the minimum short circuit.

For minimum fault currents we have applied the following assumptions under IEC 909:

- Set tap ratios to unity
- Set line charging to zero
- Set shunts to zero in positive sequence

Desired voltage magnitude at bus bars set equal to 0.9 P.U. i.e. 10 % lower than nominal, which is the minimum permissible voltage under contingency condition.

7.2 Fault Currents Calculations

In this scenario, we have modeled NBT-WPP with the proposed interconnection scheme as follows:

- Development of collector substation of 220/33kV for NBT WPP for interface with NTDC Grid after internally collecting the output of NBT-WPP
- Connect collector substation of 220/33 kV NBT WPP by looping in-out of the existing KDA-33 to Jamshoro 220 kV circuits at NBT-WPP. The looping distance is about 10 km.

7.2.1 Maximum short circuit levels

The short circuit levels have been calculated and plotted on the bus bars of substations of 500 kV, 220 kV and 132 kV lying in the electrical vicinity of our area of interest and are shown plotted in the Exhibit 7.0 attached in Appendix-7. Both 3-phase and 1-phase fault currents are indicated in the Exhibit which are given in polar coordinates i.e. the magnitude and the angle of the current. The total fault currents are shown below the bus bar.

The tabular output of the short circuit calculations is also attached in Appendix-7 for certain significant bus bars. The tabular output is the detailed output showing the contribution to the fault current from the adjoining sources i.e. the lines and

transformers connected to that bus. The phase currents, the sequence currents and the sequence impedances are shown in detail for each faulted bus bar.

The total maximum fault currents for 3-phase and 1-phase short circuit at these substations are summarized in Table 7.1. We see that the maximum fault currents do not exceed the short circuit ratings of the equipment at these 132 kV substations which normally are 25 kA or 31.5 kA for older substations and 40 kA for new substations.

Table 7.1
Maximum Short Circuit Levels with NBT-WPP

Substation	3-Phase fault current, kA	1-Phase fault current, kA
NBT-WPP 33 kV	43.02	38.18
NBT-220 220kV	12.51	9.67
Jhimpir-New 132kV	27.83	29.95
UEP 132kV	16.84	18.53
T.M. Khan 132 kV	9.63	6.80
Nooriabad 132 kV	22.72	22.37
Kotri GTPS 132 kV	11.97	10.48
Jamshoro-Old 132 kV	12.86	12.09
Lakhra 132kV	8.01	6.25
Jamshoro New 132kV	12.61	12.36
Qasimabad 132kV	12.19	9.40
Jhimpir 132kV	18.84	16.51
Gharo New 132kV	13.27	15.79
Hala Road 220kV	28.81	20.54
Jamshoro 220kV	37.92	32.08
Nooriabad 220 kV	21.15	17.73
Jhimpir-New 220kV	22.24	21.77
Gharo-New 220kV	10.80	10.89
KDA-33 220kV	31.21	31.42
NKI 500kV	15.34	14.83
Jamshoro 500kV	18.11	13.93

Dadu 500kV	**14.33**	**9.53**
Shikarpur 500kV	**18.05**	**12.75**

7.2.2 Minimum short circuit levels

The minimum fault levels have been calculated for minimum dispatch of power in the grid system. The plotted results of short circuit analysis are attached as Exhibit 7.1. Both 3-phase and 1-phase fault currents are indicated in the Exhibit which are given in polar coordinates i.e. the magnitude and the angle of the current. The total fault currents are shown below the faulted bus bar.

The tabular output of the short circuit calculations is also attached in Appendix-7 for certain significant bus bars. The tabular output is the detailed output showing the contribution to the fault current from the adjoining sources i.e. the lines and transformers connected to that bus. The phase currents, the sequence currents and the sequence impedances are shown in detail for each faulted bus bar.

The total minimum fault currents for 3-phase and 1-phase short circuit at these substations are summarized in Table 7.2.

Table 7.2
Minimum Short Circuit Levels with NBT-WPP

Substation	3-Phase fault current, kA	1-Phase fault current, kA
NBT-WPP 33kV	**29.04**	**33.53**
NBT-220 220kV	**8.91**	**5.57**
Jhimpir-New 132kV	**16.81**	**17.85**
UEP 132kV	**11.64**	**11.68**
T.M. Khan 132 kV	**7.79**	**5.77**
Nooriabad 132 kV	**13.88**	**13.35**
Kotri GTPS 132 kV	**9.45**	**8.40**
Jamshoro-Old 132 kV	**10.12**	**9.58**
Lakhra 132kV	**6.74**	**5.35**
Jamshoro New 132kV	**9.99**	**9.77**
Qasimabad 132kV	**10.05**	**7.90**

Jhimpir 132kV	**12.83**	**11.69**
Gharo New 132kV	**9.06**	**10.22**
Hala Road 220kV	**16.85**	**13.08**
Jamshoro 220kV	**19.78**	**17.02**
Nooriabad 220 kV	**13.33**	**11.52**
Jhimpir-New 220kV	**13.54**	**13.02**
Gharo-New 220kV	**7.66**	**7.51**
KDA-33 220kV	**16.97**	**17.34**
NKI 500kV	**8.25**	**8.00**
Jamshoro 500kV	**10.12**	**8.51**
Dadu 500kV	**9.46**	**7.03**
Shikarpur 500kV	**11.32**	**8.77**

7.3 Conclusions of Short Circuit Analysis

In order to see how much the NBT WPP has contributed to increase the fault levels of the substations in its electrical vicinity, we compare the maximum fault levels with the fault levels of the same bus bars in Table 3.1 (Chapter-3) evaluated without NBT WPP but inclusive of other Wind Farms such as FFC, Zorlu, Lucky, Sapphire etc in the Jhimpir cluster and FWEL-I, FWEL-II, Dawood, Tenaga and New Park etc in the Gharo cluster. We find that the fault levels substations near NBT-WPP have increased a bit, but on farther substations, the increase is insignificant. As a whole the fault levels at all the 220 kV and 132 kV bus bars are well below the short circuit rating of the equipment at these substations.

The fault levels indicate that there are no constraints in terms of short circuit ratings of the equipment of the adjoining substations and there is improvement in minimum fault levels. The proposed interconnection scheme holds good on the basis of short circuit analysis as well.

8. Transient Stability Analysis - Base Year 2015

The objective of transient stability study is to see:

1. Dynamic impact of NBT Wind Power Plant on the System
2. Dynamic impact of the System on NBT Wind Power Plant

We have modeled the Interconnection Scheme in the stability analysis which comprises connecting collector substation of 220/33 kV NBT WPP by looping in-out of the existing KDA-33 to Jamshoro 220 kV circuits at NBT-WPP. The looping distance is about 10 km. Transient Stability Analysis of the interconnection scheme has been done with Type-3 WTG.

8.1 Assumptions & Methodology

8.1.1 Type-3 Generic WTG Dynamic Model

NBT has decided that a Double Fed Induction Generator (DFIG) Type-3 Wind Turbine Generator would be installed in NBT WPP. We have used the generic Type-3 wind turbine-generator model, which has been developed for grid studies by WECC Wind Generator Modeling Group and has been made available by Siemens –PTI to their users of PSS/E software. Type-3 is classified for Doubly Fed Induction/Asynchronous Generators (DFIG or DFAG). The details and minute control parameters have been based on assumptions in the controllers of generic model of Siemens-PTI software PSS/E.

8.2 Dynamic Impact of Disturbances at 220 kV Level

8.2.1 Three Phase Fault, Normal Clearing Time of 5 Cycles & Trip of Circuits – Outage of NBT to KDA-33 220 kV circuit

The system disturbances have been simulated for this model as follows;

Three- phase fault applied at NBT220 kV Farm Substation, cleared in 5 cycles as normal clearing time i.e. 100 m seconds, followed by trip of 220 kV single circuitbetween NBT-WPP and KDA-33, which was significantly loaded in the pre-fault normal load flow case and its outage may cause severe impact.

Fig 8.1.1 indicates the bus voltages in pre and post fault conditions at 220 kV substations in the vicinity of NBT-WPP. We find that the voltages recover smoothly and quickly to their pre-disturbance values.

The system frequency indicated in Fig. 8.1.2 shows very nominal excursions of frequency that damps down very quickly and smoothly

The MW and MVAR output of equivalent WTG (NBT-1) get back to normal quickly after the fault clearance as shown in Fig 8.1.3.

The dynamic response of generator is shown in Figs 8.1.4 showing the recovery of speed and mechanical power.

Fig 8.1.5 shows that the aerodynamic torque that dips down after fault is recovered by pitch angle control which responds quickly and restores the aerodynamic torque to normal with good damping of oscillations after fault clearance.

Fig. 8.1.6 shows no impact on shaft twist angle and quick damping of transients in aerodynamic power (Paero) on the rotor blade side.

Fig. 8.1.7 indicates no impact on turbine rotor speed and quick recovery of generator speed.

Fig 8.1.8 shows the generator rotor angle deviation that shifts from its pre-fault value to a new value very smoothly.

Fig. 8.1.9 shows the dynamic response of pitch control and pitch compensation that acts quickly to stabilize the WTG. Pitch Compensation gets back to its steady state level while Pitch Control acquires a new steady state level.

The outage of 220 kV circuit between NBT 220 kV substation to KDA-33 causes the entire output of NBT WPP to shift to the intact 220 kV circuit between NBTand Jamshoro. Fig. 8.1.10 shows the transients on MW and MVAR flow on this circuit which settles the transients quickly and acquires a new steady state level soon.

The response of the adjoining power plant of Jamshoro is shown in Fig 8.1.11, where the MW outputs of the generators recover to almost their pre-fault output levels.

The dynamic response of Jamshoro generator is shown in Figs 8.1.12 showing the recovery of speed and mechanical power.

The angular stability of other conventional generators of the system can be seen in Fig. 8.1.13. The relative rotor angles of HUBCO, Muzaffargarh, Kotri, Jamshoro, Guddu-New and Nooriabad are plotted w.r.t. Guddu-New. The results show that they

remain in synchronism with the system generators and stay stable. The angular swings are also nominal and damp quickly.

8.2.2 Three Phase Faults, Clearing Time of 9 Cycles (Stuck Breaker): LVRT Test - Outage of NBT to KDA-33 220 kV circuit

The worst-case fault on system may be the failure of breaker (stuck-breaker) and fault clearing with backup protection in 9 cycles. It may also be termed as testing the ride through capability (LVRT) of Wind Power Plant for clearing time of 9 cycles i.e. 180 mswhich is a criterion set out in the Grid Code to be fulfilled.

Three-phase fault has been applied on NBT 220 kV Farm-substation, fault cleared in 9 cycles (180ms) followed by trip of 220 kV single circuit between NBT-WPP and KDA-33. The same set of variables has been monitored as of the previous normal clearing case and plotted results discussed as follows.

The system disturbances have been simulated for this model as follows;

Fig 8.2.1 indicates the bus voltages in pre and post fault conditions at 220 kV substations in the vicinity of NBT-WPP. We find that the voltages recover smoothly and quickly to their pre-disturbance values.

The system frequency indicated in Fig. 8.2.2 shows very nominal excursions of frequency that damps down very quickly and smoothly

The MW and MVAR output of equivalent WTG (NBT-1) get back to normal quickly after the fault clearance as shown in Fig 8.2.3.

The dynamic response of generator is shown in Figs 8.2.4 showing the recovery of speed and mechanical power.

Fig 8.2.5 shows that the aerodynamic torque that dips down after fault is recovered by pitch angle control which responds quickly and restores the aerodynamic torque to normal with good damping of oscillations after fault clearance.

Fig. 8.2.6 shows no impact on shaft twist angle and quick damping of transients in aerodynamic power (Paero) on the rotor blade side.

Fig. 8.2.7 indicates no impact on turbine rotor speed and quick recovery of generator speed.

Fig 8.2.8 shows the generator rotor angle deviation that shifts from its pre-fault value to a new value very smoothly.

Fig. 8.2.9 shows the dynamic response of pitch control and pitch compensation that acts quickly to stabilize the WTG. Pitch Compensation gets back to its steady state level while Pitch Control acquires a new steady state level.

The outage of 220 kV circuit between NBT 220 kV substation to KDA-33 causes the entire output of NBT WPP to shift to the intact 220 kV circuit between NBT and Jamshoro. Fig. 8.2.10 shows the transients on MW and MVAR flow on this circuit which settles the transients quickly and acquires a new steady state level soon.

The response of the adjoining power plant of Jamshoro is shown in Fig 8.2.11, where the MW outputs of the generators recover to almost their pre-fault output levels.

The dynamic response of Jamshoro generator is shown in Figs 8.2.12 showing the recovery of speed and mechanical power.

The angular stability of other conventional generators of the system can be seen in Fig. 8.2.13. The relative rotor angles of HUBCO, Muzaffargarh, Kotri, Jamshoro, Guddu-New and Nooriabad are plotted w.r.t. Guddu-New. The results show that they remain in synchronism with the system generators and stay stable. The angular swings are also nominal and damp quickly.

8.2.3 Three Phase Fault, Normal Clearing Time of 5 Cycles & Trip of Circuits – Outage of NBT to Jamshoro 220 kV circuit

The system disturbances have been simulated for this model as follows;

Three- phase fault applied at NBT 220 kV Farm Substation, cleared in 5 cycles as normal clearing time i.e. 100 m seconds, followed by trip of 220 kV single circuit between NBT-WPP and Jamshoro, which was significantly loaded in the pre-fault normal load flow case and its outage may cause severe impact.

Fig 8.3.1 indicates the bus voltages in pre and post fault conditions at 220 kV substations in the vicinity of NBT-WPP. We find that the voltages recover smoothly and quickly to their pre-disturbance values.

The system frequency indicated in Fig. 8.3.2 shows very nominal excursions of frequency that damps down very quickly and smoothly

The MW and MVAR output of equivalent WTG (NBT-1) get back to normal quickly after the fault clearance as shown in Fig 8.3.3.

The dynamic response of generator is shown in Figs 8.3.4 showing the recovery of speed and mechanical power.

Fig 8.3.5 shows that the aerodynamic torque that dips down after fault is recovered by pitch angle control which responds quickly and restores the aerodynamic torque to nominal with good damping of oscillations after fault clearance.

Fig. 8.3.6 shows no impact on shaft twist angle and quick damping of transients in aerodynamic power (Paero) on the rotor blade side.

Fig. 8.3.7 indicates no impact on turbine rotor speed and quick recovery of generator speed.

Fig 8.3.8 shows the generator rotor angle deviation that shifts from its pre-fault value to a new value very smoothly.

Fig. 8.3.9 shows the dynamic response of pitch control and pitch compensation that acts quickly to stabilize the WTG. Pitch Compensation gets back to its steady state level while Pitch Control acquires a new steady state level.

The outage of 220 kV circuit between NBT 220 kV substation to Jamshoro causes the entire output of NBT WPP to shift to the intact 220 kV circuit between NBT and KDA-33. Fig. 8.3.10 shows the transients on MW and MVAR flow on this circuit which settles the transients quickly and acquires a new steady state level soon.

The response of the adjoining power plant of Jamshoro is shown in Fig 8.3.11, where the MW outputs of the generators recover to almost their pre-fault output levels.

The dynamic response of Jamshoro generator is shown in Figs 8.3.12 showing the recovery of speed and mechanical power.

The angular stability of other conventional generators of the system can be seen in Fig. 8.3.13. The relative rotor angles of HUBCO, Muzaffargarh, Kotri, Jamshoro, Guddu-New and Nooriabad are plotted w.r.t. Guddu-New. The results show that they remain in synchronism with the system generators and stay stable. The angular swings are also nominal and damp quickly.

8.3 Dynamic Impact of Disturbances at 33 kV Level

8.3.1 Three Phase Fault, Normal Clearing Time of 10 Cycles & Trip of Circuits – Outage of NBT 220/33 kV Single Transformer

The system disturbances have been simulated for this model as follows;

Three- phase fault applied at NBT 33 kV Farm Substation, cleared in 10 cycles as normal clearing time i.e. 200 m seconds, followed by trip of one 220/33 kV 100 MVA Transformer at NBT Farm Substation.

Fig 8.4.1 indicates the bus voltages in pre and post fault conditions at the 33 kV and 220 kV bus bars of NBT-WPP and 220 kV substations in the vicinity of NBT-WPP. We find that the voltages recover smoothly and quickly to their pre-disturbance values.

The system frequency indicated in Fig 8.4.2 shows very nominal excursions of frequency that damps down very quickly and smoothly

The MW and MVAR output of equivalent WTG (NBT-1) get back to normal quickly after the fault clearance as shown in Fig 8.4.3.

The dynamic response of generator is shown in Figs 8.4.4 showing the recovery of speed and mechanical power.

Fig 8.4.5 shows that the aerodynamic torque that dips down after fault is recovered by pitch angle control which responds quickly and restores the aerodynamic torque to normal with good damping of oscillations after fault clearance.

Fig. 8.4.6 shows no impact on shaft twist angle and quick damping of transients in aerodynamic power (Paero) on the rotor blade side.

Fig. 8.4.7 indicates no impact on turbine rotor speed and quick recovery of generator speed.

Fig 8.4.8 shows the generator rotor angle deviation that shifts from its pre-fault value to a new value very smoothly.

Fig. 8.4.9 shows the dynamic response of pitch control and pitch compensation that acts quickly to stabilize the WTG. Pitch Compensation gets back to its steady state level while Pitch Control acquires a new steady state level.

The outage a 220/33 kV transformer at NBT Farm substation causes significant loading on the intact 220/33 kV Transformers of NBT WPP. Fig. 8.4.10 shows the transients on MW and MVAR flow on an intact 220/33 kV Transformer which settles the transients quickly and acquires a new steady state level soon.

The response of the adjoining power plant of Jamshoro is shown in Fig 8.4.11, where the MW outputs of the generators recover to almost their pre-fault output levels.

The dynamic response of Jamshoro generator is shown in Figs 8.4.12 showing the recovery of speed and mechanical power.

The angular stability of other conventional generators of the system can be seen in Fig. 8.4.13. The relative rotor angles of HUBCO, Muzaffargarh, Kotri, Jamshoro, Guddu-New and Nooriabad are plotted w.r.t. Guddu-New. The results show that they remain in synchronism with the system generators and stay stable. The angular swings are also nominal and damp quickly.

8.4 Dynamic Impact of System Disturbances at 500 kV Level

8.4.1 Three Phase Faults, Normal Clearing Time of 5 Cycles & Trip of Circuits– Outage of Jamshoro to Dadu 500 kV Single Circuit

The system disturbances have been simulated for this model as follows;

Three- phase fault applied at Jamshoro 500 kV bus bar, cleared in 5 cycles as normal clearing time i.e. 100 m seconds, followed by trip of 500 kV single circuit between Jamshoro and Dadu, which was significantly loaded in the pre-fault normal load flow case and its outage may cause severe impact.

Fig 8.5.1 indicates the bus voltages in pre and post fault conditions at 500 kV substations in the vicinity of Jamshoro. We find that the voltages recover smoothly and quickly to their pre-disturbance values.

The system frequency indicated in Fig. 8.5.2 shows very nominal excursions of frequency that damps down very quickly and smoothly

The MW and MVAR output of equivalent WTG (NBT-1) get back to normal quickly after the fault clearance as shown in Fig 8.5.3.

The dynamic response of generator is shown in Figs 8.5.4 showing the recovery of speed and mechanical power.

The outage of 500 kV circuit between Jamshoro and Dadu causes the entire flow of that circuit to shift to the intact 500 kV circuit between Jamshoro and Dadu. Fig. 8.5.5 shows the transients on MW and MVAR flow on this circuit which settles the transients quickly and acquires a new steady state level soon.

Fig. 8.5.6. The relative rotor angles of HUBCO, Muzaffargarh, Kotri, Jamshoro, Guddu-New and Nooriabad are plotted w.r.t. Guddu-New. The results show that they

remain in synchronism with the system generators and stay stable. The angular swings are also nominal and damp quickly.

8.4.2 Three Phase Faults, Normal Clearing Time of 5 Cycles & Trip of Circuits– Outage of Dadu to Shikarpur 500 kV Single Circuit

The system disturbances have been simulated for this model as follows;

Three- phase fault applied at Dadu 500 kV bus bar, cleared in 5 cycles as normal clearing time i.e. 100 m seconds, followed by trip of 500 kV single circuit between Dadu and Shikarpur, which was significantly loaded in the pre-fault normal load flow case and its outage may cause severe impact.

Fig 8.6.1 indicates the bus voltages in pre and post fault conditions at 500 kV substations in the vicinity of Jamshoro. We find that the voltages recover smoothly and quickly to their pre-disturbance values.

The system frequency indicated in Fig. 8.6.2 shows very nominal excursions of frequency that damps down very quickly and smoothly

The MW and MVAR output of equivalent WTG (NBT-1) get back to normal quickly after the fault clearance as shown in Fig 8.6.3.

The dynamic response of generator is shown in Figs 8.6.4 showing the recovery of speed and mechanical power.

The outage of 500 kV circuit between Dadu and Shikarpur causes the entire flow of that circuit to shift to the intact 500 kV circuit between Dadu and Shikarpur. Fig. 8.6.5 shows the transients on MW and MVAR flow on this circuit which settles the transients quickly and acquires a new steady state level soon.

Fig. 8.6.6. The relative rotor angles of HUBCO, Muzaffargarh, Kotri, Jamshoro, Guddu-New and Nooriabad are plotted w.r.t. Guddu-New. The results show that they remain in synchronism with the system generators and stay stable. The angular swings are also nominal and damp quickly.

8.4.3 Three Phase Faults, Normal Clearing Time of 5 Cycles & Trip of Circuits– Outage of Shikarpur to Guddu 500 kV Single Circuit

The system disturbances have been simulated for this model as follows;

Three- phase fault applied at Shikarpur 500 kV bus bar, cleared in 5 cycles as normal clearing time i.e. 100 m seconds, followed by trip of 500 kV single circuit between Shikarpur and Guddu, which was significantly loaded in the pre-fault normal load flow case and its outage may cause severe impact.

Fig 8.7.1 indicates the bus voltages in pre and post fault conditions at 500 kV substations in the vicinity of Jamshoro. We find that the voltages recover smoothly and quickly to their pre-disturbance values.

The system frequency indicated in Fig. 8.7.2 shows very nominal excursions of frequency that damps down very quickly and smoothly

The MW and MVAR output of equivalent WTG (NBT-1) get back to normal quickly after the fault clearance as shown in Fig 8.7.3.

The dynamic response of generator is shown in Figs 8.7.4 showing the recovery of speed and mechanical power.

The outage of 500 kV circuit between Shikarpur and Guddu causes the entire flow of that circuit to shift to the intact 500 kV circuit between Shikarpur and Guddu. Fig. 8.7.5 shows the transients on MW and MVAR flow on this circuit which settles the transients quickly and acquires a new steady state level soon.

Fig. 8.7.6. The relative rotor angles of HUBCO, Muzaffargarh, Kotri, Jamshoro, Guddu-New and Nooriabad are plotted w.r.t. Guddu-New. The results show that they remain in synchronism with the system generators and stay stable. The angular swings are also nominal and damp quickly.

8.5 Conclusion of Stability Study

The transient stability analysis performed as discussed above indicates that the NTDC system connecting to NBT WPP through both the proposed schemes i.e. Alternative-I and Alternative-II is strong enough to absorb the worst disturbances on either side i.e. on NBT WPP side or the Grid side.

There are no constraints of connecting NBT WPP with the NTDC grid in terms of transients or dynamic behavior of system under the disturbed conditions either on the Farm side or on the Grid side.

9- Power Quality

The issues of power quality are of particular importance to wind turbines that may cause flicker and distortions in the power supply due to harmonics and unbalance. These issues are more significant for weak systems of low short circuit strength. Therefore we have investigated these issues for the case of minimum short circuit of 2015 for the proposed scheme of interconnection. The same case has been re-evaluated with per unit MVA values and plotted for 3-phase faults in Exhibit 7.1.1 for the proposed interconnection scheme in Appendix-7.

9.1 Flicker

We have used IEC61400-21 for the calculations of flicker levels for steady-state continuous operation and for switching conditions [1].

9.1.1 Continuous Operation

The probability of 99th percentile flicker emission from a single wind turbine during continuous operation for short time $P_{st\Sigma}$ and longer time flicker levels $P_{lt\Sigma}$ are assumed same and calculated by the following formula

$$P_{st\Sigma} = P_{lt\Sigma} = \frac{1}{S_k} \cdot \sqrt{\sum_{i=1}^{N_{wt}} (c_i(\psi_k, v_a) \cdot S_{n,i})^2}$$

where

$c(\psi_k, v_a)$ is the flicker coefficient of the wind turbine for the given network impedance phase angle, ψ_k at the PCC, and for the given annual average wind speed, v_a at hub-height of the wind turbine at the site;

S_n is the rated apparent power of the wind turbine;

S_k is the short-circuit apparent power at the PCC.

N_{wt} is the number of wind turbines connected to the PCC.

PCC is the point of common coupling of WTGs that is 33 kV bus of NBT Farm substation.

For minimum short circuit case we have assumed the same case as discussed in Section 7.1.1 of Chapter 7 in which output of the NBT Wind farm reduced as low as 25 % of its rated capacity. Therefore, assuming WTG of 1.5 MW we have calculated as follows;

S_n= 1.58 MVA at 0.95 PF

N_{WT} =83

S_k for MV bus = 1660 MVA

The value of c (ψ_k) at 10 minute average speed (v_a) is supplied by the manufacturer after filed measurements of $P_{St.\ fic}$ for different operating conditions using the following formula.

$$c(\psi_k) = P_{st,fic} \cdot \frac{S_{k,fic}}{S_n}$$

where

S_n is the rated apparent power of the wind turbine;

$S_{k\,fic}$ is the short-circuit apparent power of the fictitious grid.

The value of c (ψ_k) may not be greater than 1, therefore for the present analysis we may assume it as 1 for the worst case.

Putting this data in the above Equation, we find

$$P_{St\Sigma} = P_{lt\Sigma} = 0.00867 = 0.867\ \%$$

Whereas the acceptable value is 4 % as mentioned in Ref. [2]. Therefore we are much less than the maximum permissible level and the WTGs at NBT Wind farm would not cause any flicker problem during steady state operation even in the weakest system conditions of minimum short circuit level for either interconnection Alternative chosen.

9.1.2 Switching Operation

The most common switching operations would be as follows;

a. Wind turbine start-up at cut-in speed
b. Wind turbine start-up at rated wind speed
c. The worst case of switching between the WTGs

The flicker emission from the wind farm of many machines can be calculated by the following equation as per IEC61400-21 (Section 8.3.2)

$$P_{st\Sigma} = \frac{18}{S_k} \cdot \left(\sum_{i=1}^{N_{wt}} N_{10,i} \cdot (k_{f,i}(\psi_k) \cdot S_{n,i})^{3.2} \right)^{0.31}$$

$$P_{lt\Sigma} = \frac{8}{S_k} \cdot \left(\sum_{i=1}^{N_{wt}} N_{120,i} \cdot (k_{f,i}(\psi_k) \cdot S_{n,i})^{3.2} \right)^{0.31}$$

where

$N_{10,i}$ and $N_{120,i}$ are the number of switching operations of the individual wind turbine within a 10 min and 2 h period respectively;

$k_{f,i}(\psi_k)$ is the flicker step factor of the individual wind turbine;

$S_{n,i}$ is the rated power of the individual wind turbine.

The values of N_{10} and N_{120} are usually provided by the manufacturers based on field measurements, but if these are not available then IEC61400-21 proposes in section 7.6.3 to use as follows;

For switching conditions of (a) and (b)

$N_{10} = 10$

$N_{120} = 120$

For switching conditions of (c)

$N_{10} = 1$

$N_{120} = 12$

The value of flicker step factor $k_{f,i}(\psi_k)$ is also provided by the manufacturer after the field and factory measurements; but for the present analysis we assume it to be equal to 1.

Substituting the numbers in the above equations, we find for switching conditions of (a) and (b) as follows;

$P_{St\Sigma} = 0.123$

$P_{lt\Sigma} = 0.118$

For switching conditions of (c) these values would be less as the frequency of occurrence assumed i.e. N_{10} and N_{120} are 10 times less.

Engineering Recommendation P28 (Electricity Association, 1989) specifies an absolute maximum of P_{St} on a network from all sources to be 1.0 with a 2 hour P_{St} value of 0.6. However, extreme caution is advised if these limits are approached as the risk of complaints increases when the limits are reached, therefore, an assessment

method proposed in the same document is based on P_{St}not exceeding 0.5. British Standard (1995) is less stringent specifying that over a one week period P_{lt} must be less than 1 for 95 % of the time. Gardner (1996) describes P_{St} limits from a number of utilities in the range of 0.25 to 0.5 [2].

The values evaluate above for both interconnection schemes Alternative-I and Alternative-II are less than the values recommended in the references of above standards.

9.2 Harmonics

Regarding harmonics, IEC61400-21 states as follows [1];

"A wind turbine with induction generator directly connected to the electrical system (i.e. without a power electronic converter) is not expected to cause any significant harmonic distortion. Hence this standard does not require any further assessment of these.

"For a wind turbine with a directly connected synchronous generator (without a power electronic converter)....the wind turbine will only give a very limited emission of harmonic currents, and hence this standard does not require any further assessment of these."

Therefore we have to look into the harmonic phenomena for a wind turbine with a power electronic converter. The important thing would be to see if the resonance of harmonics generated from the WTG occurs at or near odd-harmonic frequency or not. For this purpose we carried out frequency scan by employing a state of art software PSCAD / EMTDC. The system upto Kotri, Jamshoro-old and Thatta has been modeled in detail however the system behind these nodes has been represented by an equivalent voltage source. These equivalents have been developed from the Short Circuit cases of PSS/E discussed earlier in Chapter 7.

The frequency has been scanned through a spectrum of impedance values of this equivalent circuit at the nodes of NBT at the voltage level where equivalent WTG has been modeled in these studies. . If harmonic resonance is controlled at this node then all the emissions of harmonics are well contained within the Farm itself. The switched shunt capacitor banks installed at MV bus bar for voltage regulation would play an important role in causing or avoiding harmonic resonance. So we have carried

out the frequency scan with and without the switched shunt capacitor banks for a range of 0 to 2000 Hz i.e. from fundamental frequency to 40th harmonic. However, the results have been plotted in the figures for a frequency range up to 750 Hz i.e. upto 15th harmonic, because the frequencies beyond that value are of less importance, and once the resonant point occurs at some frequency up to that range, then it would normally not recur after that.

9.2.1 Without Switched Shunt Capacitor Banks

The frequency versus positive and zero sequence resistance and reactance i.e., R_+ R_0, X_+, X_0, are shown plotted in Figures 9.1.1, 9.1.2, 9.1.3 and 9.1.4.

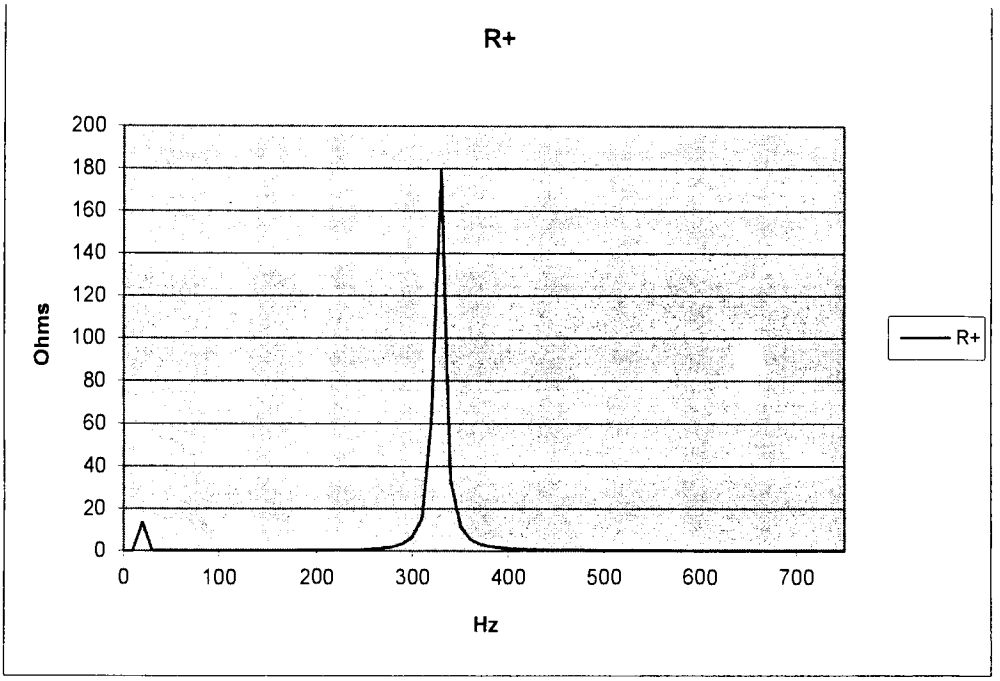


Fig 9.1.1

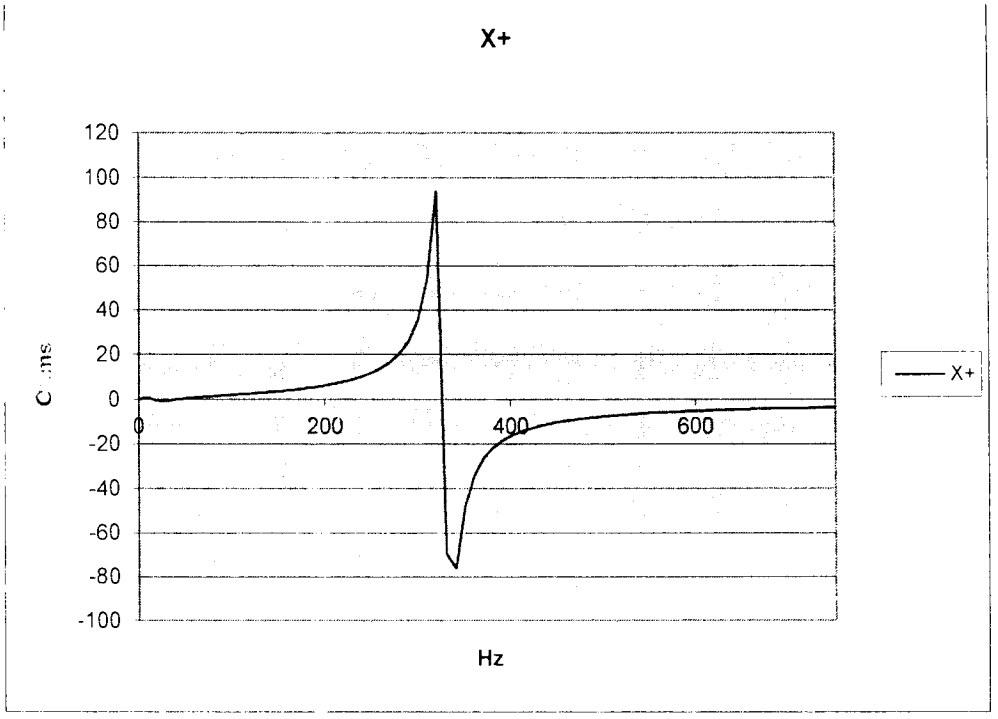


Fig 9.1.2

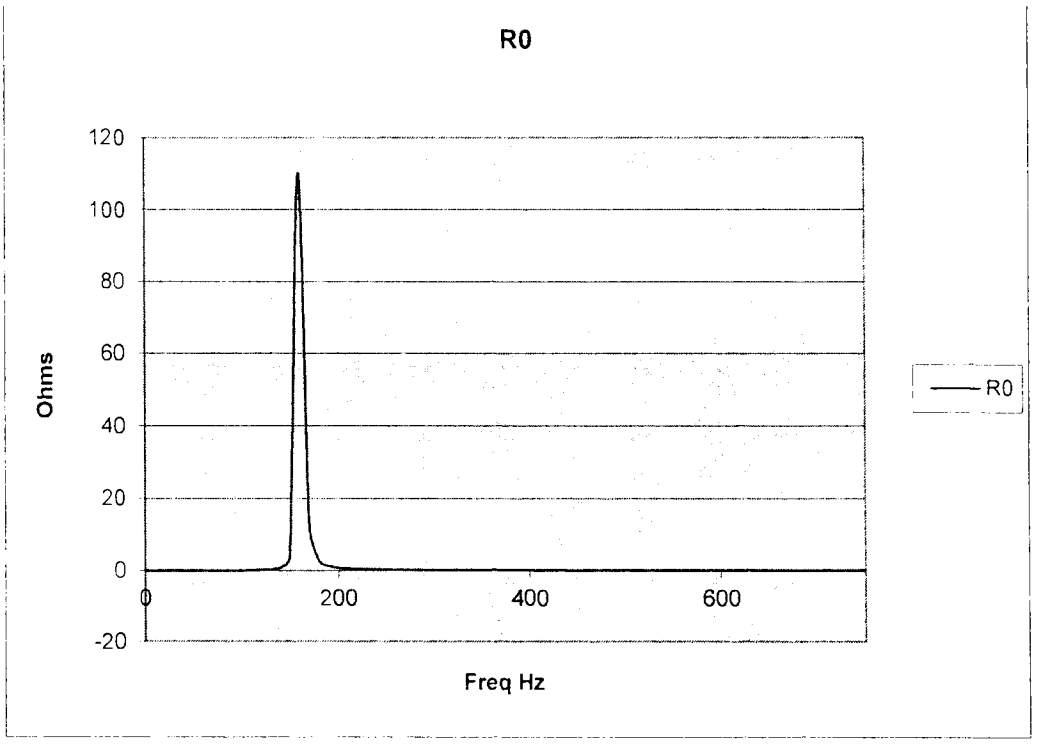


Fig 9.1.3

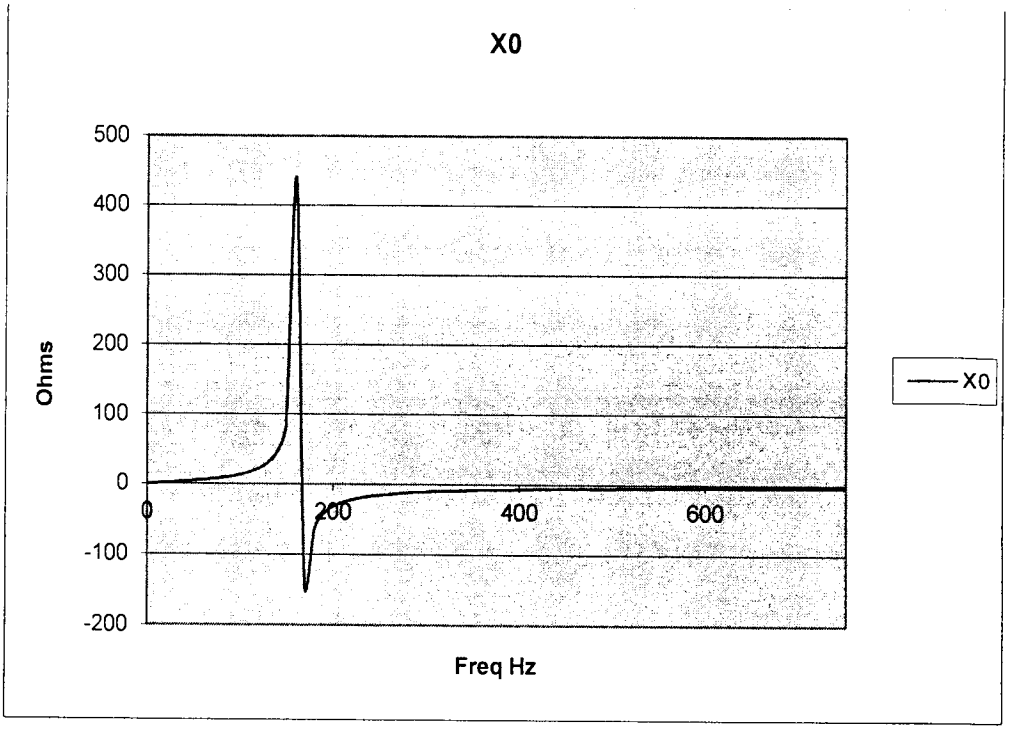


Fig 9.1.4

The curves of resistance R_+ R_0 show their highest value to occur at the resonance point whereas the reactance curves show the point of resonance where the curve crosses zero i.e. it changes sign from positive to negative and its value becomes zero. Resonance is a phenomenon when inductive reactance X_L and the capacitive reactance X_C becomes equal and cancels each other giving net reactance as zero. We find from the figures that the point of resonance for positive sequence occurs at 330 Hz, which is quite close to 7th harmonic i.e. 350 Hz; whereas for zero sequence the resonance occurs at 170 Hz which is close to 3rd harmonic i.e. 150 Hz. We see that both the 7th and the 3rd harmonic are odd harmonics and resonance at these points should be avoided.

9.2.1 With Switched Shunt Capacitor Banks

As we know that already we have proposed a switched shunt capacitor bank of 164.34 MVAR for voltage regulation and reactive power compensation of the WTG consuming VARs. Therefore, we now see the impact of this capacitor bank on harmonic resonance. The PSCAD simulation has been run for frequency scanning and

the results are shown plotted in Figs 9.2.1, 9.2.2, 9.2.3 and 9.2.4 respectively for positive and zero sequence resistance and reactance.

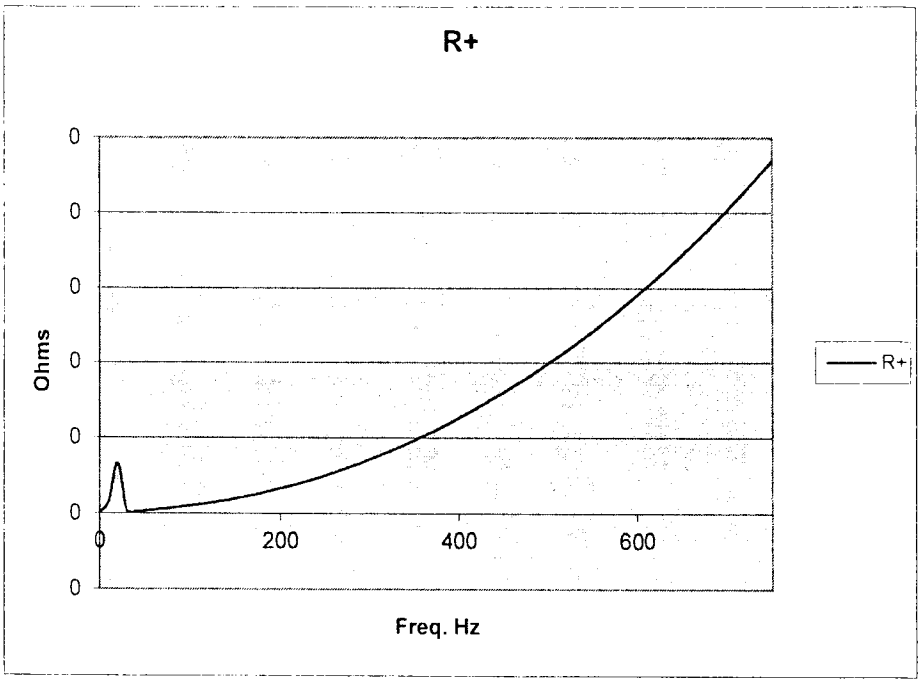


Fig 9.2.1

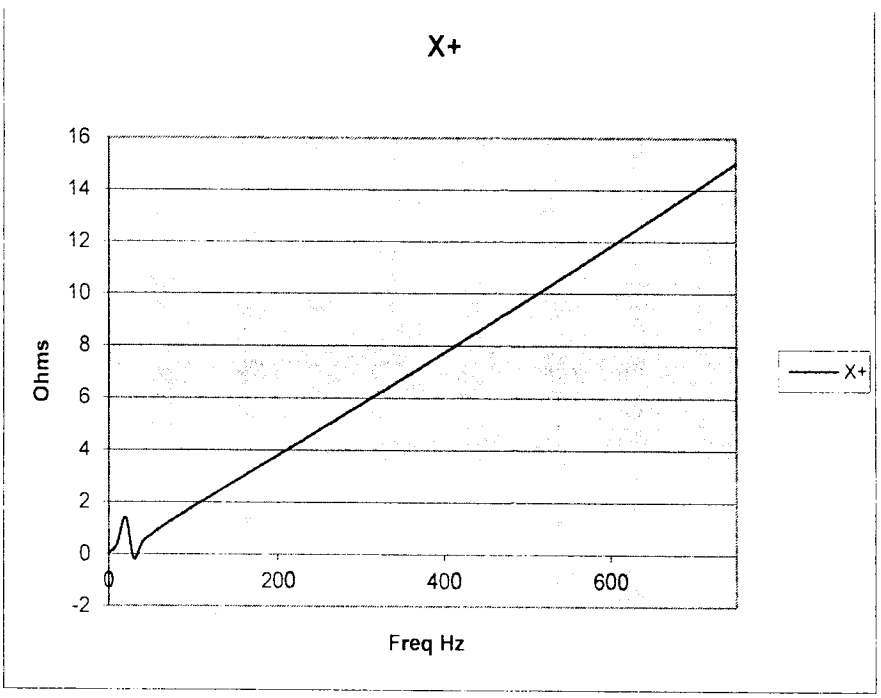


Fig 9.2.2

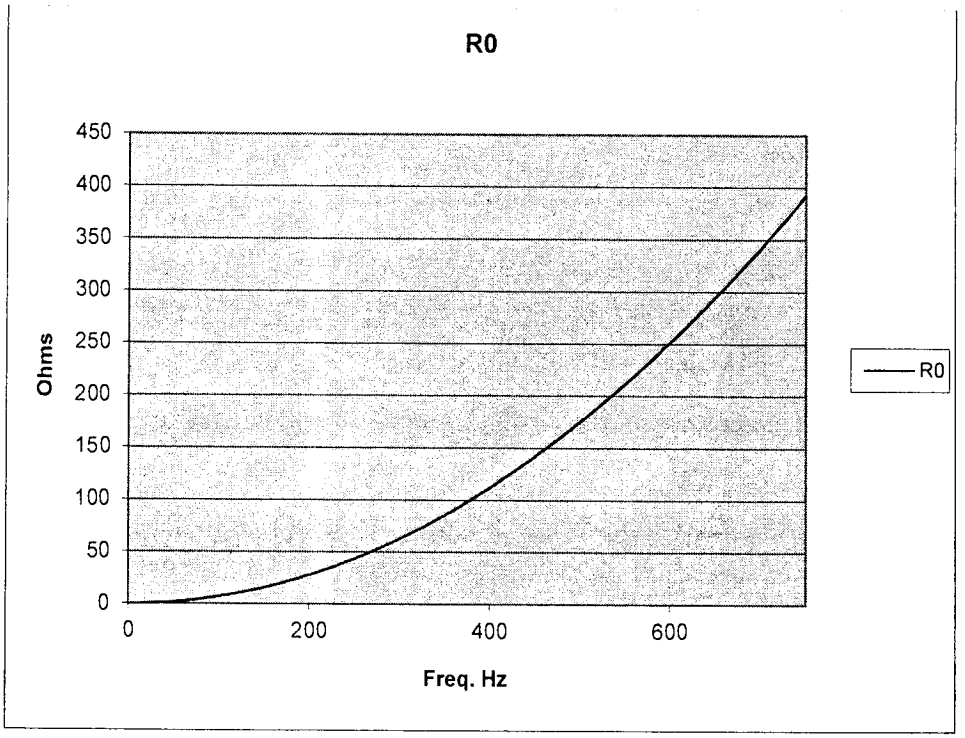


Fig 9.2.3

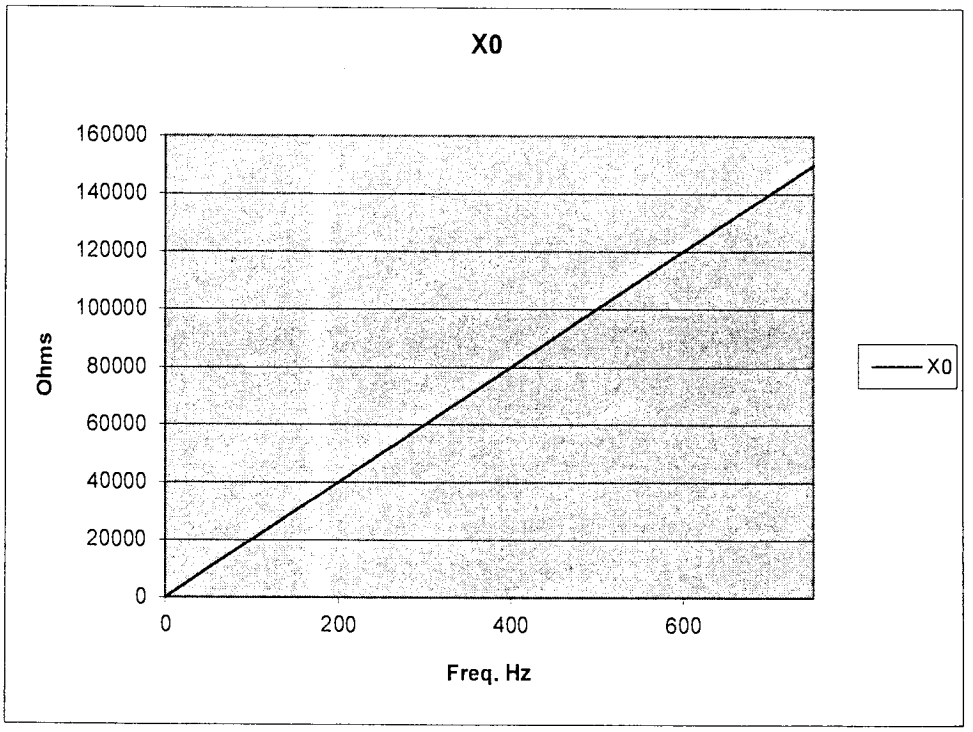


Fig 9.2.4

The results show that there is no zero crossing or change of signs of reactance or a maxima-minima of resistance showing no resonance i.e. the resonance point is detuned permanently not to occur at all. This role of capacitor banks to filter all the harmonics well within the farm field is an additional benefit of this capacitor bank.

References

1- *Wind Turbine Generator Systems*, IEC61400-21 First edition 2001-12; Part 21; Chapters 6, 7 and 8.

2- *Wind Energy Handbook*; John Wiley & Sons Ltd. 2001, Chapter 10.

10- Conclusions & Recommendations

1. The interconnection scheme for NBT WPP has been developed to evacuate the complete 2x250 MW power of NBT WPP. The proposed interconnection scheme for NBT 2x250 MW WPP would require as follows:
   - Development of collector substation of 220/33 kV for NBT WPP for interface with NTDC Grid after internally collecting the output of NBT-WPP
   - Connect collector substation of 220/33 kV for NBT WPP by looping in-out of the existing 220 kV circuit from Jamshoro to KDA-33 at NBT-WPP. The looping distance is about 10 km
2. Wind Farm of NBT has been modeled by using Type-3 Doubly Fed Induction Generator.
3. A conceptual design scheme of 220/33 kV substation of NBT Wind Farm has been laid down that comprises of as follows
   iii. For 220 kV;
      a. Two single bus-sections of 220 kV with a bus sectionalizer
      b. Five breaker bays to connect five 100 MVA 220/33 kV transformers
      c. Two breaker bays to connect outgoing lines of 220 kV to Jamshoro and KDA-33
   iv. For 33 kV;
      a. Two single bus-sections of 33 kV with a bus sectionalizer
      b. Twenty breaker bays to connect twenty collector circuits from twenty collector groups of WTGs
      c. Five breaker bays to connect five 132/33 kV transformers
      d. Two breaker bays to connect two switched shunt capacitor banks, one in each bus section
      e. Breaker bays to connect station auxiliary transformers 33/0.4 kV
4. Load flow analysis has been carried out for September 2015 considering the COD targeted by NBT, for the dispersal of load from NBT WPP into NTDC Grid at 220 kV level for using the latest load forecast, generation and

transmission expansion plans of NTDC and HESCO. The above mentioned interconnection scheme (item-1) has been evolved by performing the load flow studies testing the steady state performance for normal as well as N-1 contingency conditions fulfilling the Grid Code criteria of Wind Power Plants. The reactive power requirement at point of common coupling to meet PF of ± 0.95, voltage and line loading criteria are fulfilled by these studies. The grid facilities of HESCO, after incorporating the reinforcements of the proposed scheme, are also found adequate to absorb output power of NBT WPP.

5. Maximum and minimum short circuit levels for three-phase faults and single-phase faults have been evaluated for the year 2015, and it has been found that the proposed scheme provides maximum SC strength for the evacuation of NBT WPP power to the grid.

   The switchgear ratings for NBT WPP substation are as follows:

   220 kV:

   Short circuit rating = 50 kA (3 sec.)

   Continuous rating = 3150 A

   33 kV:

   Short circuit rating = 50 kA (3 sec.)

   Continuous rating = 9000 A

6. Transient Stability analysis has been carried out for NBT Wind Farm with connectivity of the proposed scheme. Different disturbances have been simulated to apply stresses from the system faults on the wind farm and vice versa and it was found that NBT WTG unit's dynamic characteristics and the grid connectivity is strong enough to maintain stability under all disturbances. In turn, any disturbance from NBT WPP side did not cause any stress on the main grid or the power plants in HESCO area viz. HUBCO, Guddu, Kotri, Lakhra or Jamshoro such that the whole system remained stable under all events.

7. The LVRT requirements have been tested to fulfill 100 ms (5 cycles) under normal clearing time and 180 ms (9 cycles) for contingency condition of delayed fault clearing due to stuck- breaker (breaker failure) reason. The simulations have proved that the proposed machine fulfills the LVRT criteria as required in the Grid Code for Wind IPPs.

8. The issues of power quality like flicker and harmonic resonance have been studied in detail. The results have indicated that the levels of flicker are within the permissible limits of IEC and other International Standards.

9. There are no technical constraints whatsoever in the way of bringing in the 2 x 250 MW of NBT Wind Power Plant at the proposed site and scheduled time of commissioning, in any respect of steady state (load flow) or short circuit or dynamic performance (stability) or power quality issues related to this plant.

PROSPECTUS

Introduction of sponsors.

NBT is a Norwegian renewable energy company formed in 2004 to develop wind energy projects. NBT's main business is to develop wind farms in emerging markets. In China, the 100 MW Linxi wind farm is developed, owned and operated in a joint venture with Datang, one of China's leading utilities. The Datang group operates 39,000 MW of power production in China, of which 16 per cent is renewable energy. NBT and Datang have agreed to develop and build 1,000 MW of wind power in China over the coming years. The company also has a joint venture with AEI, an American infrastructure developer, for the 50 MW Baicheng wind farm in Jilin, China. In Pakistan, NBT is developing projects in a joint venture with our Malaysian partner Malakoff. Malakoff operates 5,000 MW of power production in Malaysia and is expanding into renewables through the co-operation with NBT. NBT and Malakoff have agreed to develop and build 600 MW of wind power in Pakistan over the coming years.

Introduction of NBT Wind Power Pakistan III (Pvt.) Ltd

NBT Wind Power Pakistan III (Pvt.) Ltd., the proponent intends to establish a 250 MW Wind Farm in the Thatta-Thana Bola Khan-Hyderabad Wind Corridor. The project site has about 30931 acres of Government and private land in Union Council Jhangri, Taluka and District Thatta where the project proponent is carrying out its feasibility studies after getting Letter of Intent (LOI) from the Alternate Energy Development Board (AEDB). The Project includes designing, testing,

manufacturing, and operation as well as maintenance of its Wind Farm comprising 156 wind turbines. The proponent will have choice on turbine design including generator type, gearbox vs. gear-less, materials, besides control on maintaining inventory.

The Project Area is approximately 135 km from Karachi, the Capital of Sind Province. The subject site is on the north of the Jhimpir Wind Corridor on undulating arid land, with elevation ranging from 40 to 110 meter above mean sea level. Total project area of the Wind Farm occupies an area of approximately 2203.6 acres on 5 strips of land. Each strip of land is approximately 150 m wide by 10 km long and the land between the strips is 2 km wide.

NBT Wind Power Pakistan III (Pvt) Ltd got Letter of Intent (Lol) from Alternative Energy Development Board (AEDB) on 16th August, 2011 for the development of Wind Power project, later extended/renewed on _th October, 2013.

Proposed Investment

Project Cost including equity and debt

Total Project Cost of US$572.67 million composed equity of US$133.17 million, senior project debt of US$399.5 million and Sinosure insurance premium of US$40 million financed by additional senior debt.

Salient Features of the Facility

3 Technical Data for the 1.6-82.5

3.1 Rotor

Diameter	82.5 m
Number of blades	3
Swept area	5346 m2
Rotor speed range	9 to 18 rpm
Rotational direction	Clockwise looking downwind
Maximum tip speed	77.2 m/s
Orientation	Upwind
Speed regulation	Pitch control
Aerodynamic brakes	Full feathering

3.2 Pitch System

Principle	Independent blade pitch control
Actuation	Individual electric drive

3.3 Yaw System

Yaw rate	0.5 degree/s

a. Manufacturer: General Electrics

b. Make & Model: GE1.6 – 82.5 WTG

c. Plant Capacity (MW): 249.6MW

d. Technology: Double – Feed

e. Unit Size (MW): 1.6

f. Number of Units: 156

g. Expected Date of Financial Close: March 31st 2014

h. Expected COD: October 31st 2015

A brief Social and Environmental impact.

Review of Guidelines for classification of polluted and unpolluted sites with respect to their airshed, watershed, soil, sensitivity of ecosystem including fauna, flora, wildlife, aquatic life, historical and archaeological sites and their values, along with assessment of impact by using the "Checklist of actions affecting environment and significance of their impact" has been used in this EIA Study for assessment of impact of different activities for establishment of NBT (III) Wind Farm Project. The review process finds that:

- The impacts from NBT (III) Wind Farm Project construction, and installation of machinery and the resulting emission of noise and gaseous effluent, and wastewater discharges during siting, construction and operation of the NBT (III) Wind Farm Project would be of small order and would be of little significance at the site or microenvironment and none in the macroenvironment.
- Estimates on net saving in terms of air pollutants clearly suggest that operation of the NBT (III) Wind Farm Project would be economically viable and environment friendly.
- No untreated wastewater would be discharged from the NBT (III) Wind Farm Project. Initiatives will be taken to harvest rainwater by channelizing it into dyked ponds for subsequent use in plantation.

- Noise emissions from the wind turbines at NBT (III) Wind Farm Project site will have a high level at the top of the wind turbine and will decrease with distance. The noise level at the living areas at more than 1.5 km will be within acceptable limits of the World Bank Guidelines and the limits recently proposed by Federal EPA.

- The level of emissions and discharges suggests that NBT (III) Wind Farm Project operations will have no significant impact either on its microenvironment that includes the proposed site for NBT (III) Wind Farm Project, or on its macroenvironment that includes the UC Headquarter Jhangra.

Screening of potential environmental impacts at the different stages viz. siting, construction, installation of machinery and equipment and finally operation, leads to the conclusion that:

- The wasteland at NBT (III) Wind Farm Project has remained an isolated component of the ecosystem of Lower Sindh for a long time. Location of NBT (III) Wind Farm Project will comprise value-addition to the wasteland, besides having no significant impact on the micro and macroenvironment; will not degrade the ecology of the stony wasteland in UC Jhangra in DehKohistan.

- Visual effect, noise effect, EMI effect, flicker effect induced by operation of the wind turbines will have no significant impact on the living area, located 1.5 km outside the NBT (III) Wind Farm Project. The induced impact on operation of the wind turbines on the microenvironment will be monitored through environmental management plan, environmental monitoring plan and the IFC's HSE Guidelines, and mitigated, if necessary by adoption of suitable measures at the site.

- There are no cultural heritage, recognized archaeological sites, endangered species of flora, wildlife reserve, or potential tourism sites that may need protection and hence no mitigation measures need to be

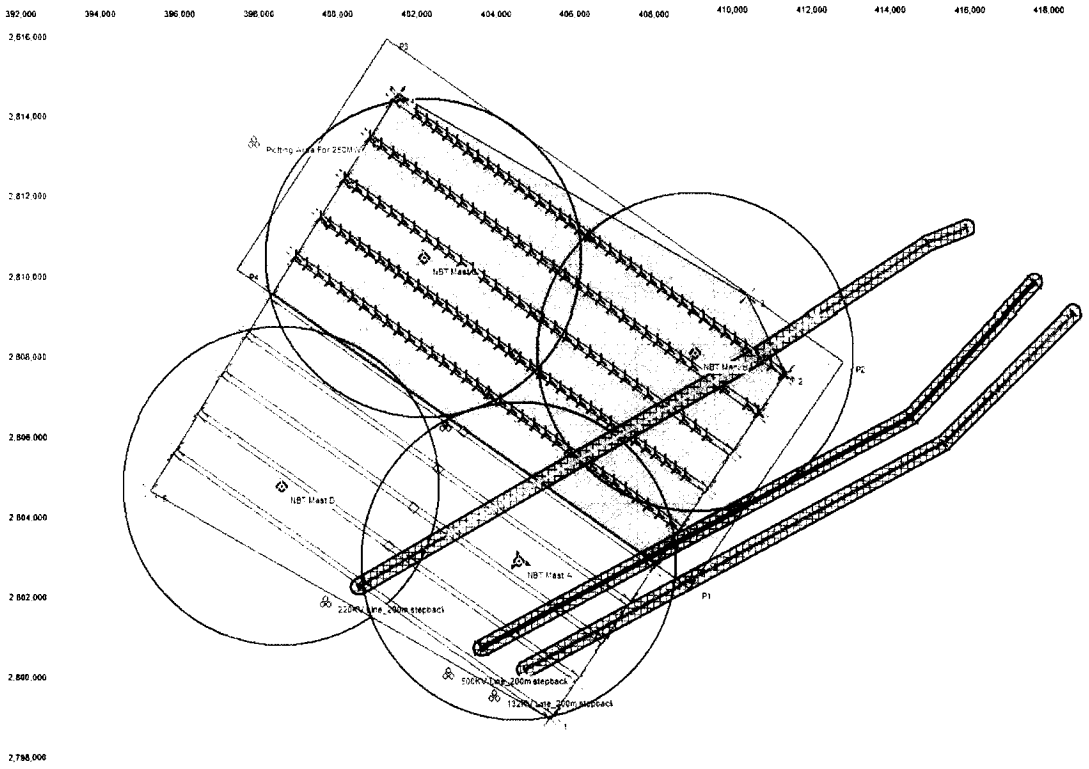
taken. Mitigation measures have been proposed for the protection of the spiny-tailed lizard (Uromastixhardwickii) Sandha and the straying high flying birds. The number of the few Houbara bustard and high flying eagles and falcons still around will be recorded during the pre-construction period. Mitigation measures such as hiring the services of sharp shooters will be in place to stupefy the high-flying stray birds and later on release them to safe environment. This is already one of the conservation practices to safe the wildlife in India. In order to implement the proposed mechanism Sindh Wildlife Department will be taken onboard so that appropriate steps are taken to save the wildlife from extinction.

- Finding of archaeological artifacts during the construction phase will be immediately reported to the Department of Archaeology, Sindh.

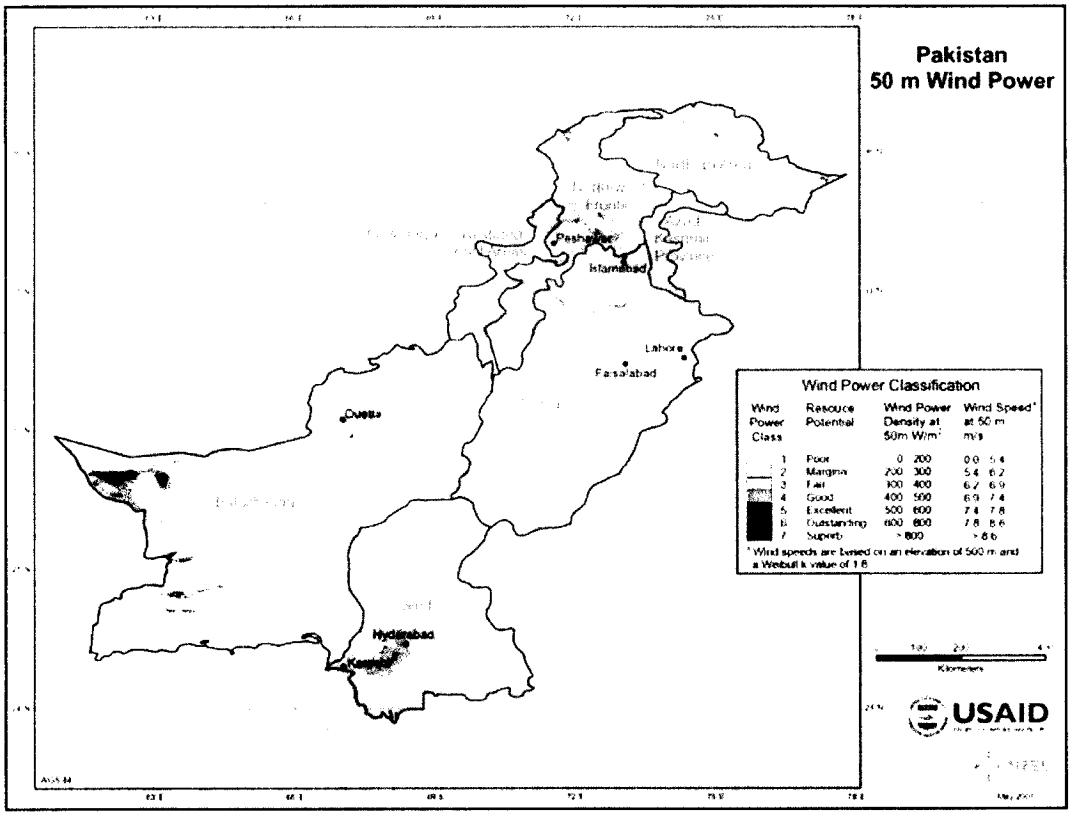
- The proposed NBT (III) Wind Farm Project, when commissioned, would add value to the otherwise wasteland on the north of Super Highway M9 in DehKohistan and Jhimpir Wind Corridor and become an integral part of the macroenvironment of Jhimpir District Thatta.

This EIA Study finds that the value-addition characteristics of NBT (III) Wind Farm Project would respond to the principles of sustainable development that aim at "socially equitable and economically viable development to improve the quality of life for all citizens of the Earth, without altering the balance in the ecosystem".

Location maps, site maps, land



	X Y	X Y
Description	UTM WGS84 Z42	Geographical (WGS84)
P1	409,310 2,801,835	68.098875° 25.330369°
P2	413,245 2,807,485	68.137609° 25.381620°
P3	401,735 2,815,625	68.022613° 25.454404°
P4	397,930 2,809,875	67.985207° 25.402229°



Technology, size of plant, number of units

3 Technical Data for the 1.6-82.5

3.1 Rotor

Diameter	82.5 m
Number of blades	3
Swept area	5346 m2
Rotor speed range	9 to 18 rpm
Rotational direction	Clockwise looking downwind
Maximum tip speed	77.2 m/s
Orientation	Upwind
Speed regulation	Pitch control
Aerodynamic brakes	Full feathering

3.2 Pitch System

Principle	Independent blade pitch control
Actuation	Individual electric drive

3.3 Yaw System

Yaw rate	0.5 degree/s

a. Manufacturer : General Electrics
b. Make &Model : GE1.6 – 82.5 WTG
c. Plant Capacity (MW) : 249.6MW
d. Technology : Double - Feed
e. Unit Size (MW) : 1.6
f. Number of Units : 156

Project cost, information regarding sources and amounts of equity, debt

Project Cost including equity and debt

Total Project Cost of US$572.67 million composed equity of US$133.17 million, senior project debt of US$399.5 million and Sinosure insurance premium of US$40 million financed by additional senior debt.

EPA NOC.

Dated: February 19, 2014

SUBJECT: DECISION ON ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

1.	Name & Address of Proponent:	Lt. General Hamid Nawaz Chairman / CEO NBT Wind Power Pakistan III (Pvt.) Ltd Address: D-94, B Street, 5th Avenue, Block 7, Kehkashan, Clifton, Karachi-Pakistan Tel: +92-21-35370353-6 Fax: +92-21-35370357
2.	Description of Project	Establishment of 250 MW Wind Power Project herein referred to as "NBT (III) Wind Power Project."
3.	Location of Project:	Project site is located just off Super Highway in Union Council Jhangri, Taluka and District Thatta
4.	Date of Filing of EIA:	07-01-2013

5. After careful review and analysis of the Environmental Impact Assessment (EIA) report, the Environmental Protection Agency (EPA) Sindh accords its approval subject to the following conditions:

   i) All mitigation measures recommended in EIA report should be complied with, for achieving negligible impacts on physical, biological, environmental and socio economic resources of the area. National Environmental Quality Standards (NEQS) for ambient air quality, noise, air emissions, wastewater and drinking water shall be followed in letter and spirit.

   ii) A complete code of Health, Safety and Environment (HSE) shall be developed which should include efficient parameters at specific work place. For this purpose HSE setup should be established and supervised by a designated HSE officer at the senior level with sufficient administrative and technical authority to perform

the designated functions. Proponent will make sure that the operating instructions and emergency actions are made available to every worker / labor at the site.

iii) Environmental management system shall be made in place during the operation of the project needing towards third party environmental audit. The proponent shall appoint an Independent Monitoring Consultant (IMC) whose responsibility shall be to monitor the project activities. The IMC shall ensure that the activities at project site are undertaken in environment friendly manner and the mitigation measures are implemented as per the recommendations of EIA. The IMC shall also guide on implementation of environmental management systems. The proponent shall be liable to submit monthly environmental monitoring reports produced by IMC to EPA Sindh. The report shall include pollutants measurement and analysis reports along with photographic records showing therein the environmental conditions at site during the construction and operation stages of project.

iv) The proponent shall also conduct modeling study for the assessment of impact of noise, shadow flicker and Zone of Visual Influence (ZVI) through IMC as per International Standards of World Bank / IFC and the report will be submitted to SEPA within 02 months from date of issuance of this approval.

v) The proponent will also conduct a detailed birds study at the microsite in the bird migration period in consultation with SWD and IMC and will formulate a plan for monitoring the impact on avian fauna from the project activities.

vi) The proponent shall be under obligation to compensate for any significant adverse short term, long term and irreversible impact occurred due to survey. A site manager shall be designated and notified, who will be overall responsible for the site. The residual impacts on the soil and water quality should be monitored throughout the project.

vii) 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.

viii) Employment should be provided to local people and assured for unskilled jobs. Skilled jobs shall be given to locals after providing them proper field training, where a minimum training is required. Local people should be informed and explained well in advance about the operation. Compensation should be provided to 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. 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.

ix) Local people should be provided with community welfare schemes i.e., draught relief programmes, educational programmes, and establishment of health units, veterinary live stock care unit etc., which should benefit them and develop mutual trust. Sustainability of these facilities should be ensured.

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

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

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

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

xiv) 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.

xv) 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.

xvi) 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.

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 Pakistan Environmental Protection Act, 1997 will be initiated against the proponent.

7. The proponent shall be liable for compliance of Section 13, 14, 17 and 18 of EIA, IEE regulation 2000, which direct for condition for approval, confirmation of compliance, entry inspection and monitoring.

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. The EIA report is meant only for proposed activities described in EIA only. Proponent should submit separate EIA or IEE required under regulations, along with site specific Environment Management Plan for any consequent and subsequent activity for approval of EPA, Sindh.

10. All the environmental conditions of this approval shall be incorporated in the terms and conditions of tender documents of the project for strict compliance. The tender documents incorporating the conditions shall be provided to this office for record. However overall responsibility for compliance of conditions of this approval shall be on the proponent. EPA Sindh at any stage of the project reserve the right to issue instruction for an independent audit for to ensure that the project is being done under strict compliance of Environmental legislation and conditions of this approval.

Naeem Ahmed Mughal
Director General

Table of Contents

1.0 Introduction

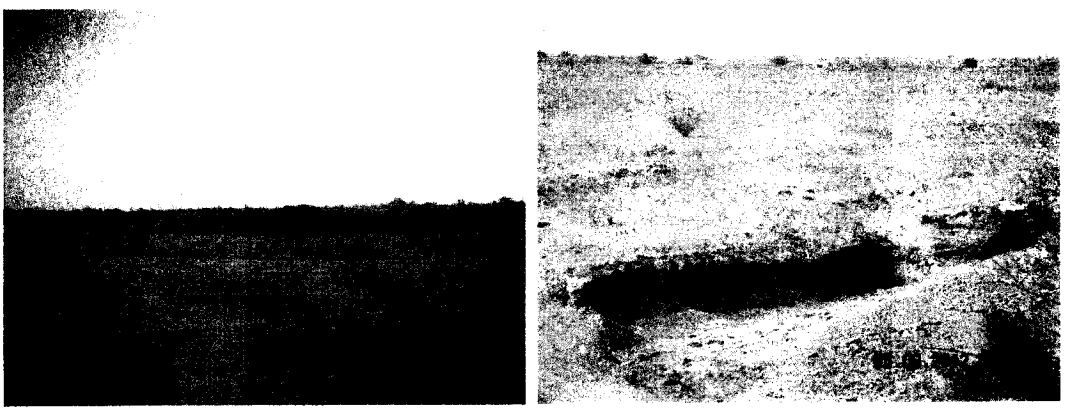
1.1 General

1.1.1 Name Of The Project

Establishment of 250 MW Wind Power Project herein referred to as "NBT (II) Wind Power Project." The project is owned by NBT Wind Power Pakistan II (Pvt.) Ltd and herein referred to as "Project Proponent".

1.1.2 Location

Project site is located just off Super Highway in Union Council Jhangri, Taluka and District Thatta.



View of NBT (II) Project Site – Stony Wasteland – Dominated by grassy wilderness

1.1.3 Name of Project Proponent

NBT Wind Power Pakistan II (Pvt.) Ltd
Lt. General Hamid Nawaz
Chairman
Address: D-94, B Street, 5th Avenue, Block 5,
Kehkashan Clifton, Karachi-Pakistan
Tel: +92-21-35370353-6
Fax: +92-21-35370357

The owner of NBT Wind Power Pakistan II (Pvt.) Ltd. is NBT Pakistan Holding (Pte.) Ltd. (herein referred to as "NBT Pakistan"), a Singapore holding company ultimately owned by NBT AS, a Norwegian company that develops, constructs and operates wind farms in China.

1.1.4 Name of Environmental Consultants

Mr. Syed Nadeem Arif
Managing Director
Environmental Management Consultants
Address: 503, Anum Estate Building
Main Shahrahe Faisal, Karachi

Mr. Haider Ali Khan
CEO, URS Pakistan
Address: United House, D-6/A, Block 9
Kehkashan, Clifton Main
Karachi, Pakistan.

1.1.5 Brief Description of Project

NBT Wind Power Pakistan II (Pvt.) Ltd., the proponent intends to establish a 250 MW Wind Farm in the Thatta-Thana Bola Khan-Hyderabad Wind Corridor. The project site has about 30931 acres of Government and private land in Union Council Jhangri, Taluka and District Thatta where the project proponent is carrying out its feasibility studies after getting Letter of Intent (LOI) from the Alternate Energy Development Board (AEDB). The Project includes designing, testing, manufacturing, and operation as well as maintenance of its Wind Farm comprising 166 wind turbines. The proponent will have choice on turbine design including generator type, gearbox vs. gear-less, materials, besides control on maintaining inventory.

The Project Area is approximately 135 km from Karachi, the Capital of Sind Province. The subject site is on the north of the Jhimpir Wind Corridor on undulating arid land, with elevation ranging from 40 to 110 meter above mean sea level. Total project area of the Wind Farm occupies an area of approximately 2203.6 acres on 5 strips of land. Each strip of land is approximately 150 m wide by 10 km long and the land between the strips is 2 km wide.

The location of project is shown in figure 1.1.

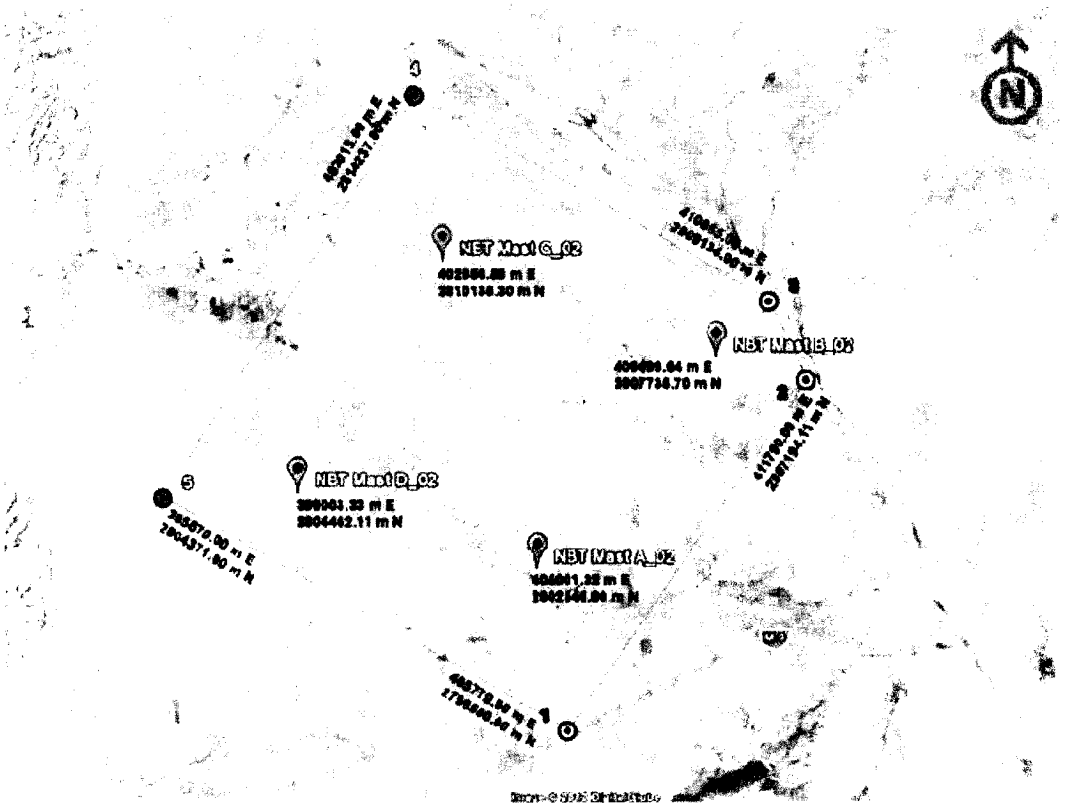


Figure 1.1: Project Location

1.2 Project Sponsors

NBT Wind Power Pakistan II (Pvt.) Ltd. has been incorporated to be the project company to own phase 1 of the Wind Farm comprising 250MW. NBT Wind Power Pakistan III (Pvt.) Ltd. has been incorporated to be the project company to own phase 2 of the Wind Farm comprising 250MW. Both of these companies are owned by NBT AS, a Norwegian wind farm developer with 150MW of wind farms in operation in China.

NBT AS, the ultimate parent company of the Proponents, is set to bring in global experience and know how in the field of wind power. NBT AS had its first two wind farms come into operation in northeast China in year 2011 and a third wind farm was completed in 2012, for a total of 150MW in operations.

In addition, NBT AS, through its project company NBT-ZAB Wind Power (Pvt.) Ltd., is developing a 100 MW wind farm in the Gharo Wind Corridor immediately outside of Karachi in collaboration with SZABIST Foundation. The EIA study of this project has already been approved by Sindh EPA.

Furthermore, NBT AS through another project company called Limak NBT Renewable Energy (Pvt.) Ltd. is going to build another 50MW wind farm outside Karachi in Sindh

province. It has also opted to buy its own land for this 50MW wind farm and became the first wind farm in the country to do so.

1.2.1 NBT AS

NBT AS develops wind farms and focuses on developing wind farms in China and Pakistan. It has operations in Norway, China, Cyprus, Hong Kong, Singapore and Pakistan. The company was founded in 2004 and is based in Oslo, Norway.

NBT AS has received two Letters of Intent from AEDB to build 2 x 250MW wind farms. NBT Wind Power Pakistan II (Pvt.) Ltd. and NBT Wind Power Pakistan III (Pvt.) Ltd. have been incorporated to own these wind farms and for development, construction and operation of the wind farms.

According to Bloomberg News, Mr. Joar Viken, the CEO of NBT AS, stated that the company is focused on building wind farms in China and Pakistan, and its plans are to tap project financing for these projects from Chinese banks and use Chinese manufactured wind turbines and equipment.

1.3 Objectives Of The Project

The main objectives of the NBT (II) Wind Farm Project are to:

- Respond to the national need to produce power from alternative or renewable energy sources that are alternative to thermal and hydro power production systems;
- Establish a wind power generation facility in accordance with GOP's policy and guidelines on development and generation of alternative or renewable energy, being implemented through the AEDB;
- Utilize the potential of wind capacity identified by the AEDB at the Jhimpir and Thatta-Thana Bola Khan-Hyderabad Wind Corridors and ground the transferred technology of wind power generation to reduce the emission of greenhouse gases including CO_2 in Pakistan through net energy gain, and
- Utilize the hitherto unexploited wind energy potential which is the resource that will help bridging the significant gap in supply and demand of energy being faced in Pakistan.

1.4 Need for the Project

1.4.1 Energy Overview

Electricity demand in Pakistan had already exceeded supply in the year 2002. Despite the unsustainable rapid growth in GDP, the generating capacity was under-estimated by 50 percent by 2010 and has to increase as soon as possible in order to meet the current and expected future demand. Rising gas and oil consumption and leveling off in local oil production together with inadequate refining capacity has left Pakistan with (a) shortfall of over 5000 MW in its theoretically maximum capacity of 17,793 MW, (b) heavy dependence on petroleum product imports from Middle East, and (c) 8 to 12 hours load shedding/blackouts which reduces the industrial production capacity and hinders GDP growth.

Natural gas accounts for the largest share of Pakistan's energy use, amounting to about 43 percent of total energy consumption. With depleting reserves of both oil and gas, Pakistan

will need to import more natural gas in the future. Pakistan currently consumes all of its domestic oil and natural gas production.

A number of technical, non-technical, operational and management constraints such as rise in oil price entailing high cost of power production, technical faults in grids, inadequate water storage in reservoirs, and unforeseen drastic reduction in Chenab river water flow after the commissioning of Baglihar Dam, have compounded the deficiency into an urgent energy crisis because supply capacity is not enough to meet demand.

Pakistan has remained an energy deficient country, dependent upon imports, mostly oil and oil products. Pakistan has had more success in finding natural gas than oil, and as a result, gas over took oil as the largest source of primary energy supplies, as shown in Figure 1.2.

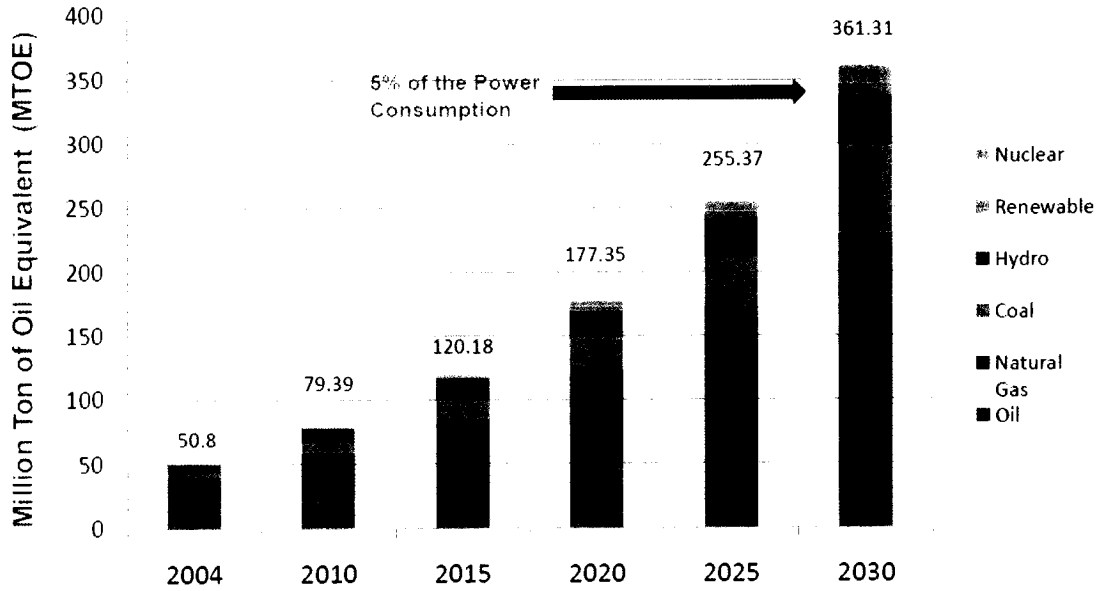


Figure 1.2: Energy Mix Plan Projections (source: Vision 2030-PC, GOP)

Pakistan has three sources of energy, namely Hydel, Thermal (gas/ steam/ furnace oil) and Nuclear.

There are four major power producers in country: WAPDA (Water & Power Development Authority), KESC (Karachi Electric Supply Company), IPPs (Independent Power Producers) and PAEC (Pakistan Atomic Energy Commission).

The break-up of the installed capacity of each of these power producers (as of June-2008) is as follows:

WAPDA Hydel

Tarbela	3478 MW
Mangla	1000 MW
Ghazi – Barotha	1450 MW
Warsak	243 MW
Chashma	184 MW
Dargai	20 MW
Rasul	22 MW
Shadi-Waal	18 MW
Nandi pur	14 MW
Kurram Garhi	4 MW

Renala	1 MW
Chitral	1 MW
Jagran (AK)	30 MW
Total Hydel	**6,461 MW**

WAPDA Thermal	
Gas Turbine Power Station, Shahdra	59 MW
Steam Power Station, Faisalabad	132 MW
Gas Turbine Power Station, Faisalabad	244 MW
Gas Power Station, Multan	195 MW
Thermal Power Station, Muzaffargarh	1350 MW
Thermal Power Station, Guddu	1655 MW
Gas Turbine Power Station, Kotri	174 MW
Thermal Power Station, Jamshoro	850 MW
Thermal Power Station, Larkana	150 MW
Thermal Power Station, Quetta	35 MW
Gas Turbine Power Station, Panjgur	39 MW
Thermal Power Station, Pasni	17 MW
Total Thermal	**4811 MW**
WAPDA's Total Hydel + Thermal capacity:	**11,272 MW**

KARACHI ELECTRIC SUPPLY COMPANY (KESC)	
Thermal Power Station, Korangi	316 MW
Gas Turbine Power Station, Korangi	80 MW
Gas Turbine Power Station, SITE	100 MW
Thermal Power Station, Bin Qasim	1260 MW
Total (KESC)	**1756 MW**

INDEPENDENT POWER PRODUCERS (IPPs)	
Hub Power Project	1292 MW
AES Lalpir Ltd, Mahmood Kot Muzaffargar	362 MW
AES Pak Gen, Mahmood Kot Muzaffargar	365 MW
Altern Energy Ltd, Attock	29 MW
Fauji Kabirwala Power Company, Khanewal	157 MW
Gul Ahmad Energy Ltd, Korangi	136 MW
Habibullah Coastal Power Limited	140 MW
Japan Power Generation, Lahore	120 MW
Kohenoor Energy Limited, Lahore	131 MW
Liberty Power Limited, Ghotki	232 MW
Rousch Power, Khanewal	412 MW
Saba Power Company, Sheikhupura	114 MW
Southern Electric Power Company Limited, Raiwind	135 MW
Tapal Energy Limited, Karachi	126 MW
Uch Power Limited, Dera Murad Jamali, Nasirabad	586 MW
Attock Gen Limited, Morgah Rawalpindi	165 MW
Atlas Power, Sheikhupura	225 MW
Kot Addu Power Company Limited (Privatized)	1638 MW
Total (IPPs):	**6365 MW**

PAKISTAN ATOMIC ENERGY COMMISSION	
KANUPP	137 MW
CHASNUPP-1	325 MW
Total (Nuclear)	**462 MW**

Hydel electricity generated by WAPDA varies between two extremes, a minimum of 2,414 MW and a maximum of 6,761 MW, depending largely on river flow.

Total Power Generation Capacity of Pakistan (including all sources) is **19,810 MW**. The electricity demand (as of April 2010) is 14,500 MW while PEPCO is merely generating 10,000 MW. The power generation companies are not buying furnace oil from PSO due to constraints on cash flow. This is the reason that refineries like PRL are operating at 40% of their capacity.

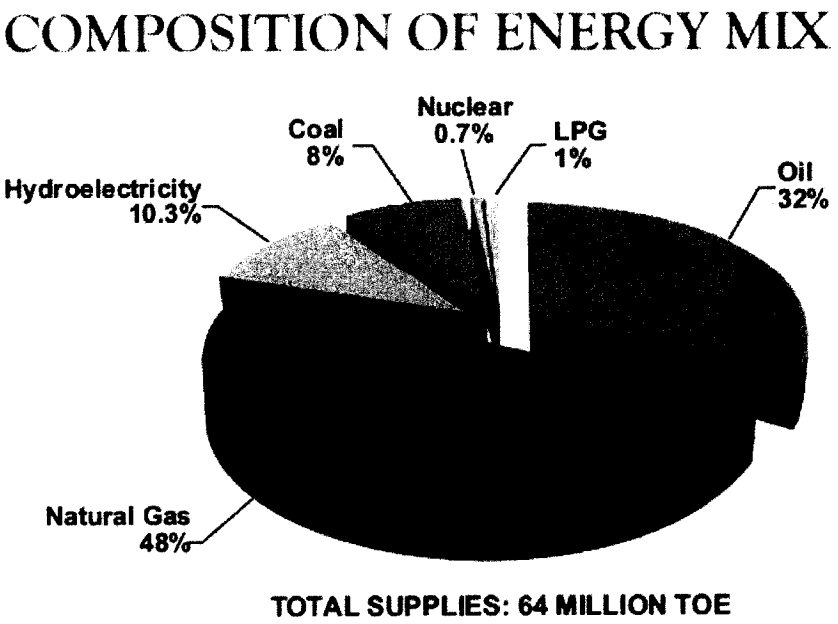


Figure 1.3: Electrical Power Generation Capacity and Power Demand in Pakistan

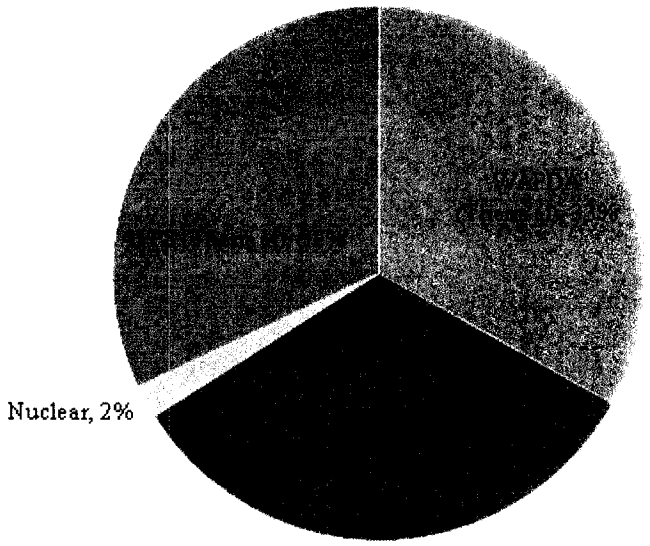


Figure1.4: Electrical Power Generation Capacity

1.4.2 Energy Consumption

Pakistan's total energy consumption, according to Pakistan Economic Survey 2011-12, stood at 38.8 million tonnes of oil equivalent (TOE) in 2010-11. The pattern of usage of different sources of energy such as Liquid Petroleum Gas (LPG), electricity and coal has been broadly similar since 2005-06. The share of gas consumption was 43.2 percent of the total energy mix, followed by oil 29.0 percent. As shown in the following table, the major consumption source of natural gas witnessed an increase in share of almost 4 percentage points during 2010-11 compared with that in 2005-06. This is attributed to the substitution of the expensive liquid hydrocarbon with the much too cheap natural gas.

Cost of producing energy from different fossil fuels ranges from $2-4 per million BTUs for coal to $19-20 per million BTUs from oil. Cost of energy from natural gas varies and depends on the source. In Pakistan, the cost of production of domestic natural gas is in the range of $2 to $4 per million BTU. Cost of shale gas in the United States is about $2 per million BTU, while if the Iran or Pakistan-Turkeministan pipeline project materializes, the cost of gas may range from $10 to $12 per million BTUs.

The liquid hydrocarbon has become the most expensive fuel because of Pakistan's imports at high international prices which for various reasons are generally above $110 per barrel. This aspect has reduced the share of oil consumption by 3.0 percentage points during the last 12 years.

Table 1.1: Annual Energy Consumption

	Petroleum Products		Gas		Electricity		Coal	
Fiscal Year	Tonnes (000)	Change (%)	(mmcft)	Change (%)	(Gwh)	Change (%)	M.T* (000)	Change (%)
2001-02	16,960	-3.9	824,604	7.4	50,622	4.2	4,409	9.0
2002-03	16,452	-3.0	872,264	5.8	52,656	4.0	4,890	10.9
2003-04	13,421	-18.4	1,051,418	20.5	57,491	9.2	6,065	24.0
2004-05	14,671	9.3	1,161,043	10.4	61,327	6.7	7,894	30.2
2005-06	14,627	-0.3	1,223,385	5.4	67,603	10.2	7,714	-2.3
2006-07	16,847	15.2	1,221,994	-0.1	72,712	7.6	7,894	2.3
2007-08	18,080	7.3	1,275,212	4.4	73,400	0.9	10,111	28.1
2008-09	17,911	-0.9	1,269,433	-0.5	70,371	-4.1	8,390	-17.0
2009-10	19,132	6.8	1,277,821	0.66	74,348	5.7	8,139	-3.0

Source Pakistan Economic Survey 2011-12

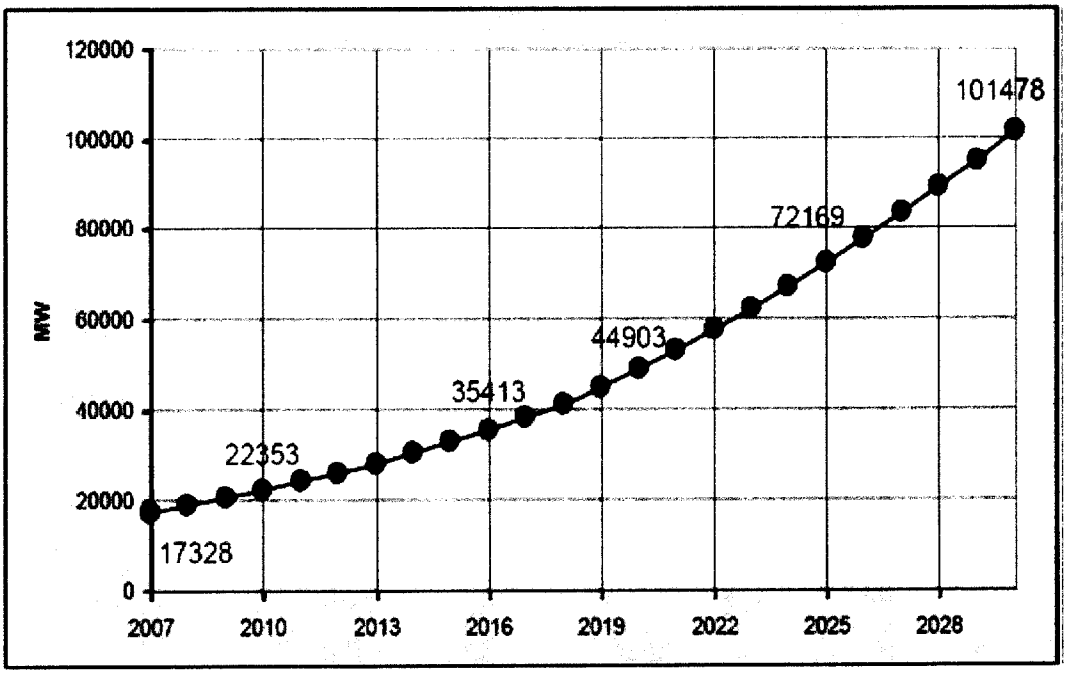


Figure 1.5: Electric Power Demand (2005-2025) Pakistan

It is apparent from Table 1.1 that despite an increase in the energy demand during the last decade, the supply failed to match the growth due to among other reasons, lack of incentives for development of renewable energy sources.

The supply shortfall of natural gas has ranged between 10-15 per cent of demand. Consumption of gas has increased from 825 Bcft in 2001-02 to 1,241 Bcft in 2011-12, with CNG recoding the highest increase from 07 Bcft in 2001-02 to 134 Bcft in 2011-12, and the industrial sector consumption increasing from 151 Bcft in 2001-02 to 334 Bcft in 2009-10 and 292 Bcft in 2010-11.

The net demand of gas during 2012-13 is expected to be around 5.497 Bcf/d which will expand further to around 6.354 Bcf/d by 2015-16, with gas shortfall estimated to expand from 2.458 Bcf/d in 2011-12 to 3.021 Bcf/d in 2015-16 as is obvious from demand-supply position.

Presently about 70 per cent of crude oil and 55 per cent of POL consumption is met through imports. Pakistan had 28 trillion cubic feet reserves of natural gas in 2006 but due to increase in its demand it is expected to be exhausted in next two decades. This obviously requires additional sources of energy to be tapped.

The wide gap between supply and demand has given rise to planned and unplanned electricity loadsheddings/blackouts, for which the government has increased the cut-off hours to 8 hours in the urban areas and 12 hours in the rural since the year 2010.

Industrial sector is the worst hit by the blackouts. It has lost more than $4 billion over the last two years due to electricity and gas shortages. In addition, environmental degradation and pollution due to use of biomass being burned is also problematic. Rising fuel prices have also raised the cost of production.

Acute energy crisis has particularly crippled the textile industry. The industry is compelled to reduce its production at least by one-third. Low supplies of gas have resulted in only three and a half days of gas supply to textile factories in one week, especially in the main industrial hubs of Punjab. The textile factories rely increasingly on the PEPCO feeders in the absence of gas supply. Due to shortfall in both sources, textile exports which is the major export earner and employer of manpower, is forced to decline. Textile exports declined by 1.30 per cent during the five months (July-November 2011) of 2011.

Rising fuel costs and non-availability of dependable sources of energy have raised the cost of production and cost of living to the extent that the small factories, workshops and businesses in the organized and unorganized sectors have had to close down the entire business and lay off their workers. Shortage of liquefied petroleum gas (LPG) and condensed natural gas (CNG) have disrupted household, transportation and commercial activities in urban areas. The demand for LPG, widely used for cooking in households, far exceeds the supply, while CNG, which is used to fuel the operation of motor vehicles, has been subjected to load shedding for two to three days a week.

This is not all. Pakistan has to face the burden of: 1) Aging and inadequate infrastructure resulting in higher line losses, 2) Failure to pay its own bills for electricity on time and almost defaulting on payments to nine independent power providers in a situation known as "Circular Debt", which amounts to $800 to $900 million, and 3) Rise of Government's energy sector debt to $4.4 billion since collection from consumers is not enough to cover the cost of generation.

According to Pakistan Economic Survey 2011-12, electricity and gas shortages are considered to be the primary cause of constrained production activities in a number of industries. Energy intensive industries (Petroleum, Iron and Steel, Engineering Industries and Electrical) shaved off 0.2 percentage points from real GDP growth in 2010-11 and in 2011-12. Also, the estimated cost of the power shortage crisis to the economy is approximately Rs.380 billion per year, which is around 2 percent of GDP, while the cost of subsidies given to the power sector to the exchequer in the last four years (2008-2012) is another 2.5 percent of GDP, (Rs. 1100 billion). The liquidity crunch in the power sector has resulted in under utilization of installed capacity of up to 4000 MW. The situation described above has affected investments in the power sector (Pakistan Economic Survey 2011-12, page 196).

Pakistan has reached the above critical stage due mainly to its adoption of agenda of the non-sustainable rapid GDP growth. The country therefore exhausted its resources much sooner than planned. It tried to increase its per capita energy consumption from 14 million BTU to anywhere near the world average of 71 million BTUs (US EIA 2009 US Energy Information Administration for 2009), and may have increased its per capita consumption of energy by sustainable growth strategies. However, there was an abrupt change in global scenario with respect to rise in consumption and the consequent increase in the gap between supply and demand of liquid and gaseous hydrocarbon whose price was raisen beyond reach of growing economies. There was a global slow down in economic growth, and Pakistan was not alone in facing the crisis.

1.4.3 Pakistan's Resolve to Amend

To ensure energy security and sustainable development in the country, the government has taken measures to diversify its energy mix. In this regard, the government has given due attention to fast track the development of Alternative / Renewable Energy (ARE) resources in the country. The Alternative Energy Development Board (AEDB) has updated the Renewable Energy (RE) Policy, 2006, in consultation with the provinces and other stakeholders. The policy includes all (Alternative Renewable Energy (ARE) technologies including Wind, Solar, Hydro, Biogas, Cogeneration, Waste-to-Energy, and Geothermal; providing extremely attractive financial and fiscal incentives to both local and foreign investors while offering them a level playing field. It is expected that the renewable energy policy and government's keen interest in energy sector will improve the power shortage situation significantly in near future.

AEDB has initiated a number of supportive measures that were required to be taken for laying a strong foundation of the ARE sector in Pakistan (Pakistan Economic Survey 2011-12, page 217). In this regard:

- Establishment of Wind Power production systems was initiated as one of the alternative renewable sources, and Gharo-Jhimpir Corridor was identified to harness the potential of this renewable source and thus to meet the rapidly growing demand of the industries, commercial organizations and the urban housing sector.
- New wind corridors in areas outside Sindh have been identified. Resource assessment of these corridors is underway and a number of wind measuring masts are being installed in all four provinces.
- National Grid Code for wind power projects has been amended. Grid Integration Plan 2010-2015 for wind power projects is developed by AEDB to support National Transmission and Dispatch Company (NTDC).
- Regional Environmental Study has been conducted by AEDB to support wind power projects. Guidelines for environmental assessment have also been developed.
- Asian Development Bank has been taken onboard to provide guarantee to the wind power project developers in order to mitigate the country risk.
- Local manufacturing of micro wind turbine has been started. Manufacturing for large wind turbines is also being initiated. The turbine towers for the first wind project are being manufactured in Pakistan.
- Issues related to financing of projects have been resolved and now leading financing agencies like International Finance Corporation (IFC), Asian Development Bank (ADB), Organization of the Petroleum Exporting Countries (OPIC), Islamic Development Bank and Economic Cooperation Organization (ECO) Trade Bank are offering financing to wind power projects in Pakistan.

1.4.4 Global Energy Supply Scenario/Global Demand Forecast

The following are the alternative renewable energy sources that are renewable and do not deplete:

Solar Influence Dependent

- Solar radiation
- Biomass
- Wind
- Ocean wave energy

Earth-related

- Tidal Energy due to earth's rotation
- Geo-thermal energy due to heat of earth's interior.

The global rise in wind power production is shown in the figure 1.6 and 1.7:

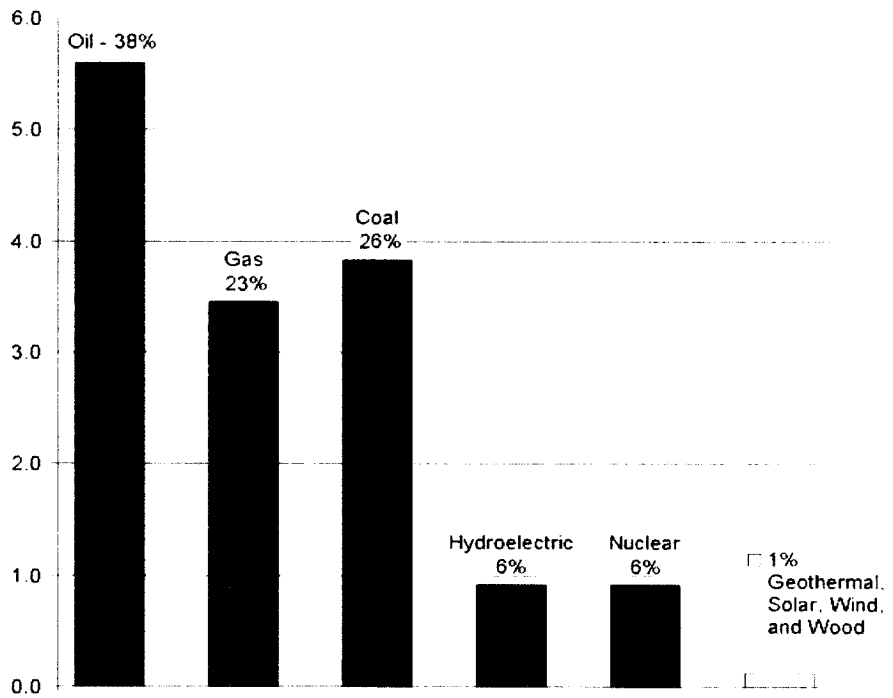


Figure 1.6: Worldwide Energy Supply in Terawatts TW

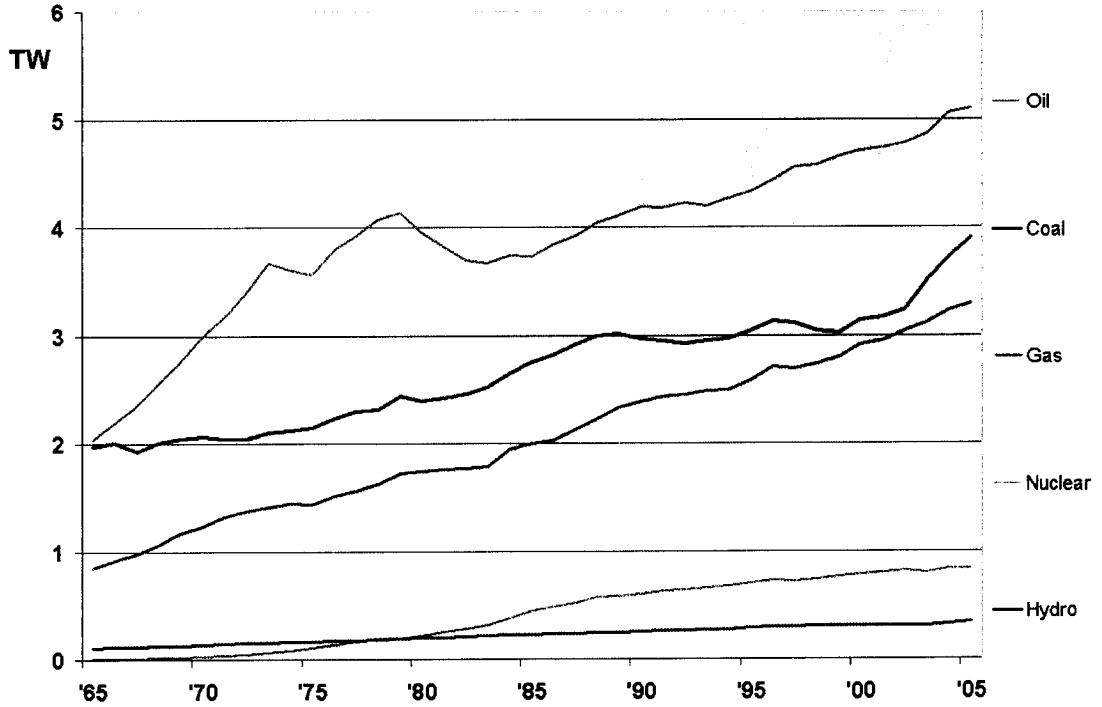


Figure 1.7: Rate of World Energy Usage in Terawatts (TW), 1965-2005

According to estimates on Global Demand Forecast:

- Wind and solar power-generation system combined will match conventional generation systems by 2025
- Wind power generation capacity will reach 7,500GW by 2025
- Conventional power stations will be phased out completely by 2037
- Demand for energy supply is expected to rise by 50 per cent globally by 2030
- Low-carbon energy industry is set to be worth $3 trillion per year by 2050.

1.4.5 Global Status of Wind Power Production System

The following is the current status of global wind energy production system (Highlights of the World Wind Energy Report 2011):

- The worldwide wind capacity reached 237,016 Megawatt, out of which 40,053 Megawatt were added in 2011, more than ever before.
- Altogether, 98 countries and regions have been identified worldwide to use wind power for electricity generation.
- Wind power showed a growth rate of 20.3 %, the lowest rate in more than a decade.
- All wind turbines installed by the end of 2011 worldwide can provide 500 Terawatthours per annum, around 3 % of the global electricity consumption.
- The wind sector in 2011 had a turnover of 50 billion Euro/65 billion USD.

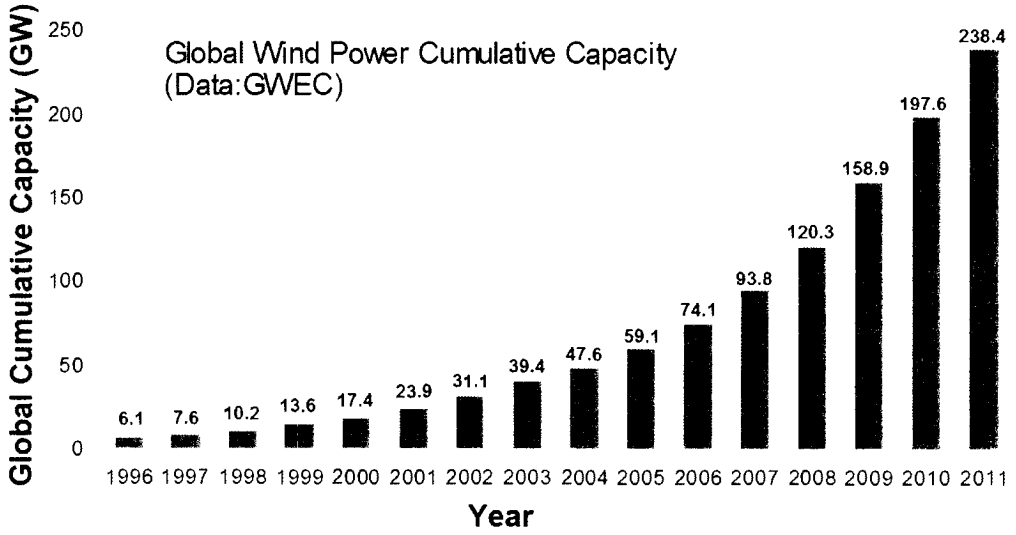


Figure 1.8: Global Wind Power Cumulative Capacity

Among the Continents:

- Asia accounted for the largest share of new installations 53.7%,
- Europe 21.9 %
- North America 20.5 %
- Latin America accounted for 2.9 %
- Australia/Oceania for 0.9 %.
- Africa (0.2 %) represented only a negligible share.
- Germany has taken a lead in this connection and has been supported by other European countries
- Many states in the USA and many provinces in Canada are successfully generating clean and cheap wind energy.

Among Asian Countries:

- China and India have followed the European Countries with considerable success, knowing fully well the growing demand and increasing limitations of relying on power generation technologies dependent on petroleum oil and water.
- China continued to be by far the largest market and added 17.6 Gigawatt; however, in 2011 it showed an unexpected decrease in new installations.
- India re-gained old strength and became the third largest market for new wind turbines, adding 2.8 Gigawatt. Recent studies suggest that the country has a much larger wind potential than assessed earlier.
- India has had the experience of aftermath of withdrawal of subsidies. It is reported that the Indian Ministry of New and Renewable Energy (MNRE) had introduced generation-based incentive (GBI) in 2009. Feed-in-tariff is the high rate that the MNRE had given to developers to promote clean energy. The GBI scheme was in addition to the government's promotional scheme, AD, launched in the 1990s. AD allowed companies investing in wind farms to save about 80 per cent of invested capital in the first year.
- GBI scheme lapsed in March 2012 and was not renewed. The Union finance ministry withdrew AD saying people were investing in wind farms only to avail tax benefits. The AD was the main driver for the sector since 70 per cent of wind energy addition

came from this scheme. However, it also led to installation of poor quality wind farms; the result was that prime wind locations in the country were lost.

- The other reasons for the decline in installed capacity are state specific but in general it was related to cash crunch, which is not easily available in developing economies seeking rapid growth. In Tamil Nadu, the state-owned utility did not pay the wind power producers their dues for more than a year. Tamil Nadu Electricity Board started clearing the dues after too much delay. The uncertainty made the banks reluctant to finance wind energy projects.
- Pakistan's geographical location in the tropics provides the country with a number of wind corridors. According to estimates based on the surveys carried out for the AEDB, there exists potential of about 43,000 MW for generating wind energy in the 9,700 km^2 area in (i) Jamshoro, Nooriabad, Talhar and Keti Bandar corridor, and (ii) Thatta, Thana Bola Khan, Hyderabad and Gharo sites that are placed respectively in the excellent and good category for generation of wind power. The site allotted to NBT II & III Wind Power Project is located in the Thatta / Thana Bola Khan/Hyderabad corridor and considered very suitable for wind power generation.
- Pakistan has about 1000 MW of wind power plants at various stages of planning and construction, and another 50x10 megawatts of wind power programs have been announced, in Jhimpir, Gharo, Keti Bandar and Port Qasim wind corridors along the Arabian Sea coast in Sindh. Some of the major wind power projects are at different stages of construction/completion include American AES Corporation's 150 MW farm, Turkey's Zorlu Enerji Electrik Uretim's 56 MW farm, and Pakistan's FFC Energy's 50 MW farm.
- In recent years, the government has completed several projects to demonstrate that wind energy is viable in the country. In Mirpur Sakro, 85 micro turbines have been installed to power 356 homes. In Kund Malir, 40 micro turbines have been installed, which power 111 homes. The Alternative Energy Development Board (AEDB) has also acquired 18,000 acres for building wind farms. Pakistan has set a goal for AEDB to generate at least 5 percent of the country's electricity needs from renewable sources by 2030.

1.5 Benefits Of Wind Farm Development

A large wind farm may consist of several hundred individual wind turbines which are connected to the electric power transmission network. Offshore wind power facilities can harness better wind speeds that are available over the sea almost throughout the year, compared to those installed on land. Small onshore wind facilities are used to provide electricity to isolated locations and utility companies increasingly buy back surplus electricity produced by small domestic wind turbines.

Although a variable source of power, the intermittency of wind seldom creates problems when using wind power to supply up to 20% of total electricity demand. But as the proportion rises, increased costs are involved since the grid needs to be balanced. Then there is need for upgrading the grid. Power management becomes an important component of the power production system and techniques such as excess capacity, storage, dispatchable backup supply (usually natural gas), exporting and importing power to neighboring areas or reducing demand when wind production is low, have to be developed to mitigate the situation.

Good wind resources are not a constraint to wind power development at this time because Pakistan has abundant good wind resources in the land of the designated Wind Corridor. The necessary conditions for successful operation of an average wind farm are moderately constraining land use and environmental restriction assumptions, and a 10-mile proximity to existing transmission line assumption.

Wind power, as an alternative to fossil fuels, is plentiful, renewable, widely distributed, clean, and produces no greenhouse gas emissions during operation. Its land use is, however, extensive. The Table 1.2 shows that requirement of land area per unit of energy produced from different sources is highest for wind power. NBT Wind Power Pakistan II (Pvt.) Ltd. has taken account of the topography of the land and the Project has proposed to site 166 1.5MW wind turbines for wind power generation.

Table 1.2: Sq kms per terawatt-hour of energy per year:	
Wind	72.1
Hydro	54.0
Solar	36.9
Natural Gas	18.6
Coal	9.7
Geothermal	7.5
Nuclear	2.4
(Source: The Nature Conservancy)	

During operation, the overall cost per unit of energy produced for wind power is similar to the cost for new coal and natural gas installations. The construction of wind farms is not universally welcomed due to the "not in my backyard" affect shared by other coal or gas fired power stations, but any effects on the environment from wind power are generally much less problematic than those of any other power source.

1.5.1 Carbon Dioxide & GHG Emissions and Pollution

The most serious threat comes from accelerating climate change, whose effects are already being seen around the world in rising temperatures, melting ice caps and volatile weather patterns. Climate change is a direct result of the build-up of greenhouse gases including carbon dioxide and water vapour in almost equal amounts besides other gases in the atmosphere above the earth. Carbon dioxide and water vapour emissions from burning of hydrocarbons for power plants, industry and the transport sector are by far the largest contributor to global warming. Additional water vapour and that too in large excess is being produced over the sea surface whose temperature has increased by at least 1°C to 1.5°C as a result of expansion of deforested land mass. Too much of water vapour will result in as much condensation over snow cover, and since latent heat of evaporation is equal to latent heat of condensation just as much energy that the vapour has been charged with, will be shed at the mountain tops and glaciers. It is therefore the excessive heat over the land mass that produces excessive moisture which in turn melts the snow and the glaciers.

The Intergovernmental Panel on Climate Change has predicted that human-induced greenhouse gas emissions will lead to a substantial increase in global mean temperatures, which will rise between 1.4 and 5.8 degrees over the course of this century.

- Wind power generation does not require fuel for turbine operation, and has no emissions directly related to electricity production. As such operation of wind turbines does not produce water vapour, CO_2, SO_2, NOx or particulate matter or any other form of air pollutant. The manufacturing, transportation, construction at site and installation, however, does consume resources and it is here that energy-intensive processes, generally using fossil fuel are involved.
- The following indicative figures relate to a 250 MW installed capacity and the production of 1 tonne CO_2 for the generation of each 1 MWh of electricity:
- CO_2 (a major contributor to the "greenhouse effect") 0.775 million tonnes/year.
- H_2O vapour: 0.634 million tones/year
- SO_2 (Sulphur Dioxide is a constituent of acid rain) 11,875 tonnes/year.
- NOx (Nitrous Oxides are a constituent of acid rain) 5,750 tonnes/year.
- Producing energy from the proposed wind farm will restrain these emissions and thus help the GOP's environmental initiatives.
- Developing a renewable energy resource will lessen the need to use fossil fuels such as coal. This conforms with the keenness of GOP to increase the share of renewable energy in electricity production, and its commitments to Kyoto Protocol. Reduction in the gas emissions from fossil fuel generation will be achieved, although the amount obviously depends on the wind farm installed capacity.

1.5.2 Net Energy Gain

The energy return on investment (EROI) for wind energy is equal to the cumulative electricity generated divided by the cumulative primary energy required to build and maintain a turbine.

The EROI for wind ranges from 5 to 35, with an average of around 18. EROI is strongly proportional to turbine size, and larger late-generation turbines are at the high end of this range, at or above 35. This suggests that higher capacity wind turbines are likely to bring better EORI and also better return on investment.

It may be noted that since energy produced by a WTG is several times the energy consumed in construction, there is a net energy gain. It is estimated that reductions in CO_2 emissions range from 0.33 to 0.59 tonnes of CO_2 per MWh. The energy used for construction is produced by the wind turbine within a few months of operation. Thus the initial carbon dioxide emissions will be paid back within about 9 months of operation.

1.5.3 Benefits of Establishment of the wind power generation system

Benefits of establishment of wind power generation system include:

- Reduction in carbon dioxide, water vapour and other greenhouse gas emission through net energy gain
- Benefit to Alternative Energy Development Board in achieving the objectives of the Government of Pakistan Policy and Guidelines on development and generation of Alternative or Renewable Energy for Power Generation-2006 to involve the private sector in generation of power through renewable resources.
- Benefit to National electricity production system in making renewable energy available to the National Grid of the WAPDA, the main stakeholder.
- Reduction in vulnerability to volatile utility prices.

- Contribution to enhancement in quality of environment of the hinterland of the Wind Corridor and restoration of the status of the area as the major user of wind power by producing sustainable form of energy.
- Contribution to enhancement in quality of life of the people resident in the area that has lost its water, surface soil, vegetative cover, besides the fauna as well as flora and is left with meagre resources of its own, except the wind, which has the desired velocity that can be utilized for power generation.

In view of the limitations on availability of national reserves of hydrocarbons and the unpredictable flow of water in the rivers to meet the energy needs, and in consideration of the pressing need to normalize the commercial, industrial and agricultural activities, it is considered essential to broaden the outlook on the energy mix. It would be most prudent therefore to explore indigenous renewable as well as non-renewable sources, and also to take immediate steps to give due share to the renewable sources and harness their potential since the conventional sources are no longer reliable.

1.6 Current Status of Project

The following milestones have been achieved:

- NBT has obtained the two Letters of Intent (LOIs) from the Alternative Energy Development Board (AEDB) for development of two 250 MW Wind Power Projects at UC Jhangri, Union Administration Jhimpir, 135 km to the northeast of Karachi City.
- NBT has received Provisional Land Allotment letter from the Government of Sindh giving it the right to use the wind farm site for development and construction work in the Jhimpir Wind Corridor in District Thatta, which is accessed from the Super Highway at milestone 135 km from Karachi.
- Feasibility Report for establishment of the 2 x 250 MW Wind Power Projects that will comprise 166 (NBT II) and 167 (NBT III) units of 1.5 MW wind turbines at the locations bounded by the following coordinates:

S. No.	Longitude	Latitude
1	25°18'22.34"N	68° 4'14.38"E
2	25°20'38.87"N	67°59'8.27"E
3	25°27'19.80"N	68° 0'36.03"E
4	25°26'0.15"N	68° 4'56.96"E
5	25°27'42.83"N	68° 5'57.46"E
6	25°22'32.95"N	68°13'6.80"E

- Wind data for FFC, Lucky and Jhirak Wind farms located in the same corridor (Jhimpir) where masts are installed according to IEC recommendation have been acquired from and provided by Wind Rose Consultancy.

1.7 Environmental Impact Assessment

This Environmental Impact Assessment (EIA) evaluates the potential environmental, social, economic, cultural, and ecological impacts of the proposed NBT (II) Wind Power Project. Environmental Management Consultants (EMC) and URS Pakistan have been contracted by NBT Wind Power Pakistan II (Pvt.) Ltd. to conduct a detailed assessment (EIA) of the proposed Wind Farm Project.

1.8 Scope of EIA Study

This EIA study of NBT (II) Wind Power Project is aimed at developing the environmental and socioeconomic profile of the project area so as to evaluate the existing physical, biological and socioeconomic aspects leading to respective impacts due to construction and operations at the Wind Farm.

The main purpose of the EIA study is to ensure that:

- Any major adverse impact on the environment (physical, ecological and social) during different phases of projects viz. siting, design, construction and operation are identified.
- Adverse impacts are appropriately addressed and adequate mitigation measures are incorporated in the siting, design, construction and operation phases of project.
- Socioeconomic aspects are identified, and mitigated.
- Alternatives to achieve the objectives are analyzed.
- Environmental Management Plan (EMP) for sustainable development and operation of the project is developed for implementation and monitoring of the project activities.

The present EIA report has identified the significant environmental aspects and screened them for severity, if any, to ensure 1) that the likely impacts due to proposed activities during construction, installation of masts and WTGs and operation of the proposed wind farm, and the residual impact on adoption of mitigation measures have been critically assessed, and 2) that all activities comply with the Pakistan Environmental Protection Act 1997, and the World Bank, IFC and ADB Guidelines.

1.9 Categorization of Project

Section 12 of Pakistan Environmental Protection Act 1997 and Pakistan Environmental Protection Agency (Review of IEE/EIA) Regulations 2000 require that every new development project in Pakistan has to be preceded by an Initial Environmental Examination (IEE) or Environmental Impact Assessment (EIA) depending upon the magnitude of the project and severity of impacts anticipated at the time of commissioning of the project.

PEPA (Review of IEE/EIA) Regulations 2000 categorize projects into two separate schedules depending on whether a project requires an IEE (Schedule-I) or an EIA (Schedule-II). The Regulations also require that all projects located in environmentally sensitive areas need submission of an EIA.

Thermal power generation of less than 200MW and hydroelectric generation of less than 50MW falls in Schedule I - lists of projects requiring an IEE while thermal power generation of more than 200MW and hydroelectric generation of more than 50MW fall in Schedule II - lists of projects requiring an EIA. Power generation from the wind turbines is not included in the existing schedules and hence is not covered in the environmental regulations of Pakistan. Of recent the SEPA has taken the initiative that all Wind Farm Projects of capscity larger than 50MW will submit an EIA.

The cost of the proposed NBT (II) Wind Power Project as well as its sensitivity with respect to impacts on the physical, biological and social environment suggest that it will be more prudent to place it in the category of projects requiring EIA under Schedule-II

(Clause-A3: Transmission lines (11 KV and above) and grid stations) of PEPA (Review of IEE/EIA) Regulations 2000. Accordingly an EIA Study has been conducted, and the same will be submitted to seek approval prior to project initiation.

1.9.1 Methodology for Environmental Assessment Study

The environmental assessment (examination and evaluation) is primarily based on simple comparative evaluation approach. Initially the baseline or the profile of the project area is developed by site surveys, collecting data, records and information on physical, ecological/biological as well as socioeconomic environment. The data so compiled is then projected or modeled for different phases of projects, i.e. design, construction, and operations. The likely changes in the critical environmental aspects or significant changes in the ambient environmental parameters are identified. Identification, assessment and evaluation of significant impact either in qualitative or quantitative terms is carried out for which appropriate mitigation measures are proposed.

1.9.2 Methodology Adopted for Social Aspects

A Team of environmentalists and environmental sociologists held consultation based on the detailed contents of the Project with main stakeholders. Environmental and social considerations being an essential component of the implementation phase of this project, the following aspects were underscored for implementing the EIA recommendations:

- Identifying the need, if any, for involuntary resettlement and for land acquisition and to prepare an appropriate Involuntary Resettlement Program.
- Reducing the impact on the living environment during the construction period, selecting appropriate construction methods and construction schedule.

Accordingly the EIA study has:

- Conducted public consultation at the early stage.
- Held stakeholders meetings during the study.
- Understood in detail the concerns of Persons resident in the villages that are outside the project land area.

Consultation meeting with stakeholders including the village residents has revealed that:

- Agreement between NBT Wind Power Pakistan II (Pvt.) Ltd. and the AEDB/GoS provides for acquisition of land for installation of Wind Power Project from the Revenue Department, Government of Sindh and from the rightful owners of land.
- Residents of the villages are rightful owners of some portion of land located at but immediately outside Project boundary. Residents of Jhangri who have some land at but outside the project area have documents that confirm their ownership.
- They were all for development of the Wind Farm and were prepared to share their land with the Proponent after negotiation for compensation in case of land acquisition and / or involuntary resettlement.

This EIA report presents the existing environmental scenario and the results from the assessment and evaluation of the environmental aspects emerging during the installation and operation phases of wind turbines. Following screening of potential environmental aspects, the assessed and evaluated impacts requiring necessary mitigation measures are suggested in the report. The report also includes the Environmental Management and

Monitoring Program that will be implemented during siting, construction and operation phases.

The methodology specifically adopted for conducting the EIA of the Project may be summarized as follows:

1.9.3 Project Specific Data Collection

The foremost step was to get the maximum information on physical aspects of the project, as well as construction and operation activities from the proponent.

The next step involved visits by the environmental assessment team comprising group of experts to the project area and its vicinity to conduct reconnaissance survey and to collect baseline data in the context to environmental (physical and ecological) and social aspects.

The survey included a focused group discussion with locals as part of information disclosure and public consultation. Detailed data collection Surveys on physical, biological and social aspects of the area and its surroundings. This included:

- Flora, Fauna including Birdlife survey;
- Detailed socioeconomic survey of the project area;
- Stakeholders Consultation including primary stakeholders and secondary stakeholders including NGOs like IUCN and WWF;
- Literature Review;
- All possible archives and published literature was surveyed along with previous IEE/EIA studies conducted in the region;
- Legislative requirements and regulatory requirements pertaining to the project were also reviewed. These included:
- Environmental Regulations, Standards & Guidelines.
- Environmental issues concerning protection and control governed by Pakistan Environmental Protection Act (PEPA) 1997.
- Legal Requirements in Pakistan for Environmental Assessment for New Projects under the Environmental Protection Agency Sindh (SEPA);
- National Environmental Quality Standards (NEQS) for gaseous, vehicular exhaust emissions; noise emissions, and liquid effluents;
- Sindh Wildlife Protection Ordinance 1972;
- Antiquities Act 1975;
- Forest Act, 1927;
- Civil Aviation Rules (1994)
- Biodiversity Action Plan;
- PEPA Guidelines for Public Consultation;
- PEPA Guidelines for Sensitive and Critical Areas;
- Policy for Development of Renewable Energy for Power Generation, 2006, Government of Pakistan;
- World Bank Guidelines on Environmental Assessment;
- IFC's EHS Guidelines for Wind Energy;
- IFC's EHS Guidelines for Electrical Power Transmission and Distribution;
- ADB Guidelines for Environmental Assessment;
- JICA Guidelines for Environmental Assessment;
- Equator Principles;

- Low Frequency Noise and Wind Turbine; British Wind Energy Association, February 2005.

1.9.4 Impact Identification and Assessment

- On acquisition of baseline information the environmental aspects were identified (screened) for different activities at the project siting, design, construction and operation phases.
- Subsequently the severity of impacts in terms of magnitude and significance was evaluated.
- In order to reduce the adverse impacts of the project mitigation measures were proposed to minimize the impacts and to sustain the project in an environment friendly manner.
- Environmental Management and Monitoring Plan was compiled and included in the environmental assessment report to make it more comprehensive and self-sustaining with the specific purpose of providing working guidelines for the project Proponent and Management personnel who shall be responsible for the construction and operations of the project, so as to enable them to maintain the environmental and social conditions in conformity with the PEPA regulations. The management plan outlines the details required to manage environmental, safety and community risks arising from the project activities as well as social issues. It also gives the details of monitoring that would be required during the operation phase of the project in order to comply with the requirements of sustainable development.

1.9.5 Preparation of Report

This EIA report has been prepared in accordance with the guidelines of the Pakistan Environmental Protection Agency (PEPA), World Bank and IFC. All pre-requisites of report writing in structural format, contents and presentation have been considered and met as per the standard format of the EIA document.

1.10 Structure of EIA Report

The EIA report has been structured on the standard format, prescribed by the Federal EPA. The Report has been presented in the following sections:

Section 1 - Introduction

Section 2 - Description of Project

Section 3 - Legal Requirements

Section 4 - Environmental and Social Baseline

Section 5 - Screening of Potential Environmental Impacts and Mitigation Measures

Section 6 - Public Consultation

Section 7 - Environmental Management Plan (EMP)

Section 8 - Findings, Recommendations and Conclusion

1.11 EIA Study Team

This EIA study has been conducted by a team of environmental experts. Valuable input was made by each team member who contributed in compilation of this report. Names and designation / role of the project team members are given as follows:

Table 1.1: EIA Study Team

S. #	Name	Position
1	Mr. Ali Khan & Syed Nadeem Arif	Project Managers
2	Mr. Saquib Ejaz Hussain	Env. & Social Consideration Specialist
3	Dr. Mirza Arshad Ali Beg	Senior Environmentalist
4	Dr. Badar Munir Ghauri	Air Quality Assessment Specialist
4	Dr. Syed Ali Ghalib	Birds & Wildlife Specialist
5	Dr. M. Asad Ghufran	Ecologist
6	Dr. I.H. Hashmi	Water Quality Specialist
7	Ms. Nida Kanwal	Sociologist
8	Ms. Farhat Shaheen	Environmental Scientist

2.0 Description of Project

2.1 The Project

NBT (II) Wind Power Project comprising development, ownership and operation of 250 MW Wind Power Project will be established near Super Highway in UC Jhangri and the Baran-Rod River Ecosystem in Taluka and District Thatta, Sindh Pakistan. The Project will be in accordance with GoP's policy and guidelines on development and generation of Alternative or Renewable Energy, being implemented through the Alternative Energy Development Board (AEDB). NBT Wind Power Pakistan II (Pvt.) Ltd. has acquired data on quality of wind and the annual energy availability at the Project site. The National Transmission and Dispatch Company (NTDC), which is responsible for transmission and distribution of electricity in the country, will purchase the power generated by NBT Wind Power Pakistan II (Pvt.) Ltd. through an Energy Purchase Agreement signed by the company.

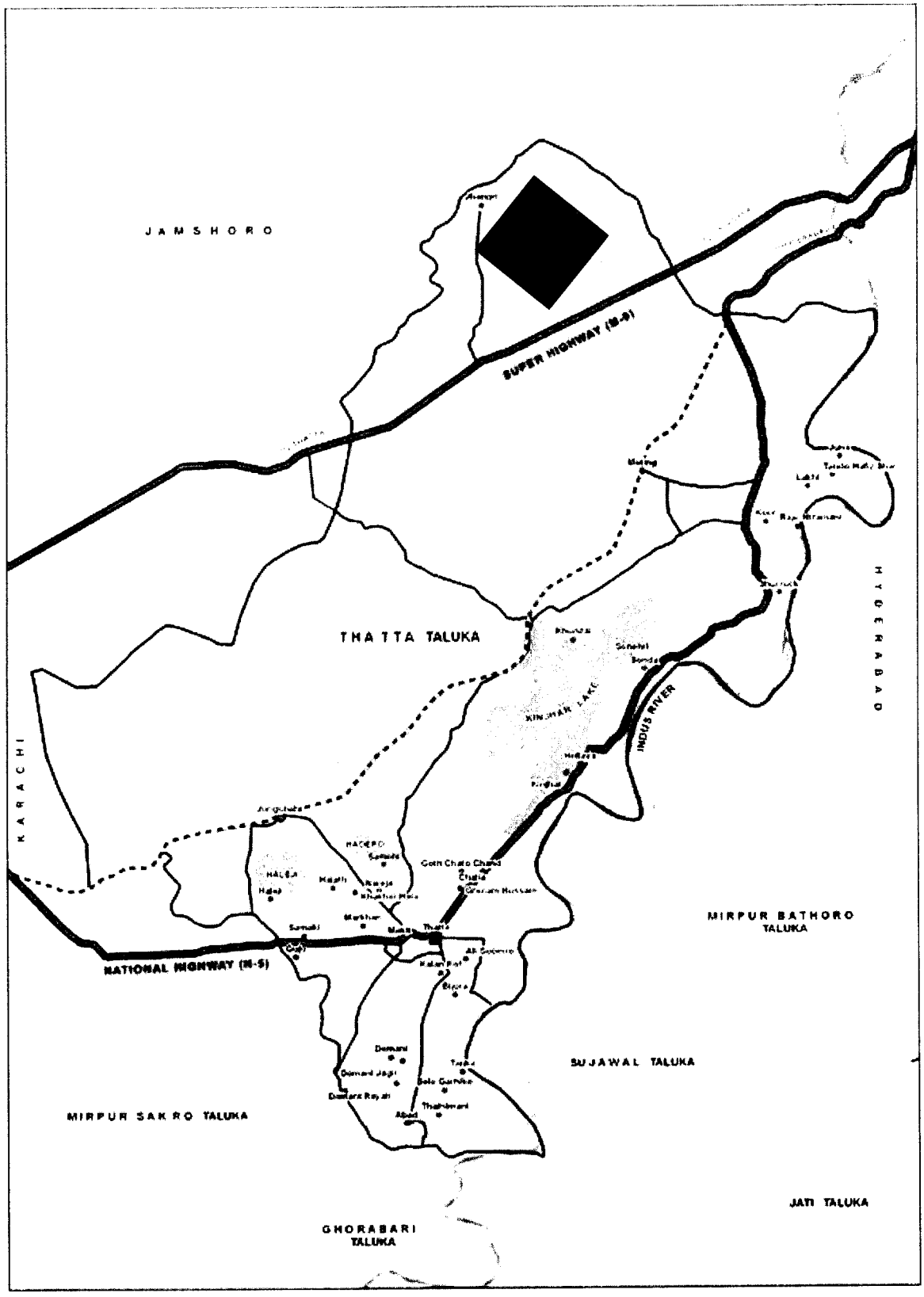


Figure 2.1: NBT (II) Wind Power Project Site

2.2 Project Components

The project components comprise the following:

- Wind resource use assessment for macro-siting the Wind Farm in the Jhimpir Wind Corridor and micro-siting the wind farm in the Stony Wasteland of the Baran Ecosystem in UC Jhangri
- Acquisition of meteorological data
- Geo-technical survey
- Appointment of the main EPC contractors for each phase of the project and signing of a memorandum of understanding (MoU) for selection of size of wind turbines on basis of wind classification arrived at from site specific meteorological data in UC Jhangri.
- Finalizing the layout plan for siting the selected wind turbines
- Logistics
- Construction of Access and Internal road network linking all wind turbines
- Procurement and Installation of the finally selected Wind turbines, likely with a generating capacity of 1.5 MW having rotor diameter of 80 to 85 m and with each turbine mounted on a prefabricated steel tower such that the hub height is 80 m.
- Installation of corresponding number of step-up transformers mounted at the foot of each turbine tower
- Construction of underground electrical collection system leading to the project sub-station
- Construction of operations and control building; substation and grid connection to NTDC 220 KV system.
- Plant O&M facility
- Operation of wind farm
- Maintenance and decommissioning.

2.3 Work Schedule

The project will be executed in phases but in parallel:

Phase 1: The first phase includes three to six months for obtaining permits and approval as well as project financing from Chinese and international banks for arrangement of project debt is in progress to provide the project finance.

Phase 2: Second Phase will involve the entire life cycle of the Project mentioned above. Construction of the Wind Farm will include the following activities:

- Grading of the field and Construction Office area (to serve also as O&M building);
- Construction of site roads, turn-around areas and crane pads at each wind turbine location;
- Piling and Construction of turbine tower foundations and transformer pads;
- Installation of electrical collection system including underground and overhead lines;
- Assembly and erection of wind turbines;
- Construction and installation of substation;
- Plant commissioning and energizing.

Work on the project is expected to commence during the second quarter of the year 2013, with the construction of the access road and site preparation (civil works). The construction phase is expected to take 18 – 20 months. The schedule of activities is expected to be as follows:

- Civil construction access roads: June 2013 - July 2013

- Site roads: June 2013 – November 2013
- WTG foundations: June 2013 - January 2014
- Electrical construction: June 2013
- Turbine delivery: November - December 2013
- Installation of Equipment: December 2013 – May 2014
- Substation transformer(s) at site: February, 2014
- Substation commissioning: May, 2014
- Collection system commissioning: June 2014
- Turbine commissioning: July – September 2014

2.4 Macro-Site Selection

Wind Power Potential of the Jhimpir Wind Corridor, the macro-site of NBT (II) Wind Power Project was established after detailed survey by Pakistan Meteorological Department in 2007. The AEDB has thereafter proceeded with:

- Completion of pre-feasibility study of the Wind Corridor,
- Issue of 45 LOIs to national and international companies for generation of 1500 MW power through wind energy by year 2015 and 9700 MW by year 2030.
- Submission of applications by seven companies to National Electric Power Regulatory Authority (NEPRA) for obtaining Generation License.
- Grant of Generation License.
- Offer of Land by AEDB in the wind corridor, and sub-lease of Land to 18 investors.
- Endorsement of Basic Wind Data collected at Jhimpir Corridor: 7.4 m/s annual average at approximately 85 meters, provided to AEDB by Pakistan Meteorological Department
- Under the Policy Guidelines the Power Purchaser would take the risk associated with wind availability i.e. underwriting of data provided by Pakistan Meteorological Department.

2.5 Determination of Wind Energy Potential For Micro-siting

2.5.1 Wind Speed Monitoring

The wind energy potential was determined for wind farm establishment by characterizing and classifying the wind and estimating the wind power density during the data collection programme of different proponents. Wind data were collected at the Project sites in Jhimpir corridor, District Thatta, Sindh. Table 2.1 show the benchmark established by the AEDB for the Jhimpir Corridor. AEDB has yet to conclude the agreement to sub-lease the land at the sites for establishment of wind farms.

Table 2.1: Monthly Benchmark Wind Speeds for Jhimpir sites

Month	Monthly Mean Wind Speeds (m/s)					
	30m	50m	60m	67m	80m	85m
January	4.25	4.70	4.90	5.02	5.24	5.3
February	4.50	4.98	5.18	5.32	5.55	5.7
March	4.77	5.28	5.50	5.64	5.89	6.0
April	6.39	7.03	7.29	7.46	7.75	7.9
May	8.29	9.05	9.36	9.56	9.90	10.0
June	8.79	9.50	9.78	9.96	10.25	10.4

July	8.83	9.59	9.89	10.08	10.40	10.5
August	8.20	8.89	9.16	9.34	9.63	9.6
September	6.63	7.28	7.54	7.72	8.01	8.1
October	4.22	4.68	4.87	5.0	5.22	5.3
November	3.59	3.98	4.14	4.24	4.43	4.5
December	3.96	4.38	4.56	4.67	4.88	5.0
Annual Average	6.0	6.6	6.8	7.0	7.3	7.4

It would be noted from Table 2.1 that the average monthly wind speed during the year is 7.4 at 85m height while during the April-September period it ranges between a minimum of 7.9m and 10.50m which is as recorded and endorsed by AEDB.

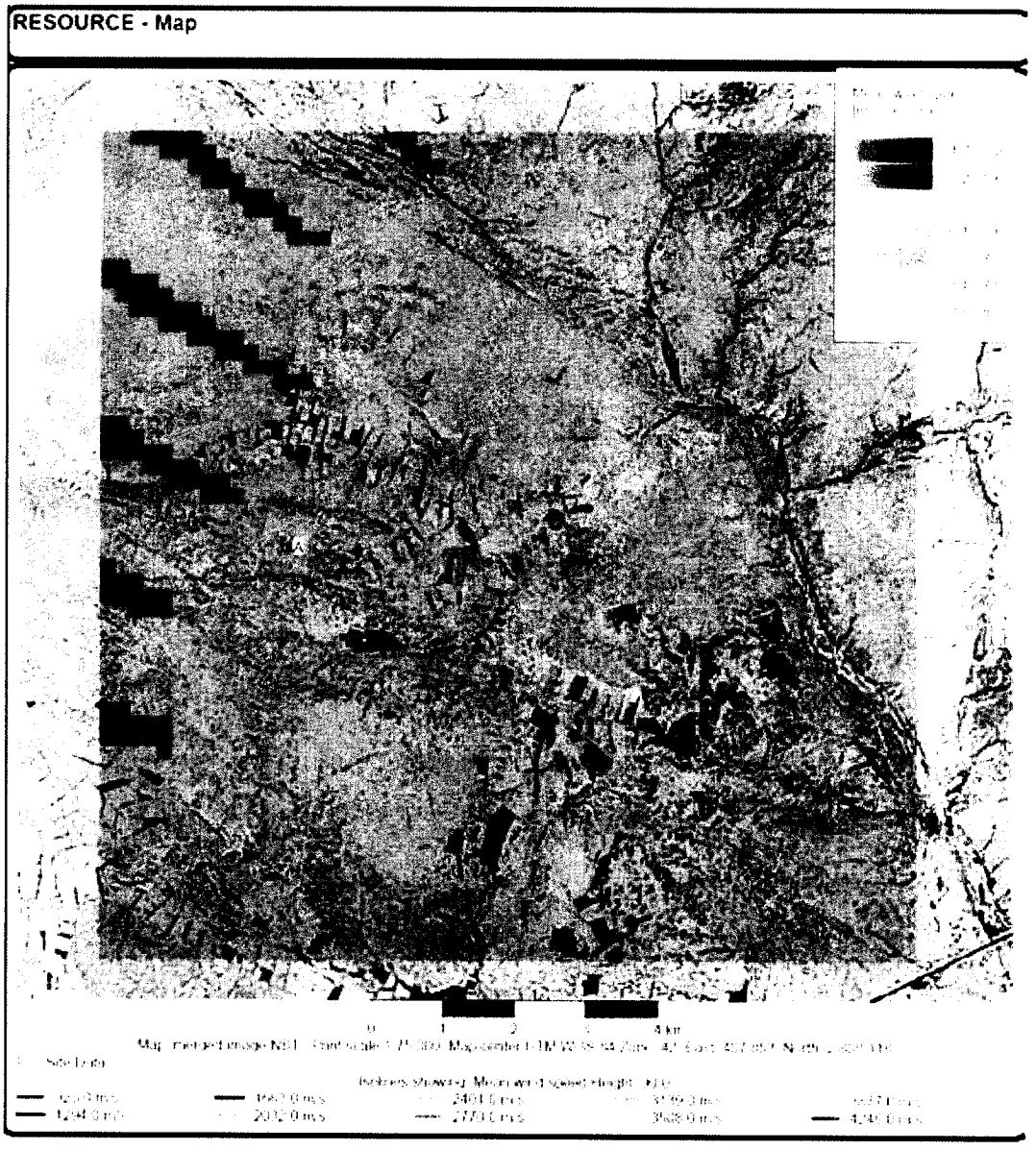


Figure 2.2: Mean Wind Speed at the Microsite

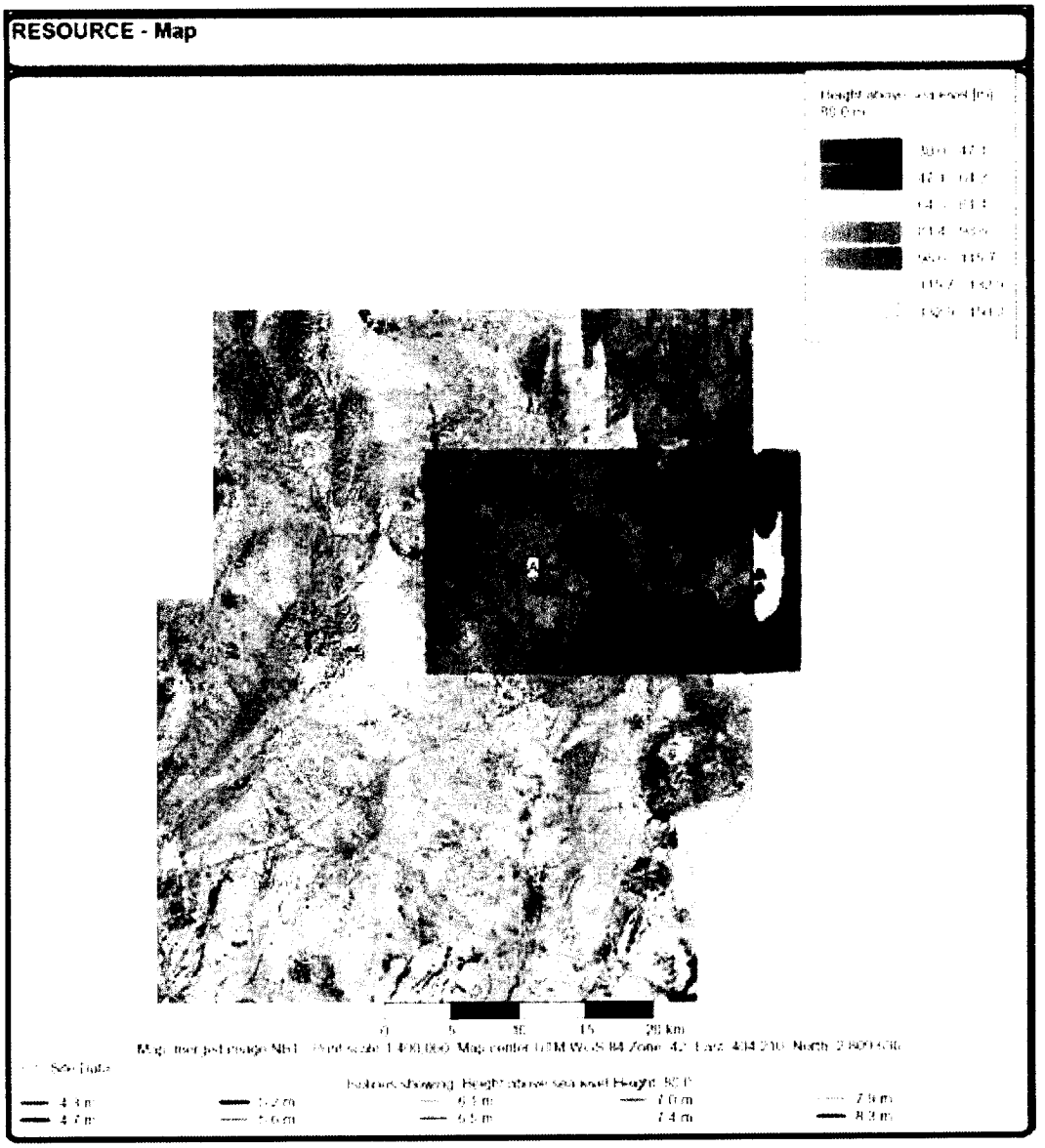


Figure 2.3: Height above Sea Level

2.5.2 Wind Characteristics

Wind potential of different areas is usually characterized by assigning one of the seven wind classes, each corresponding to range of wind speed and power density at specific height above the ground. Standard wind class definitions are shown in Table 2.2.

Table 2.2: Standard Wind Class Definition

Class	30 m Height		50 m Height	
	Speed m/s	Power W/m^2	Speed m/s	Power W/m^2
1	0- 5.1	0 -160	0 – 5.6	0 – 200
2	5.1 – 5.9	160 - 240	5.6 – 6.4	200 – 300
3	5.9 –6.5	240 - 320	6.4 –7.0	300 – 400
4	6.5 – 7.0	320 - 400	7.0 – 7.5	400 – 500
5	7.0 – 7.4	400 – 480	7.5 - 8.0	500 – 600
6	7.4 – 8.2	480 – 640	8.0 – 8.8	600 – 800
7	8.2 – 11.0	640 - 1600	8.8 – 11.9	800 – 2000

Source: Wind Power Classification of Pakistan, Pakistan Meteorological Department, Wind Mapping Project

The following figures show that by international wind classification, power density places the Jamshoro, Nooriabad, Talhar and Keti Bandar sites in the *excellent* category, while Thatta, Thana Bola Khan, Hyderabad and Gharo are placed in the category of *good* sites for generation of wind power.

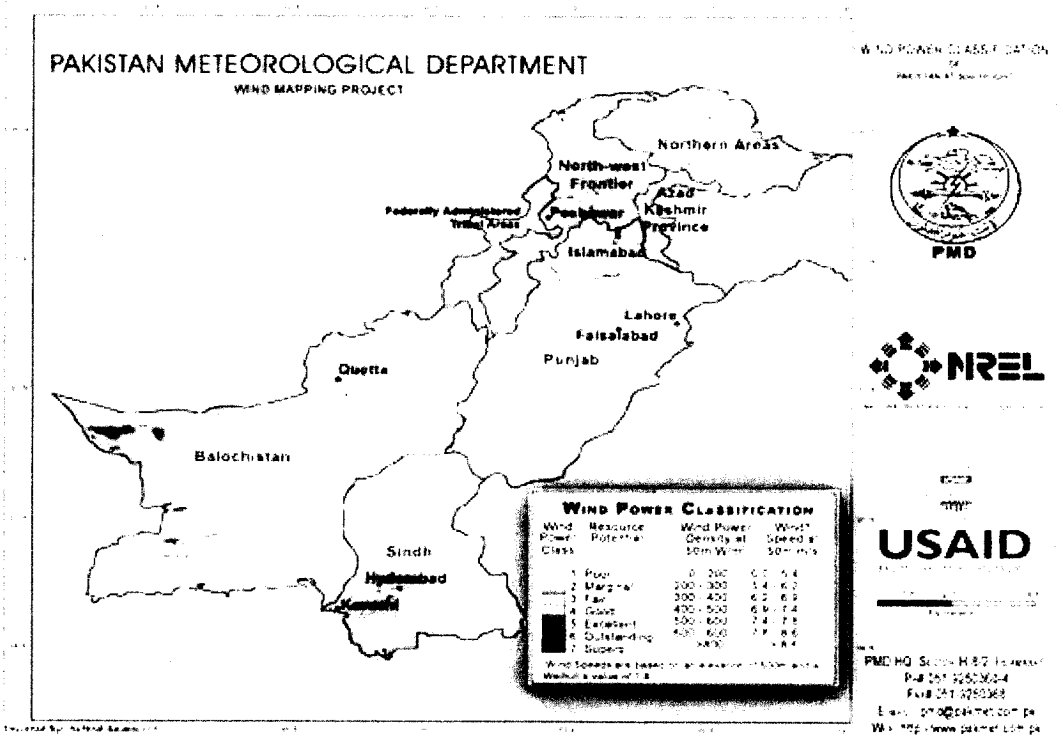


Figure 2.4: Wind Power Classification

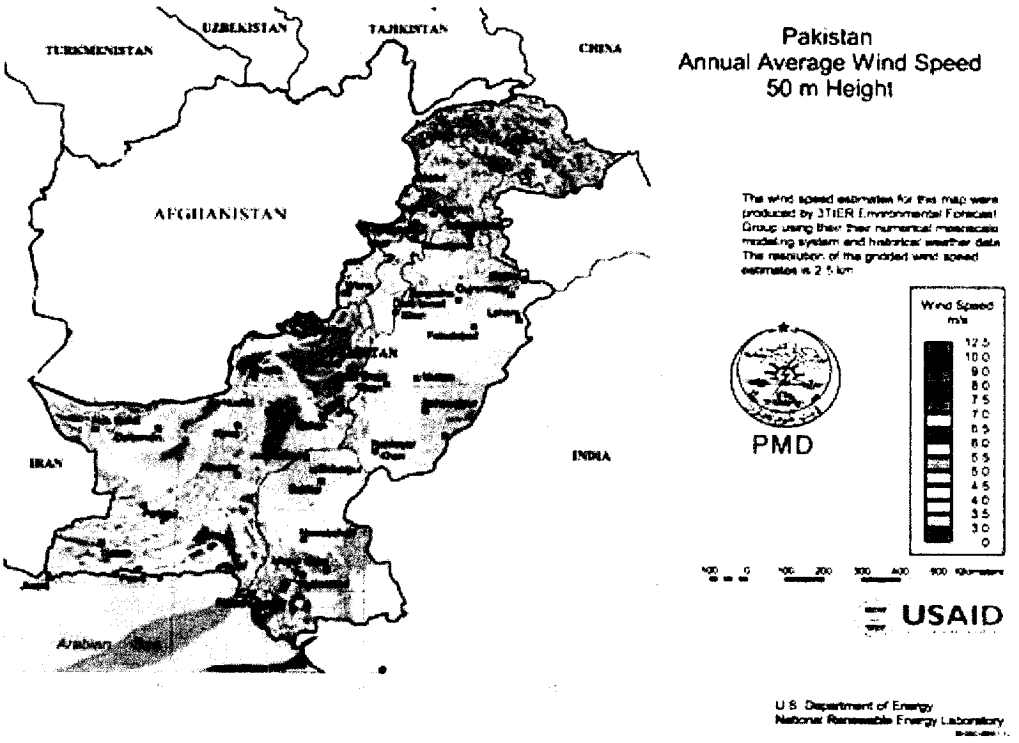


Figure 2.5: Annual Average Wind Speed at 50 m Height in Pakistan

2.6 Siting NBT (II) Wind Farm In Jhimpir Corridor

2.6.1 Wind power density

The amount of electricity produced by wind turbines depends on the amount of energy contained in the wind that flows through the area swept by the wind turbine blades in one unit of time. This energy flow is the wind power density (W/m^2), which depends on wind density cubed, which implies that the power contained in the wind increases very rapidly with wind speed. However, below a certain minimum speed, the turbine does not have enough wind to operate, whereas above a certain speed its output levels off or begins to decline. In very high winds the turbine is shut down to prevent damage to it.

Available annual wind power densities (W/m^2) at Jhimpir were recorded at 420 to 510 watts per square meter at 80m height. This places the NBT (II) Wind Farm Site in class 5 at 80 m height and class 3 at 50 m height in the wind resource classification system.

Wind resource classification and height of the site together with the accessibility of the generally flat terrain are advantages offered to the site. Furthermore the Project site is outside the areas of the four categories of land use: environmental (such as national parks), urban, forest, and cropland. The present use as subsistence cropland may not continue if the land is acquisitioned from the owners. However its use as rangeland may not be easily discontinued since keeping livestock is the major source of income of the resident population.

Two factors considered in the study are the possible conflicts between wind power plants and bird habitats and migration routes and constraints on the transmission capacity needed to carry wind power to population centers. The present EIA Study indicates that the NBT (II) Wind Power Project Site is not located anywhere near existing migration routes, yet some such bird species as the crane and Houbara bustard are reported by the locals to stray in. These are game birds and the local population participates in the trophy hunting parties arranged for the guests from the Emirates.

2.6.2 Wind Turbines

The Project site will, for using the winds in class 5 at 80m height, set up wind turbines. The turbines will use the following sub-system to catch the wind →Conversion of wind density to kinetic energy → rotational motion → drive an electric generator or alternator → generate electricity without creating environmental pollutants.

Turbine subsystems include:

- Rotor component which includes the blades that convert the wind's energy into rotational shaft energy;
- Nacelle (enclosure) containing a drive train, usually including a gearbox* and a generator includes the electrical generator, the control electronics, for converting the low speed incoming rotation to high speed rotation suitable for generating electricity;
- Tower, to support the rotor and drive train; and
- Electronic equipment such as controls, electrical cables, ground support equipment, and interconnection equipment.
- *Some turbines do not require a gearbox

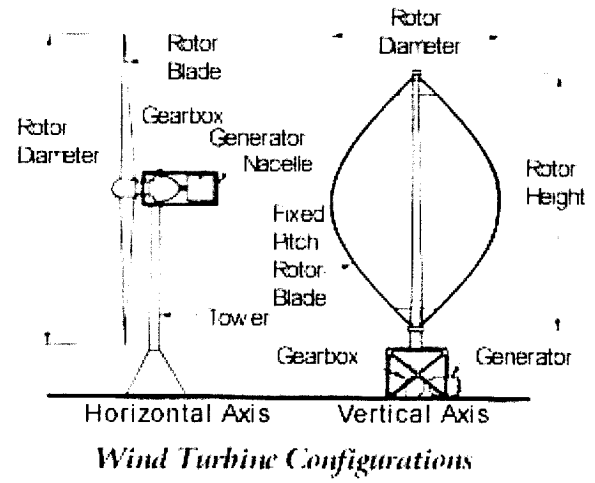
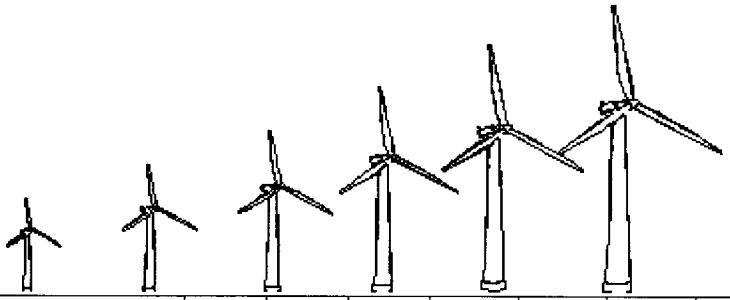


Figure 2.6: Wind Turbine Configurations



	1981	1985	1990	1996	1999	2000	2008
Rotor (meters)	10	17	27	40	50	71	107
Rating (KW)	25	100	225	550	750	1,650	3600
Annual MWh	45	220	550	1,480	2,200	5,600	13000

Figure 2.7: Historical Variation of Size & Capacity of Wind Turbines

Wind turbines can rotate about either the commonly used horizontal axis or a vertical axis. Horizontal axis wind turbines (HAWT) have the main rotor shaft and electrical generator at the top of a tower, and must be pointed into the wind. Small turbines are pointed by a simple wind vane, while large turbines generally use a wind sensor coupled with a servo motor. Most have a gearbox, which turns the slow rotation of the blades into a quicker rotation that is more suitable to drive an electrical generator. The Proponent of the project shall use a three bladed wind turbine manufactured in China.

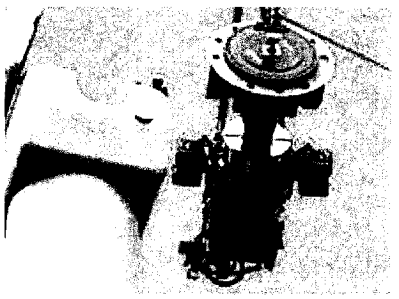


Figure 2.8: Components of a horizontal axis wind turbine (gearbox, rotor shaft and brake assembly) being lifted into position

Since a tower produces turbulence behind it, the turbine is usually positioned upwind of its supporting tower. Turbine blades are made stiff to prevent the blades from being

pushed into the tower by high winds. Additionally, the blades are placed a considerable distance in front of the tower and are sometimes tilted forward into the wind by certain extent.

NBT (II) Project turbines will, as is generally the case with commercial wind farms, use three-blade turbines that are pointed into the wind by computer-controlled motors. They have high tip speeds of over 320 km/hour or 88 m/sec, high efficiency, and low torque ripple, all of which contribute to reliability. The blades are usually colored light gray to blend in with the clouds and range in length from 40 meters or more. The tubular steel towers range will be at 80 m in height. The blades rotate at 10-22 revolutions per minute. At 22 rotations per minute the tip speed exceeds 90 m/sec. A gear box is used for stepping up the speed of the generator, but direct drive of an annular generator is also common, since more energy can be collected by variable-speed turbines which use a solid-state power converter to interface with the transmission system. All turbines are equipped with protective features to avoid damage at high wind speeds, by feathering the blades into the wind which ceases their rotation, supplemented by brakes.

Wind farms being developed currently use large wind turbines for sites in class 5 and above. Specifications for 1.5 and 1.6 MW wind turbines are given in Table 2.3.

Table 2.3 Typical Specifications for 1.5 MW & 1.6 MW Wind Turbines

Power	1.5 MW	1.6 MW
Voltage	690V	690V
Frequency	50 Hz	50 Hz
Number of Blades	3	3
Length of Blades	40 m	40 m
Tip Chord	0.80 m	0.8 m
Root Chord	2.40 m	3.5 m
Surface Gloss	Semi-matt	Semi-matt
Surface Color	Light Grey (matching the background)	Light Grey (matching the background)
Hub Height	80 m or site specific	80 m or site specific
Rotor Speed	10.6 – 19 rpm	6-16 rpm
Rotor Diameter	82 m	82.5 m
Rotor Tilt	5 degrees	6 degrees
Swept Area	3000 m^2	6800 m^2
Cut-in Speed	3 m/s	4 m/s
Cut Out Wind Speed	25 m/s	25 m/s
Maximum 2 s gust	55 m/s	55 m/s

In view of the NBT (II) Wind Power Project Site at Jhimpir being placed in class 4 to 5 at 80m height, and also in consideration of large swept area required for and available at Project site for large turbines, the Project can opt for Wind Turbines with generating capacity of 1.5 MW and over with rotor diameter of 80 to 85 m mounted at the hub height of about 80 m.

Site specific wind speed data has been acquisitioned by WindRose Consultancy and the energy availability as estimated is presented in the Table 2.4:

Table 2.4 (a): Calculated Annual Energy for Wind Farm

WTG Combination	Result Park (MWh/y)	Result 10.0% (MWh)	Gross (No Loss) Free WTGs (MWh/y)	Park Efficiency (%)	Specific Result		Full Load Hours (Hours/year)	Mean Wind Speed @ hub height (m/s)
					Capacity Factor (%)	Mean WTG Result (MWh/y)		
Wind Farm	2,037,074.5	1,833,367.0	2,245,445.1	90.7	41.9	5,55.6	3,670	7.6

Based on Result -10.0%

Table 2.4 (b): Calculated Annual Energy for each of 333 New Wtgs with Total 499.5 MW Rated Power

WTG Type						Power Curve			Annual Energy		Park	
Terrain	Valid	Manufact.	Type Generator	Power Rated (kW)	Rotor Diameter (m)	Hub Height (m)	Creator	Name	Result (MWh)	Result-10.0% (MWh)	Efficiency (%)	MeanWind Speed (m/s)
1A	NO	Chinese	1.5 MW	1,500	89.0	80.0	USER	Chinese	6,282.3	5,654	92.8	7.60
2A	NO	Chinese	1.5 MW	1,500	89.0	80.0	USER	Chinese	6,188.2	5,569	91.5	7.60
3A	NO	Chinese	1.5 MW	1,500	89.0	80.0	USER	Chinese	6,116.8	5,505	90.5	7.59
4A	NO	Chinese	1.5 MW	1,500	89.0	80.0	USER	Chinese	6,066.9	5,460	89.8	7.59
5A	NO	Chinese	1.5 MW	1,500	89.0	80.0	USER	Chinese	6,014.1	5,413	89.1	7.59
6A	NO	Chinese	1.5 MW	1,500	89.0	80.0	USER	Chinese	5,984.7	5,386	88.9	7.58
7A	NO	Chinese	1.5 MW	1,500	89.0	80.0	USER	Chinese	5,968.1	5,371	88.8	7.57
8A	NO	Chinese	1.5 MW	1,500	89.0	80.0	USER	Chinese	5,006.0	5,306	88.8	7.60

2.6.3 Performance of Wind Turbines

Performance of wind turbines depends on the average wind speed and its variability besides topography of the site.

1. Variability of winds

Performance of wind turbines is naturally constrained by large variations in the average wind speed at the site during the winter months when the movement of wind is directionless and at the beginning of the monsoon months that are marked by unusually gusty or turbulent winds which can cause extra wear and tear on wind turbine components and increase in repair and maintenance costs. Variations occurring over hours to days, being essential for wind resource evaluation, have been recorded in the Jhimpir corridor and the data acquired by WindRose Consultancy has been used for siting the Wind Turbines.

2. Wind speed dependence on height

Increase in wind speed with height, known as wind shear depends mainly on atmospheric mixing and roughness of terrain. Atmospheric mixing follows a diurnal cycle often causing wind speeds to increase in the daytime and decrease at night. At a height of approximately 10 meters, the diurnal variation can be very pronounced; as the height increases to approximately 50 meters, it weakens or even disappears. The terrain at NBT (II) Wind Power Project Site slopes towards the Baran nai from 100m above sea level to 70m above sea level and has a hill on NE which is 150m above sea level. The ascending winds in the corridor gain momentum under such conditions and in conjunction with low roughness and flat open land at NBT (II) MW Wind Power Project site will also affect wind shear allowing it to gain speed.

The wind shear has been estimated by WindRose Consultancy (WRC) for the NBT site. Since wind turbines produce much more power in stronger winds, the most favorable position would be one facing the wind squarely. With current wind turbine technology, the optimum tower height for the selected WTGs wind machines would be attained at the height of 80 to 90 meters.

As a general rule of thumb, wind turbines are so installed on towers that the rotor blades are 10 m above any obstacle within 100 m of the tower. This is where the swept area

needs to be considered. The swept area which forms the impacted area of the Jhimpir wind corridor has been taken into consideration while micro-siting the turbines.

2.7 NBT (II) Wind Power Generation Complex

2.7.1 Wind Resource Study

Detailed wind resource and micro-siting study has been conducted by Wind Rose Consultancy, the technical consultants for establishment of NBT Wind Farm. The wind resource study is based on data from the Meteorological Department, and the site specific wind data from a meteorological mast at FFC and Lucky Energy sites.The raw data from the FFC and Lucky Energy sites have been processed by WRC using international standard software like WindPRO & WAsP. The parameters like satellite image, contour map and roughness of the terrain, final wind reports, Annual Energy Production, Park efficiency etc. were generated and used as input for the model. The following are the results of the aerodynamic modeling study:

Table 2.5: Results of aerodynamic modeling study

Wake Model						**N.O.Jensen (RISØ/EMD)**
Calculation Settings						
Air Density Calculation Mode						Individual per WTG
Result for WTG at Hub Altitude						1.149kg/m^3 to 1.159kg/m^3
Air Density Relative to Standard						94.5%
Hub Altitude above sea level (asl)						133.9m to 223.7m
Annual Mean Temperature at Hub Alt.						26.2°C to 26.8°C
Pressure at WTGs						987.8 hPa to 997.9 hPa
Wake Model Parameters						
Wake Decay Constant						0.075 Open Farmland
Wake Calculation Settings						
Angle (°)			**Wind Speed (m/s)**			
Start	**End**	**Step**	**Start**	**End**	**Step**	
0.5	360.0	1.0	0.5	30.5	1.0	
Wind Statistics						NBT1 (Regression MCP using Default Meteo Data Description)
WAsP Version						WAsP 6-9 for Windows RVEA0011 1,0,0,13

The following are the preliminary estimates on availability of energy from each turbine and the number of turbines required to produce 500 MWe (Table 2.6).

Table 2.6: Results of Aerodynamic Modeling

No of Turbines	333
Rated Power	499.5MW
Results	2,037,074.5MWh/y
10% deduction	18, 33,367MWh
Free WTG's Gross (no losses)	2,245,445MWh/y
Park efficiency	91.4%
Capacity Factor	41.9%
Density	1.149 kg/m^3- 1.159kg/m^3
Array losses	9.28%

The output of the turbines, their placement and impact of changes in the direction of winds was based on the following estimates (Table 2.7):

Table 2.7: PARK – Production Analysis

WTG: All New WTGs, Air Density varies with WTG Position 1.149kg/m3 - 1.159kg/m3													
Directional Analysis													
Sector	**ON**	**1NNE**	**2ENE**	**3E**	**4ESE**	**5SSE**	**6S**	**7SSW**	**8WSW**	**9W**	**10WNW**	**11NNW**	**Total**
Roughness Based Energy (MWh)	18,103.2	374,529.4	191,778.0	23,695.5	3,038.8	4,556.8	9,029.9	26,042.2	555,565.6	847,833.6	129,383.4	62,067.3	2,246,225.8
+ Increase due to Hills (MWh)	849.4	-685.5	-202.4	195.9	29.0	-0.4	38.1	1,069.7	-914.1	-2,022.0	899.7	-36.1	-778.7
- Decrease due to Array Losses (MWh)	2,491.8	26,013.7	21,592.7	3,460.2	1,376.4	794.1	1,559.3	3,814.6	43,051.2	55,590.2	42,723.6	5,903.7	208,370.9
Resulting Energy (MWh)	16,460.7	347,830.3	169,982.8	20,431.1	1,691.4	3,762.4	7,508.7	23,897.3	511,600.2	790,221.6	87,559.5	56,128.5	2,037,075.8
Specific Energy (kWh/m2)													983
Specific Energy (kWh/kW)													4,078
Increase due to Hills (%)	4.7	-0.2	-0.1	0.8	1.0	0.0	0.4	4.0	-0.2	-0.2	0.7	-0.1	-0.03
Decrease due to Array Losses (%)	13.1	7.0	11.3	14.5	44.9	17.4	17.2	13.8	7.8	6.6	32.8	9.5	9.28
Utilization (%)	33.7	28.3	34.1	34.6	21.5	32.1	33.0	33.9	30.3	27.8	24.0	31.8	29.0
Operational (Hours/year)	148	1,081	1,019	313	64	110	155	220	1,793	2,612	689	359	8,564
Full Load Equivalent (Hours/year)	33	696	340	41	3	8	15	48	1,024	1,582	175	112	4,078

In the mean time, studies were conducted to establish baseline on the geology, topography and contour mapping, together with air quality, fauna and flora besides the socioeconomic conditions for environmental assessment. The environmental study has identified the constraints to installation of turbines and assessed the impacts in terms of severity and their being minor/major and significant/insignificant. Mitigation measures have been proposed to minimize the few impacts that were identified.

The Proponents have also set up 4 met masts at the project site to collect onsite data since July and August of 2012. The on site wind data will be correlated to existing nearby met masts so that with 6 months of on site wind data, the extrapolated results can be more long term. Garrad Hassan a world leading wind consultant has been engaged to provide this wind report when the on site wind data is sufficient for this wind analysis.

2.7.2 Siting of Wind Farm

Micro-siting of the turbines NBT (II) Wind Power Project has been carried out by aerodynamic modeling. The figure 2.9 shows the placement of the turbines for NBT (II) marked in red color:

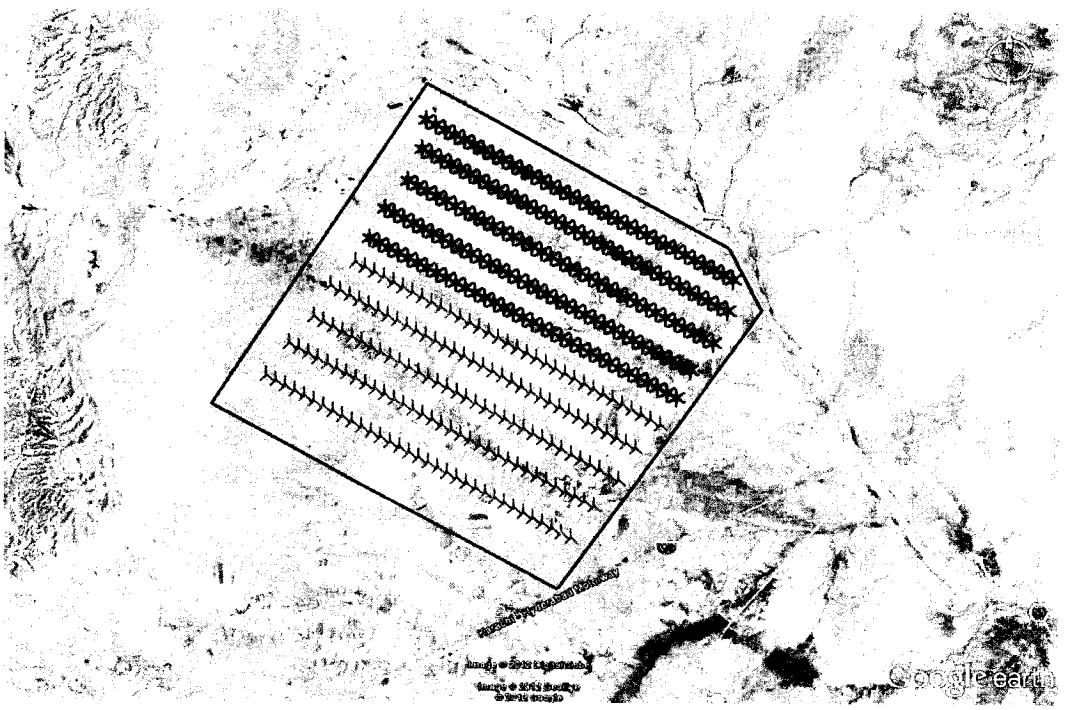


Figure 2.9: Siting / arrangement of turbines

Table 2.8 NBT -PAKISTAN Wind Farm Site Coordinates

S. No.	Longitude	Latitude
1	25°18'22.34"N	68° 4'14.38"E
2	25°20'38.87"N	67°59'8.27"E
3	25°27'19.80"N	68° 0'36.03"E
4	25°26'0.15"N	68° 4'56.96"E
5	25°27'42.83"N	68° 5'57.46"E
6	25°22'32.95"N	68°13'6.80"E

The barren land that can be classified as stony rocky land mass has at least half the area studded with cobbles and stones while the rest is rangeland with patches of alluvial soil on which subsistence agricultural activity is under way. The area is very short of ground water and people rely mostly on the scanty rainfall.

Orography and terrain conditions are normal almost all; there are no sharp facies; the surface is plain but modestly hilly at times. There is a seasonal rain drain in the area which receives surface flow during monsoon season.

10 rows of turbines are placed on the generally flat land that has height between 70m and 100m above sea level while 2 rows of turbines are placed on the small hill on the NE of the site which has height of 150m above sea level, as shown in the above figure.

The grounds and soil conditions are stable for laying the turbine foundations and locating the crane pads for launching the towers. The bearing capacity of the soil may have to be verfied by specific geo-technical study of the area because of the location of the site on the anticline of the Baran River and the Surjan Fault in the vicinity.

The site is linked with the two ports: Karachi and Port Qasim through the Superr Highway M-9. As such transportation of heavy machinery and equipment; the turbines and the cranes can be shifted from the ports through superhighway and the small road that leads to Jhangri and onwards towards the Darawat Dam site.

The site is at least 20 km outside of the Kalri Lake, which is home to migratory birds using the Indus River Flyway. High flying resident birds that are common near the poultry farms near urban clusters are not found at or near the Project land area. The wind farm is thus expected to have the least impact on bird fauna. Aridity and deforestation activities have reduced the biodiversity of the microenvironment of Project area to that of degraded land.

2.8 Logistics

2.8.1 Access Road

Equipment, supplies and personnel will move in and out from the site using the access road to Jhangri and the Super Highway M-9. Heavy vehicles carrying the wind turbines and necessary equipment will operate from Port Qasim and take the link road to National Highway N5 for onward journey to site by the Super Highway (M-9) – Jhangri link road which will be upgraded to take the heavy load of towers (~162 tons), rotor blades (~60 tons), turbines (Nacelle ~82 tons), machinery and equipment.

2.8.2 Vehicles and Traffic

Heavy vehicular traffic will operate mainly for delivery of turbines and for transportation of the batching plant and ancillaries. The latter process will require four flat bed trailers of 40-feet size with a load carrying capacity of 30 – 35 tons. The movement of the turbines and towers takes approximately two months and is expected to be from Port Qasim → National Highway N5 → M-9, the Super Highway → Jhangri Link Road → Project site. Movement of vehicles for transportation of turbines and for other needs during construction typically requires:

- Over 225 heavy haul truck / trailers of 60-feet size, with extended length and multiple axles having a load carrying capacity of 40 -70 tons, in addition to
- About 70 trucks /trailers of 20 – 25 ton capacity.
- A maximum number of 6 vehicles (4 axles and above) per hour, including the buses and coasters for movement of site staff during the construction period.

2.9 Major Construction Activities

Contract for construction will be awarded to an Engineering Firm of repute to undertake the installation of turbines. The turbine supplier will have a supervising engineer on-site during the installation phase and the commissioning engineer during the start-up phase. Installation of the sub-station would be done by sub-contractors to the Engineering Firm. All other electrical work will be done by the contractor.

Work will commence with improvement of the ~06 km - access road connecting the site with Super Highway M-9. The access road will require widening, spreading gravel and compaction to upgrade/ build to a standard that is suitable for the 60-foot flat bed trucks in good weather conditions. Lay-bys will be built at suitable points for ease of crossing. Since the entire project area is flat, road gradient will not be an issue.

The roads within the project area shall be suitably compacted / strengthened to withstand the onset of torrential surface flow and land submergence/inundation.

2.9.1 Siting The Wind Turbines

Design standards for siting the wind turbines include spatial configuration, lighting, density of turbines, tower visibility and tower design.

Siting the wind turbines will, in taking account that each turbine unit and each row of the turbine will slow down the wind behind it as it pulls energy out of the wind and converts it to electric power, space the turbines as far apart as possible in the prevailing wind direction. As a rule of thumb, turbines in wind parks are spaced somewhere between 5 and 9 RD apart in the prevailing wind direction, and between 3 and 5 RD apart in the direction perpendicular to the prevailing winds.

For the proposed NBT (II) Wind Farm, as an example comprising 1.5 MW each row of 30 WTG with ~90 m RD would be spaced 5 RD or 450 m apart in the prevailing wind direction, and 3 RD or 270m apart in the direction perpendicular to the prevailing winds.

2.9.2 Electrical Collection System

Power from the wind turbines being negotiated by NBT Wind Power Pakistan II (Pvt) Ltd Wind Farm will generate about 690 volts in each phase. The power will run through a

step-up transformer, which steps up the voltage to 33 kilovolts (kV). The power will then be fed into underground cables that will provide electrical connection among groups of wind turbines. The underground collection cables will feed the larger feeder lines that will run to the project substation. In locations where two or more sets of underground lines converge, pad-mounted junction panels will be utilized to tie the lines together into one or more sets of larger feeder conductors. At the Project substation, the electrical power from the entire wind power plant will be converted to 220 kV and will be delivered to the interconnection substation at Jamshoro 132kV, 220kV and 500kVA grid at 13 km from wind farm and Nooriabad 132kVA grid at 25km from wind farm site.

2.9.3 Substations

The main function of the substations is to step-up the voltage so that electricity can be reliably interconnected to the designated power grid. The basic elements of the substations are a control house, two main transformers, outdoor breakers, relaying equipment, high-voltage bus work, steel support structures, and overhead lightning suppression conductors. These elements will be installed on concrete foundations. Each substation will consist of a graveled footprint area of approximately two to four acres, a chain link perimeter fence, and an outdoor lighting system. Direct strike lightning protections will be provided by the use of overhead shield wires and lightning masts connected to the switchyard ground grid. Overhead shield wires will be high strength steel wires arranged to provide shield zones of protection.

2.9.4 Operations & Maintenance Center

Facility to house the operations and maintenance (O&M) section will be constructed as an integral part of the Project

2.9.5 Civil Construction

Civil works will include construction of the Sub-station and campsite preparation. The following steps will be taken in site preparation:

- Clearing of vegetation from identified areas
- Filling and compaction
- Construction of auxiliary facilities such as site camp, equipment and supplies storage areas, water tank and water pits, fuel storage areas and waste pits.
- Construction of turbine foundations and crane pad

The turbine foundation shall, where necessary, be built on pile foundations, with appropriate number of piles per location, built on detailed design, using standard piling practices. The construction at site will take into account that rotor assembly (blades and hub) weighing ~22 tons; the nacelle containing the generator component and weighing ~52 tons, may need a concrete base for the tower whose construction may require ~26 tons of reinforcing steel and contain ~190 cubic meters of concrete. The base may be ~15 m in diameter and ~2.4 m thick near the center.

Campsite facilities will include supply of safe drinking water; drainage, sewerage, and septic tanks. Standard Operation Procedures will be followed to provide safe working environment compatible with human hygienic requirements and to maintain conditions necessary for storage of medicines, materials and equipment:

- The construction campsite will cover an area of about 10,000 m^2 and will accommodate 5 to 10 construction trailers and 5 to 10 equipment storage trailers. There will also be vehicle parking and equipment staging areas.
- The water storage tank will be lined with an impervious liner to prevent seepage and loss of water.
- Sewage septic tanks will be lined. These will be periodically emptied into tankers for transporting the sewage to the nearest treatment facility. Gray water (from kitchen and washing areas) pits will not be lined, and water will be allowed to soak into the ground.
- The wastewater from campsite will be discharged as per standard practice into separate sewage lines and from there to → septic tanks → soak pit system. The quality of effluent discharged into soak pit system will be monitored for its BOD, and COD level.
- Camps for the construction crew will be established at a suitable site identified by Project Manager. The camps would accommodate around 500 to 600 personnel. The camp will be complete with living accommodation, mess and kitchen, prayer room, bathrooms and toilets, recreational facilities, fuel storage, water storage, etc. The camp will have its own power generation arrangements in the form of diesel generators or temporary electricity connection to the grid.
- At all locations involving construction activity, appropriate water and sewage treatment systems will be provided and no liquid or solid effluent or waste will be allowed to leave the site without treatment to bring the effluents within the acceptable limits. The parking area and workshop at the campsite will have a slop tank system to minimize the spread of oily drips.
- Under normal operations there will be no gaseous emissions from the campsite, or operating areas. A small capacity, 2 MVA diesel generators, shall be installed for emergency power supply for the essential loads. Only when there is need for the diesel emergency generators would there be gaseous emissions from the sites, but such emissions would be well within limits as described in a subsequent section.
- Storm water runoff from the campsite will be suitably diverted through a storm water drainage system into an existing surface flow system.
- Storm water runoff from the wind farm will be harvested and ponded at a designated site for irrigating the surrounding open area.
- Onsite storage of fuel will be limited to daily requirements.
- The onsite delivery of fuel or lubricant will be at designated site that will have an impervious base, with a dyke around to contain spills in case an accidental spill occurs.
- The excavated earth, obtained during the piling procedure, will be used to construct the embankment for the road. The remaining material required for the road embankments will be from the site. The top layer of the road, morum type material or gravel and clay, will be procured from the site.
- Installation of wind turbines, their accessories and equipment will start after completion of the construction activities. Since all components will be prefabricated there would be need for assembly only. However, some fabrication will also take place at site.

Civil construction at site will involve the following components:

1. Turbine foundation, if standard foundation, then there is no piling required. For ones that will be built on pile foundations, with about 14 piles per location, using reverse rotary drilling method for pile boring, and bentonite clay mixed with water during boring;
2. Sub-station and campsite preparation,
3. 11 km approach road, 15-30 km internal roads; culverts and the bridge, will involve the following three phases:

a) Designing and Pre-Construction,
b) Construction and
c) Post Construction including Operation.

The pre-construction phase has three components:

- Identification of land area and site;
- Topographic survey, and
- Design.

Construction activity as a major component of NBT (II) Wind Power Project is currently at the planning and development Stage. It will be followed by the construction stage when:

- The roads and bridges (if required) construction design will be prepared;
- The NBT 500 MW Wind Power Project will be sited on a net 16 km x 3.5 km land area, the gravely and rocky part of which belongs to Government of Sindh;
- A few trees will be felled, dead wood and shrubs will be removed as part of land clearance.
- Suitability of the site with respect to stability and seismicity will be determined through soil surveys by geo-technical investigations. The allowable bearing capacity of the soil will be adopted as 1.70 tsf, but this value will be verified before the start of construction through geotech study using boreholes for every foundation.
- Topographic survey for the following is currently being undertaken and in the mean time NBT will provide the detailed design for:
  - ✓ Construction of site roads, turn-around areas and crane pads at each wind turbine location;
  - ✓ Construction of the turbine tower foundations and transformer pads;
  - ✓ Installation of the electrical collection system – underground and some overhead lines;
  - ✓ Assembly and erection of the wind turbines;
  - ✓ Construction and installation of the substation.

For construction purposes the general specification/details will be worked out in respect of type of structures, grade of concrete, and all other materials required for the Construction Phase of the Road (subject to final design) of NBT (II) Wind Power Project:

- Structures and materials will conform to relevant standards and follow standard practice of civil works.
- Environmentally sound materials and goods will be selected, with priority being accorded to products meeting national and international standards.
- Traditionally well-tried materials will be chosen for provision of services for construction of roads and the tower foundations.

- Construction site will be adequately isolated to prevent entry of public and general safety measures will be effectively imposed throughout the construction period.
- Temporary inconveniences due to construction works will be minimized through planning and coordination with local population and organizations in the neighbourhood.
- The foundations of structures will be concrete on bearing soil. Bearing capacity, settlement, static and dynamic loading conditions will be determined continuously, while seismic conditions pertaining to placement of the site in zone 2A (Medium Intensity hazards) will be taken into account in the working designs that will be submitted for approval.
- The hydrology, geology and stability of soil will be verified again before laying the foundations.
- Environmental Performance Monitoring will be an essential component of the Project and will be governed through Environmental Management Plan (EMP), which will include Environmental Monitoring Plan.

The post-construction phase at the site will start after completion of the construction phase and will include:

- Provision of safe drinking water, and solid waste disposal system at campsites for the operation area
- Commissioning of the link roads into the road network.

Installation phase will start with the arrival and movement of machinery and equipment to site, and will involve the following activities:

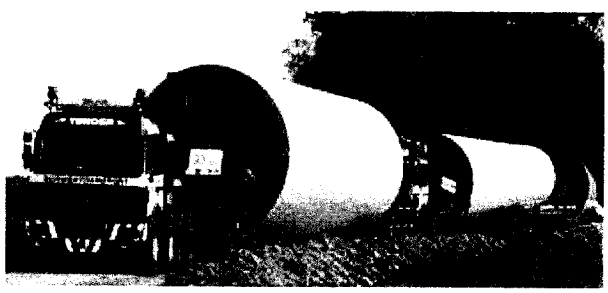


Figure 2.10: Transportation of Tower

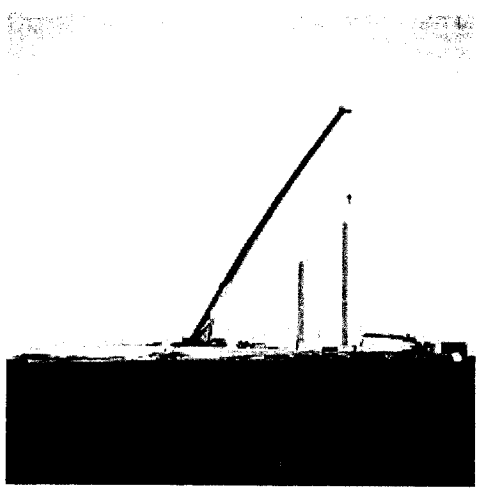


Figure 2.11: Installation of Towers

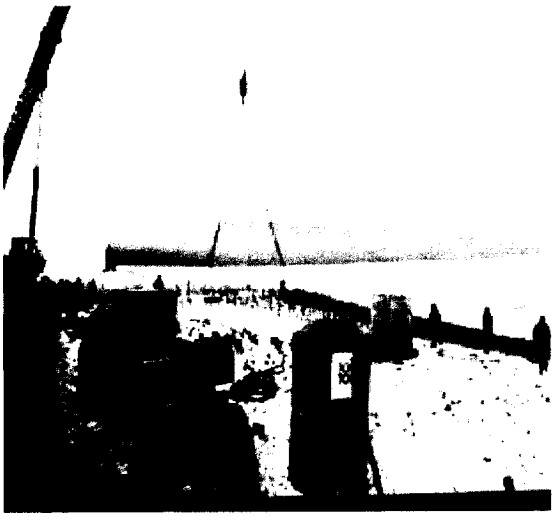


Figure 2.12: Assembly of Rotor Blades

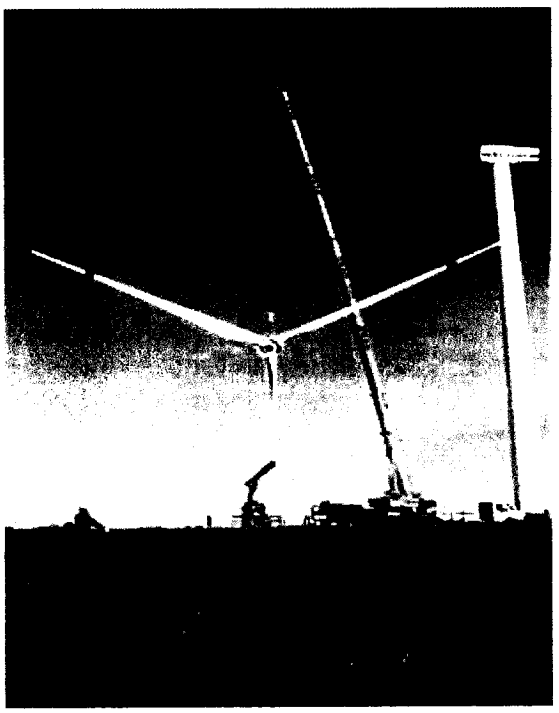


Figure 2.12: Installation of Nacelle and Blades

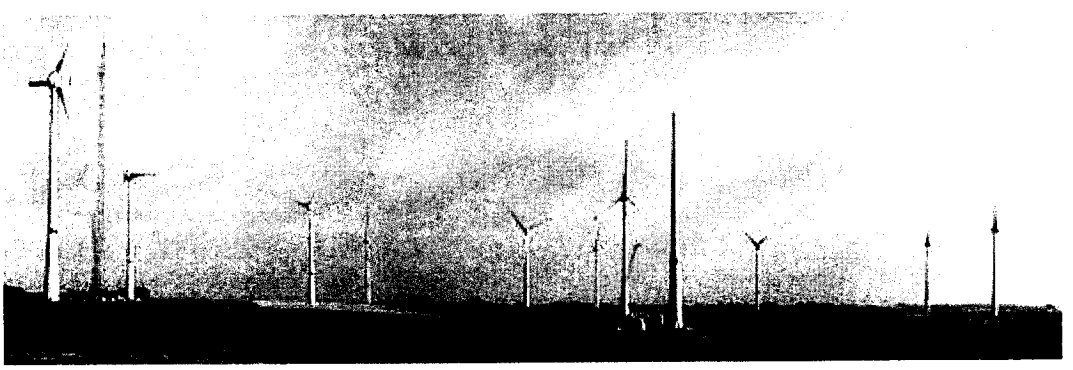


Figure 2.13 showing 11 x 7,5 MW E126 Estinnes Windfarm, Belgium, July 2010, one month before completion, with unique 2 part blades.

2.9.6 Staff Requirement during Construction Phase

It is estimated that direct manpower required during the construction phase will be about 600. About 100 support staff will be present in addition to the above. Expatriate workers are expected to be on site. Unskilled jobs will be offered mainly to the local people predominantly during the construction phase.

2.9.7 Supplies during Construction Phase

All supplies, both for construction and for the camp, will be transported by trucks from Karachi. This will include all fuels and oils, drilling requirements, spare parts for construction machinery and food and supplies for construction camp. Fuels and oils will be unloaded in designated areas.

Aggregate / sand will be procured from the designated crusher area. A cement mixing plant will be set up on site to prepare the cement for the construction work. A catering company will be contracted to supply the requirements to the campsite.

Fuel requirement during construction may be approximately 2 million liters which shall be met by transportation by tanker trucks from Karachi. An onsite storage tank of 20,000 liters on storage wheels will be provided under due safety and security conditions for the daily ongoing activities.

2.9.8 Electricity

The expected maximum requirement of electricity for construction and the campsite is estimated at 1500 KVA. Diesel generators will be used for power generation to operate the construction equipment and for the campsite. If possible, the EPC contractor will procure temporary electricity connection from the grid to the site to decrease the use of diesel generators.

2.9.9 Emissions and Discharges during Construction Phase

- The daily *estimated* fuel requirement will be about 5,500 to 7,500 liters. This quantity of fuel will be responsible for daily emission of approximately 260 kg CO, 14 kg SO_2, 65 kg NOx, and 14 kg Particulate matter, besides 16 tons CO_2. These emissions will be dispersed into the airshed of Baran River area, which is thus far in the category of unpolluted sites. The small quantity of emissions will not raise their level by sub-microgram units and would not degrade the environment.
- Emissions from the generators will be controlled by ensuring that the engines are always properly tuned and maintained, and the generators are so located that emissions are dispersed away from the camp and work areas.
- Noise emission from the vehicles and equipments will exceed 85dB(A) but the same would be reduced to less than 85dB(A) at 7.5 m from the source. Workers will be provided PPE including ear plugs and other safety equipment as safeguard against occupational hazards.
- The liquid effluents generated during the construction phase will include domestic sewage and grey water from camp operation.
- The sewage will be treated in septic tanks and soaking pits.
- The grey water from kitchens and washing areas will be directed to separate soaking pits.

- The storm water will be directed into the rivulet cutting through the slopes of the site into the Baran River.
- The operation phase may generate a small quantity of oil/oily water during the maintenance of pumping stations. This will be treated in oil/water separators.

2.9.10 Waste Management

The solid waste generated by the project will consist of campsite waste, garage waste, metal scrap, and excess construction materials.

- All efforts will be made to minimize waste generated during the construction period. The main types of waste that will be generated are:
  - ✓ Fuels and oils
  - ✓ Garage waste
  - ✓ Sewage
  - ✓ Campsite waste
- The piling operation is not likely to generate any waste as only water based bentonite clay may be used during piling. As bulk concreting will be done using concrete, pump wastage of concrete will be minimal.
- Fuels and oils will, if stored at site, despite security reasons, be stored in containers in areas with impervious floors and surrounded by dyke walls.
- Recyclable materials will be periodically transported out of the site and sold / given to contractors. Non-recyclable material will be collected and disposed of by the contractor at designated landfill sites.
- Most garage waste, such as used spare parts, is recycled in Pakistan. All such waste will be collected and sold / given to approved contractors for disposal off-site.
- As part of the site preparation stage, a drainage and sewerage system will be constructed for the camp. The sewerage system will consist of soak pits for the collection of waste water from the camp kitchen and washing / ablution areas. Sewage from the toilets will go into lined septic tanks. Sewage and solid waste disposal trucks will be used to periodically remove the sludge, sewage and solid waste from the site.
- All combustible domestic waste will be collected and burned in a garbage pit, suitably fenced to prevent from being blown away. Non-combustible and non-biodegradable waste, such as glass, metal and plastic, will be separated and transported for being sold or given to a contractor for suitable disposal.

2.9.11 Conservation of Water

The Wind Farm facility as well as campsite will keep the scarcity of water in the region in view, and adopt recommended methods to reduce the usage of water, and use recycled water as much as possible. The wind farm site slopes towards the Baran River and thus forms the drainage area of this part of Jhimpir Wind Corridor. Detailed design of the Project may consider diversion of the surface flow through the natural drainage system into the field for vegetation of the otherwise barren land.

2.9.12 Health, Safety & Environment

Several cases have been reported to occur where the nacelle that houses the wind turbine caught fire. As it is normally out of the range of standard fire extinguishing equipment, it

is nearly impossible to extinguish such fires. In several cases one or more blades were damaged or torn away. In 2010, a 110 Km/hour storm winds damaged some blades, prompting blade removal and inspection of all 25 wind turbines in Campo Indian Reservation in California, USA. Also several wind turbines collapsed catastrophically.

Accordingly all the policy, procedures, and SOPs specific to HSE will be applicable to the contractors to be engaged for construction work. The contractors will be mandated to follow:

- HSE Policy of NBT Wind Power Pakistan II (Pvt.) Ltd. and the HSE Guidelines of the IFC
- Emergency rescue plan pertaining to safety and accidents including fall, will be established before start of construction activity according to the safety and protection rules of Pakistan.
- Trained persons will be appointed on the posts relating to implementation of emergency and rescue plan.
- Trained technicians and safety equipments will be installed for technical measures during construction and production.

2.9.13 Fire-Protection System

Appropriate fire detection and fire fighting system and equipment shall be designed and provided throughout the wind farm.

2.9.14 Fire Safety and Security

According to the regulations of the authorities in charge of public security and fire fighting and the rescue procedure of emergency treatment, the facilities of an independent rescue brigade at Nooriabad Industrial Area will be availed. A dedicated ambulance shall be stationed at site for emergency needs.

2.9.15 Employment

This project will bring in employment opportunities for the local inhabitants. Approximately 600 people will be working during the construction phase while approximately 40 technical persons on shift basis shall be hired for operations at the wind farm and power plant during operational phase. This number will be in addition to those engaged at site for security and administrative duties.

2.9.16 Operational Activities

In-house as well as outsourced O&M activities will be carried out by trained staff for maintaining the availability of wind power and high performance.

2.9.17 Shift Staff

- Reasonable accommodation shall be maintained at Nooriabad for shift staff.
- Wind farm would need a maximum of 25 persons per shift in addition to the security staff.
- Security issues shall be outsourced and the level will be as per requirement at the site.
- An average of 4 staff vans and SUVs will be kept at the site to meet the transportation and emergency needs.

2.9.18 Supplies

All supplies, both for operations and for the site staff, will be transported by trucks from Nooriabad or Karachi. This will include all fuels and oils, spare parts required for maintenance and food and supplies for the site staff. Fuels and oils will be unloaded in designated areas, which will have above ground storage of adequate capacity to store fuel.

2.9.19 Water

5000 liters per day of potable water will be required. This will be obtained from Nooriabad and stored in a tank of 12,000 liter capacity. The storage tank will be fitted with treatment units to obtain decontaminated water. This treated water will be shared with the local population in the surrounding.

A underground water well will be drilled to provide water for construction such as cement production.

2.9.20 Waste Management

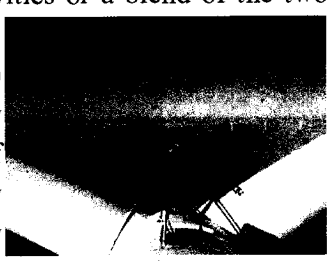
- Fuels and oils will be stored in containers in areas with impervious floors and surrounded by dyke walls.
- Recyclable materials, including garage waste, will be transported out of the site and sold/given to contractors. Non-recyclable material will be collected and disposed of at designated landfill sites.
- The drainage and sewerage system constructed during the construction phase will be used during the operations phase of the project i.e. soak pits for the collection of waste water from kitchen and washing / ablution areas and septic tanks for sewage from the toilets.
- Sewage and solid waste disposal trucks will be used to remove the sludge, sewage and solid waste from the site.
- Storm water drainage will be managed by controlled flow into the tributary to Baran River.

2.9.21 Noise

The desired noise level of 55 dB(A) would be achievable 100 m from a turbine at 90 m hub height generating 100 – 105 dB(A), with the blades operating at 15 t0 20 rpm..

2.9.22 Operation & Maintenance

O&M presents different challenges for utilities, including decisions on conducting activities with existing utility staff or outsourcing these activities or a blend of the two scenarios. Operating costs are dependent upon many factors, but data indicate that operating costs for modern (<5-year old) wind projects run between $7 and $15/MWh of electricity produced. Wind turbines can provide large amounts of electricity, cleanly and reliably, at prices competitive with any other new electricity source, provided they are properly operated and maintained. The wind farm will have a team of expert technicians to support the operations and maintenance of the wind turbines and will have a 600 ton crane at the site after the completion of the wind farm.



2.9.23 Decommissioning Activities

The wind farm site, after having remained in operation for the lifecycle, estimated at 20 to 25 years will not lose its value as a wind power generation system. Its performance would on the other hand enhance the value of the site as a wind farm. This would demand up-gradation rather than scrapping the plant and equipment or abandoning the site. What is anticipated is scrapping the existing steel structure and replacing it with a better system that may have developed in the mean time. Scrapping the site is therefore not envisaged. The towers and turbines may need replacement while the old ones will be sold as scrap to be appropriately disposed of.

However, if the site is to be abandoned much before the designed plant life of 20 to 25 years, decommissioning will be initiated by dismantling of the turbines, supporting towers O&M building / sub-station, and transporting them out of the project area. It is expected that this activity will take approximately 6 months and will require about 300 heavy haul trucks (60-feet size) for the turbine components in addition to 600 truckloads of other materials. The turbine components will be sold as scrap. All scrap will, as per practice in Pakistan, be recycled to be refurbished.

The concrete will be broken up and removed to a landfill site. The stored fuel and oil, together with the containers, will be transported out of the site for sale / disposal at suitable landfill sites. The site road embankments, if any, will be leveled and the material spread evenly over the whole site. Chances are that the embankments may have become regularized and may have come into regular use. The site will, otherwise be restored as far as possible to its original condition. The access roads may be left intact, since local communities may have started to use them. If not, they too will be dismantled and the land returned to its original condition.

However, it is the view of the Proponents that the wind resources will continue to be very good after the design life of the wind turbine. Based on O&M costs at that time, turbines can be upgraded over time and older turbines can be cannibalized for parts to maintain other turbines. New turbines can then be installed on existing foundations which is called re-powering the wind farm. Thus, the wind farm can continue to operate into the future.

Safety plans, Emergency plans as required pursuant to Regulation 3 (6)(A)(a)(11) of the Regulations

Definitions 1.x Equipment Only Energization Process Flow Chart Rev. 1

Purpose

The purpose of the Energization Flow Chart is to provide guidance to safely execute Energization- De-Energization during Installation/ Commissioning activities.

Definitions (1.x Land base/ Near Shore WTG)

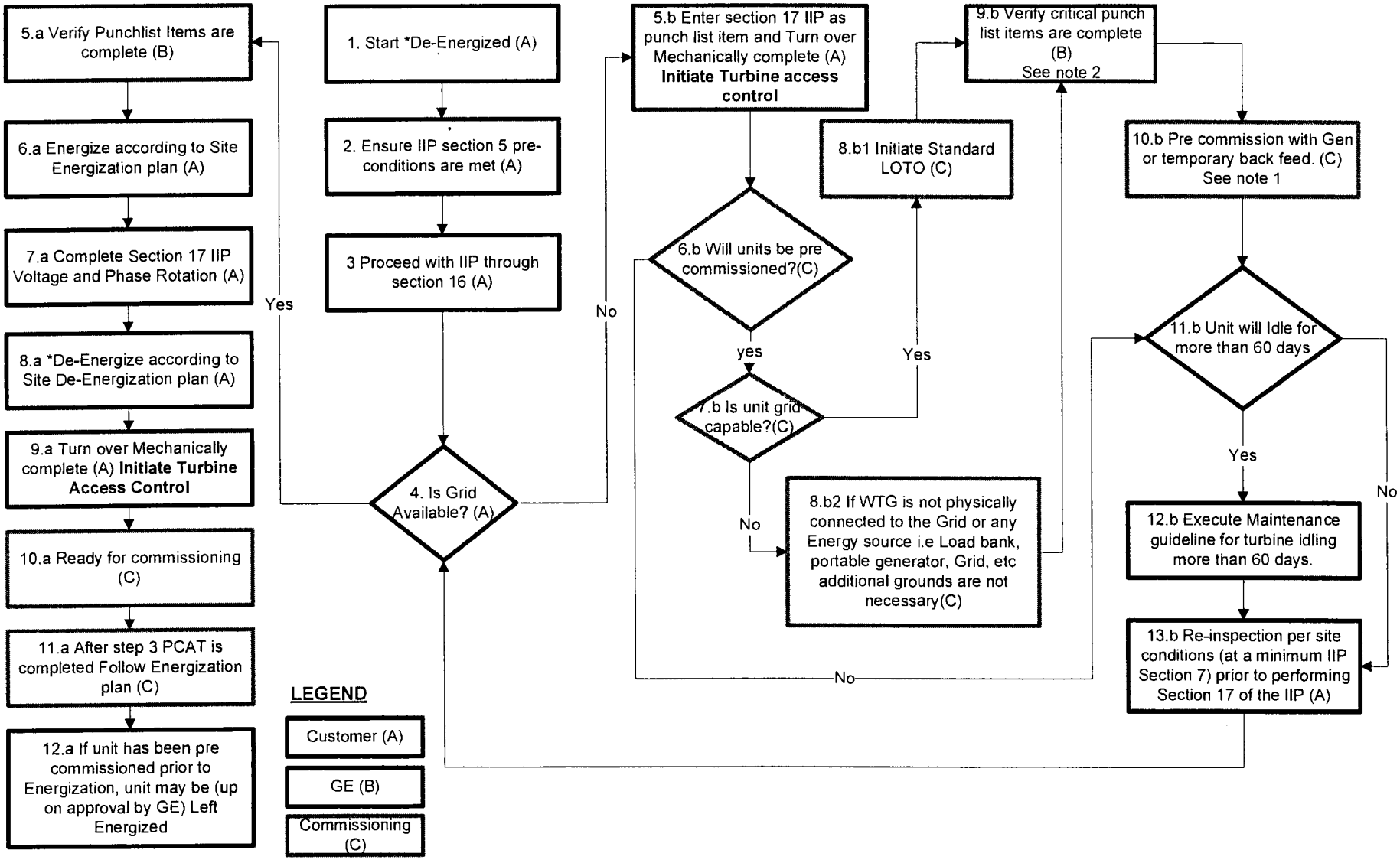
*** Turbine De- Energized State means turbine is completely isolated from the grid by one of the following means:**

- Unit transformer (PMT) oil switch is open, locked out and grounds attached.
- Substation switch gear racked out, locked out and grounds attached.
- Substation Air switch gear verified open, locked out and grounds attached.
- Transformer in PPM Verify Medium Voltage (35kV) switch open, load connector open and ground connectors closed, Lock out and tag out.
- Other GE approved location for Isolation e.g., Junction box – Air switch – Switchgear (requires approval from Regional EHS, GFO, and Project management prior to proceeding).
- WTG(s) must be Isolated before Installation or Commissioning activities on all units connected to a string that is undergoing any electrical testing.

Definitions:

- **GRID:** The distribution system between points of consumption and production of energy.
- **GRID CAPABLE:** Utility power **CAN** be distributed **from or to** the Wind Turbine Generator. **"WTG can be Energized using electricity from the Power Company or temporary power for commissioning activities or to produce electricity".**
- A **PHYSICAL CONNECTION** is defined as any means by which a circuit can be completed or closed.
- A **PHYSICALLY OPEN CONNECTION** is defined as an open circuit whose access is controlled by means of a lock and tag (LOTO)– (i.e a pulled fuse – a parked or non terminated connection).
- **Grounds:** Sufficient size Grounds capable of dissipating ground fault potential. (per section 2 104W2406).
- **Note 1:** 1.5 SERIES WIND TURBINE GENERATOR CONNECT PORTABLE GENERATOR TO TURBINE 1.5Serie_xxHz_WDI_genfreqsys_PortableGeno.
- **Note 2:** Critical Punch List is as defined starting in revision 8 of IIP section 1.3
- Any scenario not addressed by the flow chart requires input from Regional EHS, GFO, and Project Management prior to proceeding.

1.x Equipment Only Energization Process Flow Chart Rev. 1



1.x Equipment only Energization Process Flow Chart Rev. 1

Document Revision Chart

Rev	Section Modified and Revision Description	Date	Author
0	Initail release Energization Process Flow Chart April 10 2008	4/10/2008	David Fullen, Jose Virgen.
1	> Page 1 Added Purpose, Revised definition of De energized state, added new definitions. > Page 2 numbered all steps in the process map. Revised Steps 5.b, 9.b, 10.b, Added Steps 7.b, 8.b1, 8.b2, 9.a and 12.a. Removed old step *Isolate turbine from Grid. Definition of de-energized state was moved to page 2. > Added revision chart on page 3.	12/11/2009	David Fullen, Dan Olson, Jesse Carpenter, Martin Becke, Dwight Ware, Berry Bedaw, David Bryant, Jose Virgen, Joseph C Nelson, Mark Winward, Chad Harrison

Environment, Health and Safety Management Manual

Compiled by: Lin Bo, Jin Gangzhu, Chen Yingjie

Examined by: Wu Xiaoying

Reviewed by: Yang Qingli

Approved by: 

Approval Order

"*Environment, Health and Safety Management Manual*" was compiled under direction of management representative, in accordance with requirements of OHSAS 18001-2007 and Standard GB/T 2004-2000 idt ISO 14001:2004, relying on operational characteristics and managerial experiences of the Company.

"*Environment, Health ad Safety Management Manual*" is a guidance document for the operation of EHS (Environment, Health and Safety) management system. In order to fulfill EHS policy and objectives of the Company, all employees are required to abide by requirements in this Manual, during operation of the EHS management system.

General Manager:

1st June, 2009

Notice on Appointing Yang Qingli as Management Representative of HPE

Ministries, institutions, and oversea offices:

I hereby appoint deputy general manager Yang Qingli as management representative of HPE, who is responsible for the Company's environmental, health and safety management, with the following responsibilities and authorities, in additional to his current duties:

1. Establishment, execution and maintenance of Environment, Health and Safety (EHS) management system for Harbin Power Engineering Company Limited according to requirements of relevant standards;
2. Reporting operating conditions and performance of EHS management system to top management, for further evaluation and as basis for improvement of the EHS system;
3. Offering suggestions on improvement of the EHS management system to top management;
4. External affairs related to EHS management system.

General Manager:

1st June, 2009

I. EHS Policy

To Observe Disciplines and Abide by Laws　Prevention First　To Care for Employees

To Optimize the Environment　To Ensure Safety　Continuous Improvement

II. OHS Objectives

To eliminate conflagration and explosion accidents;

Zero major or fatal accident;

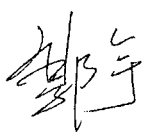
Incidence rate for minor injuries: lower than 5‰

III. Environmental Objectives

No major environmental pollution accident;

All purchased equipment and products meeting environmental protection requirements;

Vehicular emission meeting local environmental protection standards;

General Manager: 

1st June, 2009

As a subsidiary of Harbin Electric Corporation, Harbin Power Engineering Company Limited (HPE for short) is a key supplier and exporter of complete sets of large-scale power equipment, as well as a general contractor of power plant projects. In 2007, it ranked the 102nd in ENR's Top 225 International Contractors. Currently, with 6 oversea offices, HPE is mainly involved in EPC contracting of thermal, hydro and combined cycle power plants and equipment engineering, as well as engineering of power transmission and transformation facilities & utilities related to power plants.

HPE is the first professional power engineering company in China, which has passed the certification of ISO 9001 Quality Management System. Its environmental, health and safety (EHS) management system has been established for implementation based on OHSAS 18001-2007 and standard GB/T 24001-2004 idt ISO 14001-2004. The Company not only has world class project management technology, but has adopted advanced P3 project management software, PMS software and international-standard construction, so that to realize network management of projects.

As an export company of complete sets of large-scale power equipment in China, HPE is capable to undertake several good-sized power projects simultaneously. Moreover, the Company has maintained long-term technical cooperation and communication with world famous foreign companies, and jointly contracted many large power projects.

For more than two decades, HPE has extended its business to many countries, including Pakistan, Philippines, Vietnam, Iran, Bengal, Kampuchea, Sudan, India and Indonesia, etc. Up till now, HPE has undertaken multiple large turn-key projects and supplied a large number of complete sets of power equipment, with a total installed capacity of more than 13,000MW, which have won great international reputations for the Company.

HPE is expecting to establish wide cooperation with various circles both domestically and abroad, so as to provide more top-quality services for clients.

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1. Final Review and Approval

Before issuance, the Environmental, Health and Safety Management Manual (hereinafter referred to as "EHS Manual") should be reviewed by the director of Quality Control Department, examined by management representative and approved by general manager, to guarantee its legibility, accuracy, applicability and reasonableness of structure. Each version shall be attached with an approval order signed and issued by the general manager.

2. Distribution of EHS Manual

EHS Manuals should be sequentially numbered and distributed to all relevant employees in each department of the Company. Recipients are required to sign their names in document receiving/distribution record.

3. Coordination of Changes

Modification, revision and supplementation of EHS Manual, in the charge of director of Quality Control Department, should be reported to management representative for review, and go through the same approval process with EHS Manual compilation.

4. Issue and Change Control

In order to maintain effectiveness of the existing EHS Manuals, modification pages of the EHS Manuals should be clipped between the current Manuals, after the holders sign their names for receipt. Alternatively, table of contents and loose leaves may be used to ensure that the modified EHS Manuals are approved.

5. Reclaim Control

When the holder of an EHS Manual is transferred to another department or leaves the

Company, he/she shall go through hand-over formalities in the original distribution department.

6. Non-Controlled Version

EHS Manuals provided to clients for tendering or distributed for other purposes should be taken as non-controlled versions and marked with "Non-Controlled", if change control is not necessary. But issue numbers for such EHS Manuals are required.

7. Version Number of EHS Manual

Version number of this EHS Manual is HPE-15-A101 and its revision number is 0. If the version is changed, version number and revision number shall be recompiled.

8. English Version of EHS Manual

Quality Control Department should cooperate with relevant employees of the Company to provide an English version of the Chinese EHS Manual.

1. Objective and Application Scope

1.1 Objective

In order to provide clients with better EPC contracting services for power plant construction projects, equipment engineering services, and power engineering services, as well as utilities engineering services related to power plants, to implement systematical standardized control and management on environment, health and safety in the whole service process, HPE will establish and execute an EHS management system and guarantee its maintenance and continuous improvement, in accordance with requirements of OHSAS 18001-2007 and Standard GB/T 24001-2004 idt ISO 14001:2004.

1.2 Application Scope

1.2.1 This Manual includes all requirements in OHSAS 18001—2007 and GB/T 24001—2004 idt ISO 14001:2004.

1.2.2 The Manual is applicable to products, departments and workplaces covered by the EHS management system, including project construction sites, as well as products and services provided internally or externally (including certification authority), to evaluate or confirm the Company's capability to satisfy client demands.

1.2.3 Products Covered by this Manual:

Power projects EPC contracting services, EPC contracting services of power transmission and transformation projects, equipment engineering services, power plant engineering services and utilities engineering services related to power plants;

2. Normative Quoted Documents

Articles in the following documents are quoted in this Manual and become part of it. If a quoted document is dated, the modified (excluding contents in corrigendum) or revised versions will not be applicable to this Manual, but parties involved in agreements concluded under this Manual are encouraged to study applicability of the latest versions of such document. If a quoted document is not dated, its latest version will be applicable to this standard.

OHSAS 18001—2007 Occupational Health and Safety Management Systems-Requirements

GB/T 24001—2004 Environment Management Systems-Requirements with Guidance for Use